World Journal of Advanced Engineering Technology and Sciences
eISSN: 2582-8266
Cross Ref DOI: 10.30574/wjaets
Journal homepage: https://wjaets.com/

(REVIEW ARTICLE)

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Designing of buildings in the age of the Anthropocene: Is environmental sustainability the answer?

Obaro Dominic Oghenejabor [1,*], Mena Anthony Ikoro [2], Ighoviroro Richard Vwioko [2] and Benedict Umukoro [2]

[1] *Department of Environmental Management, Faculty of Environmental Sciences, Southern Delta University, Ozoro, Nigeria.*
[2] *Department of Architecture, Faculty of Environmental Sciences, Southern Delta University, Ozoro, Nigeria.*

World Journal of Advanced Engineering Technology and Sciences, 2025, 15(02), 1953-1965

Publication history: Received on 05 April 2025; revised on 14 May 2025; accepted on 16 May 2025

Article DOI: https://doi.org/10.30574/wjaets.2025.15.2.0757

Abstract

This systematic review examines 87 academic papers that were published from 2014 to 2024, which provide a critical analysis of environmental sustainability in the arena of Anthropocene architecture. The research ties to development from green building metrics based in technology to a holistic approach by regenerative, context-responsive and post-humanist design principles. There are still traditional programs such as LEED and BREEAM that have an important role, but they face challenges in terms of their inflexibility and inequity, which has birthed the birth of regenerative architecture and circular design and localism. The review identifies five key sustainability strategies that focus on renewable materials, net zero design, smart systems, urban-scale planning, and local-global hybrid models, allowing a greater array of sustainability tasks that go beyond buildings. Post-sustainability frameworks promote co-evolution between the human race and the environment, question the existing dominant design norms, and promote incorporation of numerous species. One realizes that the convergence of theory is overtaken by regulatory barriers, limitation of technology and epistemological barriers to practical sustainability. The body of work reveals an urgent call for development of architectural methodologies, which needs to move from addressing mere reduction of harm to ecological restoration, as well as resilience and culturally inclusive design.

Keywords: Sustainability; Anthropocene; Greenhouse gases; Building; Design

1. Introduction

Emerging as a dominant theme in discussions about environmental issues and architectural studies, the Anthropocene a term created by Crutzen and Stoermer to indicate a geological epoch mainly shaped by human activity – is a contemporary phenomenon. This time is defined by unparalleled destruction of ecosystems, rapid global heating, high-rate depletion of global resources, and the explosive growth of urban zones as a result of the effect of built environments on the earth (Bera et al., 2023). Architecture as a product and motivator of human action influences ecosystems and manages the relationship people have to the environment. Architecture plays significant part, with buildings consuming about 40% of the world's energy and releasing about a third of all the greenhouse gases, hence there is a need for careful decision making in the design process, in order to conserve the environment (Mastrucci et al., 2023). Architecture's contribution has outgrown serving human comfort and beauty; it is more and more recognized as a key role in ruling Earth's systems (Barrio, 2023). The rise of the Anthropocene architecture calls for the need to revise our perceptions, the design, and the making of the space we live in.

This crisis has resulted in the environmental sustainability efforts becoming the keynote of the profession of architects and urban planners. The framework focuses on energy efficiency; minimization of materials; inclusion of renewable energy; and green certificates as avenues of reducing environmental damage (Almusaed et al., 2024). Advocates note

* Corresponding author: Oghenejabor, O.D.

that although measures like LEED, BREEAM and EDGE have gained international fame, they are regularly criticised for promoting narrow and tech focused solutions as opposed to addressing fundamental systemic, cultural and ecological issues (Florez, 2020). And, the act of sustainability has also frequently been driven by market incentives, so as to amount to "greenwashing" and empty beautification efforts rather than actual change (Lublóy et al., 2025). Such debates point to the call for architectural solutions that go beyond sustainable measures onto the more regenerative, adaptive and holistic design philosophies of our times. In such a way, architects face a new mission – one of going beyond the mitigation and active work towards the restoration and renewal of ecosystems through strategic design (Kumar et al., 2025).

