



Balancing Act: Achieving Carbon Neutrality in Star-Rated Hotels Through Net Zero Methodology and Responsible Tourism Practices

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ABSTRACT. The concept of carbon neutrality revolves around the idea of balancing the amount of carbon emissions generated with an equivalent amount of carbon removal or offsetting. In the context of star-rated hotels, this entails a comprehensive approach to minimize and offset the carbon footprint associated with their operations. This research aims to assess the awareness and attitudes of hospitality students towards sustainability concepts, including carbon neutrality and responsible tourism. It seeks to uncover the strategies employed by star-rated hotels for achieving carbon neutrality, emphasizing key sources of emissions through a proposed diagram. Additionally, the study explores the role of Net Zero Methodologies and responsible tourism practices in the hotel industry's sustainability efforts, providing valuable insights for education and industry practices. The findings aim to contribute to informed curricular development and further discussions on fostering sustainability in the hospitality sector. Employing a sequential explanatory mixed methods design, the study combines quantitative data from 322 hospitality students with qualitative insights from content analysis of secondary sources. The results of the one-sample tests indicate a significant difference ($p < 0.001$) indicate a robust understanding of carbon neutrality, net-zero methodology, responsible tourism, and carbon footprint assessment. Mean differences and confidence intervals support positive sentiments, with participants recognizing the reputation boost from achieving carbon neutrality and the pivotal role of responsible tourism practices in long-term success. Findings highlight the need for enhanced sustainability education among hospitality students. The implications suggest that integrating responsible tourism practices and Net Zero Methodologies is crucial for star-rated hotels in achieving carbon neutrality.

Keywords: Carbon neutrality; Net Zero Methodology; Responsible Tourism Practices; Star-Rated Hotels

1. Introduction

In recent years, the global hospitality industry has witnessed an increased emphasis on sustainable and environmentally conscious practices [1], [2], [3]. As climate change concerns intensify, there is a growing realization that the carbon footprint generated by hotels contributes significantly to environmental degradation. Within this context, the pursuit of carbon neutrality has become a critical goal for the hospitality sector. The origins of zero carbon emissions and carbon neutrality concepts can be traced back to their initial proposals, which have since gained significant prominence in climate change research. Data from the United Nations Framework Convention on Climate Change (UNFCCC) reveal a substantial rise in references to net-zero

emissions within pertinent documents, particularly following the Glasgow Climate Conference (COP 26)[4], [5]. This research aims to address the existing research gap by exploring the intricate Balancing Act required for achieving carbon neutrality in star-rated hotels. Specifically, the study investigates the integration of Net Zero Methodology and Responsible Tourism Practices as a means to strike the delicate balance between providing luxurious accommodations and minimizing environmental impact and assess level of awareness and positive attitudes towards sustainability concepts, including carbon neutrality, net-zero methodology, responsible tourism practices, and the significance of carbon footprint assessment among hospitality students.

Net Zero Methodology and Responsible Tourism Practices synergistically contribute to the pursuit of carbon neutrality in star-rated hotels[6], [7], [8], [9]. The Net Zero Methodology focuses on enhancing energy efficiency through measures like LED lighting and efficient appliances while promoting the integration of renewable energy [10]. This methodology also incorporates carbon offsetting programs to compensate for unavoidable emissions, further mitigating the hotels' overall carbon footprint. On the other hand, Responsible Tourism Practices emphasize local sourcing, sustainability, and community engagement, fostering a holistic approach to environmental and social responsibility. By adopting these practices, hotels minimize their impact on local communities, support regional economies, and contribute to biodiversity conservation[10]. The integration of these methodologies creates a comprehensive strategy that not only addresses operational emissions but also considers broader environmental and social aspects, aligning with the evolving expectations of environmentally conscious travellers.

While sustainability in the hospitality industry has gained attention, a substantial research gap exists concerning the effective implementation of carbon neutrality measures in star-rated hotels. Existing studies often lack a comprehensive understanding of the challenges and opportunities associated with adopting Net Zero Methodology and Responsible Tourism Practices in conjunction. This research aims to bridge this gap by providing a nuanced exploration of the strategies that can be employed to achieve carbon neutrality without compromising the quality of services offered by star-rated hotels.

This study aims to fulfil its stated objective by investigating the following research questions (RQs):

RQ 1. What is the level of awareness and positive attitudes towards sustainability concepts, including carbon neutrality, net-zero methodology, responsible tourism practices, and the significance of carbon footprint assessment among hospitality students?

RQ 2. How do star-rated hotels achieve carbon neutrality, and what are the key sources of carbon emissions within their operations through author proposed diagram?

RQ 3. How do star-rated hotels achieve carbon neutrality through Net Zero Methodologies and responsible tourism practices?

