

Passive Design as A Strategy in Enhancing Sustainability and Resilience in Eco-Tourism

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Abstract

This research investigated the integration of sustainable principles and passive architectural design strategies in the development of an eco-resort in Kolokuma-Opokuma, Bayelsa State. In response to environmental degradation and the need to promote eco-tourism, the study examined how innovative eco-resort design, grounded in sustainability, could offer viable solutions. The research aimed to demonstrate pathways to achieving sustainability and resilience in the proposed eco-resort in Sagbageria, Kolokuma-Opokuma, Bayelsa State, Nigeria. The objective investigates the contextual and underlying issues relating to ecotourism. A mixed research approach was employed, focusing on non-numeric data collection, including insights, opinions, and personal experiences. Comprehensive case studies and analyses of similar eco-friendly projects within Nigeria and internationally were conducted to identify successful practices and lessons learned. The study underscored the importance of incorporating sustainable design methodologies and resilient strategies throughout the development process. It advocated for an eco-conscious design philosophy that minimized environmental degradation while maximizing cultural and social benefits. Key strategies identified included preserving local cultural identity through design, utilizing sustainable building materials, harmonizing with the natural environment, optimizing energy efficiency through passive design techniques, implementing effective waste management systems, and ensuring high indoor and environmental air quality. These strategies were found to be essential for developing an innovative and environmentally responsible eco-resort model. The research further emphasized the need to increase awareness and education on sustainable and resilient practices within educational institutions and the broader public. It also recommended proactive government support through legislative measures and financial incentives to advance research and development in sustainability and resilience initiatives across Nigeria. Furthermore, the study highlighted the importance of community involvement in the planning and implementation of eco-tourism projects, as this enhanced project success by aligning development with community needs and expectations, thereby fostering a more sustainable and enriching experience for all stakeholders.

Keywords: Sustainability, Resilience, Architecture, Eco resort

Introduction

The increasing emphasis on sustainable development has contributed to the growth of eco-tourism, encouraging the planning and development of eco-resorts that prioritize environmental conservation, efficient resource use, and community well-being as stated by (de Grosbois, 2022). Modern eco-resorts are increasingly recognized as tourism developments that integrate environmental stewardship, cultural preservation, and community participation to provide meaningful visitor experiences (Fennell D. A., 2023). In tropical climates, passive architectural design strategies such as natural ventilation, solar shading, and daylighting have been shown to reduce building energy demand while improving indoor thermal comfort.

The foundation of eco-resort development stems from the principles of ecotourism, which (Aniramu, 2025) defines as purposeful travel to untouched natural environments with facilities that are in harmony with the environment. This form of tourism prioritizes the direct observation and appreciation of local biodiversity alongside both historical and modern cultural expressions. However, for an eco-resort to truly fulfill this principle, the built environment must do more than simply sit within nature; it must actively preserve it and have more harmony with its natural environment. In tropical regions, this requires a deliberate departure from energy-intensive, conventional building practices in favor of an architecture that harmonizes with its immediate environment.

Tourist resorts establish their identity by integrating accommodation, leisure, recreation, and visitor-oriented services within a unified destination experience. These facilities function not only as places of accommodation but also as organized spaces for relaxation, entertainment, and interaction with surrounding natural and cultural resources (Zhu, 2024). In environmentally sensitive regions, resort design should incorporate climate-responsive strategies such as natural ventilation, appropriate building orientation, and passive cooling techniques to reduce energy consumption and improve occupant comfort.

Sustainable architecture involves designing buildings that efficiently utilize natural resources while minimizing environmental impacts throughout their life cycle. Rather than relying primarily on mechanical systems, sustainable buildings integrate passive design principles such as natural daylighting, natural ventilation, shading strategies, and appropriate building orientation to improve occupant comfort while reducing energy consumption. Passive design strategies form a fundamental component of climate-responsive architecture by allowing buildings to respond effectively to their environmental conditions. Furthermore, sustainable architecture emphasizes the selection of materials with reduced environmental impacts, considering factors such as embodied energy, durability, and lifecycle performance. (Ayoobi, 2024).

Statement of The Problem

The study area currently lacks a purpose-built eco-resort. Although accommodation facilities such as hotels, guest houses, and lodges exist, they were designed without considering their negative impacts on the environment. This neglect directly causes environmental degradation and leaves buildings highly vulnerable to the region's environmental challenges. There is an urgent need for a sustainable framework in the study area to solve this problem.

