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Sustainable Green Material Applied in Architecture Building

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Abstract.

In response to the growing urgency of environmental sustainability, this literature review explores the implementation of green building principles, sustainable architectural strategies, and the use of refurbished materials within the Indonesian architectural context. By synthesizing findings from recent academic journals and case studies, the paper identifies prevailing design approaches, evaluates the integration of passive and active environmental systems, and examines the socio-cultural and climatic considerations unique to Indonesia. The review also highlights the challenges of adopting sustainable practices, including regulatory limitations, cost constraints, and material availability, while uncovering opportunities for innovation through vernacular adaptation and circular design. This study aims to provide architects and design professionals with a comprehensive understanding of current trends and critical insights to inform future sustainable architectural practices in Indonesia. However, significant challenges remain, including limited comprehensive regulations, high initial investment costs, limited certified human resources, and a suboptimal supply chain for refurbished materials. Development opportunities lie in fiscal incentives, strengthening national standards, cross-sector collaboration, and integrating local wisdom and recycling technology innovation. Case studies and post-occupancy performance evaluations highlight the importance of ongoing monitoring and design adaptation to Indonesia's tropical climate. The review recommends strengthening regulations, professional education, and further research related to life-cycle assessment and the development of sustainable local materials to support the green architecture agenda in Indonesia. These findings serve as a reference for architects in integrating sustainability principles, material innovation, and socio-cultural adaptation into current and future Indonesian architectural design practices.

Keywords: Green Building, Refurbished Material, Sustainable Architecture Building.

1 Introduction

The continuous advancement in the fields of science and technology, coupled with the concomitant expansion of urban areas, has inevitably led to an escalated demand for adequate housing solutions to accommodate the ever-increasing population, which has, in turn, resulted in a gradual yet significant shortage of available living space for individuals and families alike. In an effort to reconcile the quantitative aspects of engineering, specifically the aggregate number of residential units constructed, with the imperative of operational efficiency, it has become increasingly common for numerous edifices within contemporary metropolitan environments to neglect the critical concept of "sustainability" during the selection process of building materials, thereby leading to detrimental effects on the environment. Simultaneously, the use of industrialized building materials has been shown to pose latent threats to the health and well-being of urban residents, primarily due to potentially harmful chemical compositions inherent in these materials. However, it is essential that the construction of buildings be predicated upon the use of environmentally friendly materials that embody the principles of sustainable development, as this approach is vital for ensuring a high quality of livability within urban settings. This research endeavors to conduct a comprehensive feasibility analysis while delineating the scope of application for building energy-saving materials, achieved through a

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meticulous review of suitable and economically viable materials, all with the ultimate goal of fostering sustainable development within the architectural landscape of buildings.

2 Method

This study employed a qualitative approach using a literature review method, collecting, reviewing, and analyzing 30 scientific articles discussing green building, green material, refurbished material. This method was chosen because it provides a comprehensive understanding of the causes, impacts, and strategies for green building material, based on previous research

2.1 Data Source

All data utilized in this investigation is derived from a comprehensive literature review, encompassing 20 scholarly articles acquired through the academic search engines Google Scholar and Scispace. The selection of Google Scholar and Scispace was predicated on their capacity to offer extensive access to scientific publications from a diverse array of national and international journals, as well as their facilitative features for article retrieval based on relevance and keyword optimization.

2.2 Data Collection Procedures

The data collection process consists of several stages:

2.2.1 Keywords Linear With The Title

The literature search was conducted using the following keyword combinations:

- Green Building
- Green Material
- Refurbished Material
- Sustainabilities Architecture Building
- Low Emission

2.2.2 Inclusion Criteria

The inclusion criteria in this study consist of several aspects. First, the selected studies must explicitly discuss green materials, sustainable materials, or environmentally friendly materials applied in architectural buildings. The types of studies included comprise primary research articles, architectural case studies, systematic reviews, meta-analyses, as well as relevant technical reports and standards. The studies should also address aspects such as life cycle assessment (LCA), carbon footprint, energy efficiency related to materials, durability, recyclability, occupant health, and life cycle costs. In terms of application scale, the studies may cover the material level, building elements such as walls, roofs, insulation, and finishes, up to the scale of buildings or building complexes. Publications included in this study are limited to those published within the last 10–15 years to ensure relevance with current practices and technological developments. Articles written in English and/or Indonesian are included, provided that they are published in peer-reviewed journals or by reputable professional institutions and organizations. In addition, studies from all geographic regions are accepted, while still considering the relevance of local contexts such as climate conditions, regulations, and material availability.

