Application of Green Building Aspects in Community Residential Houses

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Abstract This paper delves into the application of green building aspects in historical and modern homes, driven by the imperative to address the environmental impacts of building construction. Against the backdrop of evolving human needs and architectural forms, the study aims to assess the extent of green building implementation in typical old and modern houses. Methodologically, the research conducts a comprehensive analysis of six key aspects of green building—Appropriate Site Development, Energy Efficiency and Conservation, Water Conservation, Material Resources and Cycle, Indoor Health and Comfort, and Building Environment Management—through random observations of representative buildings from different time periods. The results indicate a notable discrepancy in the adoption of green aspects between historical and modern houses, with historical houses exhibiting a higher degree of integration. Specifically, historical homes scored 41 points in green aspect implementation, while modern houses scored 22 points. These findings underscore the importance of prioritizing sustainable building practices to mitigate environmental impacts and promote holistic well-being in residential constructions.

Keywords: green building, historical houses, modern houses, sustainability, energy efficiency


Kata Kunci: bangunan hijau, rumah bersejarah, rumah modern, keberlanjutan, efisiensi energi

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Introduction
A house is a means to sustain life. It also develops as part of basic human needs, which arise as an extension of the need for protection and security from danger outside. Then, it developed as a significant civilizational institution and a basis for community development. Humans are formed in the house and its environment and develop their personalities. As a means of self-defense, the house is not intended as a protector that covers its occupants like a fortress but must also open and integrate as part of the environment.

The development of the human need for houses then gave rise to cultural forms of buildings according to the types of human needs in carrying out their life activities. The houses' form changes, develop, and grow according to the culture, needs, and community income. Based on the community's needs and income development, they can change the house depending on their abilities and desires. It could be the shape of the house and the materials used. The development and changes in the shape and materials used in the house created typical houses such as traditional houses, stilt houses, landed houses, old houses, modern houses, and so on.

However, compared to the previous era, developments in buildings today and human activities worldwide are also among the causes of global warming. Building construction is one of the biggest producers of global carbon dioxide emissions as one of the causes (Hong et al., 2015) Then, (Hong et al., 2015) analyzed the building construction phase and concluded that the production process of building materials accounts for 94.36% of all indirect emissions. For this reason, the concept of green architecture emerged. It is an architectural planning approach that seeks to minimize harmful effects on human health and the environment. A narrower scope of green architecture is a green building, defined as a building that minimizes environmental impact by conserving resources and contributing to the health of its occupants. Green buildings have great potential to play a role in diversifying projects and the built environment in various aspects of social, economic, and environmental development (Hu et al., 2014).

Additionally, green buildings are designed to save energy and resources, use recycled materials, and minimize the emission of toxic substances throughout their life cycle (Awadh, 2017).

Some Indonesians are still aware of the importance of implementing green buildings in their homes, taking into account environmental factors, i.e. energy-saving and environmentally friendly buildings. People must know that no matter how little effort is made to realize an environmentally friendly building, it will be significant in achieving a balance of nature. This challenge is substantial in building public awareness and knowledge about energy-efficient and environmentally friendly buildings.

Based on this problem, it is necessary to review the application of green building aspects in typical modern and old houses. The results of this analysis are expected to be input for the community to be more aware and willing to work on implementing green building aspects in their home buildings.

Methods
The methodology employed in this study draws upon a multi-faceted approach integrating observations, interviews, and an extensive review of pertinent literature.
focusing on integrating green principles within residential architecture, particularly in Sumatra. The research framework, as depicted in Figure 1, was informed by prior studies emphasizing the adoption of Greensip Homes in residential architectures. With burgeoning housing developments posing challenges to environmental sustainability and exacerbating emissions contributing to global warming, as highlighted by (Rejeki et al., 2018) and (Azizah et al., 2017), there arises a pressing need for environmentally conscious solutions.

In contrast, modern houses, exemplified by Figure 4, predominantly constructed in the 2000s, manifested a shift towards multi-story landed properties, reflecting the increasing land availability constraints.

