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Green Building Certification Audit Evaluation on a National Housing Development in Purwakarta

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ABSTRACT

Sustainability aspects in construction projects, especially in large-scale housing developments, must be carefully considered and implemented to minimize negative environmental impacts. One approach adopted to address this is the Green Building (Bangunan Gedung Hijau, BGH) concept, which emphasizes energy efficiency, resource conservation, and high environmental quality. This study aims to evaluate the achievement of green building certification based on the results of a construction audit conducted by assessors from Perum Perumnas and the Purwakarta local government on the Samesta Royal Cempaka housing project, which received a "UTAMA" (Excellent) rating with a score of 80% during both the technical planning and construction phases. A descriptive qualitative method with a case study approach was used, involving the analysis of supporting documents for each assessment parameter and direct field observations. The evaluation referred to the parameters outlined in the Ministry of Public Works and Housing Regulation No. 21 of 2021 concerning Green Building Performance Assessment. The findings indicate that most indicators were implemented effectively, particularly in the areas of environmentally friendly materials, site management, energy and water efficiency, and indoor air quality. However, aspects such as waste and wastewater management were found to be suboptimal. This study offers strategic recommendations for optimizing the implementation of the green building concept in future housing projects.

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1. INTRODUCTION

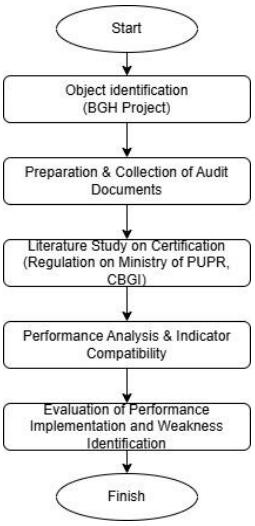
With the continuous growth of Indonesia's population, the demand for housing has also significantly increased [1]. According to data published by Statistics Indonesia (Badan Pusat Statistik) in the Housing and Environmental Health Indicators 2024, approximately 15.05% of households in Indonesia still do not own a house or reside in substandard housing conditions [2]. To address this issue, the government has implemented the One Million Houses Program, which has stimulated the housing sector and positively impacted homeownership among the population [3]. However, the expansion of housing and residential developments also poses significant environmental challenges, including global warming, climate change, and the depletion of natural resources caused by uncontrolled construction activities and the greenhouse effect [4].

To mitigate ongoing environmental degradation resulting from construction projects, the concept of Green Building (Bangunan Gedung Hijau, BGH) has emerged as a potential solution. A Green Building is designed with an emphasis on energy efficiency, water conservation, and sustainable resource use, while minimizing environmental impact [5]. It also incorporates environmentally friendly materials, effective waste management, and high indoor air quality [6]. In essence, Green buildings aim to deliver positive environmental outcomes and contribute to ecological preservation [4]. One housing project in the Purwakarta region has successfully implemented the Green Building concept, earning a certification with a Main rating and achieving an 80% score in both the technical planning and construction phases. This accomplishment reflects a strong

commitment to sustainable development. Nonetheless, further evaluation is necessary to identify areas that require improvement. Recent studies emphasize the importance of evaluating green buildings not only from a technical and environmental standpoint but also through economic and spatial lenses. A comprehensive life cycle analysis in China revealed that although the majority of incremental costs occur during the construction phase (90.5%), the long-term economic and environmental benefits—especially in the operation stage—far outweigh the initial investment, with economic benefits comprising 72.22% of total benefits [7]. Similarly, spatial analyses of LEED-certified buildings in the U.S. demonstrate that demographic, socioeconomic, environmental, and policy-related factors significantly influence the adoption of green buildings. Incentives such as expedited permitting and tax exemptions were found to be particularly effective [8]. Furthermore, in the service industry such as healthcare, renewable energy use has been identified as the most critical factor in green building transformation, emphasizing the need to prioritize energy solutions in green transitions [9]. These findings underscore the necessity for multi-dimensional assessment frameworks that integrate environmental, economic, and contextual considerations to optimize green building performance and policymaking.

This study aims to analyze the achievement of Green Building indicators during the construction phase and to develop strategic recommendations to enhance their implementation in future projects. The results of this analysis are expected not only to reflect the effectiveness of current practices but also to serve as a reference for improving the sustainability and quality of future developments.

