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Assessment Factors of Energy Efficiency Measures in Green Building Systems of Hospital Buildings in Palu City

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Article Info	ABSTRACT
	Green building is the concept of environmentally friendly green buildings that are able to support themselves, save water and energy, and use renewable energy to protect the environment from increasingly severe damage. This research aims to determine the factors that influence energy efficiency and to determine the application of energy efficiency in green building systems for hospital buildings in Palu City. Research data was collected through surveys and interviews by conducting a checklist interview table containing 7 energy efficiency assessment parameters, namely building envelope, ventilation system, air conditioning system, lighting system, transportation system in the building, energy efficiency calculation and electrical system. There were 5 respondents representing the three hospitals studied. Then it is analyzed using the percentage value obtained from each interview table that gets points. The highest results from the percentage values obtained from three hospitals, namely Anutapura Hospital, Anutapura Medical Center (AMC) Building, received a percentage value of 58% for implementing energy efficiency in the green building system.

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INTRODUCTION

Hospitals have a strategic role in providing health services while being responsible for environmental sustainability. High energy consumption in hospitals is generally caused by operational needs such as lighting, ventilation, air conditioning, and medical devices (Nurhadi & Ramdhani, 2023). To overcome this, the application of the green building concept is an effective solution in improving energy efficiency while reducing carbon emissions (GBCI, 2020; Putri & Kurniawan, 2023). In Palu City, the implementation of green building is very relevant considering that this area is a disaster-prone area, so an efficient and sustainable building infrastructure is needed (Wibowo & Andini, 2021).

Law of the Republic of Indonesia Number 36 of 2009 concerning Health states that every individual has the same right to obtain health services and has the right to live in a clean, safe, and comfortable environment (Ministry of Health of the Republic of Indonesia, 2009). Hospitals as health service institutions not only function to provide medical care to patients, but also have a responsibility to maintain the cleanliness and health of the surrounding environment to support the welfare of the community (Supriyadi & Darmawan, 2022).

Excessive energy use in hospitals can lead to a spike in operational costs, due to the high energy demand for lighting, air conditioning, heating, and the operation of medical equipment (Nurhadi & Ramdhani, 2023). In addition, energy consumption from non-renewable sources, such as fossil fuel-based power plants, can increase greenhouse gas emissions and worsen air quality, which indirectly impacts the health of the people around the hospital environment (Utami & Suryani, 2021).

To overcome this, the concept of green building is the right solution. Green buildings are designed to reduce negative impacts on the environment through energy efficiency, sustainable use of resources, and the creation of a healthy environment (GBCI, 2020). The application of energy efficiency principles in the

concept of green building in hospitals, such as those being developed in Palu City, can help reduce energy consumption and carbon emissions, as well as improve environmental quality and operational efficiency in the long term (Putri & Kurniawan, 2023).

Research Methods

This research utilizes primary data and secondary data as a source of information. Primary data was obtained directly by researchers through field activities, using interview and survey methods at the research site. The interviews were conducted using checklist tables at three hospitals in Palu City, involving five respondents as representatives of each hospital. The purposive sampling technique is used to determine respondents based on certain predetermined criteria. After the criteria are determined, the expert choice method is applied to select the most relevant resource persons, namely individuals who have direct involvement in the hospital building construction project and have an understanding of the concept of green building.

This type of research is qualitative descriptive, which relies on data collection through primary and secondary sources. The data analysis process was carried out based on an assessment of the performance of the Green Building (BGH), which is a reference in this study. The final results are presented descriptively to provide a comprehensive overview of the implementation of green building principles at the study site.

Research with a qualitative descriptive approach like this is relevant to describe actual conditions and identify best practices in the implementation of green building, especially in the context of hospital construction in disaster-prone areas such as Palu City (Widodo et al., 2021; Maulana & Sari, 2022). In addition, the use of purposive sampling and expert choice methods is highly recommended in studies that require subjective assessment from parties with special expertise (Nurhadi & Saputra, 2020; Lestari et al., 2023; Wibowo & Andini, 2021).