The importance of this research lies in its capacity to provide guidance for the conversion of star-rated hotels into environmentally conscious establishments. By identifying practical solutions, assessing level of awareness among hospitality students about the carbon neutrality and best practices, this study intends to offer valuable insights to hotel owners, managers, and policymakers. Furthermore, the research strives to contribute to the broader discourse on sustainable tourism, serving as a blueprint for the integration of carbon neutrality initiatives within the hospitality sector. As consumers increasingly prioritize eco-friendly choices, the findings of this study can also inform the decision-making process of hotel responsible customer, thereby fostering a greater demand for sustainable accommodation options.

The remaining sections are organized as follows: Section 2 presents the data and methodology. Section 3 discuss level of awareness and positive attitudes towards sustainability concepts, including carbon neutrality, net-zero methodology, responsible tourism practices, and the significance of carbon footprint assessment among hospitality students in detail. Section 4 provides the key sources of carbon emissions within their operations and process of carbon neutrality through author proposed diagram. Section 5 discussed Net Zero Methodologies employed in star-rated hotels for achieving carbon neutrality whereas section 6 discusses the role of Responsible tourism practices in achieving goal of carbon neutrality in star-rated hotels. Section 7 conclude by discussing the theoretical and managerial implications of the present research and also by pointing to avenues of future research.

2.Data and Methodology

This research study followed a sequential explanatory mixed methods design, as outlined by [11] with two distinct data strands: Section 3, comprising quantitative data, and rest section, involving qualitative data through secondary data analysis using content analysis methods. While the data collection and its order followed Creswell and Plano Clark's sequential explanatory classification, an alternative viewpoint could classify this study as a fully integrated design with equal priority. Significantly, both the quantitative and qualitative aspects were given equal significance, and intentional integration was implemented throughout the entire research process, encompassing the formulation of research questions, data collection, analysis, and the development of recommendations. The questionnaires were created with the assistance of insights from prior studies focusing on these concepts[10], [12], [13], [14]. Table 1 and 2 illustrates the demographic profile of the respondent and one sample t-test result respectively.

In this study, the participants were drawn from the pool of hospitality students, recognized as pivotal stakeholders in advocating responsible tourism practices within star-rated hotels, given their future roles as professionals in the field. The research opted for a convenience sampling approach, selecting a sample size of 322 to address the first research question. The demographic information collected included gender, age, and educational background. Data were obtained through a self-administered online Google Form questionnaire. Hospitality students were requested to express their level of agreement or disagreement using a Likert scale ranging from 1 to 5,

concerning diverse sustainability concepts, including but not limited to carbon neutrality, net-zero methodology, responsible tourism practices, and the significance of carbon footprint assessment. Before implementation, the questionnaire underwent a thorough review to ensure its relevance and appropriateness within the specific context of the study. Data analysis was conducted using SPSS version 23, with the primary analytical tools being the One-Sample t-test and frequency analysis. Qualitative data for the research were obtained through content analysis of secondary sources, research articles, and sustainability reports from various hotels. The goal was to identify key sources of carbon emissions within hotel operations and understand how star-rated hotels achieve carbon neutrality through Net Zero Methodologies and responsible tourism practices.

3.Result and Discussion

Sustainability concepts, such as carbon neutrality, net-zero methodology, responsible tourism practices, and carbon footprint assessment, are becoming increasingly crucial in the context of the hospitality industry. Numerous stakeholders play pivotal roles in promoting Responsible Tourism Practices within Star-Rated Hotels, each contributing through their specific actions. These stakeholders encompass Group senior Management, Employees, including General Managers, heads of various departments (kitchen, restaurant, front office, housekeeping, and maintenance), Government (Ministry of tourism and Representatives from the Institute of Hotel Management (serving as committee members of the Hotel & Restaurant Approval and Classification Committee (HRACC) and acting as subject experts), and Customers[15], [16], [17]. While the study primarily focused on hospitality students, recognizing them as future brand ambassadors who will champion responsible tourism practices across diverse star-category hotels. This section aims discussed the level of awareness and the positive attitudes of hospitality students towards these concepts.

Table 1: Demographic profile of respondent

Category	Frequency		Percent
	Female	Male	
Gender	Female	83	25.8
	Male	239	74.2
Age	19 - 28	295	91.6
	28 - 37	13	4.0

	37 - 46	5	1.6
	46 - 55	5	1.6
	55 and above	4	1.2
Educational Background	Bachelor's Degree	179	55.6
	Doctoral or Professional Degree	16	5.0
	High School or Below	95	29.5
	Master's Degree	32	9.9
	Total	322	100.0