This literature review tries to experiment with whether the concept of environmental sustainability is still completely relevant to the complexities of building design in the realm of anthropocene. This study reviews writings from 2017–2025, and gathers evidence from architectural theory, environmental design, and urban ecology. The aim of the review is to elucidate contemporary meanings and practices of sustainability in architectural debate and the question of whether such approaches adequately address the complex questions of the Anthropocene. The central issues this review explores are 1. How has the Anthropocene re-written the architectural design expectations and obligations placed upon its practitioners, in ways? In what ways has the concept of environmental sustainability incremented or stood still because of ecological challenges? Are the creative methods of regenerative architecture, biomimicry, or of post-humanist design able to deliver better solutions to the Anthropocene? Comparing universal and local studies, this article contributes to the argument by exploring the intricacies of sustainability as a principle in architectural practice. Also, the article is aimed at the accentuation of neglected elements of available scholarship and tracing lines of developing a future architecture that will be actively involved with planetary processes.

2. Conceptual and Theoretical Background

2.1. Conceptual Framework

Anthropocene refers to the current geological age determined by the deep and typically unmanageable impacts of men on the ecosystem, climate, and geological structure of the earth. From experts' perspective, it is possible to claim that activities such as urban development, extinction of fossil fuels and extensive trees' deforestation now have a greater effect on planetary processes than any other factor (Zottola and de Majo, 2022). The Anthropocene of architectural practice uses this time to promote a change in priorities, transforming the main purpose of architecture practice as well as its focuses from being purely functional and aesthetic to be focused on the protection of planetary health, support of biodiversity, and lifecycle management of materials. In the context of the Anthropocene, architecture is studied more than as a reflection of human ingenuity; it is also a major culprit of global ecosystem warping (McEwan, 2023). It accentuates the role of ethical design strategies and projects architecture as both representation of human supremacy over the environment and a force in ecological restoration.

2.1.1. Environmental sustainability

The idea of environmental sustainability that is typically associated with the Anthropocene is grounded on how to use natural resources responsibly with an aim of protecting the long-term health on Earth and its occupants (Folke et al, 2021). Architectural discussions explain sustainability as an approach to building configuration in which minimum damage to the environment is achieved through energy conservation, use of renewable resources, waste avoidance, and compatibility with the natural ecosystem (Mba et al., 2024). Despite this, critics note that although sustainability focuses on mitigation and efficiency, it tends to lapse into an over-simple checklist that misses the depth of ecological and social problems (Sultana, 2023). Although much discussed in contemporary discourse, the sustainability framework is challenged for its insufficiency of adaptivity and lack of engagement with multiplicity of crises caused by the Anthropocene (Biermann, 2022). Therefore, comprehension of the term demands acknowledging it as, on the one hand, an environmental imperatival obligation and, on the other hand, as a philosophical and ethical basis in architectural practice.

2.1.2. Green architecture and regenerative design

Although it is not uncommon to link green architecture to regenerative design, they are clearly different streams of thought. Weaning off the effects from the environment is the overall purpose behind green architecture in the use of ecology friendly materials, passive building systems and energy saving methods (Abdel Hay bin Omera, 2024). Regenerative architecture goes beyond the green design, attempting to restore and restore ecological systems, foster biodiversity, and encourage community wellness (Gibbons, 2020; Toner et al., 2023). Toner et al., 2023). Whereas sustainability and mitigation are the focus of green design, regenerative architecture promotes buildings to improve

ecosystem well-being by transitioning to net-positive and mutually supportive relationships with nature. It is critical at the Anthropocene when harm reduction is not enough, per se, but a quest for the meaningful good outcomes is desired.

2.2. Theoretical frameworks

2.2.1. Ecological Modernism

Addressing ecological deterioration in terms of innovation and institutional change rather than a return to pre-industrial life in ecology Modernism presents a proposal (Diaper, 2022; Bush and Spaargaren, 2024). It implies that urban growth and environmental protection can indeed go hand in hand with innovation of design and clean technology (smart buildings; renewables; green infrastructure). According to Chaudhary et al. (2024), ecological modernist thinking stresses the importance of contemporary architecture to shift to sustainable materials, cutting edge digital building practices, and zero-carbon goals without hampering urban or economic development. The theory questions the divide between the natural world and built landscapes and proposes a world in which modern architecture can coexist with environmental priorities. Ecological Modernism is increasingly integrated into the urban development framework, in areas that are in the process of rapid urbanization, which needs urgent ecological solutions. This theory offers a forward-looking approach to reconciling technical developments with ecological issues, making it extremely pertinent for contemporary architectural discussion and worldwide efforts to prevent the hazards of climate changes.