Aim of The Study

This study aims to achieve sustainability and resilience in Eco-tourism by integrating passive design strategies

Objectives of The Study

The following are the objectives this research sets to achieve:

- 1.To investigate the contextual and underlying issues relating to ecotourism
- 2.To examine the concept of passive design, its principles, implementation strategies and influence in an eco-friendly design.
- 3.To explore the application of passive design strategies as a guide in the design approach.

Research Questions

- 1.What are the contextual and underlying issues relating to eco-tourism?
- 2.what are the concept of passive design, its principles, implementation strategies and influence in an eco-friendly design?.
- 3.how can passive design strategies be applied as a guide in the design approach?.

Study Area

The proposed site is located in Sagbageria town, Kolokuma/Opokuma Local Government Area of Bayelsa State, Nigeria. The settlement lies within the Niger Delta region and is influenced by the River Nun and surrounding wetland ecosystems. The area forms part of the extensive Niger Delta floodplain, characterized by predominantly flat and low-lying terrain, interconnected rivers, creeks, and seasonal water channels. Kolokuma/Opokuma LGA is situated within a hydrologically sensitive environment where annual rainfall, tidal influences, and poor drainage conditions contribute to recurrent flooding challenges. The Niger Delta experiences a humid tropical climate with high temperatures and significant rainfall throughout the year, making many communities vulnerable to seasonal flooding due to their low elevation and wetland characteristics (Horsfall, 2023). The hydrological characteristics of the environment require a transition from conventional static architectural approaches toward flood-resilient design strategies. According to (Brisibe, 2018) post-flood architectural responses in Bayelsa State should incorporate adaptable building forms, resilient construction materials, and elevated foundations capable of reducing structural vulnerability during extreme hydrological events. The region's humid tropical climate, characterized by high relative humidity and abundant rainfall, supports dense vegetation and wetland ecosystems. However, increasing human activities have contributed to the modification of natural vegetation, resulting in areas dominated by secondary vegetation such as grasses and shrubs. The soils within the Niger Delta generally consist of alluvial deposits with variations of sandy, sandy-loam, and clay-loam textures, influencing drainage patterns and foundation considerations.

The major economic activities in Sagbageria include farming, fishing, and trading, reflecting the community's dependence on the natural resources of the Niger Delta environment. In addition, tourism and recreational activities represent emerging socio-economic opportunities. The presence of Lake Efi has enhanced the cultural and tourism potential of Sagbageria through activities such as the Lake Efi Fishing Festival, which attracts visitors and promotes the community's fishing heritage and cultural identity (Orientation, 2025).

2.0 Literature Review

Introduction to Ecotourism

The global hospitality sector is undergoing a paradigm shift, transitioning from luxury developments to ecologically responsible environments. In tropical, sensitive regions like the Niger Delta, this evolution is no longer just a trend; it is a critical necessity. Conventional

architectural practices in these climates often rely on heavy, non-porous materials and active cooling systems. When transplanted into delicate ecosystems, these structures cause severe environmental degradation and remain highly vulnerable to local climate stressors.

This literature review evaluates the intersection of ecotourism infrastructure, passive design principles, and resilient architecture. By analyzing established frameworks and contemporary regional data, this establishes the practical foundation for proposing a sustainable, climate-responsive eco-resort in the study area.

Conceptual Framework

The conceptual framework of this study intersects three core pillars: the principles of eco-tourism, environmental sustainability, and climate resilience. The objectives of eco-tourism, including environmental conservation and awareness creation, cannot be achieved if tourism facilities generate significant negative impacts on their surrounding ecosystems (Fennell D. A., 2021). Sustainability in resort design therefore extends beyond the superficial inclusion of green features; it requires the integration of efficient building systems, including passive cooling strategies, natural lighting, climate-responsive design approaches, and materials with reduced embodied carbon impacts (Ayoobi, 2024).

In the unique context of Sagbageria, located within the high-rainfall Niger Delta region and influenced by the hydrological dynamics of the Nun River, sustainability must be coupled with structural resilience. This creates a conceptual triad where eco-tourism defines the resort's purpose, sustainability minimizes its ecological footprint through passive design strategies, and resilience ensures its ability to withstand hydrological stressors. By synthesizing these elements, the architecture moves away from static and rigid forms toward adaptable flood-resilient strategies. (Brisibe, 2018) emphasize the importance of post-flood building approaches in Bayelsa State, including improved building design strategies, appropriate materials, and adaptation measures to reduce vulnerability to future flooding. These principles inform the development of a hospitality environment capable of responding to the seasonal hydrological conditions of the Niger Delta wetlands.

