

Analysis of the Level of Understanding of Green Construction in Building Consultant and Contractor Planning Companies in Banda Aceh City

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ABSTRACT

Construction projects are currently experiencing rapid growth across the country, with the aim of promoting regional development. However, construction projects inevitably have negative impacts on the surrounding environment. The issuance of Minister of Public Works and People's Housing Regulation No. 21 of 2021 on the performance assessment of green buildings serves as a foundation for construction stakeholders to understand the requirements for implementing green construction concepts to preserve the environment both now and in the future. Therefore, the author aims to analyze the level of understanding of green construction among building consulting firms and contractors in Banda Aceh. The method used was a quantitative approach with 44 respondents from consulting firms and 60 respondents from construction contractors, selected through purposive sampling. The analysis was conducted using descriptive statistics and the Respondent Achievement Level (RAL). The aspects of green construction that have been understood by construction practitioners both consultants and contractors range from 83.30% to 88.94%, all of which fall into the "understand" category (>80%)

INTRODUCTION

Construction projects are currently experiencing a sharp increase across the country, with the aim of promoting regional development. The global rise in building construction activity has become a significant phenomenon in recent decades. However, construction projects invariably have negative impacts on the surrounding environment. According to Davda (2024), the construction industry has a significant impact on the environment, contributing to approximately 23% of air pollution, 40% of drinking water contamination, and 50% of waste. Key issues include habitat loss, ecosystem disruption, air pollution, noise pollution, water pollution, and waste generation. From the massive, illegal use of materials to the operation of modern buildings, these activities have undoubtedly produced toxins, carbon emissions, and waste whose management has been neglected. Therefore, the Ministry of Public Works and Public Housing (PUPR) issued Regulation No. 21 of 2021 on the Performance Assessment of Green Buildings. The issuance of this regulation serves as a key guideline for the construction of green buildings in Indonesia.

The U.S. Environmental Protection Agency (2010) defines green construction as a construction method that involves processes that protect the environment and ensure responsible material production throughout a building's life cycle—from site selection through design, construction, operation, maintenance, repair, and renovation. Green construction is an effort to create buildings using environmentally friendly methods and efficient resource use throughout the building's lifespan. Simply put, green construction is not just about planting trees on a building's construction site; it is a holistic approach to creating structures and employing processes that are environmentally responsible and resource-efficient throughout a building's entire life cycle—a cycle that begins with site selection, design, construction, operation, and maintenance.

As the use of natural resources increases and more construction waste is dumped into the environment, environmental damage is becoming increasingly evident, as evidenced by rising carbon emissions in the city of Banda Aceh. Many areas particularly in the city of Banda Aceh have experienced land and air degradation due to lifestyle patterns and a continuously growing population (Rauzana, 2021). With numerous construction projects being carried out without considering the surrounding environment, construction practitioners are required to understand the concept of green construction, which can mitigate environmental damage caused by various development activities. The issuance of Regulation of the Minister of Public Works and People's Housing (PUPR) No. 21 of 2021 on the performance assessment of green buildings serves as a foundation for construction practitioners to understand the requirements that must be met when implementing the concept of green construction to preserve the environment both now and in the future. Therefore, the author aims to analyze the level of understanding of green construction among architectural planning consulting firms and building contractors in the city of Banda Aceh.

THEORITICAL REVIEW

Construction Projects

A construction project is a series of interrelated activities aimed at achieving a specific building or construction objective within defined time, quality, and cost constraints. Construction projects require resources such as building materials, labor, funds, implementation methods, equipment, time, and information (Munasir, F 2021). A project is a set of interrelated activities with a defined start and end point and a specific outcome. In every construction project, changes in the scope of work—whether additions or reductions—inevitably occur. These changes in the scope of work always take place during the construction phase whether at the beginning, middle, or end of the project—and can occur in all types of construction projects, including infrastructure, buildings, and residential homes, significantly impacting the project's operational effectiveness (Rinalatu, 2023).

Green Construction

Green construction is essentially a strategy in the construction process that prioritizes environmentally friendly construction through work methods, materials, management, supervision, and so on. Essentially, green construction is an implementation phase that builds upon the concept of environmentally friendly design (Thoengsal J, 2024).

Principles of Green Construction

Green building principles in building design and construction not only make a significant contribution to environmental conservation through reduced carbon emissions, efficient use of energy and water, and waste minimization, but also provide long-term economic benefits in the form of sustained reductions in operating costs, efficiency in building maintenance, and increased property value and competitiveness in a market that is increasingly aware of the importance of sustainability.

