International Journal of Sustainable Tourism

Volume: 02, Issue 0I, 2025
Peer Reviewed|Biannual|ISSN : 3021-6184
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# LOW-ENERGY UTILIZATION AND GUEST PERCEPTION IN ECO-FRIENDLY HOTEL DESIGN; INSIGHTS FROM AN URBAN WETLAND HOTEL IN COLOMBO SRI LANKA

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## Abstract

The hospitality sector is increasingly recognized as both a contributor to and a victim of climate change, making sustainable practices a pressing priority. Among these, the adoption of circular economy principles and low-energy utilization strategies in hotel operations has emerged as a crucial pathway toward reducing environmental impacts while improving guest experiences. This study investigates the role of passive architectural design and sustainable energy practices in advancing environmental and social outcomes in an urban wetland hotel located in Colombo, Sri Lanka. This study examines the role of passive architectural design and energy-efficient practices in an urban wetland hotel in Colombo, Sri Lanka, with specific focus on seven restaurant spaces operating daily across the property. The research employed a mixed-method approach involving site-based observational audits and structured surveys with 150 guests and 150 staff members to evaluate both spatial performance and user perceptions. Results highlight that the majority of the restaurants successfully relied on passive strategies such as optimal orientation, cross-ventilation, extensive daylighting, and green integration, which significantly reduced dependence on mechanical cooling and artificial lighting. Findings reveal that five of the seven

restaurants achieved scores exceeding 80%, primarily due to optimal building orientation, cross- ventilation, and extensive daylighting, while two venues demonstrated higher reliance on HVAC systems. Guest surveys (N=150) highlighted a strong preference for naturally ventilated and green- integrated spaces, with many respondents associating these attributes with greater comfort, relaxation, and satisfaction. Staff surveys (N=150) and feedback further indicated high levels of awareness and support for eco-friendly practices, while also identifying institutional challenges such as operational support and management commitment. These outcomes underscore that passive strategies not only lower energy dependency but also enhance perceived hospitality value, creating a virtuous cycle of sustainable practice, guest approval, and staff engagement. The study concludes that integrating passive cooling, daylight optimization, and biophilic design elements, alongside improved institutional support, can position urban wetland hotels as models of sustainable tourism. Ultimately, the findings contribute to the growing evidence that circular economy integration in hospitality can simultaneously drive environmental stewardship, guest well-being, and competitive advantage.

**Keywords:** *Passive architectural design, Biophilic design, Sustainable hospitality, Energy efficiency*

## 1.0 Introduction

Global warming and climate change are issues that impact ecosystems and societies worldwide today. The tourism and hospitality industry plays a role, in both contributing to and being affected by climate change by employing a workforce and making a considerable economic impact globally. Furthermore, Hotel chains are identified as one of the most energy-intensive sectors, with an increasing number of worldwide research conducted on this topic (Arenhart et al., 2022). Researchers have determined that hotel buildings shows the highest energy consumption intensity, and that international tourism positively influences energy utilization, necessitating an emphasis on the production and utilization of renewable energy (Huang et al., 2022). Due to their resource operations and maximized energy consumption in transportation and accommodations hotels, Airlines and other tourism related businesses play a part, in greenhouse gas emissions (Tourism & the Environment, n.d.). Conversely the industry is highly vulnerable, to the impacts of climate change such as the decline in biodiversity weather conditions, and the increase in sea levels. In light of escalating environmental issues and changing preferences among travelers, the hospitality sector is shifting away from conventional business frameworks centered on financial profit towards sustainable methodologies that reconcile economic viability with ecological responsibility. Contemporary tourists are

