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An Evaluation of Green Hotels in Singapore, Sentosa Island: A Big Data Study Through Online Review

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Abstract: The purpose of this study is to evaluate green hotels in Sentosa Island, Singapore, with big data analysis utilizing online reviews regarding environmental sustainability practices. Tourism, while providing significant economic benefits, also contributes to environmental degradation, particularly through the hotel industry, which accounts for a substantial share of global greenhouse gas emissions. Sustainable tourism practices are becoming increasingly popular as the public becomes more aware of the environment. As a result, green hotels emerged as a solution and hotels are taking steps to become eco-friendly. Based on the 3579 online reviews, the findings indicate that green practices, including water and energy conservation, play a crucial role in enhancing customer satisfaction, alongside traditional hospitality elements such as service quality and amenities. The integration underscores the importance of incorporating sustainability into core operations without compromising the high standards of service that guests expect. This research contributes to the understanding of sustainable hospitality practices, offering actionable recommendations for policymakers and hotel managers to foster environmentally friendly practices while maintaining customer satisfaction.

Keywords: green hotels; Sentosa Island; sustainability practices; big data analysis; customer satisfaction; online review

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1. Introduction

Tourism is one of the world's fastest growing economic sectors, significantly contributing to global economic growth (Streimikiene et al., 2021). This contribution is further demonstrated by the World Travel and Tourism Council (WTTC), which report that tourism contributes USD 8.9 trillion to the global economy, accounting for 10% of all jobs and employing 330 million people worldwide (Hambira et al., 2022). However, despite its economic benefits, the rapid growth of tourism raises serious environmental concerns. The hotel industry, in particular, has been identified as a major contributor to environmental degradation (Rahman et al., 2012) due to significant consumption of non-renewable resources such as energy, water, and generation of waste (Wang, 2022). Additionally, it significantly contributes to global greenhouse gas emission, accounting for approximately 8% of the world's CO_2 emissions (Campos et al., 2022). Between 2009 and 2013, the global carbon footprint (CF) of tourism increased from 3.9 to 4.5 gigatons, with transport, shopping, and food being the main contributions in this sector and it is estimated to become doubled by 2035 (UNWTO, 2020). Tourism activities such as air and sea transportation, accommodation, and souvenir production now account for approximately 8% of global carbon emission, with a substantial portion driven by travelers with a high income, including

the United States. The continued rise in global accessibility is anticipated to significantly increase the environmental impact of tourism in the coming decades (Sustainable Travel International, 2024).

In response to these global environmental concerns, many countries, organizations, and consumers are progressively promoting environmentally sustainable tourism, particularly within the hotel industry, which leads to the green hotel trend (Asadi et al., 2020). Globally, research highlighted the importance of green hotels in addressing environmental challenges. For instance, studies in Ecuador demonstrated a significant increase in ecological hotels, highlighting their dedication in protecting their environment (Moreno Brito et al., 2024). Similarly, in the Czech Republic, studies utilizing big data from online reviews demonstrated the importance of sustainable practices such as energy conservation and waste reduction in enhancing customer satisfaction (Nilashi et al., 2021). In the United States, the integration of customer education and green innovations has been shown to significantly influence customer experience in green hotels (Yu et al., 2017). These examples emphasized the critical role of sustainability in improving hotel performance and customer satisfaction, especially in green hotels.

Singapore embraced sustainable hotel practices, with an emphasis on integrating green initiatives within its tourism industry. The Singapore Hotel Sustainability Roadmap and Green Mark Scheme are the fundamental frameworks driving this movement. The roadmap highlights sustainability as a core value, aligning with the Singapore Green Plan 2030, which aims to minimize environmental impacts while fostering economic stability (STB, 2020). Sentosa Island, a key contributor to Singapore's tourism industry, serves as a prime example of Singapore's commitment to sustainable tourism (S. Tan, 2017). As one of Singapore's largest islands and a key contributor to the country's tourism industry, Sentosa Island plays not only as a popular tourist destination, but is also essential to the country's overall environmental goals. The island, home to numerous luxury hotels with green certification, faces challenges such as limited resources and vulnerability to climate change (Singapore's Voluntary National Review Report, 2018). Addressing these challenges, the Singapore Green Plan 2030 outlines initiatives to balance economy and growth with environmental protection, creating Sentosa a strategy for sustainability in the hospitality industry. With the hotel sector accounting for approximately 20% of total tourism profits and accounting for over 70,000 rooms across 430 hotels (BCA, 2024; STB, 2024), adopting sustainable practices is vital for balancing economic growth with environmental and ensuring long-term tourism sustainability.

Big data analysis emerged as a comprehensive method for understanding customer satisfaction in green hotels. Comparative research from Ecuador and Italy demonstrated the value of big data in identifying critical factors such as green initiatives that influence customer satisfaction. However, similar research remains underexplored in Singapore but is lacking in the Singapore context. To address this gap, this study employs big data analysis to examine customer satisfaction with green hotels on Sentosa Island. By contextualizing the findings within a global framework, this research aims to enhance the generalizability and applicability of its results.

A recent study examined customer satisfaction with green room attributes in luxury hotels in Singapore using a survey-based methodology to collect the data (Arisandi et al., 2023). Responses came from 387 participants through structured questionnaires, focusing on understanding guest preferences for sustainable room features. While surveys provide valuable insights, a big data analysis offers a complementary and improved method to examined customer satisfaction.