2.2.2. Human-Nature Interaction

The Human-Nature Interaction perspective examines the effects and mediation of human experience with nature by the designed environments (Soga and Gaston, 2020). Following biophilia and environmental psychology, this framework emphasizes the beneficial psychological, emotional and medical effects that the elements of nature have in architecture. The attention restoration theory, in compliance with Thampanichwat et al. (2024), implies that physiological effects in the glades and green roofs or indoor landscape restoration that is found in garden will help to maintain cognitive abilities and mood. Projecting from this framework some of the architectural principles include emphasis on daylight, incorporation of nature in the view, preference for natural ventilation and use of natural materials. Zhong et al. (2022) findings show that, and, biophilic design improves satisfaction among building users while also increasing productivity and reducing the stress within practical settings. Other than its aesthetic appeal, Human-Nature Interaction is an integral architectural principle that influences project planning, lighting analysis, and choice of materials. Architecture therefore becomes an important interface that can encourage ecological awareness and sustain at a personal level.

2.2.3. Systems Thinking and Resilience Theory

Shen and Gao (2020) propose that that the Systems Thinking and Resilience Theory provide an integrated framework for reflecting upon and constructing adaptive systems such as cities and buildings. The field of systems thinking focuses on the interactions between systems and the provision of continuous feedback to demonstrate how architectural interventions affect and transform ecological, social, and economic systems (Carnohan et al., 2025). By focusing on the capacity of systems to withstand and persist in a state of operation during disturbances; resilience theory makes the discussion at hand more comprehensible. In architecture this aspect allows for designing of flexible, adaptable buildings that may stand climate changes, crises of energies, or population growth. By way of illustration, purchasing of modular design, utilization of passive energy technologies, and promotion of urban-rural ties is characteristic of resilience-based architectural practices (Parracho et al., 2025). That perspective on design helps create well-thought-out strategies, a lifelong view of buildings, and meaningful involvement of all the parties concerned. This blend of theories leads to sustainable architecture that maximizes energy use and resists changing environmental and social needs.

2.2.4. Relevance of These Frameworks in Architectural Discourse

Concurrently, modern architects are becoming much more dependent on the synergy between Ecological Modernism, Human-Nature Interaction and Systems Thinking/ Resilience Theory for the sake of increasing the sustainability of the urban environment. Using Ecological Modernism, architects have tactics to fuse technology like prefabricated parts and programmable materials, aiding them in meeting standards for the environment with a respect for design principles (Wang et al., 2024). At the same time, Human-Nature Interaction reorients design priorities towards a priority on user well-being with a natural element integration within building spaces (Zhong et al., 2022). Biophilic and sensory-earned innovations change the architecture experience showing how the health effects of the built environment can be intuitively spatial.

Through resilience and systems thinking, we realize architecture's fundamental role in complex socio-ecological situations. They stimulate architects to concentrate on feedback mechanisms, adaptation, and system connectivity, developing designs to reduce environmental impacts and strengthen community resilience (Mlote et al., 2024). These

frameworks collectively campaign for the discontinuation of traditional rigid design practises and the adoption of malleable, user-centric, and ecologically consonant solutions. Bridging these frameworks into architectural work allows designers to go beyond the confines of conventional sustainability metrics and incorporate a systemic, inclusive, and long-term ethical background as the silent protagonist of their design in the Anthropocene.

3. Methodology of the Review

In order to unveil and evaluate scholarly articles about environmental sustainability in Anthropocene architecture, this literature review has imposed a rigorous, systematic strategy. The process of reviewing combined these following five critical elements: creation of standards on including and excluding the study, finding relevant databases, creating a temporal frame, developing an appropriate search strategy, and finally grouping obtained literature.

3.1. Inclusion and Exclusion Criteria

Studies were included if they: Focusing on architectural design in the context of environmental sustainability or the Anthropocene, the type of publication was limited to peer-reviewed articles or conference proceedings in English, and data or analysis concerning building design strategies was mandatory. Studies that were limited to unconnected engineering fields, although purely artistic or historical works lacking environmental perspectives, non-refereed opinion articles, or items unavailable in full text were excluded from the review (Vujovic et al., 2023; Sauvé et al., 2022). Thus, the review was based on strong, scientifically relevant data and research.