2. METHOD



Gambar 1. Flowchart of evaluation Green Building

This research employs a descriptive qualitative method using a case study approach, conducted at a national housing project: Samesta Royal Cempaka, located on Jalan Raya Sadang-Subang KM 4, Campaka District, Purwakarta Regency, West Java Province. This site was selected because it has implemented the Green Building concept and successfully obtained a "Utama" (Main) certification, achieving a score of 80% during both the technical planning and construction phases. The study was carried out in conjunction with an official audit conducted by assessors from Perum Perumnas and the Purwakarta Regional Government on Thursday, November 14, 2024.

Data collection was carried out through document analysis of the evidence submitted for each Green Building performance parameter, as well as direct field observation during the audit process. The researcher's presence during the audit enabled a comprehensive assessment of the verification process, particularly the alignment between technical documents and on-site implementation, as well as the interaction between project executors and the auditing team. As the basis for analysis, this study also refers to relevant literature and regulations, specifically the Regulation of the Ministry of Public Works and Housing (PUPR) No. 21/2021 on Green Building Performance Assessment [10]. This regulation outlines the certification system for green buildings, covering several stages: pre-design, technical planning, construction, utilization, and demolition [11]. Each stage includes parameters reflecting sustainability aspects such as energy efficiency, water conservation, waste management, indoor air quality, use of environmentally friendly materials, as well as building management and monitoring [12].

The final assessment results are classified into three certification levels: Pratama (Basic), Madya (Intermediate), and Utama (Main) [13], depending on the percentage of achievement for each evaluation

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parameter. This study integrates observations, documentary data, and literature review to evaluate the extent to which on-site implementation aligns with the Green Building certification standards, and to develop strategic recommendations for improving the application of Green Building principles in future construction projects.

3. RESULT AND DISCUSSION

The evaluation of Green Building (BGH) principal implementation was conducted to assess the extent to which sustainability criteria have been effectively realized during the construction process. Field findings, technical documentation, and interactions observed during the audit served as the basis for examining both the effectiveness and consistency of the implementation in accordance with established regulations. This analysis goes beyond the final score by also identifying strengths as well as areas with potential for improvement. Through this approach, the research aims to provide a comprehensive overview of the project's actual condition and its tangible contribution to the advancement of environmentally conscious construction practices.

3.1. Summary of Green Building Certification Audit Results

The Green Building performance audit during the construction phase was conducted based on the provisions outlined in the Regulation of the Ministry of Public Works and Housing (PERMEN PUPR) No. 21 of 2021 concerning Green Building Performance Assessment [10]. The evaluation encompasses seven key parameters: site management, energy efficiency, water efficiency, indoor air quality, use of environmentally friendly materials, waste management, and wastewater management. Each parameter carries a specific weight, and the final result is presented as a cumulative score, which is then converted into a corresponding Green Building performance rating.

In the case of the national housing project in Purwakarta, the performance assessment during the construction phase applied the same parameters and criteria previously used in the technical planning phase, for which the project had already earned a “Utama” (Main) certification. The use of consistent evaluation criteria aimed to assess the extent to which Green Building principles were implemented in the actual construction process. Based on the field audit, the project achieved a total score of 132 out of a maximum of 165, or 80% of the total possible score, which corresponds to the “Utama” rating. This outcome indicates that the implementation of Green Building principles was generally consistent during the construction phase, although certain aspects still require further improvement.

Tabel 1. Recap of Green Building Assesment Results

No	Assessment Criteria	Maximum Score	Assessment Result	
			Technical Planning	Construction Implementation
1	Site Management	21	15	15
2	Energy use efficiency	46	40	40
3	Water use efficiency	30	26	26
4	Indoor Air Quality	18	16	16
5	Utilization of Sustainable Materials	15	15	15
6	Waste Management	23	12	12
7	Wastewater Management	12	8	8
	Total Points	**165**	**132**	**132**
	Percentage		**80%**	**80%**
	BGH Rating		**Excellent**	**Excellent**

3.2. Analysis of Achievement for Each Parameter

Among the seven key parameters audited, the aspect of energy efficiency recorded the highest achievement, with a score of 40 out of 46 points. This was primarily supported by the absence of air conditioning systems, optimization of natural ventilation, and artificial lighting that complies with standards. The water efficiency parameter also demonstrated a strong performance (26 out of 30 points), attributed to the use of water-saving sanitary fixtures and a clean water supply from the municipal provider (PDAM), although the absence of rainwater harvesting systems or monitored groundwater use indicates room for further improvement. The indoor air quality parameter received 16 out of 18 points, supported by adequate natural ventilation, the presence of exhaust fans in enclosed spaces, and the absence of air pollution sources such as air conditioners. In terms of environmentally friendly materials, the project achieved a perfect score (15 out of 15 points) as all materials used met green criteria and were sourced domestically with a high local content level.