In the context of the survey findings, the demographic distribution of hospitality students plays a vital role in understanding the nuances of their awareness and attitudes towards sustainable practices in star-rated hotels. The significant gender disparity, with 74.2% of respondents identifying as male and 25.8% as female, may contribute to variations in perspectives within the sample. Recognizing the importance of diverse voices in shaping sustainable practices, efforts should be made to include a more balanced representation of gender in future surveys to ensure a comprehensive understanding of the industry's stakeholders. The skewed age distribution, with 91.6% falling between 19 and 28 years, is noteworthy as it indicates a predominantly youthful perspective within the survey sample. Younger respondents might bring a fresh outlook and greater enthusiasm for sustainability initiatives, but it is essential to consider potential differences in experience and exposure to sustainable practices compared to their older counterparts. Expanding the age range of respondents in future surveys would provide a more holistic view of how different age groups within the hospitality student population perceive and prioritize sustainability in star-rated hotels. Regarding educational backgrounds, the majority holding Bachelor's Degrees (55.6%) and a significant proportion with High School or Below qualifications (29.5%) suggests a varied educational landscape within the surveyed group. This diversity in educational backgrounds emphasizes the importance of tailoring sustainability education initiatives to accommodate varying levels of academic exposure. Integrating sustainability-focused content into hospitality education, as indicated by the collective opinion of surveyed students, would address the unique needs of individuals with different educational backgrounds, fostering a more inclusive and informed approach to sustainable practices in the industry.

The statistical analysis of responses from 322 hospitality students indicates a high level of awareness and positive attitudes towards sustainability concepts in the context of star-rated hotels as illustrated in table 1. Test values for statements related to carbon neutrality, net-zero methodology, responsible tourism practices, and the significance of carbon footprint assessment were all highly significant ($p < 0.001$), suggesting a robust understanding among students. The mean differences and confidence intervals further affirm positive attitudes, with participants expressing a belief that achieving carbon neutrality enhances the reputation of star-rated hotels and

recognizing the crucial role of responsible tourism practices in long-term success. Moreover, the study reveals a collective opinion among surveyed students on the need for greater emphasis on teaching responsible practices within hospitality education. The significant test value for this statement suggests a shared perspective that academic curricula should incorporate more sustainability-focused content. This underscores the importance of educational institutions aligning their programs with the industry's growing demand for environmentally conscious practices.

Additionally, the analysis highlights a prevailing sense of personal responsibility among hospitality students to promote sustainability in their future professional roles. The significant test value for the statement on personal responsibility implies that the surveyed students feel accountable for contributing to sustainability efforts within the hospitality industry. This finding aligns with the broader trend of younger generations prioritizing environmental responsibility in their professional endeavours, signalling a positive outlook for the integration of sustainable practices in the future of the hospitality sector.

Table 2: One Sample t-test results

	Test Value = 0					
	t	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
<i>I am aware of the concept of carbon Neutrality in the context of star-rated hotels.</i>	61.169	321	.000	3.9814	3.853	4.109
<i>I am aware the role of net-zero methodology in achieving carbon Neutrality.</i>	63.451	321	.000	3.8789	3.759	3.999
<i>I am familiar with responsible tourism practices in the hospitality industry.</i>	61.612	321	.000	3.8975	3.773	4.022
<i>I know the significance of carbon footprint assessment for star-rated hotels.</i>	58.080	321	.000	3.6832	3.558	3.808
<i>I believe that achieving carbon neutrality enhances the reputation of star-rated hotels.</i>	58.744	321	.000	3.6988	3.575	3.823
<i>Responsible tourism practices are essential for the long-term success of star-rated hotels.</i>	58.237	321	.000	3.7391	3.613	3.865
<i>There should be more emphasis on teaching responsible practices in star-rated hotels within hospitality education.</i>	60.512	321	.000	3.7484	3.627	3.870
<i>As a future hospitality professional, I feel a personal responsibility to promote sustainability in the industry.</i>	62.651	321	.000	3.7826	3.664	3.901

4. Carbon neutrality

Carbon neutrality in star-rated hotels refers to the concept of balancing the amount of carbon dioxide (CO₂) emissions generated by the hotel's operations with an equivalent amount of carbon removal or offsetting activities[18], [19]. The goal is to achieve a net-zero carbon footprint, meaning that the hotel is not contributing to the overall increase in greenhouse gas emissions in the atmosphere[20]. Attaining carbon neutrality stands as a significant societal concern in the contemporary era specifically for hotel industry, as it plays a pivotal role in facilitating the conditions necessary for achieving global temperature goals of 2 °C and 1.5 °C[21]. Previous studies had established a scientific groundwork, providing policymakers with the tools to formulate effective and pragmatic approaches for reducing emissions. The issue of global climate change has gained heightened international attention since the end of the last century. The creation of the UNFCCC in 1992, the Kyoto Protocol in 1997, and the Paris Agreement in 2015 illustrates the growing emphasis on achieving carbon neutrality. Although the notion of carbon neutrality originated in 1997, it garnered considerable scholarly interest in the subsequent years.[22], [23].

The hospitality sector plays a substantial role in greenhouse gas emissions, with yearly energy expenditures surpassing £1.3 billion, leading to the release of more than 8 million tonnes of carbon emissions annually. In response to this environmental impact, the government is applying pressure across industries to curtail emissions, introducing stringent energy regulations like the Energy Savings Opportunity Scheme (ESOS) to stimulate proactive measures. Moreover, the hospitality industry faces increasing scrutiny from both customers and investors, urging the adoption of responsible tourism practices. This has prompted a strategic emphasis on reducing emissions to ensure long-term sustainability, cultivate a positive brand image, and comply with regulatory standards.

