Balancing Guest Requirements and Sustainability: A QFD approach for Designing Sustainable Hotel Services

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Abstract

This study introduces a decision-making framework for the hotel industry, integrating customer requirements (Voice of the Customer) with sustainability goals using a Quality Function Deployment (QFD) approach. The framework, built around a two-phase process, incorporates both conventional and sustainability-driven criteria to enhance service quality while promoting environmental and social responsibility. Employing the QFD-LP-GW-Fuzzy AHP methodological approach, the framework equips hotel managers with advanced tools to handle complex, subjective judgments, enhancing alignment between guest requirements and sustainability practices. The contribution of this framework is its ability to systematically embed sustainability into hotel operations, providing a structured, data-driven approach that balances guest satisfaction with long-term sustainability. This approach offers a practical solution for advancing sustainable service design in the hotel sector, empowering decision-makers to make informed trade-offs between business, environmental, and social goals.

Keywords: QFD, Fuzzy AHP, hotel service design, sustainability practices, sustainable services

Track: Marketing and Sustainability

1. Introduction

The pursuit of sustainability has become a central theme in global policy initiatives, most notably through the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs), which emphasize the adoption of sustainable practices across all sectors. Among these sectors, tourism- with its extensive reach- offers a unique opportunity to promote sustainable practices on a global scale, contributing significantly to these goals (Abdou *et al.*, 2020). However, while tourism can drive progress, it also poses substantial risks to environmental integrity, social cohesion, and economic balance if sustainability is not prioritized in its management. For hotels, adopting sustainable practices delivers two key benefits: enhancing resource efficiency -especially in terms of energy and water use- and serving as a powerful marketing tool to attract sustainability-conscious customers (Abdou *et al.*, 2020). Research shows that sustainability practices not only shape customer perceptions but also have a direct influence on their decision-making processes (Xu & Gursoy, 2015). As a result, the design of sustainable tourism services must strike a delicate balance between delivering high-quality tourist experiences and embedding sustainability principles into every facet of operations (Maxwell & Van der Vorst, 2003; Ahmad *et al*., 2018). Yet, existing studies underscore a critical gap in the hotel industry, emphasizing the lack of a framework that seamlessly integrates sustainability principles with business decision-making processes (Calisto *et al*., 2021).

In response to these challenges, this study introduces a comprehensive Quality Function Deployment (QFD) framework designed to guide the development of sustainable hotel services. One of the key strengths of the QFD method is its ability to view customers as co-creators in the service experience, emphasizing the importance of aligning customer preferences with organizational goals throughout the service development process (Vargo *et al.,* 2010). QFD systematically translates the Voice of the Customer (VoC) into actionable design goals, that customer insights are incorporated at every stage of service development (Kamvysi *et al*., 2023). By fostering a culture of continuous improvement and enabling cross-functional collaboration, QFD helps service providers navigate the complexities of sustainable decision-making, allowing them to make informed trade-offs between business, environmental, and social goals (Sousa-Zomer & Miguel, 2017).

Specifically, the proposed QFD decision framework integrates both conventional customer requirements (VoC) and sustainability parameters, guaranteeing a consistent and cohesive design process. By incorporating customer preferences alongside sustainability criteria, the framework provides a balanced approach that accounts for the dual priorities of guest satisfaction and social and environmental responsibility. To effectively manage these diverse factors, the framework leverages the QFD-LP-GW-Fuzzy AHP methodological approach (Kamvysi *et al.*, 2014), an advanced decision-making tool specifically designed to handle the complexities of multicriteria decision-making**.** This methodological approach equips decision-makers with the ability to capture the true VoC and prioritize uncertain and subjective judgments, ensuring that the competing demands of customer requirements and sustainability goals are aligned. Thus, this comprehensive approach addresses the need for high-quality tourism experiences but also reinforces the commitment to sustainability, fostering the development of sustainable hotel services that deliver value to all stakeholders. Its ability to integrate customer-centric solutions with long-term sustainability goals positions it as a valuable tool in advancing the sustainable development of the hotel sector.

2. The Two-Phase QFD Decision Framework for the Hotel Industry

This study presents a decision-making framework based on QFD, specifically tailored for the hotel industry. The framework's goal is to provide tourism organizations with practical insights to deliver high-quality services while embedding sustainability at every operational

level. Built around a two-phase process, anchored in two interconnected Houses of Quality (HOQs), the framework offers a comprehensive approach to improve service design in the hotel sector. As illustrated in Figure 1, the two phases work in tandem to serve as a roadmap for enhancing both service quality and sustainability in hotel operations, a balance increasingly demanded by both consumers and industry standards.