Stages of Data Collection
Observation

According to Supriatna (2020), observation is a data collection technique through direct observation in the field to understand the actual conditions at each research location. Observation plays an important role in the early stages of research because it is the basis for obtaining factual information that supports further analysis. This technique also allows researchers to identify situations and problems contextually (Yuliani & Nugroho, 2021).

Interview

In addition to observation, interview techniques are also used in the data collection process. Interviews are defined as direct interaction between researchers and respondents in the form of questions and answers to explore more in-depth information (Supriatna, 2020). This method is very effective when the researcher needs clarification of the observation data and obtains subjective understanding from the source who is directly involved in the event or activity being studied (Rahmawati & Kurniawan, 2022).

Documentation

As a complement to the observation and interview methods, documentation is also used to support the validity of the data. Documentation includes the collection of visual evidence such as photographs, recordings, or documents related to activities in the field. This technique aims to strengthen the findings and provide empirical evidence of the observation and interaction process that has been carried out (Supriatna, 2020; Prasetya & Lestari, 2023).

Data Analysis

Data is analyzed through three stages: data reduction, data presentation, and conclusion drawn. Reduction is done by filtering important information based on BGH parameters. The data is then presented in the form of an energy efficiency assessment table and analyzed to obtain the percentage of achievement of each parameter.

Data Reduction

The first step in data processing carried out by the researcher in this study is to reduce the data. What is meant by data reduction here is to summarize and sort the data and information obtained in the field, so as to make it easier for researchers to understand the data and information. This will make it easier for researchers in the next data processing process.

Data Presentation

The next step after data reduction is to present the data that has been created through the interview table. At this stage, the author conducts data research based on the points listed in each aspect based on BGH Technical Planning for New Buildings. Furthermore, a checklist and points were given to the BGH Technical

Planning Stage Performance Assessment table as a benchmark for performance assessment from the data that had been received from the results of interviews with field surveys at hospital buildings in Palu City.

Conclusion and Data Verification
The final step in the data analysis process is to draw conclusions and verify the data. In the verification stage, the researcher re-examines the data that has been obtained, while in the Conclusion there is a detailed explanation of the problem being studied (Supriatna, 2020). Paraphrasing the sentence, adjust the writing to EYD and writing scientific journals, minimizing the plagiarism. Add the most recent library for at least the last 10 years

RESULTS AND DISCUSSION
Overview of Research Locations
In this study, the author has previously conducted a survey to determine three hospitals in Palu City that will be reviewed, namely:

Anutapura Hospital, AMC Building (Anutapura Medical Center) Palu, has 5 floors with a total area of 19673 m2.

Undata Hospital, Emergency Room (Emergency Installation) Building, Palu, has 2 floors with a total area of 4516.09 m2.

Tadulako University Hospital, Building A, Palu, has 3 floors with a total area of 9716.37 m2.

Research Results
Energy Efficiency Assessment The assessment was carried out on seven parameters, namely: building envelope, ventilation system, air conditioning system, lighting system, transportation system in the building, energy efficiency calculation, and electrical system. The assessment refers to the Minister of PUPR Regulation No. 21 of 2021 and SE No. 01 of 2022.

This study aims to evaluate the factors that affect energy efficiency in hospital buildings in Palu City. The assessment is carried out using assessment tools that refer to the Green Building (BGH) standard, as stipulated in the Attachment to the Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 21 of 2021 concerning the Performance Assessment of Green Buildings. In addition, the assessment also refers to Circular Letter Number 01 of 2022 which provides technical instructions related to the performance assessment of BGH. In the regulation, there are seven parameters used to assess performance related to energy efficiency in buildings. The results of the assessment based on these parameters were obtained through the respondents involved from each hospital in Palu City (Hadi & Sutrisno, 2019; Kusuma et al., 2021).