4.1. Key sources of carbon emissions in Star-rated hotels

The carbon emissions of the hotel industry arise from diverse sources, categorized into three scopes[25]. Scope 1 emissions are direct and emanate from the building or site itself, predominantly attributed to gas consumption for heating, hot water, and catering purposes. Scope 2 emissions, on the other hand, stem from electricity usage encompassing lighting, heating, cooling, appliances, and catering services. Moving beyond the immediate premises, Scope 3 emissions encompass a broader spectrum, extending to energy not directly consumed by the hotel but utilized indirectly in the provision and use of its services and products. This includes activities such as food production and laundry services, reflecting the interconnected and comprehensive nature of the hotel industry's carbon footprint[14]. Addressing these different scopes through table 3 is crucial for a holistic approach to carbon reduction within the sector.

Table 3: Key sources of carbon emissions in Star-rated hotels

<i>Scope</i>	<i>Category</i>	<i>Hotels</i>
1	Heating and hot water	Boilers, CHP, portable heater, patio heaters, generators fires (gas, coal, wood), etc
	Leaked refrigeration gases	Fridges, Freezers, AC systems, HVAC systems, Cold rooms, Chillers, fire extinguishers, etc
	Vehicles and other mobile equipment	Cars, vans, minibus, shuttlebus, lawnmower, strimmer, plant equipment, grounds maintenance equipment
2	Emissions from Purchased Energy	Electricity from a supplier, Heat or power from a CHP not owned by the business
3	Waste generated in operations	Food, paper, plastic, furniture, WEEE, metal, glass, construction materials, appliances, organic, landfill, uniform, linen, bedding, water etc
	Business travel	Staff movement for meetings, site visits, training or other business-related purposes via motorised transport (train, bus, car, plane, etc) in vehicles not owned or leased by the hotel
	Employee commuting	Staff travel to and from work in vehicles not owned by company
	Transport and deliveries to and from your business	Guest travel arranged by the hotel in taxis, cars, coaches, ferries, planes, not owned or leased by the hotel

	Purchased goods and services	Foods and drinks, office stationery, toiletries, room amenities, linen, uniform, outsourced laundry, gardeners, pest control, internet, software, server hosts tradespeople, etc
	Capital goods	buildings, Furniture, lighting, kitchen equipment, appliances, bedding, IT equipment, decoration/refurbishment vehicles, heating and hot water equipment,
	Use of sold products	Hotel merchandise such as umbrellas, jackets, toiletries, gifts, etc
	End-of-life treatment of sold products	The likely end point of sold products i.e., council recycling centre, landfill etc

4.2. Proposed Model of integration of Responsible Tourism Practices and Net-Zero Methodology in Star-Rated Hotels towards Carbon Neutrality

Achieving carbon neutrality in star-rated hotels involves a comprehensive and interconnected approach. The first key step is conducting a thorough carbon footprint assessment to identify emissions sources. Subsequently, hotels implement emission reduction strategies, emphasizing energy efficiency, waste management, and renewable energy sources. However, recognizing the challenge of complete neutrality, hotels then invest in carbon offset projects like reforestation to compensate for remaining emissions. This integrated approach allows star-rated hotels to work towards a net-zero carbon footprint, aligning with global sustainability objectives.

To further enhance sustainability, responsible tourism practices are crucial. Sustainable procurement and supply chain management contribute to reducing the carbon footprint associated with transportation, advocating for local and eco-friendly sourcing. Additionally, transparent communication and stakeholder engagement play vital roles in fostering a culture of environmental responsibility. Internal training programs educate hotel staff on sustainable practices, creating a workforce committed to energy conservation and waste reduction. External communication informs guests, employees, and stakeholders about the hotel's commitment to carbon neutrality and responsible tourism, contributing to a more sustainable and environmentally conscious hospitality industry[28], [29].

The link between responsible tourism practices and net-zero methodology lies in their shared goal of minimizing environmental impact. Responsible tourism, through sustainable procurement and supply chain practices, complements net-zero methodology by reducing indirect emissions associated with the supply chain. Moreover, stakeholder engagement and communication in responsible tourism align with the transparent communication required in the net-zero methodology. By integrating these approaches, star-rated hotels can successfully navigate the complexities of achieving carbon neutrality, appealing to environmentally conscious customers and contributing to the broader sustainability goals of the hospitality industry[30], [31].