Figure 2. The Old House

Modern houses exhibited closer proximity to roads, a lack of green spaces and vegetation, reduced air apertures, and reliance on air conditioning systems. Analysis of the implementation of green building practices was conducted through the lens of six key categories outlined by the Green Building Council Indonesia (GBCI, n.d.) within the Greenship Homes framework: Appropriate Site Development, Energy Efficiency and Conservation, Water Conservation, Material Resources and Cycle, Indoor Health and Comfort, and Building Environment Management. Through this comprehensive methodology, the study aimed to elucidate the contrasting approaches to environmental sustainability evident in the region’s historical and contemporary residential architecture.

Results and Discussion
Assessment of the Implementation of Green Aspects
Table 1 provides a detailed assessment of the implementation of green aspects in both old and modern house buildings. The evaluation was conducted across six criteria: Appropriate Site Development,
Energy Efficiency and Conservation, Water Conservation, Material Resources and Cycle, Indoor Health and Comfort, and Building Environment Management. Each criterion was further broken down into specific aspects, and scores were assigned based on the degree of implementation observed in the houses.

Table 1. Assessment of the Implementation of Green Aspects

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
<th>Score of Old House</th>
<th>Score of Modern House</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate Site Development</td>
<td>1. Green Area</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2. Supporting Infrastructure</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3. Community Accessibility</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4. Public Transportation</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>5. Stormwater Management</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Maximum Score 13</td>
<td>11</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Energy Efficiency and Conservation</td>
<td>1. Sub Metering</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2. Thermal Condition</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3. Heat Reduction</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Maximum Score 15</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Water Conservation</td>
<td>1. Water Metering</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>2. Rainwater Harvesting</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Maximum Score 13</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Material Resources and Cycle</td>
<td>1. Environmentally Friendly Source Material</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2. Environmentally Friendly Process Material</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3. Local Material</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Maximum Score 11</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Indoor Health and Comfort</td>
<td>1. Fresh Air Circulation</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2. Natural Lighting</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3. Visual Comfort</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4. Acoustic/ Noise Level</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>5. Spatial Comfort</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Maximum Score 13</td>
<td>10</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Building Environment Management</td>
<td>1. Sustainable Design and Construction</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2. Green Activities</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3. Environment Safety &amp; Security</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Maximum Score 12</td>
<td>6</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Figures 5 summarizes the findings of the assessment, comparing the implementation of green aspects between old and modern houses. Notably, the results indicate variations in the degree of implementation across different criteria.

Figure 5. Assessment scoring result of the Green Aspects implementation

The comparison between old and modern houses across various green building aspects reveals intriguing insights into the evolution of sustainable practices in residential construction. Firstly, in terms of appropriate site development, old houses stand out for their meticulous planning and utilization of space, with the majority scoring 11 out of 13 points, which indicates well-considered site development. Conversely, modern houses need to catch up, with only a few achieving a score of 5 out of 13 points, suggesting a lesser emphasis on optimizing site characteristics.

Secondly, in the realm of Energy Efficiency and Conservation, both old and modern houses demonstrate comparable levels of...
Implementation, with only a few managing to achieve a score of 6 out of 15 points. This indicates a potential area for improvement across the board, highlighting the importance of prioritizing energy-saving measures in residential constructions.

Moving on to Water Conservation, it becomes apparent that few houses, irrespective of their historical or modern nature, strongly emphasize this aspect. Scores of 3 and 2 out of 13 points for old and modern houses, respectively, underscore a need for greater attention to water conservation practices in residential developments.

Similarly, in Material Resources and Cycle, there appears to be limited implementation of sustainable material use and resource cycling across both old and modern houses. Scores ranging from 2 to 5 out of 11 points reflect a missed opportunity to maximize the use of environmentally friendly materials and promote resource efficiency in construction projects.

In Indoor Health and Comfort, old houses shine, with a majority scoring 10 out of 13 points, indicating a strong focus on providing occupants with a healthy and comfortable living environment. Conversely, modern houses exhibit lower levels of implementation, with scores of 6 out of 13 points, suggesting a potential trade-off between modern conveniences and indoor comfort.

Lastly, old and modern houses show limited implementation of Building Environment Management practices, with scores ranging from 1 to 6 out of 12 points. This indicates a need for greater emphasis on managing the built environment sustainably, encompassing aspects such as waste management and environmental safety.