The first step in the process involves collecting the VoC for the first HOQ. This vital step recognizes the key factors influencing customer decisions when selecting hotels. These factors encompass both conventional and sustainability-driven criteria. By capturing customer preferences, the framework ensures that the service design is informed by the actual needs and desires of the target audience. The next step focuses on prioritizing these hotel selection criteria and translating them into specific aspects of hotel management. Ranking hotel management aspects based on customer-driven data allows hotel management to allocate resources effectively, prioritizing areas that maximize both customer satisfaction and sustainability impact.

In the second phase (HOQ 2), the framework uses the prioritized management aspects to identify specific sustainable hotel practices. This phase is critical, as it ensures that sustainability practices are not treated as an afterthought but are embedded systematically into the hotel's operational decisions. By assigning priorities to these practices, the framework helps decision-makers determine which sustainability initiatives will provide the greatest value, both in terms of customer satisfaction and long-term environmental and social impact. Additionally, by facilitating informed trade-offs between competing demands, the framework provides a practical, data-driven approach for hoteliers to balance the dual goals of service excellence and sustainability.

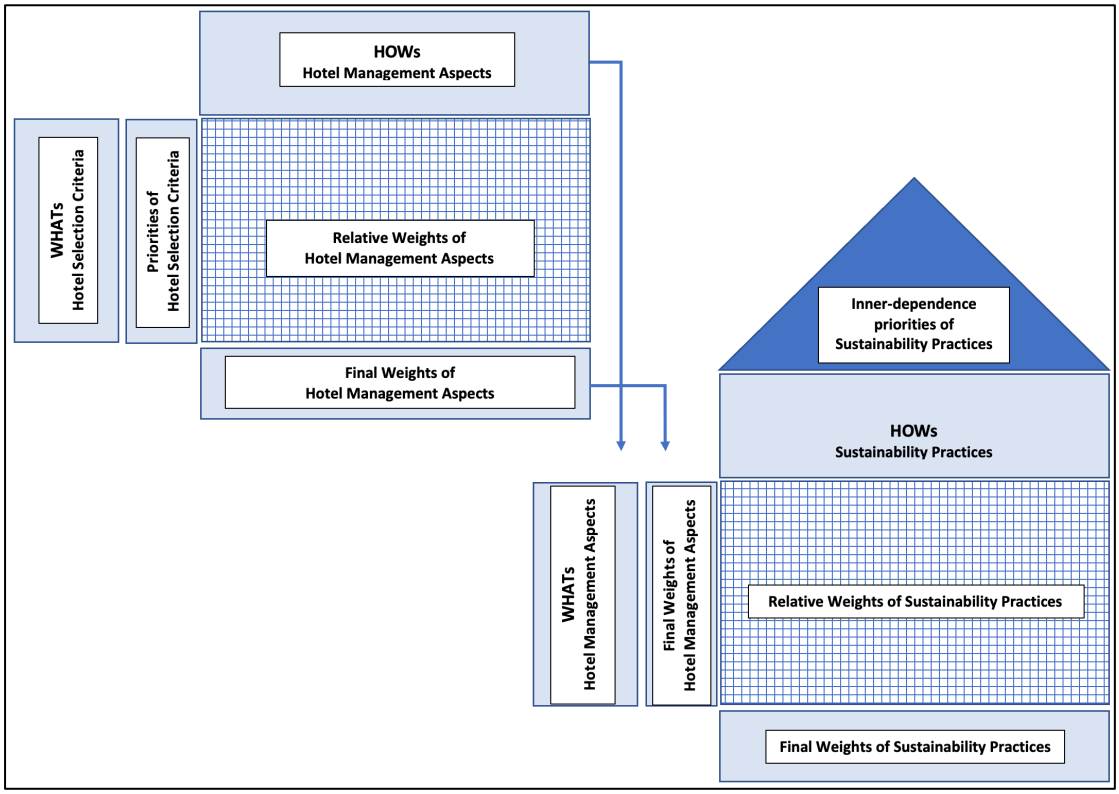


Figure 1. The two-phase QFD framework for the hotel industry

3. Developing the HOQs for Sustainable Service Design

3.1 The first HOQ

The first HOQ of the proposed QFD decision framework is designed to connect customer insights directly to hotel management decisions by incorporating both customer preferences and managerial expertise. In this phase, the hotel selection criteria represent the "WHATs", while the hotel management aspects the "HOWs", setting the foundation for sustainable and high-quality service design. The QFD-LP-GW-Fuzzy AHP