progressively emphasizing lodging and experiences that reflect a dedication to sustainability, thereby encouraging hotels to implement eco-friendly initiatives to draw in environmentally aware visitors and preserve their competitive edge (Sodhi et al., 2020). High-performance HVAC systems and renewable energy sources are two examples of technologies that are essential to lowering operating costs and carbon footprints through energy efficiency and performance (Olatunde et al., 2024). While efficient water management techniques handle water scarcity and reduce environmental impact, sustainable materials help conserve resources and reduce waste. An increasingly important component of sustainable interior design is biophilic design, which incorporates natural elements to enhance occupant well-being. Programs for education and outreach help promote sustainability by increasing public awareness and cultivating an environmentally conscious culture (Sil et al., 2025). Smart technology integration maximises building performance and resource management, but its implementation requires overcoming obstacles including managing client expectations and striking a balance between usefulness and aesthetics. In practice, passive design means leveraging local climate and natural resources (sun, wind, vegetation, water) to meet comfort needs with minimal mechanical input. For example: strategic building orientation and narrow floor plans maximize cross-ventilation; shading devices (overhangs, louvers, vegetation) cut solar heat gain; high ceilings and open-air corridors promote airflow; thermal mass and insulation moderate indoor swings and daylighting reduces electric lighting (Kobeyev et al., 2021). As urban travelers increasingly seek eco-conscious lodging, hotels that authentically integrate with wetlands using vernacular materials, open plans, and natural ventilation – can maintain guest comfort while dramatically improving energy performance. Research shows that such passive approaches are not merely theoretical: they are used in contemporary projects worldwide and are vital for meeting future energy targets in hospitality.

This study investigates the integration of circular economy principles into the design of an urban wetland hotel, emphasizing passive architectural strategies and ecological integration to advance environmental sustainability while enhancing guest experiences. It explores how these design approaches are embedded in hotel operations and daily activities, offering insights into aligning environmental stewardship with guest-centered service delivery. The research highlights the potential of sustainable design practices to position urban wetland hotels for optimizing energy utilization, mitigating environmental impacts and promoting responsible urban tourism.

## 2.0 Literature Review

### The Tourism and Hospitality Sector's Environmental Footprint

The global tourism and hospitality industry, a significant economic force that provides over 200 million jobs and encompasses more than 11 million guest rooms worldwide, has a substantial environmental impact (Faja, 2007). The sector is recognized as one of the most energy-intensive industries, and its operational energy consumption is a primary source of carbon emissions(Arenhart et al., 2024). Morever, the high demand for energy, particularly for heating, cooling, and lighting in hotel facilities, significantly contributes to these emissions. Beyond its direct carbon contributions, the expansion of the hospitality sector places immense pressure on local resources. This includes an increased demand for water and energy, as well as heightened challenges in waste management and pollution control. Even before a new hotel opens its doors, the construction process itself is highly energy-intensive, generating a substantial carbon footprint through the manufacturing, transportation, and assembly of materials. A crucial, multi-faceted dynamic is highlighted by the research: the tourism industry is both a major contributor to environmental degradation and simultaneously highly vulnerable to its effects. The very ecosystems that attract tourists—such as wetlands, mangroves, and coral reefs—are ecologically fragile and threatened by the pollution and resource depletion associated with unchecked tourism development (Suresh et al., 2025). The degradation of these natural landscapes undermines the industry's own foundation, creating a powerful, self- correcting incentive for the sector to adopt sustainable practices to ensure its long-term viability.

### The Shift Toward Eco-Conscious Tourism

In response to escalating environmental concerns and a growing awareness among consumers, the hospitality sector is undergoing a fundamental transformation away from traditional, profit- centric business models. This paradigm shift is driven by an increasingly informed and demanding traveler base that prioritizes sustainable lodging and experiences (Millar & Baloglu, 2008). While some earlier studies indicated that a traveler’s general environmental consciousness did not always translate into a preference for green hotels, more recent research demonstrates a rising demand for eco-friendly services (Ko et al., 2023). Guests are more satisfied when they believe the hotel’s actions are for "public-serving" reasons, such as genuine environmental protection, rather than "self-serving" ones, such as purely cost-cutting measures. Furthermore, green practices are more readily accepted and positively perceived when they are implemented as "extras" or peripheral attributes of the service, as opposed to core elements that might compromise the guest’s fundamental

comfort or convenience. This duality in guest perception underscores that for sustainable initiatives to be successful, they must be transparent, authentic, and integrated in a way that does not detract from the core hospitality experience (Zareh et al., 2023).

## Foundational Concepts in Sustainable Hotel Design and Operations

Passive architectural design is a strategic approach that leverages local climate conditions such as the sun, wind, and vegetation to maintain comfort with minimal reliance on mechanical systems. This method is a proven cornerstone of energy-efficient and comfortable building design (Bulbaai & Halman, 2021).

