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The Greener the Hotel, the Better Operating Efficiency It Has? A Sustainable Tourism Perspective

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Abstract: The aim of this study was mainly to analyze the operating efficiency of Green Hotels during the epidemic, and to explore whether hotels that pay more attention to green energy and saving energy would be more economically efficient. The object of this study is the top 20 Green Hotels voted on the European Union Internet Forum from 2018 to 2022. According to the empirical results, all Green Hotels were affected by COVID-19, and their operating efficiency became worse. This study further used Tobit regression to find out the factors that affect the operating efficiency, and performs regression analysis on the efficiency values of the green energy environment variables. The findings showed that the green energy equipment of EU-certified Green Hotels had a negative effect on the operating efficiency, with a coefficient value of −0.362, indicating that the investment in green energy equipment cannot be achieved in a short period of time. In addition, the education level of managers and hotel green energy licenses have positive effects on the operating efficiency of Green Hotels. In particular, when the Green Hotel licenses are the most important, they have the highest coefficient value of the efficiency of Green Hotels at 0.484. This means that the higher the education level of Green Hotel managers and the higher the level of the Green Hotel license, the higher the operating efficiency. These findings suggest that Green Hotel management should pay attention to its green certificate level and the education knowledge of managers, so as to achieve sustainable energy saving and to improve operating efficiency.

Keywords: COVID-19; green hotel; operating efficiency; sustainable tourism

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1. Introduction

Since the World Health Organization declared the end of the global H1N1 influenza pandemic in 2010, the world is gradually moving towards a post-pandemic period, and all walks of life are thriving as well. The global tourism market has begun to attract attention all over the world due to the successive opening of borders in various countries. World Travel & Tourism Council [1] found that following a decrease of 69.7% in 2020, international visitor spending rose by 3.8% in 2021. Following a loss of almost USD 4.9 trillion in 2020 (−50.4% decline), the contribution of travel and tourism's to GDP increased by USD 1 trillion (+21.7% rise) in 2021. After the tourism industry was hit hard by the epidemic, how to tap into the market has become one of the most important issues in operation and management. Moreover, with rising awareness of energy saving and environmental protection, the hotel industry, which is inseparable from the tourism industry, has inevitably had to develop different strategies to cope with environmental issues. Afsar and Umrani [2] pointed out that as people become more concerned about the environment, businesses in the hospitality industry are being forced to implement environmental management plans. It is clear that the global hotel industry should not only meet consumer expectations, but also should take on more corporate responsibility. Nisar, Haider, Ali, Jamshed, Ryu and

Gill [3] found that hotels have been subjected to critical and different pressures to take responsibility and adopt environmentally friendly practices in their various sectors, such as water and energy consumption and waste production. Today, the global hotel industry is gradually showing the results of its environmentally friendly efforts. Greenview [4] found that virtually all hotels (97.9%) implement at least one initiative that contributes to reducing inequalities. Over 80% of all hotels plan and implement initiatives to reduce energy use. Although the hotel industry has invested in energy saving and environmental protection, it has not brought positive feedback. Robinson, Singh and Das [5] pointed out that eco-labeled hotels experience higher average daily rates but lower occupancy rates. In other words, different types of hotels bring different benefits to energy-saving strategies. Chen [6] investigated a group of hotel chains and found that they had a significantly higher average energy efficiency and branding values than those of a group of independent operators when considering the reduction in holistic carbon emissions. This study used Dynamic Network Data Envelopment Analysis (DNDEA) for empirical analysis. The research objective was to analyze the production and market efficiency of the 20 most popular Green Hotels in the European Union. Further, we measured the overall operating efficiency of Green Hotels using the cross-annual operating profit developed using a two-stage dynamic model. The operating efficiency generated by green production in the first stage was used as an element in the market efficiency analysis of Green Hotels in the second stage. Finally, we conducted a regression analysis based on the operating efficiency results to explore the impact of green equipment investment, manager education level, and the green certification level on the operating efficiency of Green Hotels.

For a long time, there have been diverse studies on the hotel industry and environmental issues. Alyahya, Aliedan, Agag and Abdelmoety [7] pointed out that even though the number of studies that concentrate on the topic of sustainability in the hospitality industry has recently grown, the findings that have so far been published in the literature are fragmented and concentrate on various aspects of sustainability. It can also be seen from the relevant literature that the issues related to environmental protection hotels and economic benefits are diversified. For example, Teng, Horng and Hu [8] explored issues related to hotel environmental management decisions from a stakeholder perspective. Dodds and Holmes [9] took North American hotels as an example to explain the benefits of marketing sustainability. Malcheva [10] analyzed and assessed the potential marketing and economic advantages of the boutique hotels that provide differentiated and trade-recognized tourist products through green-oriented ideas. Salama and Mansour [11] focused on the impact of COVID-19 on Green Hotel management, highlighting the negative and positive aspects of the pandemic on the Green Hotel sectors. However, much of the research related to the economic benefits of Green Hotels up to now has been conducted for a single region or a single country and often leads to different conclusions depending on national conditions and policies. From the relevant literature, it is clear that most of the relevant studies have focused on the issue of Green Hotel revenue. Chong and Verma [12] used data provided by Sabre to determine the effect on bookings of widespread advertising of eco-certified hotels to answer the question of whether going green hurts or helps revenues, and found that booking revenue neither increased nor decreased for the certified hotels. Although extensive research has been carried out on Green Hotel revenue, few empirical investigations exist which focus on Green Hotels' operating efficiency. The current study aims to investigate Green Hotels in the European Union. Network data envelopment analysis is used to study the inputs and outputs of Green Hotels and to analyze the factors that lead to different operating efficiency. This study used Network Data Envelopment Analysis, which can avoid human subjective interference. It can also handle multiple output and input items simultaneously without preset weights, which elicits the objectivity and validity of the results. On the other hand, the Green Hotels' business model with better operating efficiency can serve as a reference for Green Hotels with weak business performance. This model can enable Green Hotel managers to determine the direction for operating efficiency improvement and resource allocation strategies. Therefore, the present study contributes to the advancement of knowledge on this topic.

2. Literature Review

2.1. Green Hotel

As people's concern for the environment becomes more important, environmental issues related to self and others are gradually manifested through emotion, behavior, and cognition. The travel industry has long been regarded as a smoke-free industry, and as the green trend sweeps the world, business strategies of the travel industry are often linked to energy-saving and environmental issues. Abdou, Hassan and El Dief [13] pointed out that the tourism industry embodies diversification strategies to sustain and develop its globally acclaimed sectors. At present, the hotel industry is one of the key players in the development of the travel industry, and it has a certain degree of impact on the environment. Saleh and Brem [14] found that the hotel sector around the world is responsible for approximately one percent of global carbon emissions, a number that could rise before long if the business continues to expand. Therefore, incorporating green energy and environmental protection into the management strategy has become one of the focuses of the hotel industry. Teng, Wu and Liu [15] pointed out that hotels are implementing eco-friendly programs in their rooms, building ecofriendly buildings, and introducing and adopting programs to save water, energy, and reduce waste. This shows that the hotel industry's practical efforts in green energy and environmental protection have led more hotels to adjust their business direction and gradually move towards the development of eco-friendly hotels.