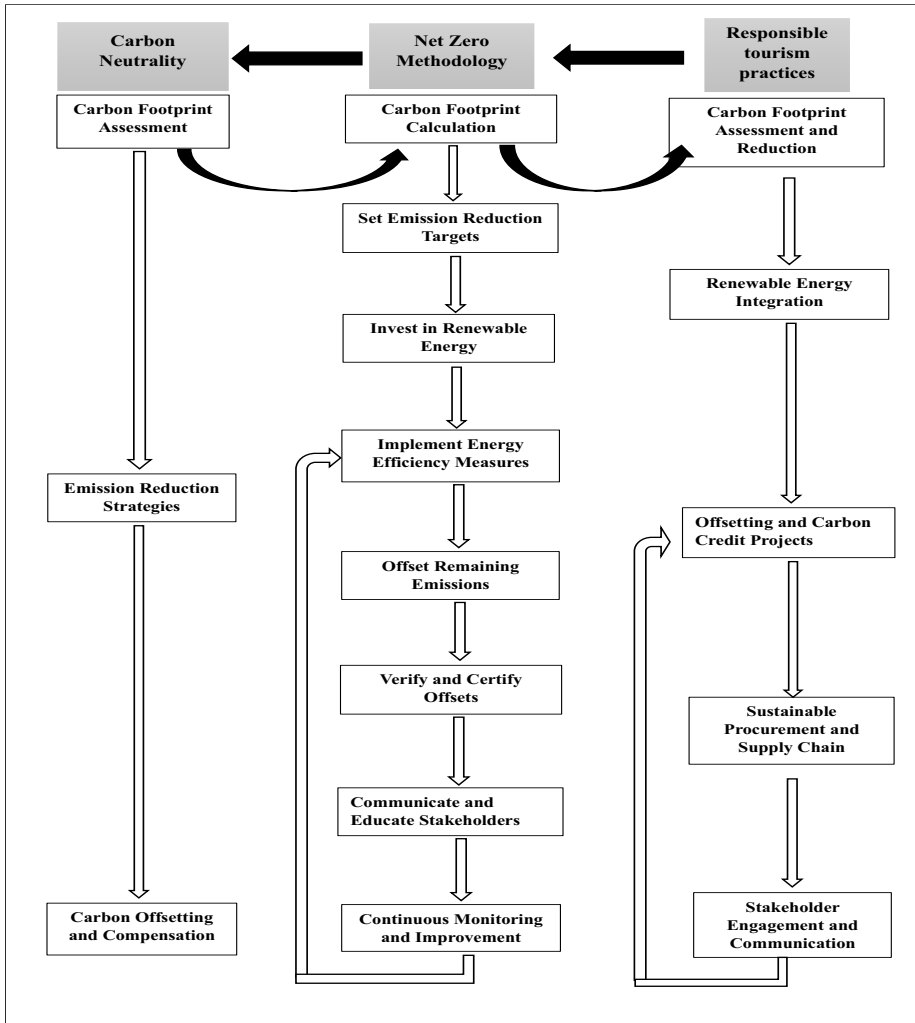


Fig 1. Proposed Model of integration of Responsible Tourism Practices and Net-Zero Methodology

5. Net Zero Methodologies employed in star-rated hotels for achieving carbon neutrality

The pursuit of carbon neutrality in star-rated hotels involves the implementation of various Net Zero Methodologies to mitigate the environmental impact of their operations[32]. Energy efficiency measures form a cornerstone, encompassing the adoption of technologies such as LED lighting, smart HVAC systems, and energy-efficient appliances[33], [34], [35], [36]. This initial focus on energy efficiency sets the stage for a holistic approach to sustainability, laying the foundation for other interconnected strategies. Renewable energy integration is another crucial aspect of achieving carbon neutrality[33], [37], [38], [39]. By incorporating on-site renewable energy sources like solar panels, wind turbines, and geothermal systems, hotels can generate clean energy, thereby offsetting their reliance on conventional, carbon-intensive power sources. This synergy between energy efficiency and renewable energy not only reduces carbon emissions but also aligns with the broader goal of creating a self-sustaining and environmentally responsible hotel environment[33].

To address unavoidable emissions, Carbon offsetting is set to be a crucial element in the hotel and broader travel industry's journey toward achieving net-zero emissions[40]. Although it has its limitations and critics, especially from certain stakeholders, carbon offsetting remains a significant tool, particularly for activities where fossil fuel alternatives are lacking, until at least 2030[41]. When implemented effectively, carbon offsetting can not only reduce carbon footprints but also bring about positive outcomes such as creating alternative livelihoods for people and supporting biodiversity, aligning with the UN Sustainable Development Goals (SDGs). Hotels are participating in initiatives such as reforestation projects or support renewable energy initiatives externally. This approach allows them to compensate for emissions that are challenging to eliminate entirely within the hotel's operations, contributing to a balanced carbon equation. The combination of internal efforts and external offsets represents a comprehensive strategy to neutralize the overall carbon impact. The trend of carbon offsetting is expected to grow in voluntary markets, as evidenced by the increasing adoption of carbon offsetting practices in consumer products and services, particularly within the travel sector. The unique potential of carbon offsetting in the travel industry lies in its alignment with the principles of sustainable tourism, emphasizing environmentally friendly practices, the preservation of natural and cultural heritage, and the generation of social and economic benefits for local communities[42].