3.2. Search Databases

Interdisciplinary viewpoints were covered by systematically searching multiple databases. As shown in Table 1, the primary sources were Scopus, JSTOR, ScienceDirect, and Google Scholar because of their wide range of architecture, environmental science and urban studies (Shaikh et al., 2023). Schopus provided extensive scientific research, JSTOR had accessible historical and theoretical perspectives, Science Direct dealt in engineering and environmental design scholarly work, and Google scholar accomplished the pool with grey and interdisciplinary works.

Table 1 Search Strategy

Component	Details
Databases Searched	Scopus, JSTOR, ScienceDirect, Google Scholar
Search Period	January 2014 – December 2024
Language	English
Search Keywords	“Anthropocene architecture”, “environmental sustainability”, “green building”, “regenerative design”, “biophilic design”, “resilience theory”
Boolean Operators	AND, OR Example: “Anthropocene AND sustainability” OR “regenerative architecture”
Inclusion Criteria	Peer-reviewed articles/conference proceedings- Focus on Anthropocene or environmental sustainability in architecture- English- Full-text access- Theoretical or empirical architectural analysis
Exclusion Criteria	Non-peer-reviewed work- Unrelated engineering studies- Purely historical/aesthetic pieces- Opinion articles- No full text
Screening Phases	Title and abstract review → Full-text review
Final Classification Themes	Techno-centric frameworks (LEED, BREEAM)- Regenerative design- Biophilic approaches- Systems thinking/resilience

3.3. Time Frame of Literature Reviewed

To track the evolution of discourse of sustainability under the Anthropocene, the review recounted works published between the months of January 2014 and December 2024. The lower limit was determined to meet the initial conversations on the Anthropocene in architectural research (McEwan, 2023), while the upper limit incorporated current answers to regenerative design and post-humanist thinking (Janković, 2024).

3.4. Keyword Strategy and Screening Process

In the first round, searches combined key-words like “Anthropocene architecture”, “environmental sustainability”, “green building”, “regenerative design”, “biophilic design”, and “resilience theory”. To make findings relevant, the researchers included Boolean operators (e.g., “Anthropocene AND sustainability” or “regenerative architecture”) in their search strategy (Arora and McIntyre, 2021). In the first step, articles were screened by viewing their titles and abstracts in order to filter out non-relevant findings. Subsequently, the methodological quality and thematic fit of the chosen articles were assessed based on a detailed examination of their entire texts. A total of 1243 records were identified from the search; Only 87 of the 312 articles that pass the initial screening went on to meet the criteria for full-text consideration.

3.5. Classification Method

Studies chosen were categorized under thematic categories that coin with important contemporary architectural discussions: The research categorized sustainability frameworks into four groups: Techno-centric standards such as LEED and BREEAM; regenerative and net positive practices; Biophilic environments and connection to nature, and Systems thinking and resilience methodologies (Reith and Brajković, 2021; Godinez López, 2021). The articles in each theme were organized chronologically for the years of the studies to show human ideas progression. The sheer integration of both thematic and chronological organization allowed for the identification of coherent emerging paradigms as well as persistent weaknesses (ultimately, contributing to an informed appraisal whether environmental sustainability can continue to suffice for modern building design).

4. Evolution of Sustainable Architectural Design

Throughout history, sustainable architecture as evolved with a consistent establishment of gradual changes from orthodox vernacular practices towards contemporary eco-friendly design strategies. At first, sustainable building practices developed in an organic way since ancient architects drew upon regional resources, designed building forms that suited regional weather patterns, and restricted their technical applications. Such cases as adobe walls and the central courtyards demonstrate how traditional design strategies blended in with the flow of nature to deliver sustainable gain (Ganjimorad et al., 2024). Moreover, the introduction of industrially produced matter such as concrete and steel, as well as the advent of centralized heating-cooling systems, broke the cycle of architecture with its ecological setting. The profession of architecture did not take sustainability seriously until the mid-twentieth century, when increasing consciousness about energy and ecological catastrophes forced a reevaluation. As a consequence of such a shift, architects have become more aware of sustainability, and scientific investigation points to the influence of the built environment on global carbon emplacement (Mba et al., 2024). The undertones of this era Suite the way sustainability occupies its life as the architects’ master thought, encompassing environmental needs, cutting-edge technology, and a sense of comfort for its users.