Today, there has been a significant change in how businesses interact with customers. People now rely significantly on the internet for finding hotel information and share their

experiences, making online reviews an important source for understanding consumer needs. Online reviews serve as a powerful marketing tool, helping customers make informed decisions, significantly influencing purchasing decisions by providing a platform for consumers to share insights and suggestions, and aiding potential customers in evaluating products and services (H. Zhang et al., 2018). Big data analysis offers an improved method in other contexts in predicting customer satisfaction, such as in analyzing TripAdvisor reviews of eco-friendly hotels in the Czech Republic to identify key factors such as service quality, location, and cleanliness (Nilashi et al., 2021), and examining consumer decision making in Mecca hotels, where factors such as cleanliness and service quality emerged as critical (Alsayat, 2023). These studies demonstrate the effectiveness of big data and online reviews in understanding customer satisfaction in the hotel industry. Applying similar approaches, this study aims to uncover customer satisfaction patterns specific to green hotels in Sentosa Island, bridging a critical research gap.

Despite the growth of research related to green hotels globally, studies focused on customer satisfaction in Singapore remain limited. Therefore, by employing big data analysis, this study examines customer satisfaction with green hotels on Sentosa Island, addressing a critical gap in sustainable hospitality literature and providing actionable recommendations to enhance environmental and operational outcomes. By integrating global comparison, the research contributes to sustainable hospitality literature while addressing Singapore's unique context.

2. Literature Review

2.1. Sentosa Island's Green Hotels

Hotels, an important part of the travel and tourism industry, have been adopting green practices for decades due to their excessive energy and water consumption (Merli et al., 2019). Today, consumers are more conscious and expect eco-friendly practices, forcing hoteliers to respond by providing sustainable options and converting to green hotels (Han et al., 2018). The serious environmental and reputational concerns that hotels face make it even more important to be green. As a result, hoteliers are pushed to adopt green practices and transform their businesses to meet customer expectations.

The definition of a green hotel has become frequently used. According to Acampora et al. (2022), a green hotel is an environmentally friendly hotel that implements sustainable development practices. These practices include the effective consumption of energy, water, and materials to protect the environment and increase the hotel's operational efficiency. Green hotels also implement initiatives such as to reduce trash, conserve energy, and promote environmental health (Rahman et al., 2012). In addition, they are identified by eco-friendly labels such as saving water, saving energy, minimizing solid waste, recycling, and reusing reusable service products, all of which are intended to protect the environment (Kushwaha & Sharma, 2016; Lee et al., 2010). Another definition explained that green hotels are the future trend for consumers aiming to reduce pollution in tourism and hospitality industries (Siti-Nabiha et al., 2014).

Since tourism is strongly reliant on environmental sustainability, visitors travel millions of miles to enjoy healthy and clean environments; as a result, the number of green hotels increased, showing their growing significance in the sector (Hsiao et al., 2014). Many hoteliers recognize the need for adopting green hotel practices into their operations, such as controlling solid waste and conserving energy and water, and green hotels can meet the demands of their visitors while lowering operational costs (Nezakati et al., 2015).

With more hotels now following the movement and support sustainable tourism and incorporating green practices to meet consumer expectation (Arisandi et al., 2023), Singapore has also been encouraged to adopt green practices as part of the country's strong

emphasis on fostering sustainable tourism. According to previous study, implementing green initiatives is considered as an important step toward reaching greater sustainability goals (Y. Y. Tan & Omar, 2022). These efforts are expected to stimulate innovative solutions for businesses to integrate and adopt green practices, eventually contributing to long-term sustainability.

The strong commitment of Singapore to sustainable tourism is reflected in Sentosa Island. Sentosa Island, located off Singapore's southern coastline and known as one of the country's most popular tourist destinations, embraced the concept of green hotels. These green hotels have been recognized by the Building and Construction Authority (BCA). BCA, a government institution under Singapore's Ministry of National Development, plays an essential role in developing sustainability in building construction (Chew, 2010). One of the BCA's initiatives, the Green Mark Scheme, launched in 2005, evaluates the environmental performance of buildings, including hotels, to promote sustainability. Through this program, Singapore aims to ensure that by 2030, 80% of Singapore's buildings are environmentally friendly, demonstrating the country's strong commitment to environmentally sustainable growth (BCA, 2024).

Green hotels in Sentosa Island promote green awareness by combining a variety of sustainable practices. These include offering eco-friendly menu options, substituting bottled water, and using energy-efficient solutions such as LED lighting and digital signage. Additionally, the hotels encourage visitors to support green programs by reducing energy and water consumption. The table below provides the list of hotels located in Sentosa Island. As shown in Table 1, only a few hotels in Sentosa Island are classified as green hotels according to the Building and Construction Authority (BCA), as listed below.

Table 1. Hotel in Sentosa Island.

No	Hotel Name	Hotel Star	Green Hotel Licenses
1	The Outpost Hotel Sentosa by Far East Hospitality	5	x
2	Village Hotel Sentosa by Far East Hospitality	4	Certified
3	Sofitel Singapore Sentosa Resort & Spa	5	x
4	Oasia Resort Sentosa by Far East Hospitality	5	x
5	The Barrack Hotel Sentosa	5	x
6	Resort World Sentosa-Hotel Ora	5	x
7	Capella Singapore	5	x
8	Resort World Sentosa-Equarius Hotel	5	Certified
9	W Singapore-Sentosa Cove	5	Certified
10	Shangri-La Rasa Sentosa	5	x
11	Resort World Sentosa-Hotel Michael	5	Certified
12	Resort World Sentosa-Equarius Villas (Beach Villas)	5	Certified
13	One 15 Marina	5	x
14	Amara Sanctuary Resort Sentosa	5	Certified
15	Resort World Sentosa-Crockfords Tower	5	Certified
16	Siloso Beach Resort Sentosa	4	x
17	Resort Word Sentosa-Equarius Ocean Suites	4	x
18	Resort World Sentosa-Tree Top Loft	4	x

Source: BCA List of Green Hotels.