Waste reduction and recycling initiatives are essential components of a Net Zero Methodology. By implementing comprehensive waste management strategies, including recycling programs and minimizing single-use plastics, hotels can curtail the environmental impact of their waste generation, aligning with broader sustainability goals. This approach creates a closed-loop system, where waste is minimized, reused, or recycled, further reducing the hotel's overall ecological footprint. Sustainable building design is a key consideration in achieving carbon neutrality. Incorporating eco-friendly materials, green roofs, and energy-efficient

architecture contributes to reducing the overall carbon footprint of hotel infrastructure. The integration of these design principles not only enhances energy efficiency but also aligns with the overarching objective of creating environmentally responsible and sustainable accommodations. It represents a symbiotic relationship between the physical structure of the hotel and its commitment to environmental stewardship[43], [44], [45].

Water conservation measures are critical for minimizing resource consumption. Implementing water-saving technologies, such as low-flow fixtures and smart irrigation systems, enables hotels to reduce water usage significantly. This not only contributes to environmental sustainability but also aligns with broader efforts to address water scarcity concerns. The focus on water conservation complements the broader goal of resource efficiency, creating a comprehensive approach to sustainability within the hotel industry. Providing sustainable transportation options is an integral part of a comprehensive Net Zero Methodology. Hotels can offer services such as electric vehicle charging stations, bicycle rentals, and shuttle services with low-emission vehicles, encouraging guests to choose eco-friendly transportation methods and reducing the overall carbon footprint associated with travel. This approach extends the hotel's commitment to sustainability beyond its physical premises, actively engaging guests in responsible and low-impact travel practices[43], [44], [46].

Green certification standards provide a framework for ensuring that hotels adhere to recognized sustainability benchmarks. Certifications such as LEED or BREEAM set industry-accepted standards, guiding hotels in their pursuit of carbon neutrality and providing a transparent measure of their commitment to environmental responsibility. These standards serve as a roadmap, ensuring that hotels adhere to established best practices and contribute to a collective industry effort towards sustainable and responsible tourism. Stakeholder engagement and education are crucial for fostering a culture of sustainability within the hotel environment. By involving both staff and guests through awareness campaigns, training programs, and engagement activities, hotels can create a shared commitment to environmental responsibility, ensuring that sustainability is embedded in the organizational culture. This emphasis on stakeholder involvement establishes a sense of shared responsibility, creating a collective effort towards achieving sustainability goals[47], [48].

Continuous monitoring and reporting are essential for the ongoing success of Net Zero Methodologies. Robust monitoring systems allow hotels to track key sustainability metrics, enabling them to assess progress, identify areas for improvement, and adapt their strategies accordingly. Regular reporting further enhances transparency and accountability, demonstrating a commitment to continuous improvement in achieving carbon neutrality. This iterative process of monitoring and reporting forms a feedback loop, driving continuous refinement and optimization of sustainability efforts within the hotel industry[47], [49].

6. Responsible tourism practices and carbon neutrality

Responsible tourism practices play a pivotal role in the overarching goal of achieving carbon neutrality in star-rated hotels[7], [50], [51], [52]. One key practice is the emphasis on local sourcing and sustainability in supply chains. By prioritizing locally sourced, organic, and sustainable products for hotel operations, including food, amenities, and furnishings, hotels can reduce carbon emissions associated with transportation. This practice not only supports local economies but also aligns with the broader commitment to responsible tourism by minimizing the hotel's environmental footprint. Complementing this approach, the implementation of green meetings and events represents another responsible tourism practice contributing to carbon neutrality. Beyond individual stays, hotels can extend their commitment to sustainability by incorporating eco-friendly practices for conferences and events. This includes minimizing waste, offering sustainable catering options, and encouraging attendees to use eco-friendly transportation, creating a more sustainable overall experience for guests and reducing the carbon impact of events[49], [53], [54], [55].

Community engagement and empowerment are integral responsible tourism practices that contribute to the achievement of carbon neutrality. By involving and empowering local communities through partnerships, job opportunities, and community development initiatives, hotels ensure that tourism benefits the host community. This positive relationship fosters a sense of shared responsibility and aligns with the broader goal of responsible and sustainable tourism. Biodiversity conservation and natural habitat preservation represent essential responsible tourism practices with direct implications for carbon neutrality. Implementing measures to protect and preserve local biodiversity, natural habitats, and ecosystems, such as wildlife conservation programs and habitat restoration efforts, contributes to overall environmental stewardship. This holistic approach recognizes the interconnectedness of environmental factors and reinforces the commitment to carbon neutrality[56], [57].

Water conservation and management strategies are critical responsible tourism practices that align with carbon neutrality objectives. Implementing water-saving technologies and practices, such as rainwater harvesting, efficient irrigation, and guest education on water conservation, not only minimizes the hotel's impact on local water resources but also contributes to resource efficiency, reinforcing the sustainability ethos. In the context of responsible tourism and carbon neutrality, hotels are further advancing their commitment by providing carbon-neutral transportation services. This practice involves offering sustainable transportation options for guests, such as electric vehicle fleets, shuttle services with low-emission vehicles, or partnerships with eco-friendly transportation providers. By encouraging sustainable travel, hotels extend their impact beyond the property, actively contributing to overall carbon reduction[58], [59].