METHODOLOGY

This study employed three stages to achieve optimal results: the research planning stage, the research implementation stage, and the research reporting stage. The research planning stage involved identifying the research subjects and location, determining the type of data, defining the population and sample, designing the questionnaire, collecting questionnaire data, and testing the questionnaire. The research implementation stage involved collecting questionnaire data and analyzing that data. The research reporting stage focused on the level of understanding of green construction practices already implemented in building construction projects in the city of Banda Aceh.

RESEARCH RESULT

Questionnaires were distributed to 44 respondents from consulting firms and 60 respondents from contracting firms; this distribution was carried out to obtain accurate data. Based on all the data collected, the results and discussion can now be presented.

Validity Test**Validity Test for the Contractor Questionnaire**

The validity test for the contractor questionnaire was conducted on 55 items using pilot test data from $n = 30$ respondents, with a table r value of 0.361. A summary of the validity test results is presented in Table 4.1

Table 1. Summary of Validity Test Results (1/3)

A1	Appropriate Land Use	r calculate	r table	description
1	How familiar are you with the placement of green open spaces at construction sites?	0.547	0.361	Valid
2	How much do you know about site selection in construction?	0.701	0.361	Valid
3	How familiar are you with public transportation access at construction sites?	0.756	0.361	Valid
A2	Energy Efficiency and Conservation			
1	How much do you know about lighting standards designed to support work at project sites, both indoors and outdoors?	0.711	0.361	Valid
2	How much do you know about the use of energy-efficient lighting in buildings?	0.713	0.361	Valid
3	How well do you understand lighting arrangements based on the sequence of work in a construction project?	0.711	0.361	Valid
4	How familiar are you with calculating CO ₂ reductions achieved through energy efficiency in construction projects?	0.688	0.361	Valid
5	How familiar are you with maximizing the use of natural light for lighting in contractor's site offices, covering at least 50% of the total floor area?	0.653	0.361	Valid
6	How familiar are you with the use of water reservoirs for storing clean water on construction projects?	0.832	0.361	Valid
7	How familiar are you with establishing rules or guidelines for the use of office equipment (lights, air conditioners, water dispensers, photocopiers, computers, water pumps, etc.)?	0.636	0.361	Valid
8	How much do you know about setting the air conditioner to 25°C for energy efficiency?	0.662	0.361	Valid
9	How familiar are you with the use of light sensors for lighting at project sites?	0.680	0.361	Valid

10	How familiar are you with measuring light intensity in accordance with the regulations (minimum 300 lux)?	0.839	0.361	Valid
11	How much do you know about vibration measurement during the construction process?	0.649	0.361	Valid
12	How much do you know about measuring noise levels during construction?	0.766	0.361	Valid
A3	Water Conservation			
1	How familiar are you with rainwater harvesting for reuse in activities that do not require potable water at the project site?	0.696	0.361	Valid
2	How familiar are you with the installation of water meters at each point of delivery for clean water sources (PDAM and groundwater)?	0.779	0.361	Valid
3	How familiar are you with the process of monitoring monthly water usage on construction projects?	0.524	0.361	Valid
4	How familiar are you with the use of automatic faucets for sinks at project offices?	0.813	0.361	Valid
5	How familiar are you with the practice of placing "Use Water Sparingly" stickers at water outlets?	0.682	0.361	Valid
6	How much do you know about the use of showers by construction workers?	0.494	0.361	Valid
7	How familiar are you with planning for dewatering in construction projects?	0.767	0.361	Valid
8	How much do you know about constructing recharge wells, such as infiltration wells or biopore holes?	0.719	0.361	Valid
9	How familiar are you with installing piezometers for groundwater level monitoring?	0.580	0.361	Valid
10	How familiar are you with the use of dewatering systems for activities at construction project sites?	0.515	0.361	Valid
A4	Material Sources and Cycles			
1	How familiar are you with the use of reclaimed materials from old buildings whether at the job site or from other locations to reduce the use of new raw materials, thereby extending the service life of the materials and reducing waste sent to landfills?	0.775	0.361	Valid