2.2. Big Data Study and Online Reviews

In recent years, there has been a lot of interest in the integration of big data analysis in the hotel sector. Big data analysis completely changed the way that consumer preferences and satisfaction are evaluated, especially when it comes to user-generated content such as online reviews. For instance, a study by Z. Zhang et al. (2010) found that online reviews significantly influenced the purchasing preferences of 79% to 87% of restaurant, hotel, and

travel service readers among over 2000 U.S. participants. Similarly, Lu and Stepchenkova (2012) used online reviews posted by U.S. travelers to Costa Rica to evaluate eco-tourists' experiences and satisfaction with their stays at green hotels, underscoring that online reviews are an accessible, credible, and readily available data source. Innovations in machine learning, sentiment analysis, and predictive modeling also improved the power of big data analysis to provide essential findings in the tourism sector (Alsayat, 2023; Nilashi et al., 2021).

Big data analysis refers to the method of analysis that is used to describe sets of large and complex information and data that require diverse techniques, such as statistical techniques, computational linguistics, mechanical learning, and web scraping to collect, analyze, and interpret different findings (X. Zhang & Kim, 2021). The objective of big data is to find trends, connections, and information that can help in decision making. For example, examining online reviews can reveal important insights about the preferences and satisfaction levels of customers. Sentiment analysis, a technique within big data analysis, allows algorithms to identify the online review as neutral, negative, or positive, providing a deeper insight.

Online reviews have become an essential source of data, serving as a digital communication platform that allows reviewers to share their opinions, experiences, and feedback with potential customers (Low, 2024). In line with this, online review is the accessible and prevalent digital platform for assessing information that helps businesses identify what the customers prefer and dislike, allowing them to enhance their service (Liu & Park, 2015). Furthermore, the role of online review was emphasized by Lu and Stepchenkova (2015), who stated that online review is appropriate to be used as a source of information due to data availability and the quickness of data collection that does not require direct connection with subjects. Following this, online reviews serve a pair of purposes: providing information about certain products and services as well as providing recommendations (Park et al., 2007).

In the case of the green hotel itself, using big data analysis, researchers can more thoroughly examine green practices and their impact on customer satisfaction. A study by Nilashi et al. (2021) utilized big data analysis to evaluate electronic word-of-mouth (e-WOM) from TripAdvisor reviews of eco-friendly hotels in the Czech Republic. This study aimed to determine traveler preferences, predict customer satisfaction, and identify critical factors impacting the outcomes. The research findings validate the effectiveness of the method in consumer segmentation and preference prediction, emphasizing the importance of service quality, location, and cleanliness in assuring consumer satisfaction across different travel categories. A similar approach identified customer satisfaction from online reviews at 14 eco-friendly hotels in Ecuador and discovered that employee politeness and hotel location were crucial in enhancing customer satisfaction (Moreno Brito et al., 2024).

2.3. Customer Satisfaction in Green Hotels

Understanding consumer preferences and demands is critical for hotel performance (Ren et al., 2016). Analyzing online reviews of hotel performance provides useful information about consumer satisfaction. To increase consumer satisfaction and maintain competitiveness, the hotel industry must recognize the importance of the online reviews. By thoroughly analyzing these reviews, hotels can identify areas for improvement and connect their services with customer expectations, eventually increasing performance and customer loyalty. In addition, in order to enhance customer satisfaction while maintaining green practices, the concept of green hotels is aligned with the triple bottom line (TBL) framework, which provides a comprehensive lens to evaluate the sustainability of green hotels by integrating environmental, social, and economic dimensions (Elkington, 1994).

By utilizing the framework, green hotels can better understand and respond to consumer demands while enhancing their sustainability practices.

A previous study examined the relationship between customer satisfaction and online reviews of seven luxury hotels in Marina Bay, Singapore (Handani et al., 2022). The selection of these hotels was based on The Clean SG certification, introduced in response to the pandemic. This study highlights the criticality of online reviews in helping hotels enhance their service and meet customer satisfaction. This aligns with the economic dimension of TBL framework, emphasizing operational cost efficiency and financial benefits associated with maintaining high service standards through customer feedback.

Gao and Mattila (2014) explored the relationship between green hotels and customer satisfaction, finding that customer satisfaction increases when visitors experience high-quality service. Moreover, this satisfaction is further significantly enhanced when green initiatives provided by the hotel have benefits for society rather than just increasing their profit only. This finding resonates with environmental perspective of the TBL framework, emphasizing the significance of hotel commitment to environmental sustainability in driving customer satisfaction.

Similarly, Berezan et al. (2014) analyzed the impact of online reviews on customer satisfaction at a green hotel in Mexico. Their research found that guests express higher satisfaction when a hotel adopts environmentally friendly initiatives, such as recycling, energy-efficient lights, and water conservation. Furthermore, the study noted cultural differences in guest experiences, where American tourists prioritize practical sustainability such as energy conservation, while Mexican visitors emphasize emotional aspects such as comfort and peace. This indicates that hoteliers should consider their visitors' social and cultural background and participate in educational campaigns on the benefits of sustainable activities. This study aligns with both the environmental and social factors of the TBL framework.

Another study evaluated an ecolabel-awarded hotel in Italy and found that green initiatives and environmental commitment such as energy and water conservation, waste reduction, and the use of environmentally friendly materials significantly improve customer satisfaction and loyalty (Merli et al., 2019). Customers who are pleased with the hotel's green initiatives are more likely to return and promote it to others. This further supports the environmental perspective of the TBL framework.

Similarly, Yu et al. (2017) analyzed guest experiences at the top ten green hotels in the United States, identifying the importance of strategies such as energy, purchasing, education, and innovation strategies in enhancing customer satisfaction. These green experiences, particularly those involving guest education, energy and water saving, and sustainable purchasing, are critical to increasing customer satisfaction. This finding aligns with the social dimension of the TBL framework, highlighting the role of guest education and interaction in fostering sustainable practices and boosting satisfaction.