Theoretical Framework

To guide the architectural approach and passive design strategies of the proposed eco-resort, this study adopts three primary theories: Climate-Responsive Architecture, based on Victor Olgyay's bioclimatic approach (Olgyay, 1963), Vernacular Architecture Theory, developed through Amos Rapoport's study of environmental and cultural influences on building form (Rapoport, 1969) and Flood Resilience / Flood Adaptation Theory

1. Theory of Climate-Responsive Architecture

Popularized heavily by Victor Olgyay in his bioclimatic approach, this theory posits that architectural form, orientation, and material composition should be dictated primarily by the local microclimate to achieve indoor thermal comfort with minimal mechanical assistance. In a high-humidity and high-temperature environment like Sagbageria, this theory provides the foundational basis for passive cooling strategies. By aligning the building axis relative to solar paths and prevailing wind currents, the architecture maximizes natural cross-ventilation, which is essential for reducing indoor relative humidity and cooling the structure naturally. This theoretical lens justifies the integration of deep roof overhangs, shaded building envelopes, and breathable wall systems to bypass the energy-intensive HVAC systems common in conventional resorts.

2. Theory of Vernacular Architecture

Vernacular architecture focuses on time-tested, regional building methodologies that have evolved natively to withstand local climate anomalies using locally sourced materials. In the Niger Delta region, traditional architecture historically relied on lightweight, elevated timber or bamboo structures that allowed floodwaters to pass underneath harmlessly while optimizing airflow. Integrating this theory allows the research to bridge traditional ecological knowledge with modern engineering. By studying local vernacular responses to the low-lying, terrain of the study area, the design framework can utilize elevated stilts (piers) and permeable layouts. This directly satisfies the objectives of minimizing the ecological footprint of construction materials while adopting the resilient, elevated substructures advocated by (Brisibe, 2018) to mitigate intense seasonal flooding.

3. Theory of Flood Resilient Architecture

Flood Resilient Architecture is based on the principle that buildings within flood-prone environments should be designed not only to resist flood impacts but also to adapt and recover from periodic water exposure. (White, 1945) argued that human settlements within flood-prone areas must adopt appropriate adjustment strategies rather than relying solely on structural flood control measures. In the context of Sagbageria, where the settlement is influenced by the hydrological dynamics of the River Nun and the seasonal flooding characteristics of the Niger Delta wetlands, flood resilience becomes a fundamental architectural consideration. This theory supports the integration of strategies such as elevated foundations, flood-resistant materials, flexible spatial arrangements, and site planning approaches that allow buildings to coexist with seasonal flooding.

3.0 Research Methodology

This study adopts an interpretivist research philosophy, which recognizes that understanding the relationship between architecture, environment, culture, and human experience requires the interpretation of contextual factors rather than relying solely on measurable variables. This philosophy is appropriate for the study as it seeks to explore how eco-tourism principles, passive design strategies, and climate-resilient approaches can be integrated into a resort design suitable for the environmental and cultural conditions of Sagbageria. The research employs a mixed research design, utilizing a case study approach to develop an in-depth understanding of sustainable eco-resort planning and design strategies. The research design focuses on the investigation of existing eco-resorts and eco-lodges to examine their spatial organization, environmental responses, construction approaches, and relationships with surrounding communities. Primary data was obtained through case studies, site observations, and surveys of selected eco-resorts, while secondary data was gathered from architectural books, academic journals, sustainability guidelines, eco-tourism policies, and heritage documents. The case study method is supported by field observations, and site analysis of Sagbageria, including the study of climate conditions, landscape characteristics, hydrological influences, and cultural factors. International and local examples of eco-tourism facilities were examined to identify relevant design principles that can inform the proposed eco-resort. Through the integration of collected data, the research establishes appropriate strategies for developing an environmentally sustainable and flood-resilient hospitality facility within the Niger Delta context.

Criteria for Selection of Case Studies

The following elements are design criteria that were used for the selection of case studies:

1. **Eco-Tourism Design:** The selected case studies must feature outstanding architectural designs that actively showcase and interpret ecotourism principles. The physical architecture should serve as a bridge between the guest and the environment.
2. **Climate:** The case study should be situated in a region with similar or the same climatic conditions as the proposed research.
3. **Site Size:** The selected case study site should be able to accommodate the various facilities associated with an eco-resort design.
4. **Sustainable Practices:** The selected case studies must showcase the application of sustainable principles.

