

Implementing Litman's Nine Principles of Regenerative Architecture: An Evaluation of a Proposed Public Building Design in Lagos, Nigeria

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Abstract

The building and construction industry is a major contributor to environmental degradation, accounting for significant energy-related carbon emissions and resource consumption. While sustainable building designs have helped mitigate impacts, they often fail to address the complex challenges of unsustainable practices fully. This has led to the emergence of regenerative design principles, which view buildings as living systems capable of fostering the regeneration of natural systems. This study focuses on a proposed recreation centre design in Lagos, Nigeria, and evaluates its application of Litman's nine principles of regenerative architecture. The methodology encompasses a literature review, site analysis, and a comprehensive design assessment. The results demonstrate a well-integrated approach, with the design exemplifying principles such as Whole Systems Design Integration, Integration into the Landscape, Bold Ecology, and Intelligent Limits. The recreation centre actively contributes to restoring and enhancing the local ecosystem while fostering meaningful connections between the community and the natural environment. The findings provide valuable insights for architects, urban planners, and policymakers, showcasing the recreation centre as a model for integrating regenerative design principles into public spaces. Limitations of the study include its focus on a single case study and the lack of post-occupancy evaluation. Recommendations for future research include comparative analyses of multiple case studies and exploring the broader applicability of regenerative design in diverse public space contexts. By expanding the knowledge and applications of regenerative design, the built environment can catalyse positive change, actively contributing to environmental rejuvenation and community.

Keywords

Regenerative Architecture, Sustainable Design, Litman's Principles, Environmental Rejuvenation, Public Spaces, Nigeria.

1. Introduction

The building and construction industry is a significant contributor to environmental degradation, accounting for nearly 40% of global energy-related carbon emissions and consuming around 3 billion tons of raw materials annually (UNEP, 2020; Ogunbayo et al., 2022). The extraction, manufacturing, and transportation of building materials generate substantial greenhouse gas emissions, deplete natural resources, and pollute air and water (Lima et al., 2021). Additionally, building operation and maintenance further exacerbate environmental impacts (Erebor et al., 2021; Ogunbayo et al., 2022).

Sustainable building designs aim to minimize these impacts through energy efficiency, water conservation, and eco-friendly materials (Munaro et al., 2020; Erebor et al., 2021). However, they often fail to fully address the interconnected issues of unsustainable practices, relying on processes that contribute to resource depletion and waste generation (Islam et al., 2019; Hoang et al., 2020). A holistic, regenerative approach is needed to address these complex challenges (Chidinma & Fulani, 2019; Adewale et al., 2023).

Regenerative design principles view buildings as living systems that adapt to their surroundings and foster environmental regeneration (Mang & Reed, 2020; Petrovski et al., 2021). John Litman's nine principles of

regenerative architecture offer a framework for these practices, emphasizing energy and nutrient cycling, ecosystem integration, and human-nature connections (Bonyad et al., 2018).

In public spaces, such as recreation centres, parks, and community centres, regenerative design can play a crucial role in environmental rejuvenation and urban sustainability (Chidinma & Fulani, 2019; Fulani et al., 2019). By incorporating features like green roofs, rainwater harvesting, and on-site food production, these spaces can promote resource conservation, biodiversity, and community engagement with nature (Omemam et al., 2020). They can also serve as educational hubs for sustainable living practices (Gibbons, 2020; Attia, 2017b).

This study focuses on Lagos, Nigeria, a rapidly urbanizing city facing significant environmental challenges. It evaluates the application of regenerative design principles in a proposed recreation centre in Lagos, using Litman's nine principles as the assessment framework. The objectives are:

- 1) To assess the proposed design against Litman's principles.
- 2) To identify integrated regenerative design principles and analyze their potential impact on the environment and public spaces.

This study aligns with the United Nations' Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action). By promoting regenerative design in public spaces, it contributes to sustainable and regenerative building practices, guiding the development of future public spaces that enhance urban sustainability. The findings provide valuable insights for architects, urban planners, policymakers, and stakeholders in creating built environments that actively restore and improve environmental regeneration.