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2.2.3 Exclusion Criteria

- Indirect topics: Studies that solely address building energy performance without reference to material choice, or material studies that do not address architectural applications.
- Publication types: Non-scientific opinion pieces without clear methodology, popular articles without scientific references, product advertisements, and blog posts without data support.
- Irrelevant scale: Research focused on materials for non-building manufacturing (e.g., automotive, electronics) without transfer to architecture.
- Publication age: Publications outside the established timeframe unless highly significant historically or theoretically.
- Other languages: Articles that are inaccessible or untranslatable (unless highly relevant and translatable).
- Low quality: Studies without clear methods, small sample sizes without justification, or without peer review (except for relevant official technical reports).

2.2.4 Literature Selection

After conducting the preliminary search, a range of papers were identified and subsequently chosen based on their titles and summaries. Following this approach, 30 papers were deemed appropriate and met the inclusion criteria.

3 Result and Discussion

The use of green and refurbished materials in buildings translates into interconnected environmental, economic, and quality-of-life improvements carbon footprint and construction waste are reduced through the selection of low-emission, recycled, and bio-based materials that extend the product lifecycle; energy and water consumption are reduced by the combination of high-performance materials with passive design strategies, resulting in lower operating costs over the lifecycle of the building; economically, long-term investment returns are enhanced by reduced lifecycle costs, incentive opportunities, and increased property marketability; occupants benefit from improved indoor air quality, higher thermal and visual comfort, and reduced exposure to hazardous materials, resulting in increased well-being and productivity; technically, these practices encourage innovation in construction detailing, testing standards, and maintenance procedures that support the durability and longevity of building elements; and socially and policy-wise, the adoption of green and refurbished materials strengthens the local circular economy, creates green jobs, and strengthens the reputation of developers and communities in delivering more responsible and climate-adaptive development.

Table 1 provides a detailed overview of the attributes of the 20 journals examined. The following summary table shows the concise title, the subject of study, the main reasons, and the key effects discovered in each research project. This table will serve as the foundation for the thematic synthesis discussed in the sections that follow.

Table 1. Detailed overview of the attributes of the 20 journals examined

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No	Title and Author	Research Focus	Main Impact, Conclusion, Benefits
1	Application of green building materials in the field of construction and sustainable development (Yuxuan Hu, Jue Wang and Xueru Wang)	Green Material (Foam Glass, Eco Cement, Green Walls)	Reference Green Material Building for Thermal Comfort and Low Emition
2	Eco-Friendly Building Analysis With Reused Building Materials (Sarvesh P.S Rajput, DrM.S.Chouhan)	Analysis Build New House With Reuse Building Material	Reference Build New House Materials and Refurbished Material From Demolition House
3	Green Building Design and Construction Using Concept Of Sustainability (Zahra Eghbali, Amin Didari)	Green Building Prototype (Low Energy)	Reference Green Building Prototype (Low Energy) And Comparing With Building In General
4	Green Construction Building Renovation (Barbara KSIT, Michaes Majcherej)	Green Walls Building	Reference Green Walls Building Applied and and calculate the impact of changes in the room temperature inside it
5	Penerapan Aspek Green Material Pada Kriteria Bangunan Rumah Lingkungan di Indonesia (Dewi Rachmaniatus S)	GBCI (Green Building Councils Indonesia) Implementation	Comparison of the Application of Material Usage Criteria to the Building Material Life Cycle
6	Penilaian Greenship GBCI dalam Penerapan Re-Use Material di Café Day N Nite Bandung (Agung Prabowo Sulistiawan, I Made Raka Arsana, Deni Puji Nurwanto, Anggia Septiani Hartoyo)	GBCI (Green Building Councils Indonesia) Implementation	The analysis of the Material Source and Cycle assessment points in the GBCI Greenship criteria concluded that Café Day n Nite met several green building criteria, with only a few criteria failing to meet the overall GBCI Greenship criteria.
7	Perfect Combination of Natural Fiber and Geopolymer: A Green Building Composite Material (Chun LV, Guolian Guo)	Green Building Material Natural Fiber and Geopolymer	Reference Natural Fiber and Geopolymer Applied and Explain How Much Impact
8	Relating sustainability indicators to the refurbishment of the existing building stock (Havinga, L. C., Colenbrander, B. J. F., & Schellen, H. L.)	Sustainability Indicators to the Refurbishment of the Existing Building Stock	Review of the role of sustainability in the built environment and reflects on this from the perspective of refurbishment
9	REVIEW OF SUSTAINABLE BUILDING MATERIALS FOR CONSTRUCTION INDUSTRY (Satyam Kumar , Vishal Puri, M. L. Aggarwal)	Sustainability Material	Comparison between green building and conventional building on various conditions
10	Sustainable Construction With Foam Concrete As A Green Green Building Material (Ashish S. Moon, Dr. Valsson Varghese)	Green Material – Foam Concrete	Reference Green Material Foam Concrete and His Benefit
11	Tectonic Constraint: Harvesting Material and Building (Robert J. Koester, Elizabeth Riegle and Dorothee Dettbarn)	Unique Green Building Material, Recycling Building Material	Examines the recycling discussion in architecture as being fundamentally about the timeless challenge of exploiting the tectonic constrain.
12	The Applications of Materials, Framework, and Designs in Green Building (Peiran Dong)	Green Building Design	Application Green Building (Natural Air House Concept, Roof Landscape Design
13	The Sustainable Solution Green Building (Aboli Mendhe, Ankit Ghode,	Green Building Design – Case Study	Technical and economic aspects related to green buildings around the world