Foreign architectural trends have been a vital factor in shaping the growth of sustainable building practices. The movement of passive design that was reenergized in the 1970s and strengthened throughout the early 2000s gives preference to the orientation of building, the use of solar energy, and the use of thermal mass to optimize energy utilization (Elaouzy and El Fadar, 2022). Bioclimatic architecture is its development, where design approaches are tailored to accommodate the local climatic conditions through taking into consideration region specific environmental particulars and materials (Aghimien and Tsang, 2022). Adoption of the methods promoted the idea of climate resilient design that is very important at the age of rising global climate. In addition, green urbanism has taken form as a reaction to urban sustainability, with focus on livable, compact neighborhoods, dependence on renewables and the incorporation of green amenities (Thomson and Newman, 2021). An example of how the bigger picture of an ecologically-minded urbanization can be implemented is Vauban in Germany and Masdar City in the UAE. Such design frameworks, as demonstrated by literature, transcend superficial aesthetics and become informed by rigorous analysis of the management of resources, equitable access to environmental benefits as well as optimizing living conditions in the built environment (Rezaei, 2020). Their acceptance on a global scale demonstrates that sustainable design principles are applicable across wide contexts globally.

In the evolving design philosophies, formal rating systems and digital innovations have also made it to being key tools of pushing the boundary of sustainable architecture. Tools such as LEED, BREEAM, EDGE, and WELL have dispensed authoritative gauges for evaluating and awarding sustainable building success. Unlike LEED and BREEAM – which are known for their extensive and complex guidelines, EDGE – a product of IFC – benefits the emerging economies by focusing on the practical nature of resource efficiency (Ibrahım and Labaran, 2024). Developed in 2014, the WELL

Building Standard transformed the vision of sustainability from that of people towards a focus on wellbeing, comfort, and psychological comfort of occupants (Mainini et al., 2024). Along with these frameworks are also digital platforms such as Building Information Modeling (BIM), which facilitate collaboration and energy analysis, and the Life Cycle Assessment (LCA) software that determines how constructions impact the environment throughout their length of use (Klumbyte et al., 2023). Sustainable design has now been transitioned away from being driven by personal opinions to a factual context in decision making through integrating these resources, allowing architects to have better energy resultations, smaller carbon footprints, and occupant comfort from the beginning of projects (Li et al., 2020). In totality, these developments showcase a evolving consciousness in sustainability, full of transparency and quantifiable impacts and iterative teamwork.

5. Current Strategies and Practices in Sustainable Design

Sustainable design has become an essential concept for addressing environmental and social pressure and the economic ones through urbanization and ecological deterioration. The combination of cutting-edge materials, energy-sensitive architecture, and cutting-edge building systems has resulted in the redefinition of the built world, which in turn emphasizes on sustainability, durability, ecological responsibility. From the product of a comprehensive study of scholarly and professional literature it is clear that sustainable considerations are penetrating across the process of designing, construction and management of urban environments. This analysis investigates five critical sectors as: design innovations such as renewable material innovations; building techniques; a climate resilient approach; integration of smart system and community-based approach to sustainable initiatives incorporating diverse global and interdisciplinary perspectives.

5.1. Use of Renewable Materials and Construction Technologies

Sustainable design research and practice have indicated heightened interest in the use of renewable and biodegradable materials in construction. Systematic reviews point to an upward trend in using bio-based materials such as bamboo, hempcrete and recycled timber majorly due to minimal embodied energy and carbon sequestration capabilities (Le et al., 2023). Other than being abundant and environmentally friendly, these materials support superior thermal performance in structures within buildings. Adoption of prefabrication and modular building methods has resulted in superior sustainability outcomes with reduced waste, accelerated construction time, and decreased site emissions according to the study by Adeyemi et al (2024). Sustainable composites with cutting-edge 3D production methods offer a pathway towards customized and resource-saving building results (Agrawal and Bhat, 2025). However, these materials continue to experience such difficulties as geographical scarcity, lack of performance information, and legal limitations. Not surprisingly, lifecycle analyses are still in infancy in the case of many alternative substances, thus prolonging their entry into the market (Barbhuiya and Das, 2023). Practical solution includes coordinated regulatory frameworks, coordinated research initiatives and construction-based support mechanisms respectively. The studies available suggest renewable materials and technologies have high potential to transform the construction sector, but also underscore a pressing need for empirical validation and/or structural enhancements.