3. Methodology

3.1. Data Collection

The first phase of the research involved the collection of raw data from user-generated content from Google Reviews of the seven hotels in Sentosa Island that are having the green hotel certification (BCA, 2024). The data extracted were an online review from 2022 to 2024 (2 years data) and were extracted using Outscraper, a tool that is capable of efficiently scraping web data. A total of 3579 reviews were collected. The purpose of this data collection process is to ensure that a comprehensive data set is acquired, which reflects a wide range of user interactions and experiences.

Following the data extraction, a refining process was implemented to prepare the dataset for detailed analysis. The refined data are then subjected to further processing in order to facilitate detailed analysis. To ensure a standardized dataset, all reviews that are not in English are translated into English during the refinement step. Furthermore, the data set is purified by removing extraneous elements and normalized into an appropriate format. Table 2 below presents a summary of the collected data, showing the number of reviews for each hotel and the average satisfactions rating as expressed by the reviewers.

Table 2. Summary of customer reviews for green hotels on Sentosa Island.

Hotels	Number of Reviews	Average Satisfaction (1–5)
Resort World Sentosa-Crockfords Tower	139	4.6
Resort World Sentosa-Equarius Hotel	378	4.3
Resort World Sentosa-Hotel Michael	381	4.1
Resort World Sentosa-Equarius Villas (Beach Villas)	388	4.5
Amara Sanctuary Resort Sentosa	958	4.1
W Singapore-Sentosa Cove	721	4.5
Village Hotel Sentosa by Far East Hospitality	614	4.3
Average Rating		4.3

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3.2. Data Analysis

3.2.1. Qualitative Data Analysis

To perform qualitative analysis, the refined data are imported into the KH Coder application, which is a useful tool for statistical analysis and text data visualization. KH Coder was designed primarily for analyzing word frequency, identifying correlations between commonly used terms (co-occurrence networks), and uncovering essential themes using topic modeling. The analysis was carried out in English, with preprocessing methods to remove irrelevant or common terms (such as "the", "and" and "is") from a specified stopword list. KH Coder's co-occurrence feature helped to uncover patterns in how customers perceive green hotel practices by examining connection between key terms. The first step of the analysis was to identify the significant trends and aspects related with customer satisfaction at Sentosa Island's green hotel. The process includes frequency analysis and co-occurrence analysis.

Frequency analysis was used to analyze and identify important trends and expressions from reviews based on frequency words. The refined dataset was examined to assess the frequency of certain terms and phrases. These data contributed to identifying the most frequently stated areas of the customer experience, such as service quality, environmental practices, and hotel amenities. A word cloud was created to visually display these frequent terms, providing a clear summary of the most relevant aspects influencing consumer satisfaction, so that general perceptions and ideas may be more easily identified.

Following the frequency analysis, a co-occurrence analysis was performed to find the relationship between different words in order to identify deeper cases and correlations. This analysis was important in determining how various parts of the consumer experience connected. This analysis provides better understanding of the factors that influence both positive and negative customer experiences.

3.2.2. Sentiment Analysis

The second step of the analysis was sentiment analysis, which was carried out in the last part of the method by utilizing Microsoft Azure's sentiment analysis tool. Microsoft

Azure was chosen for sentiment analysis in this study because of its advanced features, which include multilingual support, excellent accuracy, stability for processing big datasets, and customizability to meet a variety of research objectives (Chatterjee & Nygard, 2017). Compared to other options, Azure stands out for its improved simplicity of use, integration capabilities, and strong handling of large amounts of data. While other tools are powerful, they frequently lack user-friendliness or demand extensive technical expertise.

By classifying the data based on positive, negative, or neutral opinions, researchers may obtain a more detailed knowledge of customer perspectives. Sentiment analysis was especially important in determining how certain components of Sentosa Island's green hotel experience affect overall opinion. For example, the study may identify whether mentions of sustainable practices were generally connected with good sentiment, or if improvements were required to improve customer satisfaction.

In the final step of the study, a comprehensive co-occurrence analysis was conducted to investigate the relationship between the identified words and sentiment analysis. The analysis provided a detailed knowledge of how several characteristics of the green hotel, such as the environment, sustainability, service quality, and pricing, influenced customer satisfaction. The study found the primary determinants of positive and negative customer experiences in green hotels by analyzing the co-occurrence of sentiment results with certain words.

This structured approach to data analysis ensured an effective evaluation of customer satisfaction at a green hotel in Sentosa Island. The integration of these methods, as visually summarized in Figure 1, provided a comprehensive understanding of the factors affecting customer experiences and highlighted areas for potential improvement.

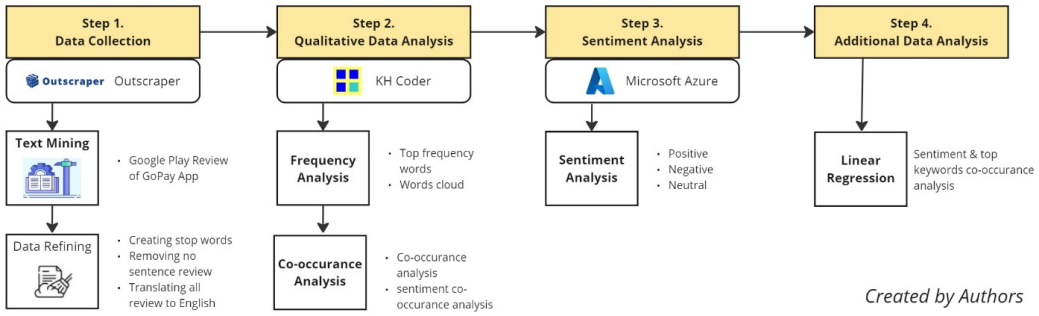

Figure 1. Research methodology.