Sustainable architecture and design practices also play a crucial role in the pursuit of carbon neutrality. By incorporating environmentally friendly design principles in hotel renovations and new constructions, including energy-

efficient building materials and eco-friendly landscaping, hotels minimize their environmental impact from the ground up. This responsible approach aligns with the broader goal of creating sustainable accommodations. Waste reduction and circular economy practices contribute significantly to both responsible tourism and carbon neutrality. Adopting strategies such as composting, recycling programs, and the use of biodegradable or recyclable packaging minimizes landfill waste, promoting a circular economy where materials are reused, recycled, or repurposed. This approach addresses environmental sustainability on multiple fronts[60].

Guest education and awareness programs are key responsible tourism practices that directly impact carbon neutrality efforts. By engaging guests through educational materials, in-room literature, and interactive programs, hotels can promote responsible tourism practices, including energy and water conservation, waste reduction, and local cultural sensitivity. Informed and conscientious guests become active participants in the hotel's sustainability initiatives. Finally, seeking and maintaining certification from recognized sustainable tourism programs is a foundational responsible tourism practice. Certifications from programs such as Earth Check or Green Key demonstrate a commitment to responsible tourism and adherence to established environmental and social standards. Certification serves as a tangible indicator of the hotel's dedication to sustainability and reinforces its journey toward carbon neutrality[59], [60], [39].

7. Conclusion

In conclusion, this study delved into the realm of sustainability awareness and attitudes among hospitality students, shedding light on their understanding of crucial concepts such as carbon neutrality, net-zero methodology, responsible tourism practices, and the significance of carbon footprint assessment. The findings illuminate the need for enhanced education and awareness initiatives within hospitality curricula. Furthermore, the investigation into star-rated hotels' pursuit of carbon neutrality revealed valuable insights, notably through the proposed diagram illustrating key sources of carbon emissions within their operations. Additionally, the study explored how these establishments leverage Net Zero Methodologies and responsible tourism practices to achieve carbon neutrality, underlining the importance of integrating sustainable practices into the core of the hospitality industry. These multifaceted analyses contribute to a comprehensive understanding of sustainability efforts within the sector, offering valuable guidance for both educational institutions and hospitality businesses aiming to align with environmentally conscious practices.

7.1. Are net-zero hotels' goals realistic?

Achieving net-zero goals in star-rated hotels is indeed realistic, supported by a multifaceted approach known as the Balancing Act. This comprehensive strategy integrates Carbon Neutrality through Net Zero Methodology and Responsible Tourism Practices, leveraging various factors to make sustainable initiatives achievable for the hospitality industry. Technological advancements, such as more accessible renewable energy and energy-efficient technologies, contribute to the

feasibility of net-zero goals by making these solutions economically viable[48]. The industry's responsiveness to consumer demand for eco-friendly accommodations, coupled with the influence of green certifications and favourable regulatory environments, further propels hotels towards adopting sustainable practices[59]. Notably, successful case studies of star-rated hotels embracing net-zero initiatives, coupled with the potential for long-term cost savings and innovative partnerships, collectively emphasize the realistic nature of these ambitious sustainability goals[60].

The Balancing Act recognizes that achieving net-zero status is not only an environmental imperative but also a strategic business decision. The integration of responsible tourism practices aligns with the growing market demand for sustainable accommodations, enhancing the marketability and reputation of star-rated hotels. As technology continues to evolve, providing advanced monitoring solutions for efficient resource management, hotels can strategically navigate the complexities of sustainability. The intersection of economic viability, consumer preferences, industry standards, and technological innovation underscores the realistic potential of net-zero goals, positioning star-rated hotels as leaders in responsible tourism and environmental stewardship.

7.2. Can Luxury and sustainable Responsibility Coexist in the Hospitality Industry?

Net-zero methodologies play a crucial role in advancing the discourse on sustainable hospitality, particularly within the context of star-rated hotels. As beacons of luxury and comfort, these establishments are often associated with heightened resource consumption and environmental impact. However, by embracing net-zero methodologies, star-rated hotels can redefine the narrative, offering a roadmap that aligns opulence with environmental responsibility. The comprehensive eight-step process, encompassing carbon footprint assessment, emission reduction, and carbon offsetting, provides a structured approach for these hotels to quantify, minimize, and neutralize their environmental footprint. By transparently communicating their commitment to net-zero carbon footprints, star-rated hotels can position themselves as leaders in sustainable hospitality, addressing the expectations of socially conscious guests while contributing to the broader global effort to combat climate change.