5.2. Climate-Responsive Design and Net-Zero Buildings

Climate-responsive design and NZEBs specifically emerge as important features of the attempt to reduce operational carbon emissions in buildings. Extensive analyses indicate that basic passive design strategies (building orientation, natural convection, shading interventions, and thermal mass) are essential to improve the climate perceptiveness (Mushtaha et al., 2021). Constructing personalized designs sensitive to the regional climate characteristics significantly reduces the use of traditional air conditioning and heating equipment. Studies done on the net zero energy buildings (NZEB) supports the implementation of an overall design strategy incorporating the use of high-performance outer walls and geothermal heat and solar photovoltaics as the sources of renewable energy (De Masi et al. 2021). The following studies recommend NZEBs to provide energy saving 80%-100% in comparison to standard buildings (Stasi et al., 2022). However, the high upfront costs, complicated technology, and diversified definitions in various parts of the world make it difficult to achieve NZEBs (Noh et al. (2024). In addition, there has not been adequate attention to strategies for turning around current structures to meet the net-zero targets. Such results indicate that post-installation attaining optimal outcomes is not easy, necessitating rigorous post-occupancy examinations and understanding of the way occupants interact with the building. As a whole, environmental benefits of net-zero and climate-responsive designs are significant, however, winning them requires adaptive practices, strong policy frameworks, as well as continuous monitoring.

5.3. Integration of Smart Systems for Energy, Water, and Waste

Through the integration of smart technologies into sustainable building designs, integrated systems have developed that are able to handle resources efficiently and provide significant benefit to dwellers' well-being. Systematic reviews show that smart systems consist of energy management tools, automated HVAC controls greywater recycling, and waste segregation systems that rely on sensors and IoT platforms (Lakhouit 2025). Real-time demand response is possible when smart grids are used to integrate renewable energy and maximize the use of energy (Albogamy et al., 2022). The current systems supervise water quality with IoT devices, such as the sensor-fit leak detection, rainwater collection control, and the maintenance algorithm oriented to waste and contamination problems. Waste systems within smart buildings benefit from the shift to the introduction of smart waste bins and waste reduction programs that are decision-based on occupancy (Suhardono et al., 2025). Though smart systems have potential, studies point to cybersecurity risks, difficulties in system integration and difference in access to systems that limit general adoption (Vassilakopoulou and Hustad, 2023). However, without sufficient dependence on renewables, the operational energy of smart systems can reverse intent of environmental improvements on their part. The issues of ethical considerations and the protection of the personal data have become the major aspects of the considerations of responsible technology of smart buildings. But the introduction of smart systems marks the epochal advance to data-driven sustainability, emphasizing the need for cross-sectoral innovation and people-oriented design principles that balance technical efficiency with ecological goals.

5.4. Urban and Community-Level Sustainable Planning

In local and citywide scope, sustainable design principles blend such aspects as land use, transportation networks, green infrastructure and equitable social practices. Metropolitan areas can become more livable and have reduced environmental footprints by incorporating compact urban models, mixed-use development, walkability, and green infrastructure supported by literature analyses (Schröpfer, 2025). Positive impacts of TOD and divested energy alternatives, such as district heating and community solar, have been persistently talked about concerning their ability to be deployed at scale and at a reduced cost in urban regions (Seo, 2025). Urban metabolism analyses show that for cities to be resilient to environmental challenges, they must change to incorporate circular resource flows (recycling, renewable energy, and local food systems) (Valencia et al., 2022). Often, implementation is hindered by lack of coherent governance, minimal stakeholder participation and variable socio-economic settings (Omweri, 2024). According to recent research, the role of participatory planning in inclusive decision-making and community-based sustainability end challenge has been increasingly emphasized. Additionally, initiatives toward sustainability tend to neglect informal settlements and disallowed populations which can undermine environmental equity. For long term development, experts suggest complementing technical planning with community involvement using integrative interventions informed with coordinated policy approaches and urban responses.