4. Results

The frequency analysis provides a review of the aspects that are most important to customers, highlighting both positive experiences and areas for improvement. This analysis serves as the foundation for further sentiment analysis to better understand customer satisfaction levels. The data, derived from KH Coder's analysis of green hotels on Sentosa Island, reveal the major topics and feedback from customers.

The most often mentioned words are "room" (2143 mentions), "hotel" (1942 mentions), and "pool" (1081 mentions), demonstrating that guests prioritize the quality of lodgings and amenities. Words such as "good" (1037 mentions), "service" (929 mentions), and "staff" (837 mentions) underline the significance of service quality and staff performance in determining customer satisfaction. Additionally, facilities such as "breakfast" (500 mentions) and "swimming" (302 mentions) pools, as well as "location" (336 mentions) and "view" (312 mentions), are critical components of the visitor experience. Overall, the result shows that customers place a high value on hotel convenience, service, and appearance, offering significant insights for hotel management to improve in these areas.

The top 100 frequency words also include several terms that show the prevalence of green activities. Notably, "environment" (91 mentions), "clean" (401 mentions), and "water" (274 mentions) are significant indicators of environmentally friendly initiatives. The frequent use of the term "environment" demonstrates guests' awareness and respect for green practices such as energy-efficient buildings and eco-friendly design. The term "clean" emphasizes the necessity of green cleaning procedures, which include the use of environmentally friendly cleaning solutions and sustainable waste management systems. Meanwhile, the term "water" implies the use of water-saving measures, such as low-flow fixtures and water-efficient lawn care. These results suggest that environmental sustainability is an important part of visitor satisfaction and the operational focus of green hotels.

Table 3, presented below, lists the top 100 frequency words identified from the customer reviews, and serves as a valuable resource for understanding the key factors that influence guest experiences and satisfaction in green hotels on Sentosa Island.

Table 3. Top 100 frequency keyword.

Word	Freq.	Word	Freq.	Word	Freq.	Word	Freq.	Word	Freq.
room	2143	swimming	302	convenient	181	more	123	better	100
hotel	1942	food	281	big	177	wonderful	121	option	97
pool	1081	small	281	desk	172	first	120	toilet	96
good	1037	water	274	excellent	171	hour	119	few	95
service	929	beautiful	266	shuttle	168	old	119	way	94
staff	837	restaurant	247	next	161	people	118	request	92
nice	674	kid	242	helpful	159	awesome	118	special	92
place	641	comfortable	229	amazing	157	island	116	environment	91
great	618	bed	228	bad	157	customer	111	quality	90
stay	504	guest	227	beach	154	staycation	111	thanks	87
breakfast	500	bus	224	minute	136	such	111	able	87
time	492	best	221	front	136	bathroom	110	lovely	86
clean	401	child	217	birthday	135	lobby	109	team	85
experience	386	spacious	214	price	134	buffet	108	bathtub	84
family	357	area	212	everything	132	station	108	reception	84
night	340	facility	211	door	130	villa	107	walk	84
location	336	free	206	large	127	amenity	106	review	83
day	332	many	197	overall	127	morning	106	manager	82
friendly	331	resort	192	check	126	check-in	103	tv	82
view	312	star	188	floor	124	suite	101	towel	81

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After the top 100 words were determined, a word cloud was generated to show how often these terms appeared in the customer review. The simple summary of the most often stated terms is provided by this visualization (Figure 2), which makes it possible to quickly understand the main ideas and subjects that are significant to visitors staying at Sentosa Island's green hotels.

Based on the word cloud presented in Figure 2, it appears to combine feedback from customers regarding the hotel itself, which is most likely related to the facility of the hotel itself. Co-occurrence visualizations also suggest that the cranes that display hotel facilities are all on the same side and are highly related to one another, such as "room", "hotel", "pool", and "breakfast".

Figure 2. Word cloud of top 100 frequency words from customer review.

Following the analysis of the top 100 frequency words, a deeper exploration into the relationships between these terms was conducted. This analysis is illustrated in Figure 3, which presents a co-occurrence visualization of the significant terms identified from the customer reviews. The co-occurrence visualization in Figure 3 focuses on the relationships between significant terms. Central terms such as "room", "hotel", and "pool" are clearly presented, indicating that they are the main issues of guest discussion. Other noticeable terms, such as "clean", "service", "staff", "breakfast", and "view", have strong correlations, indicating that these aspects are critical to visitor experiences and are frequently referenced together in evaluations. Furthermore, the visualization highlights specific terms connected to green activities. The word "clean" is central and frequently used, emphasizing the necessity of environmentally responsible cleaning methods. Terms such as "water" and "environment" are also relevant, indicating the hotels' concentration on water-saving measures and sustainable practices.