Green Hotels are "a natural tourist lodging developed and managed in environmentally sensitive ways to maintain its business environment and provide guests with green products, green services, and healthy, refreshing, and comfortable accommodation that reflect the features of natural ecologies" [16]. According to the hotel sustainability basics framework developed in [1], sustainable hotels are evaluated on 12 indicators across three dimensions:

2.1.1. Management and Efficiency

(1) Measure and reduce energy use. (2) Measure and reduce water use. (3) Identify and reduce waste. (4) Measure and reduce carbon emissions.

2.1.2. Planet

(5) Linen reuse program. (6) No single-use plastic straws or stirrers. (7) Replace single-use plastic water bottles. (8) Replace single-use plastic mini toiletry bottles. (9) Green cleaning products. (10) Vegetarian options.

2.1.3. People

(11) Community benefit. (12) Reduce inequalities.

There are currently over 200 eco labels in the hospitality industry worldwide, such as Green Globe, Green Key, Earth Check, Green Tourism, Travel Life, Biosphere Tourism, Good Travel Seal and GreenSign. These certificate authorities are recognized by various third-party certification bodies. Nowakowski [17] pointed out that both eco-certificates and eco-labels can be of an international nature, e.g., ISO 14001, GSTC (Global Sustainable Tourism Council) or Green Globe Certificate or can be recognized only locally. These certificates improve hotels' environmental management strategies and social legitimacy and attract environmentally conscious customers [18]. In addition to the above-mentioned benefits of certified eco-hotels, studies have also pointed out the advantages of eco-hotels. Buunk and van der Werf [19] investigated 68 Green Key labeled firms and had them to respond to the question of whether their profits had increased due to adoption of the ecolabel. The results of the study showed that 26% stated that their company had become more profitable after adoption, but only 4% reported that they were able to increase their price. The study referenced in [20] also concluded that being environmentally conscious would involve the underlying business culture, policy, and practices through environmental corporate social responsibility, not merely selling environmentally friendly products. The literature illustrates the advantages elicited by promoting green energy and hotel operations.

2.2. *Operating Efficiency*

The quality of a company's operating conditions is typically directly affected by its profitability. Maintaining a good operating condition continually affects investors' willingness to invest in a company. Whether investors can obtain the maximum benefits also depends on an understanding of the company's operating performance. Shawk [21] highlighted that operating efficiency is the ability of a company to reduce operating costs in attaining its objective through a combination of the right people, processes, and technology. With the right combination of resources, the business operation of any company can enhance the productivity of the services or goods offered. Previous literature shows that, in the early evaluation of hotel operating efficiency, financial ratios were often the data used as the basis of evaluation [22,23]. However, when using this method to evaluate operating efficiency within the hotel industry, it is challenging to fully measure the advantages and disadvantages of actual operating efficiency. This is because the single or partial indicators used are not comprehensive enough. Therefore, considering the input and output items of hotels to obtain a more comprehensive evaluation method became the focus of analysis [24–26]; values affecting hotel operations were examined, including the number of employees, the number of rooms, catering expenses, and other expenses as input items and the total hotel revenue as the output item to calculate the multiple efficiency indicators for 48 local hotels. The results indicate that the overall average efficiency was low. The above literature illustrates that using inputs and outputs to evaluate hotel operating efficiency can yield more comprehensive analytical results. However, there are different opinions on the advantages and disadvantages of hotel operating efficiency regarding the investment of resources in environmental protection and energy conservation. However, Balaji, Jiang and Jha [27] argued that travelers prefer environmentally responsible hotels, and some are willing to pay more for a hotel's environmental practices. It is still worth exploring what Green Hotels can do for operating efficiency. Sharma, Chen and Liu [28] pointed out that there is insufficient research to gauge whether they offer a significant competitive advantage. Kramer [29] found that many travelers say they would prefer to stay at eco-friendly hotels, but lodging facilities do not benefit financially from acquiring certification for green business practices. Yenidogan, Gurcaylilar-Yenidogan, and Tetik [30] pointed out that while some studies support green profitability, others reveal a neutral performance effect of going green in the lodging industry and even highlight some negative effects of environmental stimuli on operating efficiency within a wide spectrum of the sustainability literature. The above related study also echoes the arguments of [12] that green is not a "silver bullet" strategy. It is clear that the relationship between environmental hotels and profitability still needs to be further explored, and, therefore, the relationship between environmental protection and energy saving on operating efficiency becomes the main focus of this study.

3. Research Methodology

According to the previous research [31] on hotel production efficiency, most of the studies only discussed the relative efficiency of hotel input elements (such as labor, capital, and other changes in input, etc.) and converting them into final outputs (such as operating income, etc.) without considering the process of converting inputs into outputs, from the value stage of green energy and environmental protection certification to the final business production activities. The functions of restaurants are different, the input and output processes are different, and the required management skills and resources are also different. For example, in the stage of focusing on environmental protection and green energy, photovoltaic power generation, green plant landscape, room lighting and equipment, etc., affect the operating efficiency of each Green Hotel. In addition to investing in energy saving in the second stage, it also provides hotel landscape and reduces carbon emission economic value. These are important factors that affect the hotel's operating efficiency. Therefore, Green Hotels would have different production efficiencies at different stages of operation, which deserves further measurement and analysis.

3.1. Research Design

This paper uses the Dynamic Network SBM DEA model proposed by [32] for analysis. The study not only analyzed the production efficiency and market efficiency of the European Union Green Hotels, but also analyzed the total operating efficiency generated by the cross-year operating profit created by the two-stage dynamic model.

In this study, the operating efficiency generated by the first stage of green production is used as the basis for the second stage of Green Hotel management strategy and resource allocation. This paper mainly analyzes the performance of European Union Green Hotels in the green production efficiency stage, market efficiency stage, and overall efficiency performance from 2018 to 2022.

3.1.1. Green Hotel Network DEA Model

Green Hotels in the European Union region with green certification typically have only three departments: (1) an environmental protection department; (2) a catering department; (3) a housekeeping department. This study used a database with three departments [33]. Only a small number of Green Hotels have an additional souvenir department. According to the MDEA empirical data requirements, Green Hotel information must be consistent across the departments.

Assume that European Union Green Hotel has three departments, and each department has its own input resources and output. Additionally, there are interlinked environmental protection and green energy operations (or intermediate wealth) among the three departments, as shown in the Figure 1, of which among them, Link1→2 refers to using part of the output of department 1 as part of the input of department 2, Link1→3. The meaning of Link2→3 is the same as above.