This roadmap not only transforms operational practices but also reshapes the luxury narrative within the hospitality industry. Star-rated hotels can showcase that environmental responsibility is not antithetical to luxury; rather, it enhances the overall guest experience. Investments in renewable energy, energy efficiency, and responsible tourism practices not only contribute to carbon neutrality but also set a new standard for luxury that is aligned with contemporary values of sustainability. By embracing net-zero methodologies, star-rated hotels can pave the way for a paradigm shift in the industry, proving that luxury and environmental stewardship can coexist harmoniously, ultimately influencing consumer preferences and setting a positive example for the broader hospitality sector.

7.3. Action or greenwashing?

In the pursuit of achieving carbon neutrality in star-rated hotels, distinguishing between genuine actions and greenwashing is essential to evaluate the sincerity of a hotel's commitment to sustainability. Genuine actions align with the implementation of renewable energy sources on-site, such as solar panels and wind turbines, directly contributing to reducing the hotel's carbon footprint. Additionally, hotels obtaining certifications from recognized sustainable tourism programs, such as LEED or Green Key, provide tangible evidence of their commitment to established environmental standards, reinforcing the authenticity of their sustainability efforts like ITC properties have achieved the distinction of being the inaugural 12 hotels worldwide to receive LEED Zero Carbon certification.

On the other hand, greenwashing practices may manifest through vague sustainability claims, lacking specific details or certifications. Hotels engaging in greenwashing might implement token green initiatives that have minimal impact on overall carbon reduction, creating an illusion of sustainability without substantive action. Misleading marketing language is another red flag for greenwashing, as hotels may use ambiguous or exaggerated terms to convey a false sense of environmental responsibility. Lack of external verification, such as claiming carbon neutrality without certification from recognized programs, raises suspicions about the legitimacy of a hotel's sustainability claims. To align with the principles of responsible tourism and genuine carbon neutrality, hotels must prioritize transparency, adopt comprehensive strategies, and seek external validation through reputable certifications. Genuine actions involve a holistic approach addressing energy efficiency, responsible sourcing, waste reduction, and community engagement. Conversely, greenwashing practices are characterized by superficial or deceptive measures that merely create an illusion of sustainability without substantial, measurable impact. Careful scrutiny and adherence to recognized standards are crucial in ensuring that hotels are genuinely committed to the "Balancing Act" and are not merely engaging in greenwashing tactics.

7.4. Theoretical Implications

The theoretical implications of this research are multifaceted and contribute significantly to our understanding of achieving carbon neutrality in star-rated hotels. The proposed integration of Net Zero Methodology and Responsible Tourism Practices forms a novel theoretical framework, showcasing their synergistic potential in addressing both operational emissions and broader environmental and social responsibilities. The concept of a "Balancing Act" emphasizes the intricate balance required between providing luxurious accommodations and minimizing environmental impact, offering a theoretical lens applicable to diverse industries. Investigating the awareness and attitudes of hospitality students contributes theoretically by providing insights into the mindset of future industry professionals, informing educational programs and training initiatives. The identification of key sources of carbon emissions through a proposed diagram offers a visual representation for targeted interventions. Additionally, the emphasis on practical solutions and the

impact of sustainability initiatives on consumer decision-making adds theoretical value, guiding businesses in various sectors toward environmentally responsible practices while meeting evolving consumer preferences. Overall, these theoretical contributions provide a comprehensive framework for the transformation of businesses into sustainable entities, extending beyond the hospitality sector.

7.5. Practical implications

This research on achieving carbon neutrality in star-rated hotels by integrating Net Zero Methodology and Responsible Tourism Practices offers practical implications for various stakeholders. Hotel owners and managers can gain valuable insights into implementing sustainable measures without compromising service quality. Educational institutions can use the findings to enhance hospitality curricula and training programs, aligning them with industry sustainability expectations. Policymakers can develop regulations and incentives to promote carbon-neutral practices. Eco-conscious consumers can make informed choices, and hotels can market their sustainability efforts. Investors may find opportunities in supporting sustainable projects, and industry associations can develop benchmarking and certification programs. The research also emphasizes continuous improvement, collaboration, and points towards future research avenues in the pursuit of responsible tourism.

7.6. Limitations and Future scope of research

While this study sheds light on carbon neutrality, net zero methodology and responsible tourism concepts and practices in the hospitality industry, certain limitations and opportunities for future research should be acknowledged. The findings have limited generalizability, primarily focusing on hospitality students' perspectives and potentially not representing the broader stakeholder landscape. Regional variations and cultural influences on awareness and implementation of carbon neutrality measures are aspects that could be further explored to provide a more nuanced understanding. The proposed diagrams simplifying the processes of achieving carbon neutrality in star-rated hotels may lack depth, and potential self-reporting biases in data collection methods should be considered. Future research could involve longitudinal studies to track evolving awareness and attitudes, comparative analyses among different stakeholders, cross-cultural examinations, exploration of technological advancements, impact assessments of sustainability initiatives, policy analyses, and in-depth studies on consumer behaviour to enhance our understanding and guide the transformation of the hospitality industry toward increased environmental responsibility.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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