**Historical House Characteristics**

The examination of historical houses dating back to the early 1900s revealed distinctive architectural features reflective of the era's construction practices and societal needs. These structures, exemplified in Figure 2, represented a fusion of stilt and landed house designs. Characterized by their use of wood materials, generous air apertures, and integration of green spaces within the interior, historical houses demonstrated an inherent sensitivity towards environmental considerations. Notably, features such as rainwater storage ponds underscored a proactive approach toward resource conservation and sustainable living practices.

**Contemporary House Characteristics**

In contrast, modern houses, typified by Figure 4, epitomized the evolving architectural trends shaped by contemporary land constraints and lifestyle preferences. Constructed predominantly in the 2000s, modern residences exhibited a departure from traditional design principles. Proximity to roads, minimal green spaces, and reliance on mechanical ventilation systems marked a paradigm shift towards compact, urban-centric living. The transition towards multi-story configurations underscored the pragmatic response to land scarcity, albeit at the expense of traditional environmental considerations.

The juxtaposition of historical and contemporary house characteristics unveiled contrasting approaches to environmental sustainability. While historical houses embodied a holistic integration of green principles, contemporary residences prioritized spatial efficiency and modern conveniences. This dichotomy underscores the evolving dynamics between tradition and modernity, wherein
societal shifts and urbanization exert profound influences on architectural preferences and environmental consciousness. The findings presented herein underscore significant disparities in the implementation of green aspects between old and modern houses, illuminating crucial insights into the realm of sustainable residential architecture. Notably, traditional architectural practices, as evidenced by the old houses examined, appear to inherently integrate sustainable elements, thereby exhibiting higher levels of adherence to green principles across multiple criteria. This observation resonates with prior research indicating the historical wisdom embedded within traditional building techniques, which often prioritize environmental harmony and resource efficiency (Baca & López, 2018). The incorporation of natural ventilation systems, utilization of locally sourced materials, and integration of green spaces within historical houses exemplify such sustainable design elements that contribute to their superior environmental performance (Mundo-Hernández et al., 2014).

Conversely, modern houses, while showcasing advancements in architectural design and construction methodologies, demonstrate notable shortcomings in various aspects of green implementation. The findings suggest a significant room for improvement, particularly in energy efficiency and conservation measures, where both old and modern houses exhibit comparably low scores. This underscores the imperative of promoting energy-saving technologies and sustainable building practices in contemporary residential constructions, aligning with broader sustainability goals outlined in international frameworks such as the United Nations Sustainable Development Goals (UNSDGs) (United Nation, 2015).

Encouragingly, ongoing research and innovations in green building technologies offer promising avenues for addressing these deficiencies and fostering more environmentally responsible housing solutions (Patil et al., 2022). Moreover, the findings underscore the multifaceted nature of sustainable residential architecture, encompassing not only environmental considerations but also social and economic dimensions. The emphasis on indoor health and comfort in old houses, as reflected in their superior scores in these aspects, highlights the intrinsic link between sustainable design and human well-being (Desideri & Asdrubali, 2018). This aligns with the overarching goal of green architecture, which seeks to create built environments that promote occupant health, productivity, and overall quality of life (Karimi et al., 2023).

Conclusion
The comparative analysis of green building implementation in old and modern houses reveals significant variations in adherence to sustainable principles. Old houses demonstrate inherent sustainability through traditional architectural practices, exhibiting superior performance in areas such as energy efficiency, material use, and indoor comfort. In contrast, modern houses, while showcasing advancements, exhibit notable deficiencies, particularly in energy conservation and material resource management. These findings underscore the need for broader adoption of green building practices to mitigate environmental impacts and promote sustainable living. Moving
forward, efforts to integrate green principles into residential construction practices are crucial for fostering environmentally responsible communities and mitigating the adverse effects of urbanization.

Author(s) Statement

authors with this declare that this research is free from conflicts of interest with any party, has never been published anywhere and has complied with the rules of publication ethics.

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**Author(s) contributions**

**Kemala Jeumpa** conceptualized the study, conducted the data analysis, and drafted the manuscript.

**Rumilla Harahap** contributed to the literature review, data collection, and interpretation of results.