Accordingly, Key passive strategies include;

• Building orientation and form; The optimal positioning of a building is fundamental to managing solar gain and promoting natural ventilation. For tropical climates, a building's longer axis is ideally oriented perpendicular to the east-west direction to minimize direct sun exposure. This orientation, combined with narrow floor plans and strategically placed overhanging roofs, reduces heat absorption and the need for artificial cooling.

• Natural ventilation; This is a vital strategy for tropical environments. It involves the strategic placement of windows and openings on opposite sides of a building to facilitate cross-ventilation, which effectively provides cooling without mechanical systems. Stack ventilation, which utilizes the principle that warm air rises, is another effective technique for moving air and flushing heat from a building (Jiang et al., 2023).

• Daylighting and shading: Maximizing natural light reduces the need for artificial lighting, which not only conserves energy but also contributes to the well-being and productivity of occupants. However, this must be meticulously balanced with effective shading devices, such as louvers or vegetation, to prevent excessive solar heat gain and glare(Mazzetto, 2025).

## The Biophilic Advantage: Connecting Guests with Nature for Enhanced Well-being

Biophilic design is a transformative approach to architecture that leverages the innate human connection to nature to improve well-being. This method extends far beyond simply incorporating plants; it involves the holistic integration of natural light, sound, ventilation, materials, and forms into the built environment (Tekin et al., 2025). Studies have shown that biophilic designs can elicit more favorable emotional and behavioral responses from guests than standard designs. The presence of natural

elements is associated with numerous benefits, including stress recovery, lowered blood pressure, improved cognitive function, and enhanced moods. Guests often perceive hotels with biophilic decor to be of a higher quality and are more likely to remember and respond positively to the unique experience (Akinyemi et al., 2024).

A compelling connection exists between biophilic design and the concept of psychological adaptation. A substantial body of research indicates that people tend to adapt psychologically to warmer conditions when their environment is perceived as natural, pleasant, and connected to the outdoors (Nikolopoulou & Steemers, 2003). In a naturally ventilated hotel restaurant in a tropical climate, for instance, guests who might otherwise feel uncomfortably warm may psychologically tolerate the heat better because of the pleasant ambience, connection to outdoor views, and natural breeze (Lin et al., 2015).

## Guest and Staff Perceptions of Green Initiatives

The long-term success of sustainable initiatives in hospitality is contingent on the perceptions and active participation of both guests and staff. The literature confirms that guests' satisfaction with green practices is influenced by their perception of the hotel's motives and the nature of the initiative itself. While recycling bins and energy-saving lighting are well-received, practices that are perceived as compromising core comfort, like certain refillable soap dispensers, may not be as popular (Zareh et al., 2023). The impact of sustainable practices on employees is equally significant. Research indicates a strong, positive correlation between employee job satisfaction and involvement in eco-friendly initiatives (Mansukhe & Mehta, 2024). Such programs can boost staff morale and productivity, while the adoption of technologies like AI and IoT can improve working conditions by streamlining routine tasks, directly contributing to social sustainability (Gajić et al., 2024). However, to foster this positive outcome, it is essential that staff receive adequate training, management support, and a recognition of their competence in these areas. The evidence points to a self-reinforcing dynamic within sustainable hospitality. When a hotel implements authentic, well-communicated sustainable practices, it attracts a clientele that is already environmentally conscious.

These guests are more likely to engage in sustainable behaviors themselves. Simultaneously, staff who are engaged and competent in these initiatives experience higher job satisfaction and are better equipped to communicate the hotel's green image to guests (Bindawas, 2025).

This creates a virtuous cycle where authentic green practices lead to satisfied guests and engaged staff, which in turn strengthens the hotel's brand reputation and operational performance.