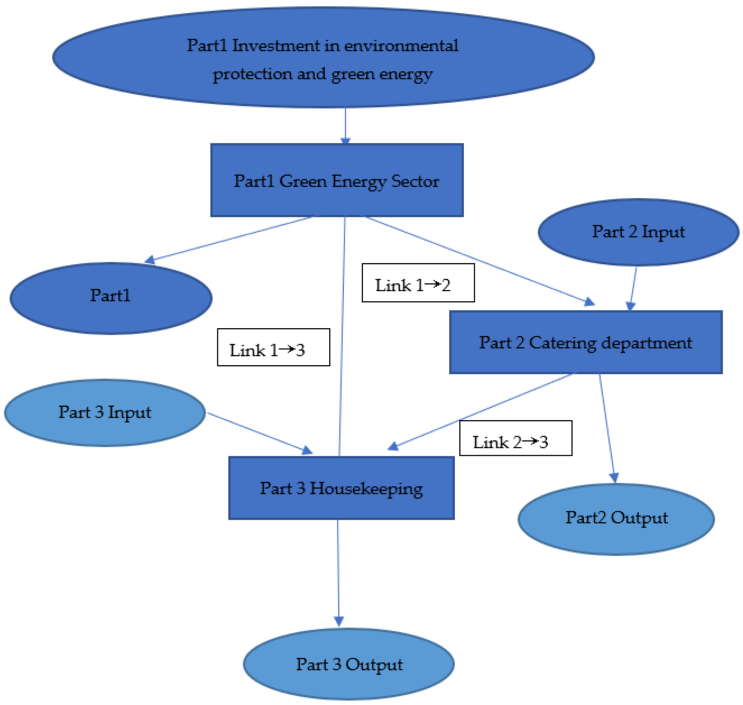

Figure 1. DEA model of the environmental protection hotel network.

It can be seen from Figure 1 that the network DEA model solves the problem that the traditional DEA model cannot handle intermediate goods issues. The network DEA model also transforms the production within the Green Hotel into sub-production activities that are interconnected and influenced by each other.

Let m_k and r_k represent the input and output of each department K, and use $(h,k)i$ to represent departments k to h; L_{hk} represents the set of departments k and h, and the input–output, connection, and existence period are defined as follows:

(1) Inputs and outputs

$$X^t_{tjk} \in R_+ (i = 1, \ldots m_k; j = 1, \ldots, n; k = 1, \ldots, k; t = 1, \ldots, T)$$

represents the input item i of k division of DMU_j in period t

$$y^t_{rjk} \in R_+ (r = 1, \ldots r_k; j = 1, \ldots, n; k = 1, \ldots, k; t = 1, \ldots, T)$$

It represents the output item r of the k division of DMU_j in period t.

(2) Intermediate goods (links)

$$Z^t_{j(hk)t} \in R_+ (j = 1, \ldots, n; l = 1, \ldots, L_{kh}; t = 1, \ldots, T)$$

represents the intermediate wealth linking from k division to h division in DMU_j in period t, where L_{hk} is the number of items linked from k to h.

(3) Carryovers

$$Z^{i,t+1}_{jkl} \in R_+ (j = 1, \ldots, n; l = 1, \ldots, l_k; k = 1, \ldots, k; t = 1, \ldots, T-1)$$

represents the cross-period of $DMU_j k$ division to h division in period t to $t+1$, where l_k is the number of items spanning the k division.

3.1.2. Mathematical Model of This Study

(1) Definition of production possible

$$x^t_k \geq \sum\nolimits_{j=1}^n x^t_{jk} \gimel^t_{jk} (\forall k, \forall t)$$

$$y^t_k \leq \sum\nolimits_{j=1}^n y^t_{jk} \gimel^t_{jk} (\forall k, \forall t)$$

$$z^t_{(hk)l} \geq, =, \leq \sum\nolimits_{j=1}^n z^t_{j(hk)l} \gimel^t_{jk} (\forall l, \forall (hk), \forall t) \text{ (Output of k division in period t)}$$

$$z^{(t,t+1)}_{kl} \geq, =, \leq \sum\nolimits_{j=1}^n z^{(t,t+1)}_{jkl} \gimel^t_{jk} (\forall k_t, \forall k, t = 1, \ldots, T-1) \text{ (Carryovers of } t \text{ periods)}$$

$$z^{(t,t+1)}_{(kl)} \geq, =, \leq \sum\nolimits_{j=1}^n z^{(t,t+1)}_{jkl} \gimel^{t+1}_{jk} (\forall k_t, \forall k, t = 1, \ldots, T-1) \text{ (Carryovers of t + 1 periods)}$$

$$\gimel^t_{jk} \geq 0 (\forall j, \forall k, \forall t) \sum\nolimits_{jk}^n \gimel^t_{jk} = 1 (\forall k, \forall t) \text{ (Represents economies of scale)}$$

(2) Mathematical objective formula of this study The objective formula of the overall efficiency model of input and output in this research is as follows:

$$\theta^*_0 = \min \frac{\sum_{t=1}^{T} \mathrm{w}^t \left\{ \sum_{k=1}^{k} \mathrm{w}^k \left[1 - \frac{1}{\mathrm{m_k + linkin_k + nbad_k}} \left(\sum_{i=1}^{mk} \frac{\mathrm{s}^{t-}_{\mathrm{iok}}}{\mathrm{x}^t_{\mathrm{iok}}} + \sum_{(kh)t=1}^{\mathrm{linkin_k}} \frac{\mathrm{s}^t_{\mathrm{o(kh)tin}}}{\mathrm{z}^t_{\mathrm{o(kh)tin}}} + \sum_{k_l=1}^{\mathrm{nbad_k}} \frac{\mathrm{s}^{(t,(t+1))}_{\mathrm{ok,bad}}}{\mathrm{z}^{(t,t+1)}_{\mathrm{ok,bad}}} \right) \right] \right\}}{\sum_{=1}^{T} \mathrm{w}^t \left\{ \sum_{k=1}^{k} \mathrm{w}^k \left[1 + \frac{1}{\mathrm{r_k + linkout_k + ngood_k}} \left(\sum_{r=1}^{rk} \frac{\mathrm{s}^{t+}_{\mathrm{rok}}}{\mathrm{y}^t_{\mathrm{rok}}} + \sum_{(kh)t=1}^{\mathrm{linkout_k}} \frac{\mathrm{s}^t_{\mathrm{o(kh)tout}}}{\mathrm{z}^t_{\mathrm{o(kh)tout}}} + \sum_{k_l=1}^{\mathrm{ngood_k}} \frac{\mathrm{s}^{(t,(t+1))}_{\mathrm{ok,good}}}{\mathrm{z}^{(t,(t+1))}_{\mathrm{ok,good}}} \right) \right] \right\}}$$