4.0 Results and Discussion

Case Studies

The selected architectural case studies were evaluated using a thematic analysis framework adapted from case study research methodology and informed by sustainable design principles discussed by (Xu, 2024). The framework focused on three analytical themes: Eco-tourism and Contextual Integration, Spatial Design and User Experience, and Passive Design Strategies. These themes were used to examine how existing eco-resorts respond to their environmental context, organize functional spaces, enhance user experience, and incorporate sustainable design approaches. Three case studies comprising both local and international examples were selected and analyzed to identify relevant architectural strategies applicable to the proposed eco-resort design in Sagbageria.

Case Study 1: Ibom Hotel & Golf Resort, Uyo, Nigeria

Project Name: Ibom Hotel & Golf Resort (formerly Le Méridien Ibom)

Location: Nwaniba, Uyo, Akwa Ibom State, Nigeria

Scope: 163 rooms, 26 suites, and 7 individual chalets spread across a 174-hectare estate

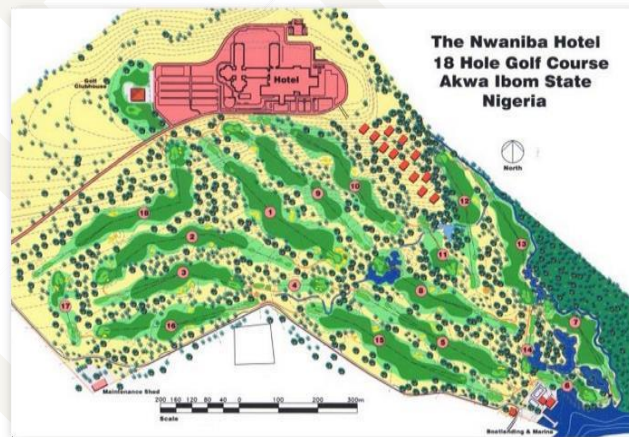


Figure 1: Site layout of the ibom icon resort

Design Intent: Built in 2007, the resort is situated within a dense, rolling tropical palm forest along a riverfront marina. The core master plan balances a 18-hole championship golf course with a secluded, nature-bound luxury hospitality environment designed to showcase the regional landscape of Akwa Ibom.

Eco-Tourism & Contextual Integration:

Instead of flattening the site's natural topography, the layout utilizes an expansive 174-hectare footprint to wrap the architectural structures around the existing palm forest vegetation. Over 90% of the site's natural greenery is preserved, acting as a massive carbon sink and local habitat protection zone. The structural zoning features a, low-rise main building (only 2 stories) and decentralized chalets. This low-rise profile prevents the resort from towering disruptively over the natural tree canopy line, protecting the scenic skyline and visual ecology. The resort integrates with the local waterfront economy by featuring a riverside marina and a floating jetty, linking high-end tourism with the historic local river transport routes along the Nwaniba coastal network.



Figure 2: integration of building with landscape Source:

Spatial Experience:

The spatial organization prioritizes panoramic outward views. Every single room and private chalet are deliberately oriented with a private terrace or balcony overlooking either the lush palm forest jungle or the expansive golf greens. This continuous visual link keeps the guest physically isolated from urban noise and entirely immersed in the natural, rural landscape.



Figure 3: aerial view of facility highlighting the spatial flow

Passive Design Strategies

The buildings use long, linear massing with exterior hallways and corridors. This structural form increases the exposed surface area of the building envelope, maximizing the capturing of local breezes off the adjacent river marina. Deep, recessed private concrete terraces project outward from every room facade. These overhangs act as massive passive shading devices, blocking the harsh, high-angle afternoon sun from hitting the windows directly, thereby lowering heat gain. The structural core utilizes standard durable materials (such as concrete masonry), but uses extensive local timber and natural stone detailing across the public common spaces, bars, and the Marina Club House to blend with the environment.