methodological approach treats HOQs as multicriteria decision problems. As such, the first HOQ is structured into three hierarchical levels: customer satisfaction as the "goal", hotel selection criteria as the "criteria", and hotel management aspects as the "alternatives" (Figure 2). This structured approach ensures a clear alignment between what customers value and how hotels can effectively deliver those values through targeted management actions.

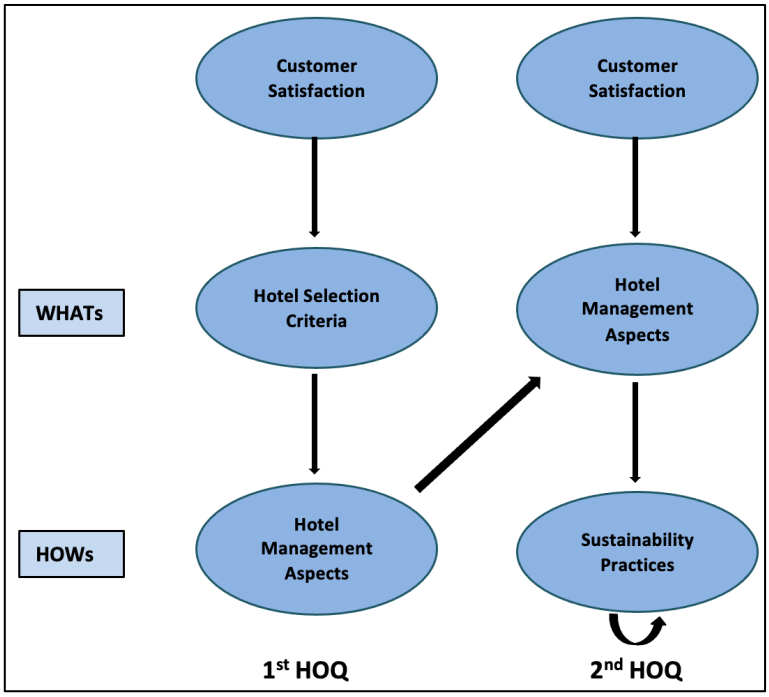


Figure 2. The decision hierarchies of the first and second HOQ

The process of identifying hotel selection criteria began with a review of relevant literature and data from hotel booking and review platforms (e.g., Chen, 2015; Lee *et al*., 2010; Njite & Schaffer, 2017; Verma & Chandra, 2018). A focus group, made up of three hospitality management academics and three experienced hotel managers, was then established to blend both academic insights and practical industry knowledge. Using the affinity diagram technique, the group sorted the criteria into seven major categories: "Room Amenities and Hotel Physical Facilities", "Location", "Conformance-Encounter Quality", "Food & Beverages Quality and Variety", "Pricing and Perceived Value", "Environmental Responsibility", and "Social Responsibility". In a follow-up session, these categories were further translated into five key hotel management areas: "Physical Property Management", "Food & Beverages Management", "People Management", "Process Management", and "Communication Management".

A customer survey was conducted to prioritize the hotel selection criteria, using a stratified random sampling method to ensure a diverse and representative sample. Responses were collected through a self-administered AHP questionnaire from guests who had stayed in

3- to 5-star hotels within the past year. Participants rated pairs of criteria on a 9-point AHP scale (Table 1). To address uncertainties in the responses, the data were converted into fuzzy preferences, and the LP-GW-Fuzzy AHP methodology was applied to rank the criteria accurately.