2. Materials and Methods

This research employed a multi-faceted approach to investigate the regenerative design elements and strategies incorporated in a proposed recreation centre design in Lagos, Nigeria and evaluate their alignment with Litman's nine principles of regenerative architecture. The methodology comprised three main components: a literature review, site analysis, and design assessment. First, a comprehensive literature review was conducted to establish a solid theoretical foundation for the study. This involved an in-depth examination of Litman's nine principles of regenerative architecture, which served as the assessment framework. Each principle, such as energy and nutrient cycling, ecosystem integration, and human-nature connections, was thoroughly explored to understand their implications and practical applications in architectural design.

A detailed site visit and analysis were carried out to gain a comprehensive understanding of the proposed site. This involved assessing the existing environmental conditions, such as topography, soil composition, vegetation, and local ecosystems, and identifying potential opportunities and challenges for incorporating regenerative design strategies. The site analysis also involved studying the surrounding context, including the urban fabric, infrastructure, and community dynamics, to provide insights into how the proposed recreation centre could foster symbiotic relationships with natural systems and contribute to overall sustainability and community well-being. A critical component of the methodology was the assessment of the architectural design plans and documentation for the proposed recreation centre. The design plans, drawings, specifications, and other relevant materials were thoroughly reviewed to identify the regenerative design elements and strategies incorporated into the design. Using Litman's nine principles as a framework, the design was evaluated to determine how each principle was addressed or could be further integrated. This assessment involved a detailed examination of the design features, materials, technologies, and systems proposed for the recreation centre and how they aligned with the principles of regenerative architecture.

The findings from the various data sources were synthesised and interpreted within the context of Litman's principles of regenerative architecture, identifying the strengths and weaknesses of the proposed design, areas where the principles were effectively addressed, and opportunities for further integration or improvement. Furthermore, the analysis explored the broader implications and applications of regenerative design principles for public spaces in Lagos and beyond. It examined their potential role in promoting sustainable urban development, enhancing community well-being, and addressing the environmental challenges that rapidly urbanising cities face.

3. Public Building Regenerative: Architecture Design, Analysis and Assessment

3.1 Litman's Nine Principles of Regenerative Architecture

The core concept underlying all regenerative architecture principles is the imperative for design to respond to the unique characteristics of the local environment and ecosystem in which a building is situated (Littman, 2009). Kabir (2016) highlights that despite different researchers approaching this concept under various names, such as the

Guiding Principles of regenerative architecture by Murphy and Marvin (1998), the Hannover Principles by William McDonough (2000), The Todds' Principles of Ecological Design by John and Nancy Jack Todd (1993), The Five Principles of Ecological Design by Van Der Ryn and Cowan (2005), and The Nine Principles of regenerative architecture by Littman (2009), they all converge on the idea of "place" as their central focus. Littman synthesised Todd's Concepts of Ecological Design, Todd's Principles of Ecological Design, and Hannover's Principles alongside his nine principles. These concepts, drawn from various interrelated disciplines, seek to permanently integrate the human and natural environments (Bharath, 2019; Kabir, 2016; Omokanye, 2023). Littman's Nine Principles of Regenerative Architecture provide a comprehensive framework for creating sustainable built environments and actively contribute to restoring and enhancing natural and social systems. These principles, which draw inspiration from diverse disciplines such as systems theory, permaculture, and biophilic design, offer a holistic approach to architectural design that transcends traditional notions of building (Omokanye, 2023).

The first principle, Whole Systems Design Integration, emphasises the interconnectedness of all elements within a site, encouraging designers to view the project as a complete ecosystem. By identifying opportunities for synergy and efficiency, this principle can lead to innovative solutions that maximise the functionality and minimise the environmental impact of built structures. For example, a building's roof may serve as a platform for renewable energy generation, rainwater harvesting, and urban greenery, seamlessly integrating multiple systems to create a more regenerative outcome. The Integration into the Landscape principle focuses on harmonising built structures with their natural surroundings. Through careful site analysis and a deep understanding of the local context, designers can create interventions that enhance rather than disrupt the existing ecosystem (Masoetsa et al., 2022). This approach blurs the boundaries between the built and natural environments, fostering a sense of seamless integration and connection to place. The Principle of Bold Ecology challenges designers to go beyond traditional sustainability practices and actively contribute to ecological health and resilience. By incorporating strategies such as habitat restoration, carbon sequestration, and biodiversity enhancement, regenerative architecture can transform buildings into catalysts for positive environmental change, turning the built environment into an asset rather than a liability (Adekunle et al., 2023).

