Assessment of Green Building Performance Using BGH and Greenship: A Case Study of the Gelora Inovasi Kreativitas (GIK), Gadjah Mada University

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Abstract -- *Urban population growth is increasing global energy consumption and carbon emissions, with the building sector contributing more than 30% of greenhouse gas emissions and raw material use. In Indonesia, buildings consume 50% of the nation's energy and more than 70% of electricity. To reduce the environmental impact of the construction sector, the green building concept is implemented as an effort to create sustainable and energy-efficient buildings. This study compares two assessment systems, BGH (Bangunan Gedung Hijau, Green Guilding) and Greenship, through a case study at the Creative Innovation Center (Gelora Inovasi Kreativitas, GIK) of Gadjah Mada University. Evaluation based on actual point achievement shows a score of 114.01 out of 165 points (69.1%) according to BGH, with the Silver category, which when converted to the Greenship system is equivalent to 69 points and the Gold level. This finding indicates a difference in assessment approaches between the percentage-based BGH with loose intervals and the more stringent and specific Greenship. The analysis results show the implementation of green building principles in GIK, especially in quality management, energy conservation, thermal comfort, and environmentally friendly behavior. However, aspects of construction waste management and environmentally friendly supply chains require improvement to support Greenship certification to the Gold or Platinum level. This research is expected to be a strategic reference in encouraging the development of green buildings in higher education institutions in Indonesia.*

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1. INTRODUCTION

In Indonesia, the building sector plays a significant role in national energy consumption. Buildings account for approximately 50% of total energy expenditure and over 70% of electricity use nationwide. Furthermore, buildings contribute 30% of greenhouse gas (GHG) emissions and use 30% of all raw materials produced. This trend demonstrates the building sector's direct impact on environmental balance and the efficient use of natural resources. In fact, global energy consumption from high-rise buildings is expected to increase by 70% between 2000 and 2030, and is likely to continue to rise beyond that period if not balanced with sustainable measures.

With increasing awareness of the importance of sustainability, the green building concept has begun to be adopted in various regions of Indonesia, including major cities like Jakarta, Surabaya, and Yogyakarta. The government has also strived to provide support through regulations that encourage the implementation of green buildings. One concrete step is the issuance of Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 02/PRT/M/2021 concerning Green Buildings, which serves as a reference for the planning, implementation, and management of environmentally friendly buildings.

Although various policies have been implemented, the implementation of the green building concept in Indonesia is still not running optimally [1]. One of the main causes is the low investment interest from developers, who often assume that building green buildings requires high initial costs and has a slow return on investment (ROI) [2]. However, in the long term, the implementation of green buildings has been proven to reduce operational costs, increase property values, and make a positive contribution to the environment and the quality of life of the community.

Green buildings (GWs) are designed for economic and environmental sustainability, taking into account local climate and cultural needs, which can facilitate the health, safety, and productivity of occupants [3]. The green building movement is now mature enough to demonstrate the value of the green economy in the real estate market for building owners and tenants, as evidenced by the rapid increase in the use of renewable energy and the conversion of information technology and technology development into smart city development, eco-districts, and green campuses.

There are two fundamental differences between green buildings and conventional buildings (often called gray buildings). First, green buildings are designed with an approach that mimics and adapts to natural ecosystems, so that their interaction with the environment is harmonious and has minimal negative impacts. In contrast, gray buildings rely more on technological engineering and human thinking without paying attention to ecological balance. Second, green buildings are multifunctional, meaning that in addition to carrying out their main function as a place for activities, the building also provides additional services to the community, such as improving air quality, controlling micro-temperatures, and energy efficiency [4].

This study aims to analyze and demonstrate the extent to which environmentally friendly principles are implemented in the GIK UGM building, with a primary focus on the Green Building (GGH) aspect and Greenship certification. It is hoped that the results of this study will demonstrate the GIK UGM building's compliance with the criteria stipulated in the Regulation of the Minister of Public Works and Public Housing (Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat Indonesia) number 21/PRT/M/2021 concerning Green Buildings, while also meeting the Greenship assessment standards issued by GBCI.

2. METHODOLOGY

2.1 Research Design

This research uses a literature review method, which is a method carried out by collecting, reviewing, and analyzing various sources of scientific literature relevant to the research topic. The literature sources used include scientific journals, academic books, research reports, national and international green building standards, and government regulatory documents related to the Green Building concept and its implementation in Indonesia. Through the literature review, the researcher attempts to gain a deep theoretical understanding of the principles of green buildings, the assessment criteria for Green Buildings (BGH), and the Greenship system issued by the Green Building Council Indonesia (GBCI). Through this approach, the research attempts to analyze the level of suitability of the application of green building principles at GIK UGM, while also comparing the assessment results between the two methods. The results of this study are expected to provide an empirical overview of the implementation of the green building concept in educational facilities in Indonesia, as well as provide recommendations for policy development and the application of similar concepts in other development projects.