Table 1. Crisp AHP scale and Fuzzy AHP scale

Linguistic variables	AHP Scale	Fuzzy AHP Scale	
		TFNs	Reciprocal TFNs
Equally important	1	(1,1,1) if diagonal (1,1,2) otherwise	(1,1,1) (1/2,1,1)
Intermediate	2	(1,2,3)	(1/3,1/2,1)
Moderately more important	3	(2,3,4)	(1/4,1/3,1/2)
Intermediate	4	(3,4,5)	(1/5,1/4,1/3)
Strongly more important	5	(4,5,6)	(1/6,1/5,1/4)
Intermediate	6	(5,6,7)	(1/7,1/6,1/5)
Very strongly more important	7	(6,7,8)	(1/8,1/7,1/6)
Intermediate	8	(7,8,9)	(1/9,1/8,1/7)
Extremely more important	9	(8,9,10)	(1/10,1/9,1/8)

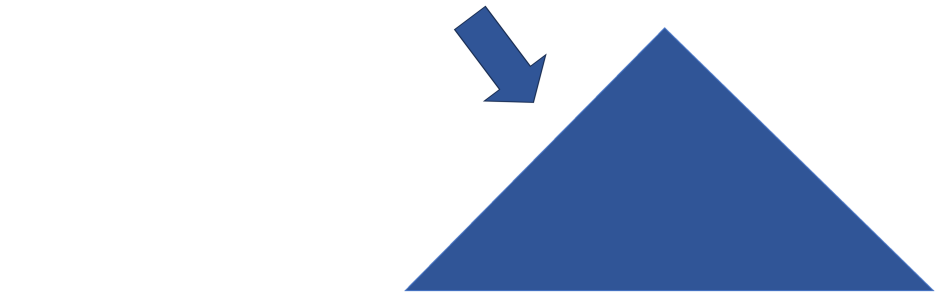
Following this, a field survey was conducted to assess the strength of relationships between hotel selection criteria and management aspects and complete the Relationship Matrix of the first HOQ. The purpose of this survey was to identify key management areas critical for meeting hotel selection criteria. Data was collected through structured interviews with 15 senior hotel managers, chosen through purposive sampling to ensure a diverse range of expertise. The questionnaire, pre-tested and aligned with AHP standards, required managers to make pairwise comparisons of management aspects and evaluate their significance in meeting each criterion. The managers' responses were transformed into fuzzy preferences (Table 1), and the LP-GW-Fuzzy AHP method was used to determine both the relative and final weights of each hotel management aspect and complete the first HOQ (Figure 3).

Hotel Selection Criteria	Hotel Selection Criteria Priorities %	Hotel Management Aspects				
		Physical Property Management	Food & Beverages Management	People Management	Process Management	Communication Management
Conformance-Encounter Quality	**17.20**	0.0668	0.0918	0.4045	0.3981	0.0388
Price & Perceived Value	**24.40**	0.4469	0.0835	0.0417	0.3436	0.0843
Room Amenities & Hotel Physical Facilities	**19.58**	0.6643	0.1016	0.0650	0.1153	0.0539
Food & Beverages Quality and Variety	**6.38**	0.0403	0.6368	0.0990	0.1832	0.0408
Location	**18.87**	0.2779	0.2202	0.1729	0.1643	0.1647
Environmental Responsibility	**6.64**	0.5539	0.1954	0.0399	0.0833	0.1275
Social Responsibility	**6.93**	0.4946	0.1259	0.1441	0.1167	0.1186
Final Weights %		**37.67**	**15.99**	**14.41**	**23.12**	**8.82**

Figure 3. The first HOQ of the two-phase QFD framework

3.2 The second HOQ

Sustainability Practices	Natural Resources Conservation Practices (Energy, Water)	Recycling and Waste Reduction Practices	Health and Safety Practices for Indoor Spaces and Materials	Local Community Support and Awareness Practices	Staff/Clients Training and Awareness Raising Practices	Green Certification/ Environmental Management System
Natural Resources Conservation Practices (Energy, Water)	0.0000	0.2551	0.2176	0.0305	0.1502	0.3466
Recycling and Waste Reduction Practices	0.2062	0.0000	0.2047	0.0303	0.2239	0.3350
Health and Safety Practices for Indoor Spaces and Materials	0.1160	0.1651	0.0000	0.0410	0.1332	0.5447
Local Community Support and Awareness Practices	0.2471	0.2077	0.0779	0.0000	0.1834	0.2838
Staff/Clients Training and Awareness Raising Practices	0.3049	0.2685	0.0630	0.1070	0.0000	0.2559
Green Certification/ Environmental Management System	0.3148	0.2371	0.2294	0.1210	0.0977	0.0000