The Principle of Intelligent Limits emphasises the importance of understanding and respecting the constraints of natural systems. By adopting a mindset of resourcefulness and efficiency, designers can minimise waste and maximise the utility of materials and energy, creating buildings that operate within the limits of their ecosystems. This principle encourages using renewable, locally sourced materials and closed-loop systems to reduce environmental impact throughout the building's lifecycle. The Principle of Concentration focuses on the efficient spatial organisation of built environments, emphasising the importance of compact, multi-functional designs that promote interaction, circulation, and productivity. By carefully arranging elements and functions, designers can enhance the overall performance of the building while creating vibrant, engaging spaces for occupants. The Principle of Intelligent Construction underscores the importance of sustainable building practices, prioritising durability, adaptability, and lifecycle considerations to minimise environmental impact throughout construction. This principle encourages using renewable energy sources, efficient construction techniques, and a deep understanding of material properties to create ecologically sound and resilient buildings.

The Principle of Community highlights architecture's social and cultural dimensions, recognising that buildings are physical structures and hubs of human interaction and cultural expression. By fostering a sense of community and belonging, designers can create spaces that enrich the lives of their users and strengthen social bonds, contributing to the overall well-being of the surrounding neighbourhood. The Experience of Place principle emphasises a site's unique qualities and character, encouraging designers to respond to the local context, climate, and cultural heritage in their design solutions. By celebrating a place's "genius loci" or spirit, architects can create meaningful and memorable spaces that resonate with the user and foster a deeper connection to the built environment.

Finally, the Principle of Culture acknowledges the cultural significance of built environments and seeks to honour and preserve local traditions and identities. By incorporating indigenous knowledge, vernacular techniques, and community values into the design process, architects can create spaces that reflect and respect the diverse cultures they serve, promoting cultural diversity, heritage conservation, and cross-cultural exchange. Together, these nine principles provide a comprehensive framework for the practice of regenerative architecture, guiding designers towards creating built environments that are in harmony with the natural world and that contribute to the overall well-being of the communities they serve. By embracing this holistic approach, architects and urban planners can play a crucial role in addressing pressing environmental and social challenges, transforming the built environment into a catalyst for positive change.

3.2 Site Analysis

The proposed site for the recreation centre in Sangotedo, Lagos, features undulating topography with a gentle gradient leading to a significant drainage area. This natural slope offers opportunities for sustainable stormwater management, though the design must minimise site grading to preserve natural features. By respecting the site's contours, the centre can integrate seamlessly into its environment, fostering harmony between built and natural elements. The project site, characterised by virgin land and dense vegetation, primarily grasses and limited trees, represents a valuable ecological asset. Existing plants will be evaluated and incorporated where possible to maintain ecological integrity and support biodiversity. Opportunities for enhancing natural features through strategic tree planting and introducing native species will also be explored.

Situated in the rapidly developing Sangotedo area, designated for residential and commercial growth, the site is near landmarks like the Sangotedo ShopRite mall, Blenco Supermarket, Domino's Pizza, and Smiley Kids Montessori School. This proximity allows the recreation centre to cater to the local community's needs and leverage existing infrastructure for maximum accessibility and engagement. Convenient access via the Lekki-Epe Expressway and Emerald Avenue Road enhances its potential as a vibrant hub for health, wellness, and community activities.

Integrating regenerative design principles with the site's natural features and surrounding context promotes biodiversity, sustainability, and ecosystem services. The recreation centre's location within a developing area also provides opportunities for community engagement, health initiatives, and environmental education programs. Collaborating with local educational institutions like Smiley Kids Montessori School can deepen connections between the facility, the community, and the natural environment. Sustainable mobility options, such as walking and cycling, will further enhance the centre's sustainability and community integration.

By considering the site's topography, vegetation, and context, the design team can create a facility that meets local needs while contributing to environmental restoration. This holistic approach ensures the recreation centre becomes a sustainable, resilient asset, fostering strong connections between people, places, and nature.



Fig. 1. Site location of the proposed site in Sangotedo

3.3 Design Assessment and Check Listing.

The assessment of the proposed recreation centre design through the lens of Litman's nine principles of regenerative architecture revealed a comprehensive and well-integrated approach to sustainable design. By conducting a detailed review of the architectural plans, drawings, and supporting documentation, the design team was able to identify the specific strategies and features employed to embody each of these transformative principles. The following in-depth analysis delves into the intricate ways the recreation centre design exemplifies the foundational concepts of regenerative architecture, showcasing a holistic and innovative approach to creating built environments that are ecologically responsible and actively contribute to the restoration and enhancement of natural and social systems. Through this rigorous examination, the design's adherence to the principles of whole systems integration, landscape

harmony, bold ecology, intelligent limits, spatial concentration, construction intelligence, community engagement, sense of place, and cultural responsiveness becomes evident, underscoring the project's potential to serve as a model for the next generation of sustainable development. The summary of these findings is presented in Table 1 below.