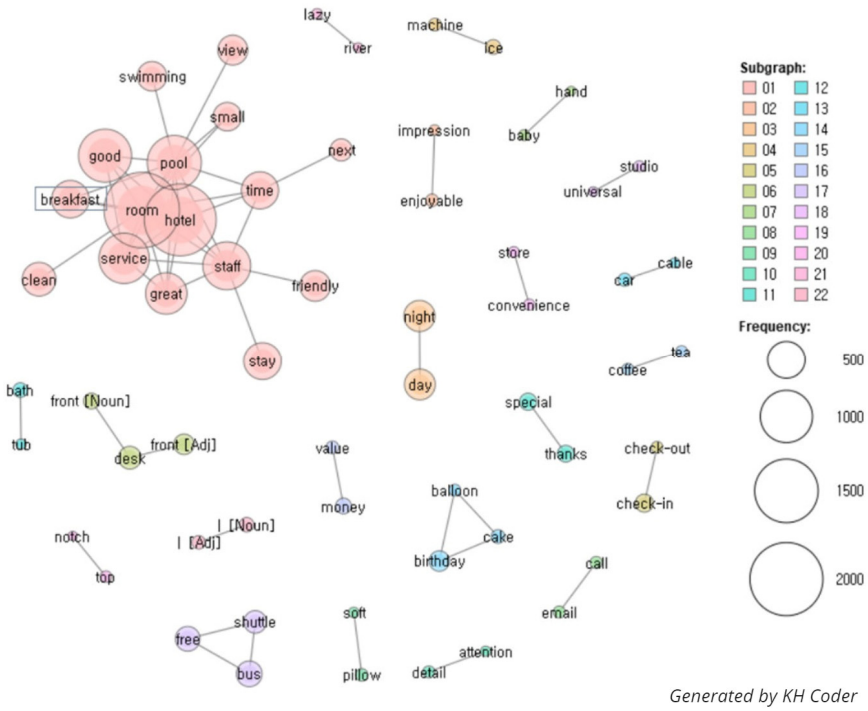

Figure 3. Co-occurrence visualization.

The words "universal" and "studio" have a high connection, as do their appearances independently and together. This is due to Singapore Universal Studio's location on Sentosa Island. The prevalence of related clusters, such as "shuttle", "free", and "bus", indicates that attention is placed on providing environmentally friendly transportation options. The island provides free shuttle buses for taking visitors around the island.

Building on the findings from the co-occurrence analysis, the next phase of the study delves into sentiment analysis. Online reviews have been undergoing a great deal of research in the area of sentiment analysis. Preprocessing the data is then performed using text mining techniques. An important aspect of this study is the tone of the review. To obtain the sentiment score, Azure machine learning will be utilized. Following the sentiment score, the analysis will be conducted using the provided score. The process of sentiment analysis enables one to evaluate user comments and to judge their opinions (Pang & Lee, 2008). Moreover, the study examines sentiment analysis techniques utilizing machine learning classifiers and deep learning algorithms. As well as examining the accuracy of Azure sentiment analysis in terms of the language and length of the text, the study examined its effectiveness.

Using sentiment analysis as a basis for the co-occurrence analysis will be the next step in this study. There is a diagram in Figure 4 that illustrates words that are frequently used in positive, negative, and neutral ways related to customer experience. Positive sentiment is associated with words reflecting favorable customer experiences, such as satisfaction with hotel experiences, services, location, and the overall stay. Negative sentiment corresponds to words linked to unfavorable experiences, such as complaints or dissatisfaction with specific aspects of the hotel. Neutral sentiment represents words that do not explicitly convey a strong positive or negative impression. Through this approach, it is possible to identify word groups whose narratives have meaning and sentiment scores corresponding to those groups.

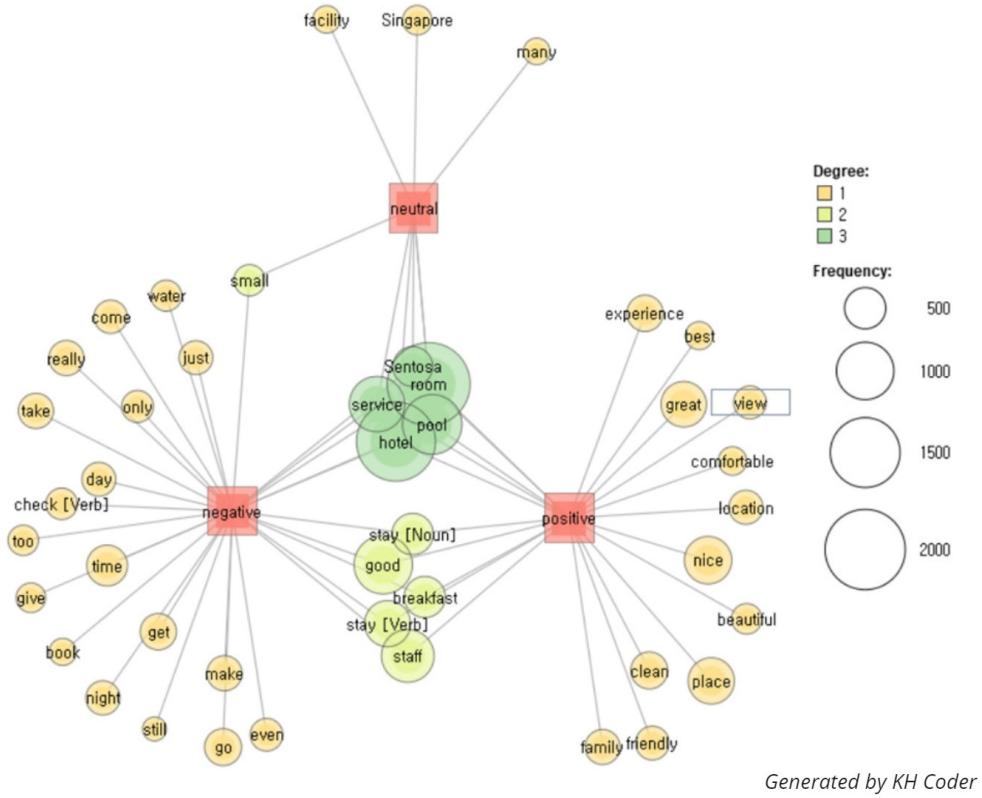

Figure 4. Sentiment co-occurrence visualization.

5. Discussion

The significance of green hotels in the tourism industry cannot be pointed out. As visitors' environmental consciousness grows, so does the demand for green hotels. This trend not only shows an increase in consumer preferences, but it also emphasizes the importance of sustainable practices for the hotel industry's sustainability and competitiveness. Green hotels help to reduce the industry's environmental impact, improve company reputation, and subsequently boost customer satisfaction. As a result, integrating sustainable practices into hotel operations is critical for tourism's sustainable future, ensuring that it is both commercially and environmentally responsible.