Hotel Management Aspects	Hotel Management Aspects Final Weights %	Sustainability Practices					
		Natural Resources Conservation Practices (Energy, Water)	Recycling and Waste Reduction Practices	Health and Safety Practices for Indoor Spaces and Materials	Local Community Support and Awareness Practices	Staff/Clients Training and Awareness Raising Practices	Green Certification/ Environmental Management System
Physical Property Management	**37.67**	0.2626	0.1116	0.4731	0.0328	0.0275	0.0924
Food & Beverages Management	**15.99**	0.1558	0.0789	0.0701	0.4371	0.0472	0.2109
People Management	**14.41**	0.0457	0.0444	0.049	0.3817	0.3535	0.1257
Process Management	**23.12**	0.1015	0.0414	0.0774	0.0575	0.1806	0.5415
Communication Management	**8.82**	0.0665	0.0526	0.0439	0.5419	0.2432	0.0519
Final Weights %		**19.82**	**20.47**	**12.36**	**5.64**	**12.74**	**28.95**

Figure 4. The second HOQ of the two-phase QFD framework

Subsequently, the prioritized hotel management aspects act as "WHATs" in the second HOQ, guiding the selection of suitable sustainability practices ("HOWs") (Figure 4). This HOQ follows as a three-level AHP hierarchy, with interdependencies highlighted in the alternatives cluster (Figure 2). The three levels of the hierarchy are: customer satisfaction as the "goal", hotel management aspects as the "criteria" and sustainability practices as the "alternatives".

Afterward, sustainability practices were identified through a thorough literature review (e.g., Han *et al*., 2018; Kularatne *et al*., 2019; Mbasera *et al.,* 2016; Trang *et al*., 2019). The focus group members then used affinity diagrams to classify these practices into six key categories: "Natural Resources Conservation Practices (Energy, Water)", "Recycling and

Waste Reduction Practices", "Health and Safety Practices for Indoor Spaces and Materials", "Local Community Support and Awareness Practices", "Staff/Clients Training and Awareness Raising Practices" and "Green Certification/ Environmental Management System".

Structured interviews with 15 senior hotel managers, who were selected through purposive sampling, provided data to finalize the Relationship Matrix and uncover the key sustainability practices. The AHP questionnaire, pre-tested for reliability, prompted managers to engage in pairwise comparisons of sustainability practices, evaluating their relevance to various management areas and determining the strength of their relationships. This approach ensured a comprehensive assessment of how each practice influenced hotel operations. The LP-GW-Fuzzy AHP method was then used to calculate the relative weights of the practices, based on the managers' preferences, which had initially been transformed into fuzzy numbers.

The process of completing the Roof Matrix involved senior managers evaluating the interconnections between sustainability practices in a third round of structured interviews. Managers worked through an AHP-based questionnaire, making pairwise comparisons of the practices, and considering each one's implementation individually. After converting their crisp preferences into fuzzy values, the LP-GW-Fuzzy AHP method was used again to calculate interdependence priorities and final weights, finalizing the second HOQ (Figure 4).

3.3 The QFD-LP-GW-Fuzzy AHP methodological approach

The QFD-LP-GW-Fuzzy AHP methodological approach utilizes Fuzzy AHP to handle the uncertainty and subjectivity in decision-making, improving the accuracy and reliability of QFD input data (WHATs). Additionally, it replaces the eigenvalue method with linear programming (LP) principles, which improves precision in the prioritization and weighting process. Figure 5 outlines the algorithmic steps for implementing the QFD-LP-GW-Fuzzy AHP. A detailed explanation of how to calculate priorities and determine relative and final weights using this method, however, is beyond the scope of this paper.