2	How much do you know about the use of factory-made building materials that utilize environmentally friendly raw materials and production processes?	0.758	0.361	Valid
3	How much do you know about the use of wood raw materials that are traceable or certified?	0.798	0.361	Valid
4	How much do you know about efforts to improve material efficiency in order to reduce construction waste?	0.692	0.361	Valid
5	How much do you know about efforts to reduce the carbon footprint of material or product procurement by using materials sourced from the project site or local products to promote domestic economic growth?	0.792	0.361	Valid
A5	Health and Safety on the Project Site			
1	How well do you understand the prioritization of construction workers in project implementation?	0.753	0.361	Valid
2	How much do you know about public health concerns in the vicinity of construction sites?	0.751	0.361	Valid
3	How much do you know about selecting construction methods based on minimizing dust to create a healthy work environment?	0.817	0.361	Valid
4	How well do you understand the selection of construction methods based on minimizing materials or substances that cause pollution (pollutants)?	0.711	0.361	Valid
5	How much do you know about replacing old equipment with new equipment to improve energy efficiency and reduce emissions?	0.370	0.361	Valid
6	How much do you know about controlling dust generated by deconstruction activities?	0.668	0.361	Valid
7	Are you planning to pay attention to materials that contain hazardous substances (paint, glue, sealant)?	0.692	0.361	Valid
8	How much do you know about managing materials that contain hazardous substances, such as paint, glue, and sealant?	0.681	0.361	Valid
9	How familiar are you with the placement of "No Smoking" signs at project offices?	0.770	0.361	Valid
10	How familiar are you with the provision of smoking areas located approximately 5 meters outside the office building?	0.746	0.361	Valid

11	Are you planning to provide a smoking area at least 5 meters away from the workplace?	0.657	0.361	Valid
12	How familiar are you with the provision of smoking areas located approximately 5 meters outside the workplace?	0.792	0.361	Valid
13	How familiar are you with the policy on not using asbestos materials in construction projects?	0.742	0.361	Valid
14	How familiar are you with the policy against using mercury lamps for lighting at project sites and project offices?	0.706	0.361	Valid
15	How well do you understand the policy against using Styrofoam as thermal insulation?	0.780	0.361	Valid
16	How familiar are you with installing safety nets to prevent materials from falling during the construction process?	0.741	0.361	Valid
17	How much do you know about watering the ground at a construction site to reduce dust?	0.692	0.361	Valid
A6	Building Environmental Management			
1	How familiar are you with tracking the amount of leftover materials on a construction project?	0.630	0.361	Valid
2	How familiar are you with tracking the amount of renewable materials used in construction projects?	0.693	0.361	Valid
3	How familiar are you with recording the amount of recycled materials used in construction projects?	0.763	0.361	Valid
4	How familiar are you with recording the amount of local materials used in construction projects?	0.728	0.361	Valid
5	How familiar are you with the process of documenting the use of certified wood products in construction projects?	0.628	0.361	Valid
6	How familiar are you with keeping track of the quantity of materials shipped and the methods for protecting those materials during the shipping process?	0.612	0.361	Valid
7	How familiar are you with air quality program documentation for construction projects?	0.695	0.361	Valid

8	How familiar are you with construction waste management documentation for construction projects?	0.654	0.361	Valid
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Based on Table 4.1, all 55 items in the contractor questionnaire had a calculated r value greater than the table r value (0.361); therefore, all items were deemed valid and suitable for use as a research data collection instrument.

Validity test of the consultant questionnaire

The validity test for the contractor questionnaire was conducted on 33 items using pilot test data from $n = 30$ respondents, with a table r value of 0.361. A summary of the validity test results is presented in Table 2.

Table 2. Summary of Validity Test Results (1/3)

A1	Appropriate Land Use	r calculate	r table	description
1	How well do you understand the selection of project sites that are consistent with regional land-use plans?	0.447	0.361	Valid
2	How well do you understand the importance of preserving green spaces in construction project planning?	0.775	0.361	Valid
3	How well do you understand the analysis of land characteristics as a basis for building design?	0.412	0.361	Valid
A2	Energy Efficiency and Conservation			
1	How well do you understand the application of energy principles in building design?	0.746	0.361	Valid
2	How much do you know about the use of natural lighting in building design?	0.601	0.361	Valid
3	How much do you know about natural ventilation design to reduce energy use?	0.781	0.361	Valid
4	How familiar are you with selecting energy-efficient lighting systems in planning documents?	0.373	0.361	Valid
5	How much do you know about using energy-efficient mechanical and electrical equipment?	0.328	0.361	Invalid
6	How familiar are you with building energy needs analysis during the planning phase?	0.512	0.361	Valid
7	How much do you know about efforts to reduce carbon emissions through building design?	0.746	0.361	Valid
A3	Material Sources and Cycles			
1	How much do you know about choosing environmentally friendly materials in building design?	0.471	0.361	Valid
2	How much do you know about using local materials to reduce your carbon footprint?	0.733	0.361	Valid