## 3.0 Methodology

The study employed a mixed-method approach, combining structured surveys of guest and staff with systematic field observations and experts estimates to investigate sustainable tourism outcomes. The investigation was specifically focused on seven distinct restaurant areas located within the hotel's 23-acre property. This selection of multiple, distinct venues within a single institutional framework provides a controlled environment for a comparative case study. Data collection drew on established tourism research methods. Two parallel questionnaires were designed: one targeting visitors ("guest survey", N = 150) and one targeting on-site staff or employees (N = 150). Both instruments contained multiple items rated on 5-point Likert scales (e.g. 1 = "strongly disagree" to 5 = "strongly agree"), covering key sustainability dimensions (economic, environmental, social) and institutional overall satisfaction with tourism development (Trišić et al., 2023). Questionnaire items were adapted from prior studies and industry guidelines to ensure content validity (Satghare, 2024). A sample item was, "I believe that the hotel's low-energy design features (such as natural ventilation, abundant daylight, and efficient HVAC systems), combined with its sustainable operational practices, enhance my satisfaction and my perception of the hotel's eco-friendly design" reflecting environmental, social and economic impacts. The questionnaires also collected demographic data (age, education, role) to profile respondents. A draft instrument was pre-tested with a small pilot group to refine wording and confirm clarity.

To systematically conduct this study, data collection process was carried out by guest surveys, staff surveys, direct observations and staff estimates. Guest intercept surveys followed a systematic random approach (e.g. interviewers approached every 5th departing visitor at attractions or in hotel lobbies) to recruit voluntary participants, yielding 150 usable questionnaires. Staff surveys employed a structured questionnaire (both paper and online) distributed to 150 on-site employees (managers, tour guides, service staff, etc.), with respondents chosen via purposive (and snowball) sampling to cover different departments and shifts. In parallel with the surveys, systematic field observations were conducted for 07 restaurants areas across the hotel property to capture objective behavioral data. Observers recorded a range of behaviors and facility usage patterns, including visitor routes, dwell times in key areas, and visible actions the utilization of natural lighting, natural ventilation, and mechanical HVAC systems. The observations were conducted according to a predetermined schedule, such as tracking every third group of visitors, to ensure consistency and enhance the reliability of the behavioral data. Furthermore, direct observations of tourist flows and behaviors: following Galí & Donaire's method, observers quietly tracked visitors from a distance and logged their routes through the

facility, durations at key areas, and visible actions (e.g. waste disposal, facility usage – Natural lights, Natural Ventilation and HVAC systems) according to their operational duration. key personnel (such as facility managers and tour operators) were interviewed to provide expert estimates of aggregate measures (daily visitor counts, average energy/water use per guest), supplementing the survey/observation data where direct measurement was impractical – an approach consistent with integrated sustainability assessment practice (Casals Miralles et al., 2023). The analysis employs a rigorous, Minitab- based statistical methodology, incorporating both descriptive and inferential techniques to ensure a robust and transparent evaluation.

## 4.0 Results and Discussion

The analysis presented in this study reveals a complex yet solvable challenge for hotel management. While guests and staff demonstrate a shared, high-level appreciation for the hotel's environmental design, this consensus masks fundamentally different underlying motivations and a critical operational gap in the institutional framework. The descriptive analysis provides a clear overview of the perceptions of both guests and staff (Table 1). According to the the above table 01, the Environmental dimension received the highest mean scores from both guests (4.35) and staff (4.28). This indicates a strong consensus that the hotel's design choices, such as the use of natural light and ventilation, are highly effective and positively perceived. Conversely, the Institutional dimension received the lowest mean scores from both guests (3.95) and staff (3.85), suggesting a shared perception of weakness in this area. The standard deviations for all dimensions are relatively low (ranging from 0.55 to 0.70), which points to a general agreement within each group and indicates that the opinions are not widely dispersed.

This emphasized that the hotel's low-energy design features, when combined with sustainable operational practices, enhance guest satisfaction and their perception of the hotel's eco-friendly design. The open-ended responses provide a crucial layer of context, directly supporting and explaining the quantitative data. The high mean scores for the Environmental dimension are directly reinforced by positive guest feedback such as, "I really enjoyed the bright, naturally lit areas. It felt refreshing and comfortable". Similarly, the staff response that "Daylight reduces lighting costs and improves staff alertness" confirms the strong quantitative correlation between the Economic and Environmental dimensions observed in the staff data. The most valuable qualitative information, however, pertains to the lowest-scoring Institutional dimension. Guest responses suggest a moderate trust in the hotel's communication of its policies, while staff responses indicate a need for "stronger management support"

and better "operational support". The staff comment, "Some areas need better HVAC scheduling; operational support could improve," provides a specific, practical example of a management failure that could undermine staff confidence and policy execution.