However, some parameters still indicate potential areas for improvement. Site management scored only 15 out of 21 points, due to the lack of a rainwater infiltration system and a reduction in green space coverage

to 11.06% during construction—falling below the standard requirement of more than 20%. Waste management also remains suboptimal (12 out of 23 points); although waste sorting is practiced and there is collaboration for the removal of inorganic waste, the absence of composting systems or organic waste treatment facilities is a notable gap. The wastewater management parameter scored 8 out of 12 points; while the building is equipped with a biotank, it still lacks a grease trap and a more comprehensive wastewater treatment system.

Tabel 2. Analysis of Achievement for Each Parameter

Assessment Criteria		Score	Max. Score	Remarks
Site Management				
Site Management	Roor and pavement coverings have the lowest albendo (reflectively) value of 0.3	3	3	Albendo Value 0.317
	Rainwater drainage facilities to reduce urban drainage network burden	0	5	Not available
Open Green Space	Green area 10 - 20 %	3	3	Planning stage green area: 14.22% Execution stage green area: 11.06%
	Green area > 20 %	0	1	Not fulfilled during technical planning.
	Planting greening vegetables in the form of shade trees (minimum 1).	3	3	Yellow Tabebuia tree.
	Planting of at least 1 m² of consumable plants, comprising at least two different types	2	2	Chili pepper plant and Japanese papaya tree
Carport provision.	The carport area does not encroach on public land	2	2	Carport dimensions: 4.5m x 4.425m Family car dimensions: 4.07m x 1.65m So, the carport area does not encroach on public land
Outdoor lighting system.	Utilizing an automated switch or light sensor.	2	2	The photograph depicts a light fixture utilizing an automated switch or light sensor, along with documentation showing the handover of the sensor-equipped light fitting to the consumer
Total Score		**15**	**21**	
Energy Efficiency				
Building envelope.	Shading is provided for all north- and south-facing windows.	5	5	The as-built drawings include building plans, building orientation, building elevations, building sections, and details of shading devices
	Shading is provided for all north- and south-facing windows.	6	6	There is a photograph showing exterior shading devices such as canopies, fins, verandas, and other types of shade that reduce solar radiation.
	The area of glazing constitutes 5-10% of the wall area on one side of the building's orientation.	0	1	Not fulfilled during technical planning.
	The glazing area comprises 10-15% of the wall area on a single building orientation.	4	4	Room 1: 11.550% Room 2: 14.634%
Air Conditioning (AC)	Air conditioning is limited to a maximum of 25% of the total building area.	5	5	No air conditioning used.
	The air conditioner (AC) unit must have a minimum energy efficiency rating of four stars	5	5	No air conditioning is used. A commitment letter exists encouraging the avoidance of air conditioning, and a recommendation to use energy-efficient labeled air conditioners is provided if air conditioning is desired.
	Air-conditioned rooms include ventilation openings comprising at least 1% of the room's area, located on two different walls.	5	5	No air conditioning is used; the building features operable windows and ventilation openings.

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Lighting system	Room depth does not exceed twice the height of the windowsill.	5	5	Family Room: 1.79 (units unspecified, likely meters) Bedroom: 1.36 (units unspecified, likely meters)
	Artificial lighting power adheres to maximum standards.	5	5	Lighting Power Consumption (in Watts): Terrace and Carport: 15 W Family Room: 12 W Kitchen: 12 W Bedroom: 12 W Bathroom: 5 W
Electrical system.	Renewable energy sources provide a minimum of 10% of total electricity needs.	0	5	No electricity from renewable energy sources is present.
Total Score		**40**	**46**	
Water Use Efficiency				
Water source.	Water supply from PDAM (Regional Drinking Water Company) or other water companies	11	11	A photograph shows the location where a water source connects to a system.
	Rainwater is collected and simply treated for use as an alternative water source.	0	2	Using PDAM
	Groundwater is used as a water source and must be equipped with a water meter.	0	2	
Use of water-efficient sanitaryware. Share (select one)	At least 25% of all sanitary fixtures are water-efficient models.	0	0	This was not met during the technical planning phase.
	At least 50% of all sanitaryware is water-efficient models.	0	0	
	At least 75% of all sanitaryware are water-efficient models.	15	15	Total products are 100% energy efficient.
Total Score		**26**	**30**	
Indoor Air Quality				
Indoor air circulation.	The total window area in each room is at least 5% of the floor area.	3	3	Opening Percentage (as built): Family Room: 7.42% Bedroom 1: 10.43% Bedroom 2: 17.16% Bathroom: 19.74%
	The minimum window area in each room is 10% of the floor area.	0	2	The requirement was not met during the technical planning phase.
	Cross-ventilation is implemented in at least the living and family rooms, with openings not aligned in a straight line.	3	3	Cross-ventilation is present, with the two openings not aligned in a straight line. This implies that the air flows diagonally through space, improving air circulation.
	Bathrooms and kitchens are equipped with exhaust fans if there are no ventilation openings.	5	5	Full points awarded due to the presence of ventilation.
Control of the use of setting agents.	Air conditioners (ACs) must be labeled as "CFC and HCFC-free," complying with Indonesian Ministry of Industry regulations	5	5	Full points awarded due to the presence of ventilation.
Total Score		**16**	**18**	
Utilization of Environmentally Friendly Materials				
Concrete	Originating from a maximum distance of 1,000 km or from the	1	1	There is proof of payment/invoice for the purchase of concrete materials, including the name and address of the distributor or