Thus, the research methods presented in this chapter not only explain the procedures for conducting the study but also demonstrate the scientific basis and rationale for selecting the methods used, ensuring that the research has both academic validity and practical relevance to the development of sustainable buildings in Indonesia.

2.2 Research Data

The research data used in this study was obtained through an in-depth review of each assessment criterion, with direct reference to applicable Indonesian laws and regulations concerning buildings and the environment. This study includes a detailed analysis of regulatory aspects governing the construction, utilization, and management of buildings, including technical requirements, building performance, and established environmental sustainability principles.

A review was also conducted of the Greenship New Building criteria version 1.2, a certification system implemented by the Green Building Council Indonesia (GBCI). The Greenship review included an analysis of all criteria and benchmarks, including location and land use, energy efficiency, water management, indoor environmental quality, environmentally friendly materials, and waste management (Figure 1).

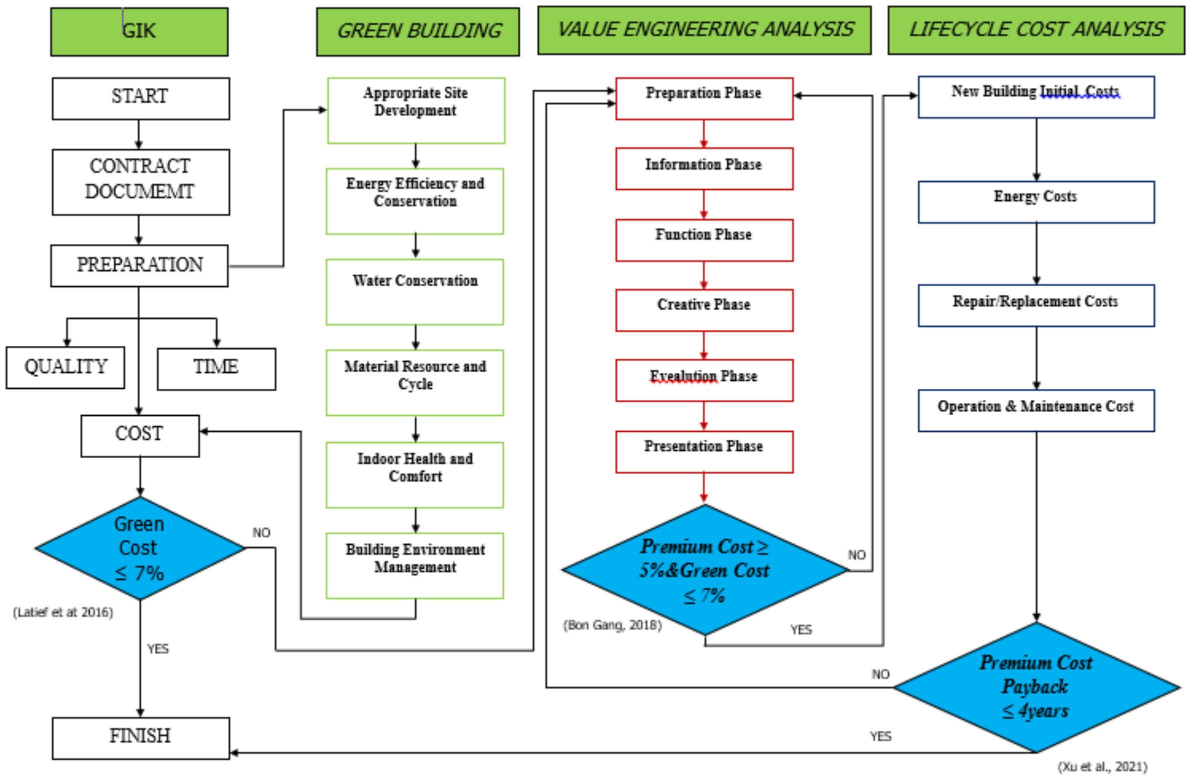

Figure 1. Flowchart of Overall Analysis

3. RESULT AND DISCUSSION

3.1 Results

Green building is generally defined as an approach to development that seeks to create structures and built environments that have minimal impact on ecosystems while improving environmental quality [5]. This approach focuses not only on energy, water, and material efficiency, but also on occupant comfort and reducing emissions and waste generated by buildings.