5.5. Global vs. Local (Context-Specific) Approaches

This topic of the current argument between global sustainability guidelines or region specific solutions which are more effective is a constant feature in the world of sustainable design. There are standards such as LEED, BREEAM, and EDGE, which provide equal standards for environmental performance, and they have facilitated the spread of sustainable construction worldwide (Saleh et al., 2024). However, it is commonly debated that these models fail to adapt for specific climatic, cultural, and economic settings of the Global South (Owen, 2020). For example, a green building benchmark designed for a temperate zone may need massive modifications for it to have any effect in a tropical or arid zone. Meanwhile, indigenous design methodologies and locally grounded acumen are a proven leader in sustainability schemes, with a unique demonstration found in the application of natural cooling, spatially-specific materials, and communal arrangements (Tiwari and Vij, 2024). Regional schemes such as GRIHA and Green Star SA, which are tailored products aiming at fulfilling specific local demands, are less prominent on the international arena and lack such investment opportunities as universal schemes. According to research, incorporating global norms with the local wisdom, socio-economic circumstances and stakeholder values in hybrid models may produce more effective results (Meshram, 2024). By contextualization, this approach improves the cultural sensitivity, efficiency, and fair achievement of the sustainability targets across different places.

6. Toward a New Design Paradigm in the Anthropocene

The entry of the Anthropocene epoch has markedly reshaped conversations around architecture and has called for a shift from traditional sustainability to more restorative and equitable positions. The array of research shows the general awareness that modern architecture design cannot remain within the framework of established, single-path paradigms that are able to effectively address ecological ruin, social discrepancies, and global warming.

6.1. Post-Sustainability and Regenerative Architecture

Scientific work indicates that sustainability is no longer enough because its emphasis is on reducing harm rather than ecological restoration (Biermann 2022). Compared to that, Regenerative architecture is characterized by the design methods that work in concert with natural systems, and focuses on restoration, resilience and reciprocal relationship. Cheshire's (2024) view is that regenerative architecture should be a profound part of living systems and a change in architect's perception on building as an essential part of the ecological networks is ushered in. Urban densification and climate resilience are among the most relevant contexts because regenerative approaches, such as green roofs, biophilic design, and net-positive energy buildings, provide considerable, integrated benefits.

6.2. Indigenous and Vernacular Design Principles

The indigenous and vernacular architectures are being rediscovered in academics recognized by their natural resilience and responsiveness to place. Indigenous knowledge systems were defined by Sjökvist (2023) as having centuries old seasonal adaptation, responsible resource-stewardship, and shared spatial premises to offer a different mindset to the exploitative processes in current architecture. Climate responsive design strategies are now borrowing vernacular principles of passive ventilation, use of local materials and cultural spatial typologies (D'amato and Kapoor, 2024). However, scholars discourage surface borrowing instead encouraging collaborative approaches that appreciate cultural sovereignty (Stubbs et al., 2023).

6.3. Adaptive Reuse and Circular Design

Circular design and adaptive reuse have become effective approaches to respond to material and energy strains of the Anthropocene. According to Wong (2024) research, adaptive reuse adds to the lifespan of buildings, reduces demolition waste and helps save embodied energy. Through the reuse of materials and structural systems, designers overturn the traditional notion of building from the ground up which is the central concept for circular economy. The body of literature, on the other hand, tends to critique contemporary adaptive reuse by focusing on aesthetics over functionality or sustainability, and by highlighting the need for advanced lifecycle analysis and enhanced stakeholder collaboration (Davies et al., 2024).

6.4. Decolonizing Sustainability in Architecture

References to the critiques of the colonial foundations underlying the mainstream sustainability models are topical in the scholarly record. Since these frameworks are more likely to be grounded in the intellectual tradition of Eurocentric culture, they rarely consider the concerns of socio-environmental injustice and indigenous dispossession (Byrne, 2024). Decolonized as a repurposed concept, sustainability refers to amplifying the voices and knowledge of the historically marginalized by conventional architectural practices. In the work, Letkemann (2023) argues that design should embrace different perspectives especially the Global South in order to question the hegemony of universal standards like LEED or BREEAM in sustainability. Adjudging by the nature of these changes' implementation, commitment to theirs requires restructuring our approach to teaching architecture, overseeing its practices, and professional appointment of them.