	nearest supplier to the project site.			supplier of the concrete materials, located within 1000 km of the project site.
	Cement must be sourced from factories implementing ISO 14001 environmental management systems, possessing Green Industry Certification (SIH), and/or displaying eco-friendly labels	3	3	Rajawali cement was used, which includes the implementation of the ISO 14001 environmental management system, Green Industry Certification (SIH), and/or an eco-friendly label scheme.
Wall Material	Sourced from a maximum distance of 1000 km or from the nearest supplier to the project site.	1	1	Proof of payment/invoice for the purchase of concrete materials is available. This documentation includes the name and address of the distributor or supplier, located 1000 km from the project site.
Wood	Comply with relevant legal regulations and/or carry an eco-friendly label	4	4	The wood vendor holds a certificate that meets the Indonesian Timber Legality Verification System (SVLK) standards.
Paint	Selected from factories implementing ISO 14001 environmental management systems and/or possessing eco-friendly labels.	1	1	Propan paint, featuring a green label on its packaging, was used.
Roofing	Free from hazardous and toxic materials (B3), including asbestos, and/or carries an eco-friendly label.	2	2	The roofing material has been verified by the supervisor and/or MK consultant as conforming to the technical specifications in the work contract for the business applicant. The product's traceability confirms it is free of hazardous and toxic substances (B3) and/or carries an eco-friendly label.
TKDN	The combined Domestic Component Level (TKDN) for the construction of the house must be at least 40%	3	3	The Domestic Component Level (TKDN) calculation results for the Bill of Quantities (RAB) are attached and meet the required standards.
Total Score		**15**	**15**	
Waste Management				
Implementation of the 3R principle (Reduce, Reuse, Recycle).	Equipped with separate waste bins and implements a waste sorting system for at least two types of waste (organic and inorganic).	8	8	Two trash receptacles are already in place around the house. A letter of commitment confirms that sorted waste bins will be installed after handover to the customer.
Waste management system implementation.	The house processes organic waste using an individual-scale composter.	0	11	This requirement was not met during the technical planning phase.
	Inorganic waste management is implemented through third-party channels (e.g., waste banks, collectors, etc.).	4	4	There is documentation (letter of agreement, proof of payment, or receipt) for the management of inorganic waste channeled through a third party.
Total Score		**12**	**23**	
Wastewater Management				
If not located in an area served by a municipal/communal wastewater system, it must have its own wastewater treatment facility.	eptic tank conforms to standards.	0	2	The requirement was not met during the technical planning stage.
	Septic tank with media (biofilter) conforming to standards.	8	8	The building is equipped with a biotank.
	Septic tank, or septic tank with media (biofilter), conforming to standards and equipped with pre-treatment (grease trap and/or filter) for mixed wastewater.	0	2	Not fulfilled during the technical planning phase.
Total Score		**8**	**12**	
Grand Total		**132**	**165**	**80 % (EXCELLENT)**

The following assessment table presents the results of the evaluation of Green Building Performance (Bangunan Gedung Hijau, BGH) implementation during the construction phase. According to the Ministry of Public Works and Housing Regulation (PERMEN PUPR) No. 21 of 2021, the construction phase assessment

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should cover four main parameters: conformity of green building construction performance, green construction processes, green behavior practices, and green supply chain management. However, in practice, Perum Perumnas, as the project developer, opted to adopt the performance indicators used in the technical planning phase as the basis for auditing the construction phase. This approach was taken to ensure that all criteria and targets established during the planning stage were not merely documented but were also fully implemented in the physical construction process on-site.