This study utilized big data analysis to evaluate customer satisfaction at green hotels on Sentosa Island, Singapore, through the analysis of online reviews. The results provide valuable insights into the priorities and experiences of customers staying at these green hotels. The key findings from frequency analysis, co-occurrence analysis, and sentiment analysis highlight the importance of hotel amenities, service quality, and green practices in shaping customer satisfaction. Comparative insights with similar studies in other countries such as Ecuador, Mexico, Italy, and the United States provide a broader context for understanding global trends in green hotel performance.

Frequency analysis demonstrates that the most frequently mentioned words are "room" (2143 mentions), "hotel" (1942 mentions), and "pool" (1081 mentions). These results align with previous research in Ecuador, which mentioned the first group that is extracted being "tangible" (Moreno Brito et al., 2024). In particular, the term environment appeared 91 times, demonstrating that visitors are aware of the hotel's green initiatives. The frequent mention of water 274 times emphasizes the need of water-saving measures, which are consistent with the green hotels' fundamental goals of promoting environmental sustainability. These findings show that while typical hotel aspects such as room quality and service are important, green practices are also critical to customer satisfaction.

Co-occurrence analysis further presents a better understanding of how different aspects of consumer experiences are interconnected. Words such as "room", "hotel", "pool", and "service" are commonly used together, emphasizing their importance in influencing consumer experiences. The use of the word "clean" used together with other terms emphasizes the importance of cleaning procedures in maintaining customer satisfaction. Furthermore, the words "environment" and "water" are strongly related, implying that visitors notice and value hotels' efforts to implement environmentally friendly practices such as water conservation.

Sentiment analysis provides information into the general tone of customer reviews. Positive emotions are highly related with expressions such as good, service, and staff, showing that visitors are usually happy with the level of service offered by hotels. This finding is consistent with prior research, which has shown that high-quality service and a well-trained staff are significant elements in increasing customer satisfaction in the tourism industry (Gao & Mattila, 2014).

Interestingly, the sentiment analysis suggests that green activities have a significant impact on consumer satisfaction. Positive attitudes are associated with words such as "clean" and "environment", implying that visitors that are environmentally conscious are more likely to enjoy the green hotel. However, negative sentiments were found to be associated with some phrases such as "price" and "bad", implying that some visitors may believe that the expense of staying at a green hotel does not always translate to a valuable experience. This finding is consistent with previous research, which indicated that while many visitors are prepared to pay a premium for eco-friendly services, the perceived value must also match their expectations (Berezan et al., 2014).

The results align closely with the principle of the triple bottom line (TBL) framework, which emphasizes the interconnection of economic, social, and environmental sustainability (Elkington, 1994). First, the economic dimension is expressed in green hotel activities that can save money, such as the use of energy-efficient systems and waste-reduction programs. These methods not only improve operational efficiency, but they also attract environmentally aware travellers, who are willing to pay a premium for sustainable services.

The social dimension is noticeable in the way green initiatives impact consumer satisfaction and community engagement, underscoring the importance of maintaining high service standards. According to this study, green amenities provided by the hotel, such as room features, are well received by customers, adding to a better overall customer experience. Furthermore, these activities promote a sense of community involvement and support for local economies, which is consistent with previous studies emphasizing the significance of social responsibility in hospitality (Berezan et al., 2014). This factor emphasizes the importance of green hotels in establishing trust and long-term customer connections, complementing the social dimension in TBL.

Finally, the environmental dimension is supported by the actual benefits of green practices, such as decreased resource use and reduced environmental impact. Green hotels contribute to global sustainability goals by focusing on renewable energy sources and eco-friendly operations, which are consistent with the aims of TBL's environmental dimensions. This study improves the use of TBL by demonstrating how green hotel practices solve environmental concerns while also improving economic and social benefits.

Comparisons with studies in other countries reveal both common global trends and local insights into the role of green hotel practices in shaping customer satisfaction. Research in Italy highlights the significant impact of ecolabel certifications, demonstrating how customer trust and loyalty enhanced by signaling the hotel's commitment to environmental responsibility (Merli et al., 2019). Visitors in ecolabel-certified hotels showed higher satisfaction, emphasizing the importance of clearly communicating sustainability efforts to visitors. Similarly, studies in the United States highlight the critical role of visitors education in promoting green initiatives (Yu et al., 2017). In addition, this study reveals that practices such as energy conservation, water-saving measures, and sustainable purchasing are well-received by customers when coupled with clear communication and education about their benefits. This emphasizes the need for hotels to actively engage customers in understanding and supporting sustainability efforts.

Findings from Ecuador and Mexico further reveal the influence of cultural context on visitors' perception of sustainability. In Ecuador, research identified tangible factors such as cleanliness and the physical environment as primary contributors to customer satisfaction (Moreno Brito et al., 2024). In contrast, in a study in Mexico, Berezan et al. (2014) found that cultural differences shaped the way customers valued green practices. For instance, American visitors prioritized functional aspects, such as energy conservation and recycling, while Mexicans placed greater emphasis on emotional aspects, such as comfort and tranquility. These findings underscore the need for green hotels to adapt their sustainability strategies to the sociocultural preferences of their customer, ensuring that eco-friendly initiatives resonate with diverse customer groups.

To summarize, the findings of the green hotel in Sentosa Island, Singapore, are consistent with global trends found in Mexico, Ecuador, Italy, and the United States, suggesting that green practices are critical for improving customer satisfaction. Although environmental keywords such as environment and sustainability are less common, they represent customer' awareness and appreciation of green activities performed by these hotels. This is consistent with this study which focus on green hotels, highlighting the relevance of sustainability in improving customer satisfaction. Hotels must prioritize strategic branding and

effective communication of their green initiatives, educate visitors on the benefits of these practices, and assure continual development in order to optimize customer satisfaction and loyalty.