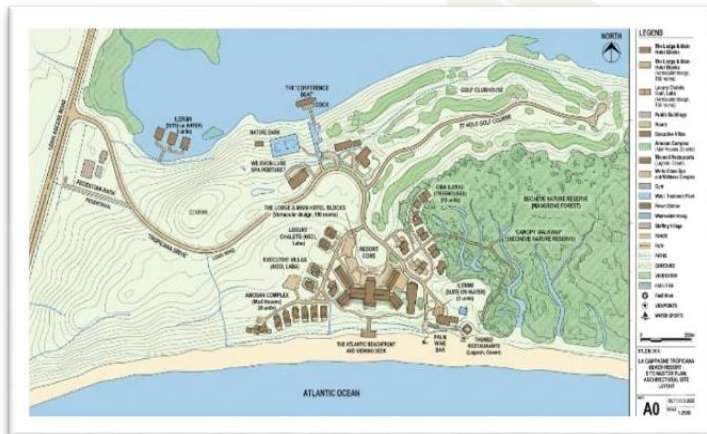
Figure 4: open local hut style pavilion

Figure 5: interior view from the suites

Case Study 2:

Project Name: La Campagne Tropicana Beach Resort, Lagos, Nigeria

Location: Ibeju-Lekki, Lagos State, Nigeria



Scope: Over 65 acres encompassing a mangrove forest, freshwater lagoon, and Atlantic oceanfront.

Eco-Tourism & Contextual Integration

The resort's master plan deliberately retains the natural terrain, entirely minimizing paved concrete walkways to avoid soil sealing. Pathways are left as natural sand or dirt trails. The layout protects a vast on-site mangrove swamp that serves as a protective ecological buffer zone between the freshwater lagoon and the Atlantic Ocean. Rather than clearing trees to build massive hotel blocks, accommodations like the "Anago" and "Obailerigi" chalets are built directly into the existing jungle canopy and riverbanks as isolated, freestanding structures, protecting the natural habitats of local wildlife.



Figure 7: The resort showing the beach Source: *La Campagne Tropicana* ng, (2009)

Spatial Design:

The spatial hierarchy forces an interaction with the elements. Public zones and dining terraces are open-sided and overlook the water or green area. The resort substitutes modern technology with cultural touchpoints—for example, utilizing traditional talking drums as acoustic doorbells for the chalets, completely immersing the visitor in an Afrocentric sensory environment.

Passive Design Strategies

The primary accommodation units are designed as warm, circular chalets and elevated wooden treehouses. The circular form allows prevailing ocean breezes from the Gulf of Guinea to flow around and through the structures, maximizing passive cross-ventilation potential. High-volume, conical roof spaces allow hot internal air to rise naturally away from the living spaces via thermal buoyancy. Instead of installing heavy steel or concrete shading fins, the resort relies heavily on the preserved palm groves and thick mangrove canopy to provide extensive, passive microclimate shading across the building envelopes. Private decks and balconies feature extended thatched eaves that shield the windows from direct equatorial solar radiation and intense coastal glare. The material palette is almost entirely biodegradable and locally sourced: thick local leaf thatch for the roofs, mud/earth-toned masonry, bamboo structural elements, and hand-woven local palm-frond mats for the interior ceilings. These natural materials possess excellent thermal massing and low thermal conductivity, keeping the interiors significantly cooler than standard concrete blocks.





Figure 8: The resort showing the pool
Source: La Campagne Tropicana ng, (2009)

Case Study 3:

Project Name: Gaakoshinbi Island Resort, Maldives

Location: Shaviyani Atoll, Maldives

Scope: Construction Area: 32,000 m² | Project Site Area: 175,000 m²

Design Background: Built with an organic layout, the master plan focuses directly on the island's unique climate, textures, and natural surroundings. The design process was rooted in sustainability and celebrating the interplay of light and shadow, aiming to create a luxurious sanctuary where the villas blend seamlessly into the environment instead of imposing upon it.

Eco-Tourism & Contextual Integration



Figure 9: Site Plan of Island Resort Source: Gadarchitecture.com, (2013)

Site Planning & Organic Layout:

The master plan utilizes a decentralized, organic layout that matches the natural contours of the island. Villas and essential support facilities are dispersed across the site to minimize density and prevent major land clearing.

By maintaining an organic geometry, the architectural masses harmonize with the island rather than disrupting it, ensuring that the natural vegetation line and coastal boundary remain uncompromised.