Consequently, the assessment parameters used in this construction phase audit directly follow the performance indicators from the technical planning phase. These include site management, energy efficiency, water efficiency, indoor air quality, use of environmentally friendly materials, waste management, and wastewater management. This approach aims to maintain consistency between design and execution, and to strengthen the validity of the "Predikat Utama" (Prime Rating) certification—ensuring that it is awarded not only based on planning documentation, but also on the demonstrable implementation in the field. As the construction work was implemented based on the approved plans, it can be concluded that the project's less-than-perfect score was mainly a result of limitations in the initial technical planning, not shortcomings in the actual construction

3.3. Challenges and Issues Encountered in the Field

The implementation of Green Building (Bangunan Gedung Hijau, BGH) principles during the construction phase of the Samesta Royal Cempaka project faced several technical and administrative challenges that affected the achievement of optimal performance outcomes. Based on audit findings and field assessments, it was observed that several key criteria were not fully implemented in accordance with the evaluation standards outlined in PERMEN PUPR No. 21 of 2021. From a technical standpoint, the absence of a rainwater management system and pre-treatment facilities for domestic wastewater indicates that the integration of sustainability principles into building utility infrastructure remains insufficient. Furthermore, the reduction in green open space during the construction phase, compared to the initial planning, negatively impacted the achievement of site management indicators.

In terms of implementation, renewable energy technologies have not yet been incorporated, and strategies for rainwater conservation have not been applied. On the administrative and documentation front, challenges were encountered in providing formal proof for certain parameters, such as eco-labels for materials or product certifications. However, based on direct field observations and verifications, the project team was able to present relevant visual and technical evidence, including product information, brand labels, and manufacturer details. As a result, full credit was still awarded for the use of environmentally friendly materials, as the substantive principles of sustainability were deemed to have been met.

These findings underscore that the successful implementation of green building principles requires strong coordination across planning, execution, and verification systems, along with comprehensive documentation support to ensure that all performance aspects can be systematically validated.

3.4. Recommendations to Enhance the Implementation of Green Buildings

The evaluation of Green Building (Bangunan Gedung Hijau, BGH) implementation during the construction phase indicates that although the majority of parameters were satisfactorily fulfilled, several aspects still require improvement and reinforcement. Accordingly, a set of strategic recommendations has been formulated to enhance the quality of BGH implementation in future housing projects. These recommendations encompass technical, managerial, and documentation-related aspects, aiming to promote the comprehensive application of sustainability principles from the planning stage through to construction execution.

First, the integration of rainwater management systems and pre-treatment of domestic wastewater should be more systematically incorporated into the initial design phase. This effort is essential to ensure that ecological utilities—such as infiltration wells and grease traps—are available and functional from the time the building is occupied. Second, site plan oversight must be strengthened to maintain the proportion of green open space (GOS) consistently throughout the construction process. The utilization of GOS should go beyond shading and aesthetic functions, and instead support productivity—such as through the cultivation of fruit trees like mango, guava, or papaya. The selection of vegetation must also consider ease of maintenance, resilience to local climatic conditions, and its contribution to environmental conservation. Third, the planned and sustained use of energy-saving technologies and renewable energy sources should begin to be implemented. One unmet parameter in this project was the provision of electricity from renewable sources accounting for at least 10% of total energy demand. As a solution, the installation of household-scale photovoltaic (solar panel) systems is recommended. To facilitate this, provisions for installation space or conduit pathways should be prepared during the technical planning phase. Fourth, waste management—both organic and inorganic—should be optimized through the provision of individual-scale composting facilities and stronger collaboration

with local waste management services. In addition, the use of biotanks equipped with grease traps can improve the treatment quality of household wastewater. Lastly, the documentation system for compliance evidence must be improved to ensure systematic organization and readiness from the outset of the project. This includes storing eco-labels for green materials, technical specification data, Domestic Component Level (TKDN) information, and records of efficient device usage. Developing a digital checklist, providing technical training for field personnel, and implementing photo-based and certificate-based documentation are concrete steps to support a more efficient, verifiable, and standards-compliant audit process.

4. Conclusion

The national housing project in Purwakarta Regency has successfully obtained the Green Building Certification with a "Main Predicate" (80%) at both the technical planning and construction implementation stages. This outcome reflects a commendable level of adherence to sustainability principles, particularly in the areas of energy efficiency, water use, and the application of environmentally friendly materials. Nevertheless, there remains room for improvement, especially in the management of waste and wastewater. The implementation of appropriate strategic recommendations will further enhance the sustainability quality of future construction projects and contribute to the realization of environmentally conscious development.

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