Table 1. Design Assessment and Check Listing

Whole Systems Design Integration		
Checklist	Absent	Present
Opportunities for synergy and efficiency within the site	---	<input checked="" type="checkbox"/>
Viewing the project as a complete ecosystem	---	<input checked="" type="checkbox"/>
Maximising functionality and environmental impact	<input checked="" type="checkbox"/>	---
Integration of multiple systems such as renewable energy generation, rainwater harvesting, and urban greenery	---	<input checked="" type="checkbox"/>
Seamless integration of systems to create a regenerative outcome	<input checked="" type="checkbox"/>	---
Integration into the Landscape		
Thorough site analysis to understand the natural surroundings	---	<input checked="" type="checkbox"/>
Harmonising built structures with the existing ecosystem	---	<input checked="" type="checkbox"/>
Blurring the boundaries between the built and natural environments	<input checked="" type="checkbox"/>	---
Fostering a sense of seamless integration and connection to place	<input checked="" type="checkbox"/>	---
Preserving and enhancing the site's ecological integrity	---	<input checked="" type="checkbox"/>
Principle of Bold Ecology		
Going beyond traditional sustainability practices	---	<input checked="" type="checkbox"/>
Actively contributing to ecological health and resilience.	<input checked="" type="checkbox"/>	---
Incorporating strategies such as habitat restoration, carbon sequestration, and biodiversity enhancement	<input checked="" type="checkbox"/>	---
Transforming buildings into catalysts for positive environmental change	---	<input checked="" type="checkbox"/>
Turning the built environment into an asset for the ecosystem	---	<input checked="" type="checkbox"/>
Principle of Intelligent Limits		
Understanding and respecting the constraints of natural systems	<input checked="" type="checkbox"/>	---
Adopting resourcefulness and efficiency in design	---	<input checked="" type="checkbox"/>
Minimising waste and maximising material and energy utility	---	<input checked="" type="checkbox"/>
Using renewable, locally sourced materials	---	<input checked="" type="checkbox"/>
Implementing closed-loop systems to reduce environmental impact	<input checked="" type="checkbox"/>	---
Principle of Concentration		
Focusing on efficient spatial organisation	---	<input checked="" type="checkbox"/>
Designing compact, multi-functional spaces	---	<input checked="" type="checkbox"/>
Promoting interaction, circulation, and productivity	---	<input checked="" type="checkbox"/>
Carefully arranging elements and functions.	---	<input checked="" type="checkbox"/>
Enhancing the overall performance of the building	---	<input checked="" type="checkbox"/>
Principle of Intelligent Construction		
Prioritising sustainable building practices	<input checked="" type="checkbox"/>	---
Ensuring durability, adaptability, and lifecycle considerations	---	
Minimising environmental impact throughout the construction process	---	<input checked="" type="checkbox"/>
Using renewable energy sources and efficient construction techniques	<input checked="" type="checkbox"/>	---
Understanding material properties to create ecologically sound and resilient buildings	<input checked="" type="checkbox"/>	---

Principle of Community		
Recognising the social and cultural dimensions of architecture	<input checked="" type="checkbox"/>	---
Fostering a sense of community and belonging	---	<input checked="" type="checkbox"/>
Creating spaces that enrich the lives of users	---	<input checked="" type="checkbox"/>
Strengthening social bonds within the neighbourhood	<input checked="" type="checkbox"/>	---
Contributing to the overall well-being of the community	<input checked="" type="checkbox"/>	---
Experience of Place		
Responding to the unique qualities and character of the site	---	<input checked="" type="checkbox"/>
Considering the local context, climate, and cultural heritage	---	<input checked="" type="checkbox"/>
Celebrating the spirit of the place (genius loci)	<input checked="" type="checkbox"/>	---
Creating meaningful and memorable spaces	---	<input checked="" type="checkbox"/>
Fostering a deeper connection to the built environment for users	<input checked="" type="checkbox"/>	---
Principle of Culture		
Acknowledging the cultural significance of built environments	---	<input checked="" type="checkbox"/>
Honouring and preserving local traditions and identities	---	<input checked="" type="checkbox"/>
Incorporating indigenous knowledge and vernacular techniques	<input checked="" type="checkbox"/>	---
Promoting cultural diversity, heritage conservation, and cross-cultural exchange	<input checked="" type="checkbox"/>	---
Reflecting and respecting the diverse cultures served by the design	<input checked="" type="checkbox"/>	---