3	How much do you know about selecting materials with environmental certifications?	0.498	0.361	Valid
4	How much do you know about the use of recycled materials in construction projects?	0.462	0.361	Valid
5	Seberapa paham Anda mengenai konsep <i>life cycle assessment</i> dalam pemilihan material bangunan?	0.482	0.361	Valid
A4	Building Health and Comfort			
1	How much do you know about building designs that promote indoor air quality?	0.420	0.361	Valid
2	How much do you know about choosing low-emission materials to improve air quality?	0.725	0.361	Valid
3	How much do you know about natural lighting design that provides comfort for building occupants?	0.569	0.361	Valid
4	How much do you know about ventilation design that meets thermal comfort standards?	0.261	0.361	Invalid
5	How much do you know about choosing materials that do not contain substances harmful to health?	0.592	0.361	Valid
6	How much do you know about choosing materials that do not contain substances harmful to health?	0.616	0.361	Valid
A5	Building Environmental Management			
1	How familiar are you with the process of drafting planning documents that incorporate the principles of green construction?	0.608	0.361	Valid
2	How familiar are you with developing technical specifications that support the implementation of green construction?	0.539	0.361	Valid
3	How familiar are you with the process of preparing environmental management documents for a project?	0.398	0.361	Valid
4	How familiar are you with drafting specifications for construction waste management in contract documents?	0.718	0.361	Valid
5	How familiar are you with drafting requirements for the use of environmentally friendly materials in bidding documents?	0.534	0.361	Valid
6	How well do you understand how to coordinate with contractors to ensure that green construction principles are implemented in accordance with the planning documents?	0.516	0.361	Valid
A6	Water Conservation			
1	How much do you know about planning a rainwater harvesting system?	0.693	0.361	Valid

2	How much do you know about the use of recycled water in buildings?	0.665	0.361	Valid
3	How much do you know about the use of water-saving plumbing fixtures in building design?	0.362	0.361	Valid
4	How familiar are you with the inclusion of infiltration wells or biopores in land-use planning?	0.477	0.361	Valid
5	How much do you know about stormwater management in the project area?	0.619	0.361	Valid
6	How much do you know about water needs analysis in building planning?	0.352	0.361	Invalid

Based on Table 4.2, of the 33 items in the planning consultant questionnaire, 3 items were deemed invalid namely, A2.6, A4.4, and A6.6 because their calculated r values were smaller than the table r value (0.361). These items were excluded from further analysis, while the remaining 30 items were deemed valid and suitable for use as data collection instruments.

Reliability Test

A reliability test was conducted to determine the consistency or reliability of the research instrument when used repeatedly on the same subjects. The reliability test was conducted using Cronbach's Alpha, with the criterion that the instrument is considered reliable if the alpha coefficient (α) is greater than 0.6.

Table 3. Results of the Reliability Test for the Research Instrument

Respondent Groups	Number of Items (k)	Cronbach's Alpha	Critical Value	Description
Contractor	55	0.980	0,6	Reliable (Very High)
Planning Consultant	33	0.927	0,6	Reliable (Very High)

Based on Table 4.3, the Cronbach's Alpha value for the contractor questionnaire was 0.980 and for the planning consultant questionnaire was 0.927. Both values are well above the critical value of 0.6; therefore, both research instruments are considered to have a very high level of reliability and consistency when used for repeated measurements.

Respondents' Achievement Levels

The Respondent Achievement Level (RAL) analysis was used to measure respondents' level of understanding of each green construction variable and indicator under study. The RAL value was calculated by comparing the average score of respondents' answers with the maximum score that could be obtained for each statement item, and then expressed as a percentage. Furthermore, TCR values are interpreted based on the criteria proposed by Riduwan (2010), namely: 90–100% falls into the "Very Well Understood" category, 80–89% falls into the "Well Understood" category, 65–79% falls into the "Fairly Understood" category, 55–64% falls into the "Poorly Understood" category, and less than 55% falls into the "Not Understood" category.

Table 4. Results of TCR Analysis of Research Variables – Contractors (n = 60)

Variable	Total Score (Rs)	Maximum Score	TCR (%)	Category
A1	795	900	88.33%	Understood
A2	3045	3600	84.58%	Understood
A3	2499	3000	83.30%	Understood
A4	1303	1500	86.87%	Understood
A5	4321	5100	84.73%	Understood
A6	2032	2400	84.67%	Understood

Based on Table 4.4, the TCR values for all variables in the contractor group ranged from 83.30% to 88.33%, all of which fall into the “understand” category (>80%). This indicates that the contractor respondents generally gave positive ratings for all variables measured in this study.