(3) The restrictions are as follows:

$$x_{ok}^{t} = x_{k}^{t}ℷ_{k}^{t} + s_{ko}^{t-}(\forall k, \forall t)$$

$$y_{ok}^{t} = Y_{k}^{t}ℷ_{k}^{t} - s_{ko}^{t+}(\forall k, \forall t)$$

$$eℷ_{k}^{t} = 1(\forall k, \forall t)$$

$$ℷ_{k}^{t} \geq 0, s_{ko}^{t-1} \geq 0, (\forall k, \forall t)$$

$$z_{(hk)free}^{t}ℷ_{h}^{t} = z_{(hk)free}^{t}ℷ_{k}^{t}(\forall (k,h)free, \forall t)$$

$$z_{(hk)free}^{t} = \left(z_{l(kh)free,\ldots,}^{t} z_{n(kh)free}^{t}\right) \in R^{L_{(h)}free \times n}$$

$$z_{o(kh)fix}^{t} = z_{(hk)fix}^{t}ℷ_{h}^{t}(\forall (k,h)fix, \forall t)$$

$$z_{o(kh)fix}^{t} = z_{(hk)fix}^{t}ℷ_{k}^{t}(\forall (k,h)fix, \forall t)$$

$$z_{o(kh)in}^{t} = z_{(hk)in}^{t}ℷ_{k}^{t} + s_{o(kh)in}^{t}((k,h)in = 1, \ldots, linkin_{k})$$

$$z_{o(kh)out}^{t} = z_{(hk)out}^{t}ℷ_{k}^{t} + s_{o(kh)out}^{t}((k,h)out = 1, \ldots, linkout_{k})$$

$$\sum\nolimits_{j=1}^{n} z_{jk_{l}\alpha}^{(t,(t+1))}ℷ_{jk}^{t} = \sum\nolimits_{j=1}^{n} z_{jk_{l}\alpha}^{(t,(t+1))}ℷ_{jk}^{t+1}(\forall k; \forall k_{l}; t = 1, \ldots, T-1)$$

$$z_{ok_{l},good}^{(t,(t+1))} = \sum\nolimits_{j=1}^{n} z_{jk_{l},good}^{(t,(t+1))}ℷ_{jk}^{t} - s_{ok_{l}good}^{(t,(t+1))}k_{l} = 1, \ldots, ngood_{k}; \forall k; \forall t$$

$$z_{ok_{l},bad}^{(t,(t+1))} = \sum\nolimits_{j=1}^{n} z_{jk_{l},bad}^{(t,(t+1))}ℷ_{jk}^{t} - s_{ok_{l}bad}^{(t,(t+1))}k_{l} = 1, \ldots, nbad; \forall k; \forall t$$

$$z_{ok_{l},free}^{(t,(t+1))} = \sum\nolimits_{j=1}^{n} z_{jk_{l},free}^{(t,(t+1))}ℷ_{jk}^{t} - s_{ok_{l}free}^{(t,(t+1))}k_{l} = 1, \ldots, nfree_{k}; \forall k; \forall t$$

$$z_{ok_{l},fix}^{(t,(t+1))} = \sum\nolimits_{j=1}^{n} z_{jk_{l},fix}^{(t,(t+1))}ℷ_{jk}^{t} - s_{ok_{l}fix}^{(t,(t+1))}k_{l} = 1, \ldots, nfix_{k}; \forall k; \forall t$$

$$s_{ok_{l}good}^{(t,(t+1))} \geq 0, s_{ok_{l}bad}^{(t,(t+1))} \geq 0, s_{ok_{l}free}^{(t,(t+1))} : free(\forall k_{l}; \forall t)$$

(4) Period efficiency is as follows:

$$\tau_{0}^{t*} = \frac{\sum_{k=1}^{k} w^{k}\left[1 - \frac{1}{m_{k}+linkin_{k}+nbad_{k}}\left(\sum_{i=1}^{m_{k}} \frac{s_{iok}^{t-}}{x_{iok}^{t}} + \sum_{(kh)t=1}^{linkin_{k}} \frac{s_{o(kh)tin}^{t}}{z_{o(kh)tin}^{t}} + \sum_{k_{l}=1}^{nbad_{k}} \frac{s_{ok,bad}^{(t,(t+1))}}{z_{ok,bad}^{(t,t+1)}}\right)\right]}{\sum_{k=1}^{k} w^{k}\left[1 + \frac{1}{r_{k}+linkout_{k}+ngood_{k}}\left(\sum_{r=1}^{r_{k}} \frac{s_{rok}^{t+}}{y_{rok}^{t}} + \sum_{(kh)t=1}^{linkout_{k}} \frac{s_{o(kh)tout}^{t}}{z_{o(kh)tout}^{t}} + \sum_{k_{l}=1}^{ngood_{k}} \frac{s_{ok,good}^{(t,(t+1))}}{z_{ok,good}^{(t,(t+1))}}\right)\right]}$$

(5) Division efficiency is as follows:

$$\delta_{0k}^{t*} = \frac{\sum_{t=1}^{T} w^{t}\left[1 - \frac{1}{m_{k}+linkin_{k}+nbad_{k}}\left(\sum_{i=1}^{m_{k}} \frac{s_{iok}^{t-}}{x_{iok}^{t}} + \sum_{(kh)t=1}^{linkin_{k}} \frac{s_{o(kh)tin}^{t}}{z_{o(kh)tin}^{t}} + \sum_{k_{l}=1}^{nbad_{k}} \frac{s_{ok,bad}^{(t,(t+1))}}{z_{ok,bad}^{(t,t+1)}}\right)\right]}{\sum_{t=1}^{T} w^{t}\left[1 + \frac{1}{r_{k}+linkout_{k}+ngood_{k}}\left(\sum_{r=1}^{r_{k}} \frac{s_{rok}^{t+}}{y_{rok}^{t}} + \sum_{(kh)t=1}^{linkout_{k}} \frac{s_{o(kh)tout}^{t}}{z_{o(kh)tout}^{t}} + \sum_{k_{l}=1}^{ngood_{k}} \frac{s_{ok,good}^{(t,(t+1))}}{z_{ok,good}^{(t,(t+1))}}\right)\right]}$$

(6) The period efficiency of the division is as follows:

$$\vartheta_{0k}^{t*} = \frac{1 - \frac{1}{m_k + linkin_k + nbad_k}\left(\sum_{i=1}^{m_k} \frac{s_{iok}^{t-}}{x_{iok}^{t}} + \sum_{(kh)t=1}^{linkin_k} \frac{s_{o(kh)tin}^{t}}{z_{o(kh)tin}^{t}} + \sum_{k_l=1}^{nbad_k} \frac{s_{ok,bad}^{(t,(t+1))}}{z_{ok,bad}^{(t,t+1)}}\right)}{1 + \frac{1}{r_k + linkout_k + ngood_k}\left(\sum_{r=1}^{r_k} \frac{s_{rok}^{t+}}{y_{rok}^{t}} + \sum_{(kh)t=1}^{linkout_k} \frac{s_{o(kh)tout}^{t}}{z_{o(kh)tout}^{t}} + \sum_{k_l=1}^{ngood_k} \frac{s_{ok,good}^{(t,(t+1))}}{z_{ok,good}^{(t,(t+1))}}\right)}$$

3.2. Questionnaires/Sample

This study's research object was the 20 most popular Green Hotels voted online in the European Union in 2022. The Decision-Making Unit (DMU) is the decision-making unit in the input–output analysis. The DMU typically represents a Green Hotel for evaluating efficiency and performance in the present study. Each DMU has its own input and output items. These can be analyzed and evaluated through methods such as network data envelopment analysis.