In Indonesia, this concept has been formalized through the Minister of Public Works and Housing Regulation No. 02/PRT/M/2011, which states that green buildings (BGH) are buildings that not only meet technical building requirements but also demonstrate measurable performance in energy, water, and other resource efficiency through the application of sustainability principles. Furthermore, the Green Building Council Indonesia (GBCI) developed the *Greenship approach* which includes six main parameters, namely: appropriate site development, energy conservation, water conservation, material cycle management, indoor comfort, and building environmental management [6][7].

Based on research on the implementation of the BGH system at the UGM Creative Innovation Center (GIK), it was found that the level of green building planning principles was carried out very well, with an achievement of 90.30% of the maximum total points. This achievement demonstrates that conceptually, GIK UGM has been designed with reference to strong sustainability principles. However, actual implementation results indicate that only 69.10% of the total points have been successfully implemented. This disparity reflects the fact that several technical aspects of *green building principles* have not yet been optimally implemented in the field. This suggests that planning success is not fully proportional to the actual performance of sustainable construction.

Some indicators that show successful implementation include:

1. Complete and standard work handover documentation (100%)
2. Implementation of construction safety management system (14 of 14 points)
3. Optimization of construction equipment use (12 out of 12 points)
4. Orderly and documented implementation of system training and commissioning

These aspects align with the GBCI parameters for project management, operational efficiency, and support for sustainable operations. However, significant gaps were found in indicators that directly impact the environment, such as:

1. Energy efficiency, which only scored 2.96 out of 8 points
2. Construction waste management, with realization of 1 out of 7 points
3. Energy conservation in the supply chain, which only got 1 out of 2 points

Unlike the Greenship rating system developed by the Green Building Council Indonesia (GBCI), the BGH system does not use an absolute points approach. Greenship assesses building performance based on the total points from various assessment aspects, which are then added together to determine certification levels, such as Silver, Gold, or Platinum. For example, in the Greenship system, a building that scores 69 points is automatically placed in the Gold category, as its score falls within the appropriate point range.

Table 1. Summary of Green Building (BGH) Point Achievements Based on Assessment Categories

Category	Max Points	Realization Points (BGH)	Percentage
Construction Implementation Compliance	74	50.01	67.6%
Job Handover	16	16	100%
Green Construction Process	60	38	63.3%
Green Behavior Practices	14	12	85.7%
Green Supply Chain	11	7	63.6%
Total BGH Points	**165**	**114.01**	**69.1% (Greenship Gold Equivalent)**

The matching scheme is as follows:

- The achievement percentage of 40 - 49 points is equivalent to the Certified level, indicating fulfillment of the basic principles of green building.
- Percentage 50 - 59 Points is equivalent to Silver, indicating that most of the green aspects have been implemented.
- Percentage of 60 - 79 Points is equivalent to Gold, which reflects efficient and good building performance.
- Meanwhile, achieving ≥ 80 Points is equivalent to Platinum, which indicates superior and highly sustainable performance.

with the following calculations:
Greenship Points
= (BGH % × 110 / 100)*100%
= (69.1% × 110 / 100)*100%
= 76.1

3.2 Discussion

A green building assessment was conducted on the construction of the GIK UGM building, and the results showed that the building demonstrated a commitment to implementing green building practices. The BGH evaluation resulted in a total realization score of 114.01 out of 165 points, equivalent to 69.10%. Compared to the initial plan of 149 points, this realization reflects that most aspects of green building have been implemented, although there are still shortcomings in several parameters.

In addition, the construction of GIK UGM has partially met the BGH achievement with greenship criteria, especially in the EEC, WC, IHC, and BEM indicators, demonstrated through energy and water conservation, building quality management, and the implementation of occupational safety management. The MRC (*Material Resources and Cycle*) aspect has not been optimally fulfilled, especially in construction waste management and the selection of certified materials. ASD (Appropriate Site Development) has not been evaluated in the BGH assessment, so an additional audit is required if you want to apply for full Greenship certification.

This research has several similarities with previous research. Research conducted by Wang et al (2021b) accurate electricity demand predictions that account for impacts of extreme weather events are needed to inform electric grid operation and utility resource planning, as well as to enhance energy security and grid resilience. Three common data-driven models are used to predict city-scale daily electricity usage: linear regression models, machine learning models for time series data, and machine learning models for tabular data.

Another study conducted by Rizki et al., (2023) applied green building assessment to create a green campus. Changing the micro-scale climate is one method in implementing the Green Campus concept, namely through the Greenship assessment approach method at the Design Recognition stage established by the Green Building Council Indonesian (GBCI). Design recognition implements Building Information Modeling (BIM) in 3D modeling. The results obtained by UMSIDA Campus 3 received a Bronze predicate. It can be concluded that Technical Recommendations are needed with a total index of 61.17 to achieve the platinum predicate.