TCR Group of Planning Consultants

Table 5. Results of the TCR Analysis of Research Variables – Planning Consultants (n = 44)

Variabel	Skor Total (Rs)	Skor Maksimal	TCR (%)	Kategori
A1	587	660	88.94%	Understood
A2	1288	1540	83.64%	Understood
A3	960	1100	87.27%	Understood
A4	1106	1320	83.79%	Understood
A5	1136	1320	86.06%	Understood
A6	1135	1320	85.98%	Understood

Based on Table 4.5, the TCR values for all variables in the planning consultant group ranged from 83.64% to 88.94%, and all fell within the “understand” category. These results are consistent with those from the contractor group, indicating a shared positive view or perception of the research variables among both groups of respondents.

DISCUSSION

The general understanding among construction stakeholders regarding support for development that takes environmental aspects into account through the concept of green construction in the city of Banda Aceh.

Based on the results of the Respondent Achievement Level (RAL) analysis and descriptive statistics, it can be concluded that construction practitioners in Banda Aceh, including both planning consultants and contractors, have a good level of understanding of the concept of green construction. This is indicated by the high RAL scores on most indicators, which fall within the “Understand” to “Strongly Understand” categories. These findings indicate that the principles of

sustainable development are beginning to be understood by construction service providers, particularly those related to site planning, resource efficiency, the selection of environmentally friendly materials, water conservation, and project environmental management. These results are consistent with Van Basten et al. (2018), who state that increased knowledge is one of the main factors influencing the implementation of green construction in the construction industry in developing countries.

This high level of understanding indicates that the concept of green construction is no longer viewed as merely a theoretical idea but has begun to be accepted as part of professional practice in the execution of construction projects. Respondents appear to have understood that good construction not only emphasizes the functional and aesthetic aspects of a building but must also consider its environmental impact, energy efficiency, and resource sustainability. This is important because the construction sector is one of the sectors that contributes significantly to energy consumption, material use, and waste production; therefore, an understanding of green principles is a crucial foundation for reducing the negative impacts of construction. As explained by Liu et al. (2023), the ability of construction practitioners to implement green construction is closely related to energy efficiency, material management, resource conservation, and project environmental management systems.

Nevertheless, the research findings also indicate that this level of understanding is not yet consistent across all aspects of green construction. Several indicators—particularly those related to carbon emission reduction, monitoring of energy and water use, and project operational management—still receive relatively lower scores compared to other indicators. This situation indicates that the application of green construction concepts in Banda Aceh is still primarily understood in terms of commonly implemented technical aspects rather than those requiring environmental analysis, documentation, or continuous environmental performance evaluation. Therefore, capacity building through training, professional certification, and outreach on green construction regulations remains necessary to ensure that this understanding can be implemented more comprehensively at every stage of construction projects. This finding is also consistent with Van Basten et al. (2018), who emphasize that increased knowledge must be accompanied by policy support and implementation mechanisms so that the application of green construction can proceed effectively.

The low level of understanding regarding certain indicators also suggests that the green construction approach is still often understood only in a fragmented manner. This means that while some construction practitioners are familiar with practical measures—such as using local materials or conserving water they do not yet fully grasp the interrelationships among variables throughout a building's life cycle. In fact, the concept of green construction requires integration between the planning, construction, and management stages of a building so that environmental benefits can be optimally achieved. Thus, a thorough understanding must focus not only on easily implementable actions but also on the ability to assess the long-term impacts of technical decisions made

during a project. The importance of integration at this early stage is also emphasized by Huo et al. (2018), who demonstrate that site planning and design are among the most critical aspects for the success of green buildings.

CONCLUSION

The aspects of green construction that contractors already understand range from 83.30% to 88.33%, all of which fall into the “understand” category (>80%). This indicates that contractor respondents generally gave positive ratings for all variables measured in this study. Meanwhile, for planning consultants, the range was 83.64% to 88.94%, and all results also fell into the “understand” category. These results are consistent with those from the contractor group, indicating a shared positive view or perception of the research variables among both groups of respondents.

RECOMMENDATION

It is recommended that construction professionals including consultants and contractors always take green construction into account to support environmentally friendly development.

FURTHER STUDY

Future research could explore the administrative and technical aspects covered in this study to identify which elements of the green construction concept are already understood and applied in ongoing construction projects.

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