The characteristics of the hotels are different, and the operating conditions are different, resulting in different economic benefits. The information is shown in Table 1:

Table 1. European Union Green Hotels and characteristics.

DMU	Hotel Name	Located in the Country	Hotel Features
D1	Jetpak Eco Lodge	Berlin, Germany	100% of the energy this hostel uses comes from renewable sources.
D2	Hostel Trastevere	Rome, Italy	All electricity is generated by solar panels, so the air conditioning and heating are 100% green
D3	Reykjavik City HI Hostel and Downtown HI Hostel	Reykjavik, Iceland	Facilities for recycling including different disposal containers and information available to guests
D4	City Backpackers Hostel	Stockholm, Sweden	Electricity from renewable sources
D5	Alter Hostel	Lyon, France	Energy is supplied by Enercoop, a French company that works with small producers of renewable energy
D6	Sleep Well Youth Hostel	Brussels, Belgium	Use of sustainable supplies. Electricity is 100% green!
D7	Ecomama	Amsterdam, The Netherlands	They use cradle-to-cradle (C2C) furniture, a production system that minimises waste Use of fair-trade materials
D8	Eco Hostel Republik	Uzice, Serbia	They pay close attention to waste, recycling and reselling
D9	Urban Garden Hostel	Lisbon, Portugal	Use of recycled materials in construction projects
D10	Twentytu Hi-Tech Hostel	Barcelona, Spain	Lighting on each floor has presence and timing detectors to save energy
D11	High Street Hostel	Edinburgh, United Kingdom	There is a waste recycling system that is completely green
D12	The Circus Hostel	Berlin, Germany	The energy is green and energy saving gadgets are used here.
D13	Sleep Green	Spain	The energy is 100% generated from renewable sources
D14	Saas-Fee	Switzerland	Hot water is boiled with solar panels here, and the building is green.
D15	Hostel Strowis Utrecht	Netherlands	The atmosphere is warm and ecological, and social innovations are imbibed.
D16	Green Solution House	Denmark	Have built a carbon-negative extension entirely from wood.
D17	Parcel Tiny House	France	Each house is built with wood from responsibly managed forests in France and is equipped with solar panels

Table 1. *Cont.*

DMU	Hotel Name	Located in the Country	Hotel Features
D18	Apipura Hotel Rinner	South Tyrol, Italy	Electricity comes from a new district heating station that generates power from waste wood products
D19	Explorer Hotels	Germany and Austria	Each property is carbon neutral, uses ecologically safe cleaning products
D20	Dene Cottage	Orkney Islands	Solar panels and a small wind turbine provide the electricity

This study adopts the dynamic network data envelopment analysis model. The input items are tree planting area, environmental protection equipment investment and solar photovoltaic input cost. Take energy saving and carbon reduction benefits as the output item of the first stage. The second-stage input items include the first-stage output (intermediate wealth), the number of employees, the number of guest rooms, and operating expenses. The output item of the second stage is EPS, and the net profit is used as the multi-year carryover to measure the efficiency change in each period. Details are shown in Table 2.

Table 2. Definition of input and output variables.

	Variable	Variable Definition Description	Unit
Environmental protection and green energy input item	Tree Planting and Green Area	Planting area of trees and flowers	Ping
	Investment in green energy and environmental protection equipment	Environmental protection material input and lighting cost	EUR million
	Solar photovoltaic input cost	Solar power equipment cost	EUR million
Intermediate output	Energy saving	Save electricity and water costs every year	EUR million
	Reduce the amount of plastic waste	Reduce waste by using environmentally friendly materials	Kilogram (kg)
	Reduce carbon emissions	Plants and solar photovoltaics lead to carbon reduction	Kilogram (kg)
The second stage input item	Number of employees	Number of employees	People
	Operating expenses	Including water and electricity charges	EUR million
	Number of rooms	Number of rooms	Room
Interdepartmental Link	Operating income	Net revenue after deducting sales returns and discounts	EUR million
Final output	EPS	Net profit after tax ÷ number of common shares outstanding	EUR
Inter-period carryover	Profit	presented in the financial statements net profit after tax	EUR million

The above Table 3 shows that in 2022, the Tree Planting and Green Area of the Green Hotels in the European Union invested the most in DMU6, with 16,587 Ping, while the minimum was DMU11, with 16,587 Ping. Regarding the environmental protection equipment variable, the maximum investment was DMU3, with EUR 2.12 million. The minimum was DMU9, with only EUR 0.52 million. Regarding the solar photovoltaic input cost investment variable, the maximum was DMU17, which is EUR 1.62 million, and the minimum was DMU15, which is EUR 0.28 million. Among the profit output variables of Green Hotels, the highest was DMU9, with EUR 10.36 million. The minimum was DMU16, with EUR 4.68 million. According to the statistical data presented in this study, investing more in green energy equipment elements may not necessarily produce a higher profit for a Green Hotel.

Table 3. Narrative Statistics Table of the Input–Output Variables for Green Hotels in the European Union in 2022.

Variable		Average	Maximum Value	Minimum Value	Standard Deviation
Environmental protection and green energy input item	Tree Planting and Green Area	30,126 Ping	51,668 Ping	16,587 Ping	865
	Environmental protection equipment	EUR 1.26 million	EUR 2.12 million	EUR 0.52 million	0.046
	Solar photovoltaic input cost	EUR 0.86 million	EUR 1.62 million	EUR 0.28 million	0.018
Intermediate output	Energy saving	EUR 0.68 million	EUR 0.97 million	EUR 0.38 million	0.011
	Reduce the amount of plastic waste	12,366 kg	18,650 kg	8856 kg	869
	Reduce carbon emissions	28,669 kg	48,552 kg	12,338 kg	1026
The second stage input item	Number of employees	98 people	185 people	36 people	5.68
	Operating expenses	EUR 4.368 million	EUR 6.885 million	EUR 2.581 million	0.054
	Number of rooms	62	86	42	3.82
Interdepartmental Link	Operating income	EUR 12.82 million	EUR 18.61 million	EUR 8.98 million	0.468
Final output	EPS	EUR 0.67	EUR 0.96	EUR 0.35	0.015
Inter-period carry over	Profit	EUR 7.82 million	EUR 10.36 million	EUR 4.68 million	2.16

4. Empirical Findings and Discussion

4.1. Dynamic Network DEA Empirical Results

This study mainly uses DEA-SOLVER Professional 16.0 application software, sets the production process as variable returns to scale, and uses the Dynamic Network DEA model to explore the operating performance of Green Hotels in the European Union and help relatively inefficient departments find improvement strategies. Additionally, the empirical results of the overall efficiency and ranking, departmental efficiency and ranking of the 20 most popular Green Hotels in the European Union from 2018 to 2022.