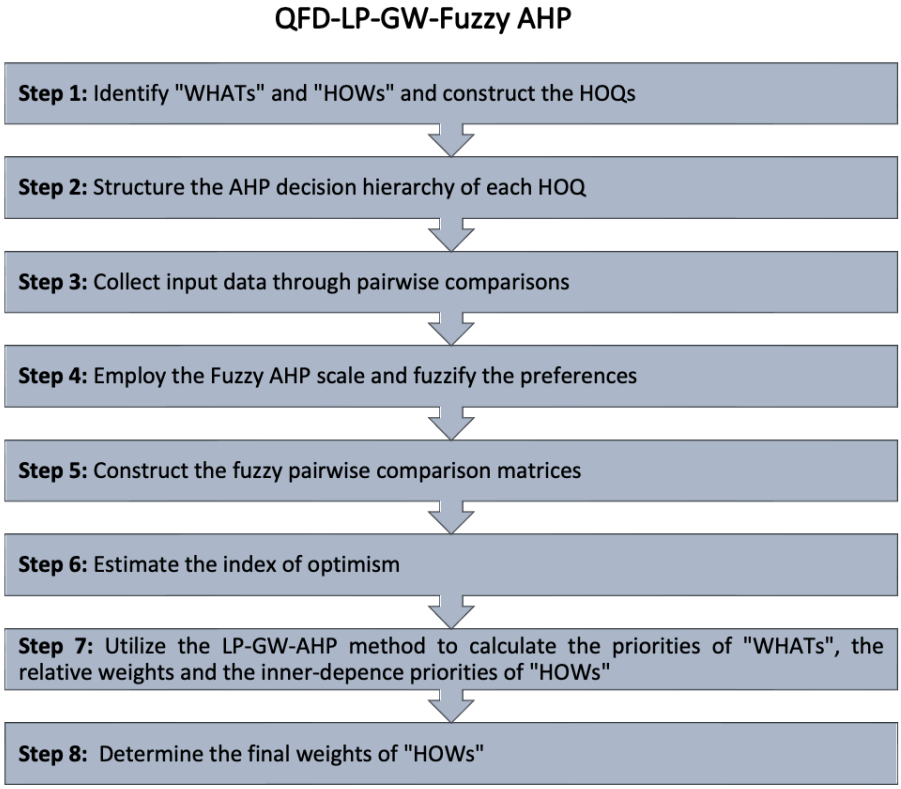


Figure 5. The algorithmic steps of the QFD-LP-GW-Fuzzy AHP

4. Results

The QFD-LP-GW-Fuzzy AHP methodological approach produced a detailed ranking of hotel selection criteria, highlighting distinct customer preferences (Table 2). "Price and Perceived Value" ranked highest, accounting for 24.40% of the total weight. This finding aligns with previous studies (e.g., Caber & Albayrak, 2014; Njite & Schaffer, 2017), which also emphasized the importance of price in customer decision-making. Closed behind were "Room Amenities and Hotel Physical Facilities" (19.58%), "Location" (18.87%) and "Conformance – Encounter Service" (17.20%). Interestingly, despite growing awareness of sustainability issues, "Social Responsibility" and "Environmental Responsibility" were less significant to customers, with weights of 6.93% and 6.64% respectively. This mirrors previous research, where travelers' positive attitudes towards green practices, did not consistently translate into bookings at environmentally friendly hotels (Galati *et al*., 2023, Njite & Schaffer, 2017). Lastly, "Food & Beverages Quality and Variety" ranked lowest at 6.38%, making it the least important factor in hotel selection.

Table 2. The prioritization of hotel selection criteria

Hotel Selection Criteria (WHATs)	QFD-LP-GW-Fuzzy AHP Priorities	Ranking
Price & Perceived Value	**24.40%**	**1**
Room Amenities & Hotel Physical Facilities	**19.58%**	**2**
Location	**18.87%**	**3**
Conformance-Encounter Quality	**17.20%**	**4**
Social Responsibility	**6.93%**	**5**
Environmental Responsibility	**6.64%**	**6**
Food & Beverages Quality and Variety	**6.38%**	**7**

Table 3. The prioritization of hotel management aspects

Hotel Management Aspects (HOWs)	QFD-LP-GW-Fuzzy AHP Final Weights	Ranking
Physical Property Management	**37.67%**	**1**
Process Management	**23.12%**	**2**
Food & Beverages Management	**15.99%**	**3**
People Management	**14.41%**	**4**
Communication Management	**8.82%**	**5**

The Relationship Matrix of the first HOQ highlights the need for an integrated approach to hotel management to effectively meet selection criteria. The analysis indicates that multiple management aspects can simultaneously satisfy hotel selection criteria and must work together cohesively. According to the final weights (Table 3), "Physical Facilities Management" stands out as the most critical factor at 36.67%, underscoring the role of infrastructure, cleanliness, and amenities in shaping customer satisfaction. Close behind, "Process Management" and "Food & Beverages Management" hold considerable importance, at 23.12% and 15.99%, respectively. The emphasis on "Process Management" highlights the significance of streamlined operations and smooth service delivery, while the importance of "Food & Beverages Management" reflects the impact of food quality and efficient supply chains on the overall guest experience. "People Management" (14.41%) emphasizes the value of well-trained, motivated staff in delivering superior customer service. Finally, "Communication

Management" (8.82%) plays a supportive yet valuable role by ensuring clear and effective communication across all operational levels.