| Sustainability Dimension | Group | Mean Score (1–5) | Standard Deviation |
|---|---|---|---|
| Economic | Guests | 4.12 | 0.61 |
| | Staff | 4.08 | 0.59 |
| Environmental | Guests | 4.35 | 0.55 |
| | Staff | 4.28 | 0.57 |
| Social | Guests | 4.05 | 0.63 |
| | Staff | 3.95 | 0.64 |
| Institutional | Guests | 3.95 | 0.68 |
| | Staff | 3.85 | 0.7 |

*Table 1:Descriptive Statistics Summary for Guest and Staff Surveys (n = 150)*

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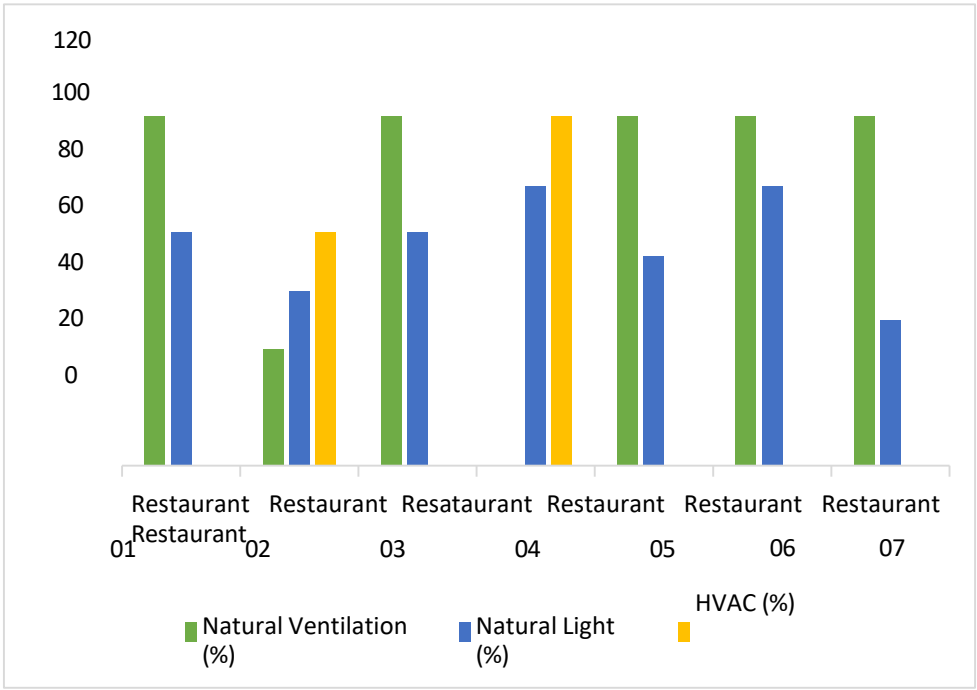
Low energy utilization in the hotel across the restaurant areas

The seven restaurants in the hotel across 23acres of land area were analyzed for their usage of passive vs mechanical systems during daily operating hours. This investigated for each restaurant the natural ventilation usage ratio, natural light usage ratio and HVAC usage ratio (each as a percentage of operating hours).

Figure 1 compares these three usage ratios for each restaurant. It highlights that natural ventilation is maximized (100%) in five of the seven venues, whereas Restaurant 02 uses ventilation only one-third of the time. Conversely, Restaurant 04 and Restaurant 02 rely heavily on HVAC (66.7% and 100% of operating hours, respectively), unlike the other restaurants where HVAC usage is zero. Daylight availability also varies (41.7–80% of hours), reflecting differences in layout or fenestration. These patterns imply that most dining spaces exploit passive design (open dining areas, courtyards, cross-ventilation) to minimize energy use, consistent with tropical bioclimatic principles. In fact, passive strategies like well-designed courtyards and high natural-ventilation rates are known to lower indoor temperatures well below ambient in warm–humid climates (Rajapaksha et al., 2003).