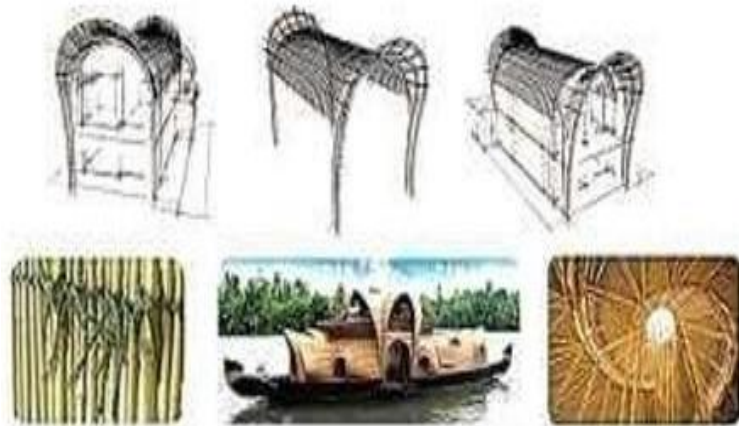


Figure 10: Photo showing inclusion of culture in the architecture Source: Gadarchitecture.com, (2013)

Socio-Cultural Preservation & Vernacular Architecture:

The primary design inspiration is drawn from the Kettuvallam, a traditional South Asian houseboat. Traditional boatbuilding techniques were adapted to the resort's structural expression, honoring the region's historic maritime identity. The design emphasizes vernacular craftsmanship, utilizing local carpenters to employ specific joining techniques—such as using coir ropes to bind wooden elements together—which preserves local, tangible heritage.

Spatial Experience & Nature Connectivity: The resort's spatial zoning uses architectural variations to immerse guests in different micro-environments. This includes 65 beachfront villas nestled into the coastal foliage, 1 presidential villa, and 40 overwater villas elevated above sea level. The public and wellness zones, such as the spa areas, incorporate specific regional characteristics designed to heighten the sensory experience of relaxation and connection to the water.



Figure 11: Photo of a villa showing sun shading devices at the resort, Source: Gadarchitecture.com, (2013)

Passive Design Strategies

The villas utilize open spatial layouts with large window openings positioned to maximize natural

airflow inside the buildings. By focusing on natural cross-ventilation from prevailing sea breezes, the architecture maintains indoor thermal comfort passively, minimizing the operational reliance on heavy mechanical cooling systems. The buildings feature massive structural overhangs and deep thatched roofs that shield indoor spaces from the intense direct sunlight and glare of the sun. The design also utilizes organic shading, positioning villas within the existing tree canopy to leverage natural shade from trees, which acts as a buffer against solar heat. The architectural material palette relies heavily on eco-friendly, natural materials that showcase their natural appearance, including traditional leaf thatch for roofs, 'Anjili' wood, and structural bamboo. These low-emissions materials serve a dual purpose: they function as decorative elements that celebrate nature while providing the primary structure with low thermal conductivity.



Figure 12:

5.0 Conclusion

This study successfully establishes a comprehensive framework for achieving ecological sustainability and structural resilience in the study area. By confronting the dual challenges of intense micro climate and the effect of environmental degradations, the research demonstrates that the evolution of leisure spaces does not require a choice between luxury and environmental preservation. Through the theoretical lenses of Climate-Responsive and Vernacular Architecture, and backed by successful regional and international case studies, it is clear that passive design strategies—such as optimized solar orientation, elevated substructures, thermal buoyancy loops, and local biodegradable material palettes—serve as the definitive link between a resort's commercial viability and its ecological responsibility. Ultimately, transitioning from rigid, conventional building practices to an adaptable, passive architectural approach allows the proposed eco-resort to minimize its carbon footprint while safeguarding the local biodiversity of the study area. This research underscores that true eco-tourism infrastructure must function as an active participant in environmental conservation, transforming local climatic challenges into defining spatial experiences that protect both the natural landscape and the socio-economic future of the host community.

Recommendation

The design and construction of eco resorts should prioritize the use of locally sourced, renewable, and low-or non-toxic building materials to minimize environmental impacts while supporting local industries. Collaboration with surrounding communities is essential, incorporating indigenous

building traditions, local craftsmanship, and cultural programming to create community-supported eco resorts that preserve cultural heritage and enhance local economic empowerment. Sustainable technologies, including renewable energy systems, greywater recycling, rainwater harvesting, and other resource-efficient solutions, should be integrated to improve the overall sustainability and operational efficiency of eco resorts. In addition, eco resorts should actively promote sustainable living practices among guests and staff through education, awareness campaigns, and environmentally responsible operations. Continued research collaborations between educational institutions, industry professionals, and government agencies should be encouraged to advance knowledge and innovation in sustainable and resilient architecture. Furthermore, government agencies should establish and enforce standards for sustainable building practices to ensure that the design and construction of eco resorts consistently meet environmental, social, and economic sustainability objectives.

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