The overall ranking of the efficiency of Green Hotels in the European Union from 2018 to 2022 is shown in Table 4; the overall efficiency average is 0.833, the maximum is 1, the minimum is 0.712, and the standard deviation is 0.20. The top 3 rankings are: D3, D14, and D11. According to the efficiency of each year, the maximum average is 0.916 in 2020, and the minimum average is 0.753 in 2018. The data show that when the Green Hotel first began operations in 2018, the operating efficiency could not reach the target. The Green Hotel achieved its the best operating efficiency in the third year of operation. However, after the impact of the COVID-19 epidemic in 2020, operating efficiency declined in 2021 and 2022.

Table 4. Overall Efficiency of Green Hotels in the European Union 2018–2022.

DMU	2018	2019	2020	2021	2022	Efficiency Value	Ranking
D1	0.571	0.632	0.903	0.680	0.911	0.739	18
D2	0.600	0.623	0.963	0.957	1.000	0.829	10
D3	1.000	1.000	1.000	1.000	1.000	1	1
D4	0.566	0.566	1.000	0.766	0.917	0.763	16
D5	0.531	0.651	0.815	1.000	1.000	0.799	13
D6	0.852	1.000	0.852	0.781	0.806	0.858	8
D7	0.877	0.867	1.000	0.846	0.868	0.891	5
D8	0.698	0.713	0.971	0.765	0.866	0.802	12

Table 4. *Cont.*

DMU	2018	2019	2020	2021	2022	Efficiency Value	Ranking
D9	0.728	0.918	0.855	0.793	0.809	0.821	11
D10	0.656	0.772	0.720	0.675	0.861	0.737	19
D11	1.000	1.000	1.000	0.844	0.945	0.958	3
D12	0.529	0.539	0.982	0.886	0.887	0.765	15
D13	0.842	0.930	0.905	0.687	0.788	0.830	9
D14	1.000	1.000	1.000	0.857	0.960	0.963	2
D15	0.956	0.962	0.994	0.805	0.843	0.912	4
D16	0.851	1.000	0.851	0.627	0.660	0.798	14
D17	0.936	0.952	0.983	0.662	0.762	0.859	7
D18	0.514	0.651	0.896	0.750	0.751	0.712	20
D19	0.705	0.812	0.941	0.952	0.983	0.878	6
D20	0.647	0.861	0.683	0.736	0.852	0.756	17
Average value	0.753	0.822	0.916	0.803	0.873	0.833	NA
Maximum value	1.000	1.000	1.000	1.000	1.000	1.000	NA
Minimum value	0.514	0.539	0.683	0.627	0.660	0.712	NA
Standard deviation	0.12	0.26	0.08	0.18	0.31	0.20	NA

Among the annual operating efficiency values, the average efficiency in 2018 was 0.753, the maximum value was 1 for D3 and D14, the minimum value was 0.514 for D18, and the standard was is 0.12. The average efficiency in 2019 was 0.822, the maximum efficiency value of D3, D6, D11, D14 and D16 was 1, the minimum value was D12, its efficiency value was 0.539, and the standard deviation is 0.26. The average efficiency was 2020 is 0.916, the maximum value was D3, D4, D7, D11, D14, their efficiency value was 1, the minimum value was D20, its efficiency value was 0.683, and the standard deviation was 0.08. The average efficiency in 2021 was 0.803, the maximum values were D3 and D5, their efficiency value was 1, the minimum value was D16, its efficiency was 0.627, and the standard deviation was 0.18. The average efficiency in 2022 was 0.873, the maximum were D2, D3, D5, their efficiency values were 1, the minimum was 0.660 for D16, and the standard deviation was 0.31.

According to the analysis of individual DMUs, the input–output efficiency D3 is maintained at 1 and the performance is relatively good from 2018 to 2022. The operating efficiency values of D11 and D14 also remained above 0.8. All belong to the advantage Green Hotel. However, the operating efficiency of D10 and D18 is relatively low, and the management problems of these two Green Hotels need to be reviewed and improved.

4.2. Green Production Efficiency Stage and Market Efficiency Stage Discussion

This part discusses the sectoral efficiency of Green Hotels in the European Union from 2018 to 2022. The first stage is the green efficiency stage. The input cost of solar power, the number of trees planted, and the equipment cost of environmentally friendly building materials are the input variables, and the energy saving and carbon reduction benefits are the output. We took the operating profit as the cross-divisional link with the market efficiency stage as well. The average performance and ranking of the green production efficiency stage are shown in Table 5. The European Union Green Hotel input costs and output technologies are used to maintain the competitiveness of the hotel. Therefore, the performance of both input and output shows high scores. The average green production efficiency is 0.862, the maximum green production efficiency is 1, which are D2, D3, D11, and D14, respectively, and the minimum green production efficiency is D20, which is 0.647.

Table 5. Comparison of Green Production Efficiency and Market Efficiency.

DMU	Green Production Efficiency Average	Average Market Efficiency	Overall Efficiency Average
D1	0.871	0.932	0.903
D2	1.000	0.623	0.963
D3	1.000	1.000	1.000
D4	0.987	1.000	1.000
D5	0.931	0.851	0.815
D6	0.852	1.000	0.852
D7	0.977	1.000	1.000
D8	0.986	0.913	0.971
D9	0.728	0.918	0.855
D10	0.656	0.772	0.720
D11	1.000	1.000	1.000
D12	0.929	0.939	0.982
D13	0.842	0.930	0.905
D14	1.000	1.000	1.000
D15	0.956	0.962	0.994
D16	0.851	1.000	0.851
D17	0.936	0.952	0.983
D18	0.814	0.851	0.896
D19	0.905	0.812	0.941
D20	0.647	0.861	0.683
Average value	0.862	0.902	0.916
Maximum value	1.000	1.000	1.000
Minimum value	0.647	0.623	0.683
Standard deviation	0.22	0.15	0.08

In the second stage of the market efficiency stage of this research model, the output item of the first stage is the energy saving and carbon reduction benefit as a cross-departmental link to the market efficiency stage. The output item of this stage is earnings per share, and then the net profit is used as the multi-year carryover; the average value of the overall market efficiency in the market efficiency stage from 2018 to 2022 was 0.902, the maximum value was 1, and the minimum value was 0.623. Among them, the market efficiency of D3, D4, D6, D7, and D14 is the best, with an efficiency score of 1 from 2018 to 2022.