*Figure 1:Energy utilization patterns across seven restaurants in the Colombo urban wetland hotel. The grouped bar chart (left) shows the proportion of operating hours reliant on natural ventilation, natural light, and HVAC.*




These results indicate clear patterns of passive strategy adoption. Five restaurants (Restaurnat 01, 03, 05, 06 and 07 operated with 100% natural ventilation, suggesting open-air or well- ventilated designs. Such "free-running" interiors minimize HVAC dependence, aligning with sustainable hotel design principles. Passive design literature notes that optimizing natural ventilation and daylighting can "significantly reduce reliance on mechanical systems" (Zhiri & Bawa, 2024), cutting energy use. Indeed, the chart shows those five venues use no HVAC at all, relying instead on natural breezes. In contrast, Restaurant 02 (33% ventilated) and the Restaurant 04 (0% ventilated) function essentially as closed spaces, reflected by their high HVAC ratios (66.7% and 100%). Furthermore, Natural daylighting is also leveraged to varying degrees. Restaurant 06 and 04 achieved 80% natural-light usage, reducing artificial lighting needs. This practice is explicitly recommended for Sri Lankan hotels: a sustainable tourism study lists "using natural lighting and

ventilation" as key eco-friendly energy-management practices (Dilshan & Toko, 2023). In this study, higher daylight usage correlates with lower electric lighting and is consistent with guidelines that daylighting considerably reduces reliance on mechanical systems (Zhiri & Bawa, 2024). This study shows the most restaurants combine high ventilation with moderate daylight (40–80%), indicating a design emphasis on open layouts and large windows or skylights.

These utilization patterns have important implications for guest comfort and perception. In tropical climates, open, naturally ventilated spaces can sometimes feel warm or humid. However, study shows that guests often prefer and positively perceive environmentally friendly hotel spaces that embrace nature. For example, Rajapaksha et al. note that tourists on pleasure travel prefer hotels which promote environmentally friendly built environment with free- running interiors (Rajapaksha, 2017). Moreover, it emphasized that people tend to adapt psychologically to warmer conditions when the environment is perceived as natural and pleasant. guests in these open-air restaurants likely tolerate tropical heat better because of the connection to the outdoors (water views, vegetation, breeze) an effect referred to as the positive role of spatial ambience on comfort. Indeed, one study found that attributes of openness and integration with the surrounding environment promoted guest comfort in warm hotel spaces.

## 5.0 Conclusion and Recommendations

This study demonstrates that passive, biophilic, and circular-economy–informed design strategies in an urban-wetland hotel significantly reduce mechanical energy reliance while enhancing guest and staff perceptions of environmental quality. Objective usage data from dining venues showed extensive natural ventilation and daylighting in most spaces, with only a minority of venues depending heavily on HVAC, confirming that design can deliver measurable operational benefits. However, lower institutional and management scores reveal a critical implementation gap: without robust operational protocols and monitoring, design advantages are at risk of being overridden by ad hoc HVAC use and inconsistent practices. To secure and scale the observed energy and comfort benefits, the hotel should prioritize installation of environmental sensors, submeters, and simple automated

controls that trigger mechanical systems only when objective thresholds (e.g., $CO_2$, temperature) are exceeded. Complementary low-cost interventions such as targeted shading, fan deployment, and staff standard operating procedures for window and door management can maintain comfort while avoiding unnecessary mechanical cooling. Organizational change is equally essential, a cross- functional sustainability committee, routine post-occupancy evaluations, and staff training with incentives will align daily operations with the building's passive design intent. Strategic retrofits, including hybrid ventilation systems and daylight-optimizing glazing or shading, should be evaluated through dynamic simulation and life-cycle assessment to prioritize cost- effective measures. Integrating greywater reuse and wetland restoration will strengthen the hotel's circular-economy credentials and deliver co-benefits for site ecology and resource resilience. Monitoring key performance indicators percent hours naturally ventilated, HVAC run-hours per guest, daylight availability, and institutional perception indices will provide the feedback needed to demonstrate performance and guide continuous improvement. Taken together, these technical, operational, and governance actions will convert design potential into sustained energy savings, improved comfort, and credible sustainability outcomes that enhance both ecological stewardship and guest value.

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