Research by Sutikno et al. (2023) shows that energy is the most influential factor in obtaining platinum rating certification, which requires value engineering and lifecycle cost analysis to achieve optimal investment costs with additional costs ranging from 7,494% to 4,689%. Research in the field of green building has also developed with 53 scientific publications. From this cutting-edge review, it was found that the implementation of green building in Indonesia has been carried out in various aspects of buildings. Going forward, strategic policies and regulations are needed at the national and regional levels that are integrated to implement green buildings comprehensively in Indonesia [2].

Results of the evaluation show that, in the category of Appropriate Site Development, the planning of Gianyar Public Market obtains 41.18% points. It means that the planning has not yet fully fulfilled the criteria. Therefore, some efforts and improvements need to be taken and made to fulfill the criteria of the categories in which the planning has not yet obtained maximum points. One of such categories is technology application [8].

Based on an extensive literature review, a hypothetical framework, incorporating Pakistan's unique local contexts and adding cultural and governmental dimensions to the widely adopted social, environmental, and economic dimensions of sustainability, was proposed in this paper. This framework was further validated by in-depth interviews with multiple stakeholders in Pakistan. A qualitative analysis of the interview results was carried out, and the final framework was proposed with key indicators, reflecting all five dimensions of sustainability. The verified sustainability framework can be used to improve or develop green building rating tools for Pakistan, and it can also inform other developing countries' rating tool development [9] .

The use of green buildings to achieve water, material, and energy conservation can not only ensure environmental benefits, but also improve ecological benefits. In order to further improve the environmental benefits of green buildings from the perspective of carbon emissions, it is also necessary to conduct a specific analysis combining the development advantages and environmental benefits of green buildings [10].

The green building concept has been adopted as the main approach in the development of this project. Evaluation was conducted to assess the level of compliance with applicable regulations. In the implementation stage, it includes the selection of environmentally friendly materials, optimization of energy use through the installation of solar panels and the use of energy-saving equipment, efficient water management, and utilization of recycling and organic waste. The results of this final project are expected to provide a deep understanding of the implementation of the green building concept [11].

Rainwater harvesting is the collection of rainwater that falls in a water catchment area. Artificial Aquifer Rainwater Storage is one of the rainwater harvesting technologies designed and developed by the Water Resources Research and Development Center of the Ministry of Public Works and Public Housing, Indonesia. Rainwater is a water source that can be used to recharge groundwater and/or used directly to overcome water shortages during the dry season and flooding during the rainy season. As well as increasing development activities that result in reduced water catchment areas that can cause environmental damage [12].

Using a small chamber test (American Society for Testing and Materials (ASTM)-D5116) for VOC investigation and SimaPro software modeling with the ReCiPe method for evaluating human health impacts. Life cycle assessment (LCA) methodology is used, and the results indicate that switching the fully hybrid bio-based biocomposite with the fully petroleum-based composite could reduce more than 50% impacts on human health in terms of indoor and outdoor. Our results indicate that the use of biocomposites as GBMs can be an environmentally friendly solution for reducing the total indoor and outdoor impacts on human health [13].

The results found general contractors in Vietnam are facing the four components of challenges, namely "Planning activities-related challenges", "Organizational activities-related challenges", "Onsite

management and control activities-related challenges" and "Greensupplychain-related challenges"; and all of them have statistically significant effects on the success of GB projects in Vietnam. Furthermore, the most dominant component was related to the non-readiness of external GB supply chain [14] .
The result is the silver predicate, with the lowest value being Material Resource and Cycle (MRC) and the highest being Energy Efficiency Conservation (EEC). After improvisation, a maximum point was obtained (95) with a platinum predicate. Based on the analysis of the Life Cycle Cost (LCC) calculation for the next 15-20 years, the BINUS Syahdan campus building can save costs of Rp. 7,515,719,282 [15].

4. CONCLUSION

Based on the research results, it can be seen that this study used two assessment systems, namely BGH and Greenship, while the object studied was the Creative Innovation Center (GIK) of Gadjah Mada University. The evaluation results based on actual point achievements showed a score of 114.01 out of 165 points (69.1%) according to BGH with the Silver category, which when converted to the Greenship system is equivalent to 69 points and the Gold level. This finding indicates a difference in the assessment approach between BGH, which is percentage-based with loose intervals, and Greenship, which is more stringent and specific. The analysis results show the application of green building principles in GIK, especially in quality management, energy conservation, thermal comfort, and environmentally friendly behavior. However, aspects of construction waste management and environmentally friendly supply chains require improvement to support Greenship certification to the Gold or Platinum level..

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