Table 4. The prioritization of sustainability practices.

Sustainability Practices (HOWs)	QFD-LP-GW-Fuzzy AHP Final Weights	Ranking
Green Certification/ Environmental Management System	**28.95%**	**1**
Recycling and Waste Reduction Practices	**20.47%**	**2**
Natural Resources Conservation Practices (Energy, Water)	**19.82%**	**3**
Staff/Clients Training and Awareness Raising Practices	**12.74%**	**4**
Health and Safety Practices for Indoor Spaces and Materials	**12.36%**	**5**
Local Community Support and Awareness Practices	**5.64%**	**6**

The evaluation of management aspects, combined with the relative weights of sustainability practices and their interdependencies, resulted in a clear prioritization (Table 4). "Green Certification/Environmental Management Systems" ranked the highest at 28.95%**,** reflecting their role in improving environmental performance and showcasing hotels' commitment to sustainability, as supported by previous studies (Martínez García de Leaniz *et al*., 2018). "Recycling and Waste Reduction" followed at 20.47%, emphasizing its long-standing importance in reducing waste and promoting resource efficiency in the hospitality industry (Han *et al*., 2018). "Natural Resources Conservation (Energy, Water)", ranked at 19.82%, involves widely implemented practices (Acampora *et al*., 2022), underscoring its role in promoting sustainability. Additionally, "Staff/Client Training and Awareness Raising Practices" (12.74%) and "Health and Safety for Indoor Spaces and Materials" (12.36%) followed closely. The ranking of "Staff/Client Training and Awareness Raising Practices" highlights the importance of well-trained employees in executing sustainability initiatives (Pereira *et al*., 2021), while "Health and Safety Practices" ensure healthier environments benefiting both guests and staff (Mbasera *et al*., 2016). Lastly, "Local Community Support and Awareness Practices", with a weight of 5.64%, emphasizes the hotel's role in fostering community relationships and promoting local sustainability efforts (Trang *et al*., 2019).

Conclusions

This study introduces a comprehensive decision-making framework based on QFD, tailored for the hotel industry to balance customer requirements with sustainability objectives. By integrating customer preferences (VoC) and sustainability criteria in a two-phase process, it provides hoteliers with a structured, data-driven approach to design services that meet both consumer demands and sustainability standards. By leveraging the QFD-LP-GW-Fuzzy AHP methodological approach, this framework equips decision-makers with tools to elicit and prioritize complex and subjective judgments, ensuring strong alignment between customer expectations and sustainability goals. The LP-GW-Fuzzy AHP method tackles uncertainty and subjectivity in decision-making by exploiting the benefits of Fuzzy AHP, while improving prioritization accuracy through the use of LP principles for calculating priorities.

This framework operates as a continuous process, with each phase unfolding within the two HOQs and being guided by the outcomes of the preceding one, ensuring consistency and enabling adjustments to achieve the goals of high-quality, sustainable services. The initial step is identifying and capturing the VoC, which is essential for aligning service offerings with guest expectations, as tourists play an integral role in sustainability. Subsequently, businesses define the key management aspects that address both traditional and sustainability criteria, influencing hotel choices. Once sustainability practices are identified, their relationships with the management aspects and their interdependencies are analyzed to determine the most effective

practices. In this regard, the proposed QFD framework provides hotel managers with a practical tool for navigating the complexities of sustainable service design, offering a roadmap to balance quality, operational efficiency, environmental and social responsibility, positioning it as a valuable asset in advancing sustainability within the hotel sector. Furthermore, it provides avenues for researchers to examine sustainable initiatives within diverse hotel categories and across various operational dynamics or geographic regions, facilitating deeper insights into sustainability within hotel supply chains.

Despite the clear advantages offered by the proposed framework, this study has some limitations. The framework focuses on environmental and social dimensions, without detailing the actions hotels should take to balance the trade-offs between sustainability benefits and operational costs. Additionally, collecting the required data presents a challenge, as it often involves extensive research efforts. While these efforts are necessary due to the critical nature of service design, they demand significant investments of time and labor. To address this, artificial intelligence methods are being explored to enhance data collection and processing workflows. Moreover, future research should aim to validate the framework in practical applications within various hotel businesses to further refine its effectiveness in improving service quality and sustainability.

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