4.3. Tobit Regression Analysis

After estimating the efficiency value with DEA, further use the regression method to find out the factors that affect the efficiency, and then regress the efficiency value on the operating environment variable, and then judge whether the environmental variable has a positive or negative effect on the manufacturer's efficiency value based on the sign and significance of the regression coefficient have a significant impact on it. Because the explained variable (that is, the efficiency value) is limited to not be greater than 1, the general least squares (Ordinary Least Squares) evaluation method is not applicable, and the Tobit regression method must be used. This study uses SHAZAM for analysis.

This study uses hotel green energy equipment capital, manager education level, hotel green license (gold, silver, copper level, dummy variables) as explanatory variables, and the value of manufacturer efficiency as explained variables. Since the efficiency value of DEA is greater than 0 and less than or equal to 1, Tobit regression can only limit yi on one side, and the reciprocal of the efficiency value can be converted into a natural logarithm to convert the lower limit of yi to 0; that is, the smaller the value of yi, the better the efficiency Therefore, the coefficient of any variable that has a positive impact on the efficiency value should be negative. The impact of environmental variables on the efficiency value was investigated by Tobit regression, and the results are shown in Table 6.

Table 6. Tobit regression results (numbers in brackets are t values).

Variable	Constant	Green Energy Equipment	Manager Education	Green License
Coefficient value	0.347 (1.708 *)	−0.362 (−1.812 *)	0.379 (1.681 *)	0.484 (2.460 **)

* express $p < 0.05$, ** express $p < 0.01$.

Table 6 shows that the green energy equipment of Green Hotels in the European Union has a negative effect on the operating efficiency. It not only indicated that the investment of green energy equipment cannot bring positive operating efficiency to Green Hotels in a short period of time, but also indicated that the cost of green energy equipment is higher than that of general equipment. However, both the education level of managers and hotel green energy licenses have positive effects on the operating efficiency of Green Hotels; in particular, the t-value of hotel green licenses is the most significant, and the coefficient value for Green Hotels is as high as 0.484. This means that the higher the education level of Green Hotel managers and the higher the level of the Green Hotel license, the higher the operating efficiency.

5. Conclusions and Implications

How to balance the protection of the earth's environment with the efficiency of Green Hotel operation is a very important issue. The empirical results of this study show that Green Hotels will have differences in green energy efficiency, market efficiency, and total efficiency with different types of energy conservation and environmental protection inputs and outputs. According to the operating efficiency of 20 European Union Green Hotels from 2018 to 2022, it was observed that the COVID-19 epidemic occurred in 2020, which had an obvious negative effect on the operating efficiency of each Green Hotel. It can be seen that the COVID-19 epidemic has seriously affected the operating efficiency of Green Hotels.

All of this is to say that the future business strategy of Green Hotels must be adjusted. Specifically, it has been suggested that Green Hotels can grasp the demand for health care in the post-epidemic era and can create new values through humanized experiences in line with the global trend of "Wellness Travel". For example, Green Hotels may recommend the use of local and seasonal ingredients in the food and beverage section in order to reduce the carbon footprint by reducing transportation consumption and air pollution. In addition, sourcing local ingredients reduces the consumption of ingredients and transportation costs. This helps companies reduce the cost of raw materials for their products. The green purchasing concept not only helps to enhance the corporate social responsibility image of Green Hotels, but also improves the operating efficiency by focusing on the niche market of health tourism and establishing a unique market niche.

According to the analysis of this study, the more investment in green energy equipment, the worse the operating efficiency of Green Hotels. The reason may be that the investment in green energy equipment increases the cost of Green Hotels, which leads to their inability to have a positive effect on short-term operating efficiency. In other words, the energy-saving and environment-related facilities of Green Hotels do not easily translate into revenue in a short period of time. In terms of customer, we suggested that Green Hotels could clearly explain green prices so that consumers could understand that they could pay reduced prices through fewer toiletries, fewer linen changes, etc., thus reducing operating costs. On the other hand, through price increases, consumers could choose to use green buildings, organic ingredients, or environmentally friendly products in Green Hotels to raise their fees. In terms of management, the construction of vertical farms is also one of the strategies that can be adopted for Green Hotels. Building vertical farms in Green Hotels may help meet hotel food demands in an environmentally responsible and sustainable way by reducing distribution chains in order to offer lower emissions, and by providing higher-nutrient produce. Building vertical farms also enhances the building construction resources within the space of Green Hotels, and creates a base for the production of ingredients for Green Hotels through the recycled use of water resources and energy systems, so as to satisfy the dual redevelopment of food production and visitor accommodation. In the long run, the savings in water and food transportation costs per unit will help to improve the efficiency of Green Hotel operations.

Both the education level of Green Hotel managers and the green license level of Green Hotels have positive effects on their operating efficiency; the Green Hotel license level in particular is more significant. This indicates that customers pay more attention to the license level of Green Hotels. It is clear that leaders could create an environment for sustainable development in the workplace to make it easier for managers to set specific environmental goals and maintain meaningful policies. Furthermore, providing educational opportunities could improve managers' understanding of the contributions they can make to an environmentally workplace. In other words, creating a motivating environment for managers to know more about the workplace is crucial for Green Hotel leaders. By creating such an environment, the managers not only have a more comprehensive understanding of energy saving policies and environmental practices, but are also familiar with the knowledge required for the Green Hotel certification process. Therefore, in the future, Green Hotels should pay attention to the application of their green certificate level and operate efficiently and sustainably.

The findings of this study indicate that it is not sufficient to measure their actual operating efficiency if Green Hotels only use financial ratios as the data basis of evaluation. Considering input–output-related factors through the DEA, a more comprehensive analysis of the operating efficiency of Green Hotels in the European Union can be obtained. This finding echoes the focus of current research on hotel operating efficiency.

Regarding future research directions, this study used Green Hotels in the European Union as research objects. With the global rise of green issues and environmental awareness, hotels worldwide have invested in Green Hotel certification and related software and hardware construction. Green Hotels in different regions can handle multiple output and input items through the network data development analysis adopted in this study. These can be used to further compare the operating efficiency of Green Hotels in different regions, such as whether the education level of Green Hotel managers varies due to cultural differences in Europe and Asia, which needs to be further explored.