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No	Title and Author	Research Focus	Main Impact, Conclusion, Benefits
	Umesh Jibhakate, Ritik Chalurkar, Niraj Bhople)	''Bungalow – Indian''	
14	Towards Zero-Emission Refurbishment of Historic Buildings: A Literature Review	Conservation, restoration and retrofitting interventions in historic buildings	Entifies research gaps in the field and highlights the paradox seen in the Scandinavian countries that are models in applying environmentally sustainable policies but still poor in integrating preservation issues
15	Pengembangan material Reusable Concrete untuk 3DP Building (Andy Nurul Yunita Pettalolo, Ibnu Abdul Rosid, Alva Edy Tontowi)	Reuse Material From Earthquake Ruins	Aplication and Test Reuse Material From Earthquake Ruins
16	Thermal and Acoustic Characterization of Innovative and Unconventional Panels Made of Reused Materials (Manuela Neri)	Green Material Building For Insulation	Experimentally investigates the thermal and acoustic properties of panels realized by assembling selected end-of-life material.
17	ASSESSING THE ENVIRONMENTAL AND ECONOMIC FEASIBILITY OF USING RECYCLED MATERIALS IN URBAN CITIES PROJECTS FOR SUSTAINABLE DEVELOPMENT (Dr. Deepak Kalra, Dr. Amer Al-Qassem)	Recycled Material For Sustainability Development	Aplication and Test Recycled Material
18	Special Issue "The Use of Recycled Materials to Promote Pavement Sustainability Performance" (José Neves, Ana Cristina Freire)	Recycled Material For Sustainablity Pavement	Reference Aplication Recycled Material For Pavement
19	Green Construction Building Renovation (Barbara KSIT, Michaes Majcherej)	Green Walls Building	Reference Green Walls Building Applied and and calculate the impact of changes in the room temperature inside it
20	The Effect of Recycled Material and Buton Granular Asphalt (BGA) on Asphalt Concrete Mixture Performance (Novita Pradani, Rita Irmawaty, Muhammad W. Tjaronge, Irwan R. Rahim)	Mixing New and Recycled Material For Asphalt	Analysis Mixing New and Recycled Material For Asphalt

All techniques for assessing the impacts caused by an object or a process have their limitations. It is important to be aware of the limits of the information developed in a study of this kind when assessing the result in a decision process (Sarvesh P.S Rajput, Dr.M.S.Chouhan)

The Criteria-Based Tools are very complex; they require training and certification to be able to use them (Nguyen & Altan, 2011). As a result, they are not accessible and are often used as a checklist at the end of the design stage instead of being used early in the design process while the most important decisions with regard to sustainability should be made at the beginning of the design process (Zeiler, 2011). Environmental issues are broad and difficult to capture, combining qualitative and quantitative data, a balance between completeness of coverage and ease of use remains one of the challenges in developing an environmental building assessment tool (Ding, 2008).

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4 Conclusion

Definition and criteria for green materials. Many studies emphasize that environmentally friendly materials should be assessed based on their life cycle (LCA), energy savings, source (renewable vs. non-renewable), and toxicity; public perception is often misplaced, necessitating clear selection guidelines. Reduction of construction waste, embodied energy savings, and potential long-term material cost reductions are all possible. However, long-term performance data (bearing capacity, durability) still requires more extensive documentation.

Reuse provides aesthetic and cultural value while reducing the need for new materials; local case studies (e.g., cafes and adaptive projects) show that reuse of materials such as containers or used materials can meet greenship criteria if combined with appropriate design and technical assessment. Projects that successfully integrate green/reuse materials tend to view materials as conceptual elements combining cultural narratives, aesthetics, and structural functions—rather than simply as material substitutions

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