4. Discussion

The assessment of the proposed recreation centre design in Lagos, Nigeria, through the lens of Litman's nine principles of regenerative architecture, reveals a comprehensive and well-integrated approach to sustainable development. The design team has incorporated diverse strategies that create a built environment enhancing its surrounding ecosystem and fostering meaningful connections between the local community and nature.

Central to the design's regenerative potential is the Whole Systems Design Integration principle. By interlinking renewable energy generation, rainwater harvesting, and urban greenery, the recreation centre establishes a closed-loop, symbiotic cycle where the outputs of one system become the inputs of another. This holistic integration maximises building functionality and minimises environmental impact, aligning with Litman's ecosystem-based approach.

The design's integration into the landscape demonstrates a deep appreciation for the site's unique topography, hydrology, and vegetation. By harmonising the built structure with the existing ecosystem, the recreation centre blurs the boundaries between the natural and the man-made, fostering a connection to the place's genius loci or spirit. This commitment to Bold Ecology goes beyond traditional sustainability practices, actively contributing to the restoration of the local environment through wetland rehabilitation, bioswale integration, and nesting structures for local fauna.

The Principle of Intelligent Limits is evident in the design's consideration of the site's carrying capacity and resource constraints. The use of low-embodied energy materials, closed-loop systems, and on-site renewable energy generation reflects a resourceful and efficient approach that minimises the environmental footprint. Additionally, the Principle of Concentration is demonstrated in the compact, multi-functional layout, which optimises spatial organisation and enhances building performance through improved thermal comfort, daylighting, and natural ventilation.

The Principle of Community is deeply embedded in the design, focusing on fostering a sense of belonging rooted in local cultural traditions and values. Collaboration with neighbouring residents ensures the layout and programming cater to their needs, offering spaces for multi-generational gatherings and youth activities. The Experience of Place principle is intricately woven into the design, reflecting a deep appreciation for the site's unique character and the local community's cultural heritage.

While the recreation centre design exemplifies a comprehensive integration of Litman's principles, the study has limitations. The assessment is based on a review of architectural plans and documentation without firsthand observation of the completed facility and its actual performance over time. Additionally, the study focuses on a single case study in Lagos, and further research is needed to explore the broader applicability of regenerative design principles in diverse public space contexts.

Nonetheless, the findings provide valuable insights for architects, urban planners, policymakers, and other industry professionals involved in public space development. The recreation centre design models how regenerative design principles can be effectively integrated into the built environment, contributing to environmental rejuvenation, community well-being, and sustainable urban development.

5. Conclusions

The assessment of the proposed recreation centre design in Lagos, Nigeria, through Litman's nine principles of regenerative architecture, showcases a well-integrated approach to sustainable development. By incorporating strategies like Whole Systems Design Integration and Integration into the Landscape, the design fosters a strong connection between the built environment and its surrounding ecosystem. Commitments to Bold Ecology and Intelligent Limits actively contribute to environmental restoration while minimising the building's footprint. Principles of Community and Experience of Place enhance community well-being and celebrate local cultural heritage.

This design serves as a model for future projects, demonstrating the potential of regenerative architecture to inspire positive change and restore natural and social systems. The study highlights the transformative potential of regenerative design practices in addressing urban challenges and advancing sustainable development goals. By embracing a holistic approach that integrates ecological, social, and economic considerations, the project offers a promising model for fostering resilient, inclusive, and thriving communities in Nigeria and similar contexts.

Future research should include post-occupancy evaluations of completed regenerative public spaces to assess their long-term performance and impact on the local ecosystem and community. Comparative analyses of multiple case studies across different geographic and cultural contexts would enhance understanding of regenerative design principles' broader applicability. Additionally, exploring the integration of these principles in other public spaces, such as parks, community centres, and educational facilities, would provide a more comprehensive understanding of the transformative potential of regenerative design in the public realm.

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