The literature also explores architectural theory's adoption of post-humanist thinking in its attempt to break down anthropocentric design's approaches. Post-humanist architectural practice acknowledges the importance of non-human players (plants, animals, materials, and climate systems) in influencing design decisions (Zaretsky and Zaretsky, 2024). << With this perspective, architecture assumes a basis in the ethics of collaboration and care, which envisions buildings as enacting members of larger ecological networks rather than as separate solutions for human use. Academics argue that this shift challenges the nature-culture divide and instead advocate for the architectural practices that would promote narrow species co-existence (Grobman et al., 2023). Nevertheless, the practice of setting post-humanist ideas into everyday practice is highly challenging in nature, especially regarding regulatory and market norms.

On the whole, the body of work reveals a compelling trend towards describing a new design paradigm that would accommodate the diverse challenges of the Anthropocene. The paradigm exudes designs that are regenerative, inclusive, circular and post-humanist and beyond the discipline's core beliefs. Importing these perspectives envisions architecture that gives first priority to ecological ethics, cultural diversity, and systemic responsiveness.

7. Conclusion

A systematic review of literature on sustainable architectural design shows a narrative which continually develops according to historical, technological, cultural and ecological considerations. It is clear that traditional vernacular to modern sustainable architecture development has not been a linear process, but has dialectically responded to

environmental challenges by combining aged knowledge with contemporary technology (Yunxuan et al., 2025). The pioneering architecture of the past, noted by climate-responsive and resource-conservative approaches, set the foundation for the current prevailing sustainable architecture standards represented in LEED, BREEAM, and EDGE (Butt, 2025). Moreover, academic debates lead to the implementation of all-inclusive systems perspective that incorporates passive design concepts, adaptive technologies, and participatory urban strategies (Abujder Ochoa et al., 2025).

However, a close re-calibration points to the fact that in the Anthropocene, conventional thinkers of sustainability may not do well. Scholars indicate that the existing sustainable architecture seems to focus on mitigation rather than developing ecosystem resilience eventually inhibiting its potential to cause significant changes (Gibbons, 2020; Mang and Reed, 2020). Regenerative design, post-humanism and decolonial methodology calls for a transformative ethical and philosophical considerations which architects should use to collaborate with nature, to appreciate indigenous knowledge and to challenge anthropocentric principles. These models do not follow traditional green design standards because it requires that they be technologically oriented, can be shaped by the market, and stifle local cultural expressions, especially when they fail to acknowledge regional realities (Ortiz, 2024).

Although sustainable design theory and practical tools are still developing, there are still considerable research gaps. First, there is a dearth of post-occupancy evaluations research, especially in net zero and smart buildings, gaps that define their actual performance versus that defined by their study design (Zhao et al., 2024). Second, there is a lack of uniform application and theoretical exploration of adaptive reuse and circular design in conventional architectural methods. Third, more empirical review is required to comprehend the socio-cultural impact of sustainability practices especially in the informal urban neighborhoods and socially excluded areas (Carrilho and Trindade 2022). In addition, very little work explores how a post-humanist or pluriversal design framework could be implemented within regulatory and economic settings.

Future research should aim at developing studies that track sustainable buildings and technologies through all their lifecycle. It is important to establish frameworks which will enable global sustainability indicators to be adjusted to meet the needs of specific communities. It is with the help of cooperation between ecology, sociology, the world of digital sciences, and indigenous sciences that we will be able to expand our knowledge of architecture and create more just and environmental design approaches.

Academically, the study and teaching of architecture should take a pluralistic, decolonised, perspective with a proper consideration of various world view and a method of design (Salama, 2022; Harriss et al., 2022). Harriss et al., 2022). Through-on-the-ground implementation, architects need to integrate participative methodologies, lifecycle consideration, and adaptive reuse as core instruments in sustainable design. Proposed policy changes call for revised building regulations promoting regenerative measures and solutions as well as context-sensitive design, studies post-occupancy and encouragement of involving indigenous people and locals in planning decision making.

In conclusion the merits of academic and practitioner perspectives reviewed focus on a progressive architecture of a form that transcends classic sustainability towards regenerative and inclusive and ethical design strategies. This change cannot be facilitated by technical modification alone; it requires ontological shift, which relocates architecture as a basis for ecological harmony, cultural conservation and social equity.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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