In addition, customer satisfaction in a green hotel is not simply determined by the hotels' green indicators. Traditional components of the hospitality industry, including room quality, cleanliness, and staff performance, remain critical to customer satisfaction. Furthermore, the study indicates that customer satisfaction is influenced by hotels' ability to find a balance between providing environmentally friendly services and maintaining a high degree of comfort and convenience.

However, socio-cultural dimensions also play a significant role in shaping customer expectations and preferences. For instance, cultural values influence how customers perceive and prioritize eco-friendly amenities (Berezan et al., 2014). The study demonstrated that cultural background significantly shapes how customers evaluate sustainable practices, with some prioritizing functional benefits such as energy efficiency, while others value emotional aspects such as comfort. Furthermore, the study showed that many customers are willing to pay a premium for ecologically friendly hotels; however, incentives such as discounts are highly valued. This recommends that hotel managers consider their visitors' sociocultural backgrounds and potentially engage in initiatives to demonstrate to them the benefits of sustainable activities.

Understanding these socio-cultural factors is essential for designing green practices that resonate with diverse customer groups. Hotels could benefit from the adaptation of their sustainability initiatives to aligning with the values and preferences of specific cultural demographics. For example, hotels in regions with strong environmental awareness might emphasize renewable energy usage, while those serving culturally diverse customer bases could incorporate multilingual sustainability messaging and culturally inclusive designs. By considering these socio-cultural influences, hotel managers can enhance customer satisfaction while promoting sustainable practices.

6. Implication, Limitation and Suggestion for Future Research

6.1. Implication

This study contributes to the practical implication by providing suggestion to management. From a management perspective, the results suggest that hotel managers on Sentosa Island and other tourist destinations should continue to invest in green technologies and practices. As evidenced by the sentiments expressed in online reviews, their environmental impact is not the only reason for this, as they also heavily influence consumer perception and decision making. As part of their green initiatives, hotels should ensure that they are well publicized and visible to their guests so that it may influence their online reviews, and, consequently, the decision making of future guests.

To effectively enhance customer satisfaction and promote sustainable practices, hotel management should focus on understanding what their visitors value. They should use feedback to find the green activities that engage most effectively and express these efforts clearly across all media, as well as educate employees by delivering training on sustainability practices, allowing them to bravely share these initiatives with customers. The use of technologies such as smart energy systems and data analytics to improve operations and track the progress of green initiatives is essential for ensuring efficiency and effectiveness in sustainability efforts. These solutions allow hotel managers to monitor the use of resources in real time, identify areas for improvement, and make decisions based on data to increase energy consumption, waste reduction, and overall operational performance. For instance, by doing regular cost–benefit evaluations, hotels can select programs that provide the best return while also increasing their sustainability policies and qualifications.

Hotels that use these technologies may not only accomplish their sustainability targets, but also demonstrate openness and accountability to visitors, encouraging trust among environmentally concerned tourists. When implementing sustainability strategies, it is helpful to maintain cultural differences in mind to ensure that they meet your customers' diverse expectations. Finally, collaborate with government and industry stakeholders to obtain certifications and engage in sustainability programs.

6.2. Limitation and Suggestion for Future Research

Despite providing valuable insights, the study has a number of limitations. Since the online reviews are heavily dependent on the subjective nature of individual perceptions and the voluntary nature of user reviews, the analysis may not fully capture the full scale of guest experiences. While the primary focus of this study is on using big data analysis to examine customer satisfaction in green hotels, cultural factors are considered to have an essential role. While this study does not directly analyze cultural differences, it emphasizes the need for future research into how cultural backgrounds influence perceptions about green practices and their impact on consumer satisfaction.

Data collection is primarily based on Google Reviews, which may introduce selection bias due to the platform's user demographics. Google Reviews frequently attract younger, tech-savvy users or people from specific cultural or regional backgrounds, which might limit the findings. As a result, the insights gained from this dataset may not fully represent the variety of customer experiences and preferences across all demographic groups. Future studies might address this limitation by combining data from different platforms to provide a more comprehensive and balanced representation of customer satisfaction.

The reliance on translated reviews limits sentiment analysis, as machine translation can introduce mistakes due to differences in language. Cultural expressions and sensitivities differ across languages, which may have an impact on the reliability of the analysis. Future studies could address this issue by analyzing original-language reviews or utilize advanced translation technologies to reduce errors. In future research also, there should be a more in-depth analysis of how the green aspects of a hotel affect its financial performance in terms of income and expenses. It is important to note that the result of research could give more insight when it focuses on the management part, where it could suggest that conducting green practices is an important part of hotel management and services.

In addition to better determining the effect of green practices on customer satisfaction, future research could conduct a comparative analysis between hotels that have green certification and those that do not in order to determine the specific effect of sustainability on guest satisfaction or to assess the relative significance of various green practices in order to determine which ones have the biggest influence on customer satisfaction.

7. Conclusions

This big data analysis of customer reviews for Sentosa Island's green hotels provides a complete insight of the primary elements impacting customer satisfaction. While typical hotel amenities and services are still important, there is a clear recognition of these hotels' commitment to sustainability. The result emphasizes the need of green hotels maintaining high standards of service and comfort while also promoting sustainability initiatives. As the demand for green hotels rises, hotels that successfully integrate green practices with high-quality service are most probable to take advantage of greater customer loyalty and positive word-of-mouth feedback. Hotels on Sentosa Island have the opportunity to fulfil the needs of modern customers who respect sustainability while remaining comfortable. Future research might look into the long-term effects of green hotel policies on customer

loyalty and profitability, especially as the tourism sector adapts in response to global environmental issues.

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