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References

1. World Travel & Tourism Council. Economic Impact Reports. 2022. Available online: https://wttc.org/research/economic-impact (accessed on 30 May 2023).
2. Afsar, B.; Umrani, W.A. Corporate social responsibility and pro-environmental behavior at workplace: The role of moral reflectiveness, co-worker advocacy, and environmental commitment. *Corp. Soc. Responsib. Environ. Manag.* **2022**, *27*, 109–125. [CrossRef]
3. Nisar, Q.A.; Haider, S.; Ali, F.; Jamshed, S.; Ryu, K.; Gill, S.S. Green Human Resource Management Practices and Environmental Performance in Malaysian Green Hotels: The Role of Green Intellectual Capital and pro-Environmental Behavior. *J. Clean. Prod.* **2021**, *311*, 127504. [CrossRef]
4. Greenview. Green Lodging Trends Report. 2022. Available online: https://greenview.sg/wp-content/uploads/2022/12/Green_Lodging_Trends_Report_2022.pdf (accessed on 30 May 2023).
5. Robinson, S.J.; Singh, A.J.; Das, P. Financial Impact of LEED and Energy Star Certifications on Hotel Revenues. *J. Hosp. Financ. Manag.* **2016**, *24*, 110–126. [CrossRef]
6. Chen, L.F. Hotel chain affiliation as an environmental performance strategy for luxury hotels. *Int. J. Hosp. Manag.* **2019**, *77*, 1–6. [CrossRef]
7. Alyahya, M.; Aliedan, M.; Agag, G.; Abdelmoety, Z.H. The antecedents of hotels' green creativity: The role of green HRM, environmentally specific servant leadership, and psychological green climate. *Sustainability* **2023**, *15*, 2629. [CrossRef]
8. Teng, C.C.; Horng, J.S.; Hu, I.C. Hotel Environmental Management Decisions: The Stakeholder Perspective. *Int. J. Hosp. Tour. Adm.* **2015**, *16*, 78–98. [CrossRef]
9. Dodds, R.; Holmes, M. Is there a Benefit from being Green. Assessing Benefits from Marketing Sustainability by North American Hotels. *J. Hotel. Bus. Manag.* **2016**, *5*, 145. [CrossRef]
10. Malcheva, M. Green boutique hotels-marketing and economic benefits. *Известия На Съюза На Учените-Варна. Серия Икономически Науки* **2019**, *8*, 179–187. [CrossRef]
11. Salama, W.M.E.; Mansour, H. The Impact of COVID-19 Pandemic on Green Hotel Management. *Afr. J. Hosp. Tour. Leis.* **2022**, *11*, 440–456.
12. Chong, H.; Verma, R. *Hotel Sustainability: Financial Analysis Shines a Cautious Green Light*; Cornell University: Ithaca, NY, USA, 2013.
13. Abdou, A.H.; Hassan, T.H.; El Dief, M.M. A Description of Green Hotel Practices and Their Role in Achieving Sustainable Development. *Sustainability* **2020**, *12*, 9624. [CrossRef]
14. Saleh, R.; Brem, A. Creativity for sustainability: An integrative literature review. *J. Clean. Prod.* **2023**, *388*, 135848. [CrossRef]
15. Teng, Y.M.; Wu, K.S.; Liu, H.H. Integrating altruism and the theory of planned behavior to predict patronage intention of a green hotel. *J. Hosp. Tour. Res.* **2015**, *39*, 299–315. [CrossRef]
16. Yadegaridehkordi, E.; Nilashi, M.; Nizam Bin Md Nasir, M.H.; Momtazi, S.; Samad, S.; Supriyanto, E.; Ghabban, F. Customers segmentation in eco-friendly hotels using multi-criteria and machine learning techniques. *Technol. Soc.* **2021**, *65*, 101528. [CrossRef]
17. Nowakowski, M. *"Labels and Certificates for Green Hotels" Mariusz Cembruch-Nowakowski Pedagogical*; Cracow University of Techology: Kraków, Poland, 2020; Volume 22, pp. 308–323.
18. Borella, I.L.; de Carvalho Borella, M.R. Environmental impact and sustainable development: An analysis in the context of standards ISO 9001, ISO 14001, and OHSAS 18001. *Environ. Qual. Manag.* **2016**, *25*, 67–83. [CrossRef]
19. Buunk, E.; van der Werf, E. Adopters versus Non-Adopters of the Green Key Ecolabel in the Dutch Accommodation Sector. *Sustainability* **2019**, *11*, 3563. [CrossRef]
20. Rashid, N.R.N.A.; Khalid, S.A.; Rahman, N.I.A. Environmental Corporate Social Responsibility (ECSR): Exploring Its Influence on Customer Loyalty. *Procedia Econ. Financ.* **2015**, *31*, 705–713. [CrossRef]
21. Shawk. Operational Efficiency a Brand Point Management Perspective. 2008. Available online: http://www.schawk.com (accessed on 30 May 2023).
22. Baker, M.; Riley, M. New perspectives on productivity in hotels: Some advances and new directions. *Int. J. Hosp. Manag.* **1994**, *13*, 297–311. [CrossRef]
23. Wassenaar, D.J.; Stafford, E.R. The lodging index: An economic indicator for the hotel/motel industry. *J. Travel Res.* **1991**, *30*, 18–21. [CrossRef]
24. Higuerey, A.; Viñan-Merecí, C.; Malo-Montoya, Z.; Martínez-Fernández, V. Data Envelopment Analysis (DEA) for Measuring the Efficiency of the Hotel Industry in Ecuador. *Sustainability* **2020**, *12*, 1590. [CrossRef]
25. Poldrugovac, K.; Tekavcic, M.; Jankovic, S. Efficiency in the hotel industry: An empirical examination of the most influential factors. *Econ. Res.-Ekon. Istraživanja* **2016**, *29*, 583–597. [CrossRef]
26. Anderson, R.I.; Fok, R.; Scott, J. Hotel industry efficiency: An advanced linear programming examination. *Am. Bus. Rev.* **2000**, *18*, 40–48.
27. Balaji, M.S.; Jiang, Y.; Jha, S. Green hotel adoption: A personal choice or social pressure? *Int. J. Contemp. Hosp. Manag.* **2019**, *31*, 3287–3305. [CrossRef]
28. Sharma, T.; Chen, J.; Liu, W.Y. Eco-innovation in hospitality research (1998–2018): A systematic review. *Int. J. Contemp. Hosp. Manag.* **2020**, *32*, 913–933. [CrossRef]
29. Kramer, B. *Eco-Friendly Credentials Not Benefiting Hotels Financially, Study Says*; WSU Insider: Pullman, WA, USA, 2022.

30. Yenidogan, A.; Gurcaylilar-Yenidogan, T.; Tetik, N. Environmental management and hotel profitability: Operating performance matters Gestão ambiental e rentabilidade hoteleira: Questões de desempenho operacional. *Tour. Manag. Stud.* **2021**, *17*, 7–19. [CrossRef]
31. Liao, G. A Study on the Operating Efficiency of Tourist Hotels in Scenic Areas. Master's Thesis, National Taichung University of Science and Technology Business Administration, Taichung City, Taiwan, 2021.
32. Tone, K.; Tsutsui, M. Dynamic DEA with Network Structure: A slacks-based measure approach. *Omega* **2014**, *42*, 124–131. [CrossRef]
33. Alltophotels. Hotel Database Europe. 2022. Available online: https://www.alltophotels.com/hotel-database-europe/ (accessed on 30 May 2023).