Anutapura Hospital, AMC Palu Building

Table 1. Results of the Energy Use Efficiency Performance Assessment Checklist of Anutapura Hospital, AMC Palu Building

Energy Efficiency Performance Assessment Parameters	Standard Points	Points claimed	Information
Building Sheath	9	0	The building still uses an air conditioning system so it doesn't get points.
Ventilation System	3	3	The building is equipped with an air conditioning system but still utilizes natural ventilation to meet comfort.
Air Conditioning System	7	0	The building still uses air conditioning so it doesn't get points.
Lighting System	12	12	The building uses a lighting system that complies with existing standards as well as the use of energy-efficient LED lights.
In-Building Transportation System	3	0	Buildings use elevators so they don't get points.
Energy Efficiency Calculation	5	5	The building has calculations for the saving of electrical energy.

Electrical System	7	7	The use of renewable energy is used in buildings as the utilization of electrical energy.
Total Points	46	27	

Undata Hospital, Palu Emergency Room Building

Table 2. Results of the Energy Use Efficiency Performance Assessment Checklist of the Undata Hospital Emergency Room Palu Building

Energy Efficiency Performance Assessment Parameters	Standard Points	Points claimed	Information
Building Sheath	9	0	The building still uses an air conditioning system so it doesn't get points.
Ventilation System	3	3	The building is equipped with an air conditioning system but still utilizes natural ventilation to meet comfort.
Air Conditioning System	7	0	The building still uses air conditioning so it doesn't get points.
Lighting System	12	6	The building has not fully implemented an energy-saving system due to the use of lights that are turned on throughout the day.
In-Building Transportation System	3	0	Buildings use elevators so they don't get points.
Energy Efficiency Calculation	5	5	The building has calculations for the saving of electrical energy.
Electrical System	7	7	The use of renewable energy is used in buildings as the utilization of electrical energy.
Total Points	46	21	

UNTAD Hospital Building A Palu

Table 3. Results of the Energy Use Efficiency Performance Assessment Checklist of UNDATA Hospital Building A Palu

Energy Efficiency Performance Assessment Parameters	Standard Points	Points claimed	Information
Building Sheath	9	0	The building is planned to use an air conditioning system so it does not get points.
Ventilation System	3	3	The building is planned to be equipped with an air conditioning system but still utilize natural ventilation to meet comfort.
Air Conditioning System	7	0	The building is designed using air conditioning so it does not get points.
Lighting System	12	10	The building uses a lighting system that complies with the standard but has not fully implemented an energy-saving system.
In-Building Transportation System	3	0	Buildings use elevators so they don't get points.
Energy Efficiency Calculation	5	5	The building has calculations for the saving of electrical energy.
Electrical System	7	5	It has not been planned for the use of electrical energy from renewable sources so it does not get full points.
Total Points	46	23	

From the three results of the checklist of the interview table for energy efficiency assessment in three hospitals in Palu City, a comparison table and percentage value of each value that has been claimed have been obtained based on 7 parameters of energy efficiency assessment based on PUPR on Green Building Performance Assessment (BGH). Here's a comparison table:

Table 4. Comparison of Energy Efficiency Performance Assessment Results in Hospital Buildings in Palu City

Hospitals in Palu City	Number of Standard Points	Number of Points claimed	Percentage Results
Anutapura Hospital AMC Building	46	27	58%
Undata Hospital Emergency Room	46	21	46%
UNTAD Hospital Building A	46	23	50%

The comparison table of assessment results shows:

Anutapura Hospital AMC Building: 58% (27/46 points)

Undata Hospital Emergency Room Building: 46% (21/46 points)

UNTAD Hospital Building A: 50% (23/46 points)

The highest points are obtained in the lighting system and electrical system, while the lowest points are found in the building envelope and transportation within the building. From the evaluation carried out, several factors were found that are obstacles to the optimal implementation of green building in Palu City:

Limited Infrastructure: Some hospitals still use conventional technology that is energy-consuming and has not been able to accommodate smart or energy-efficient systems (Wibowo et al., 2020).

Lack of Human Resource Knowledge and Training: Lack of technical capacity and insight into modern energy management has led to widespread internalization of energy-saving practices (Lestari & Iskandar, 2022).

Limited Funding and Technical Regulation: Not all hospitals have internal budget and policy support that supports the procurement of energy-efficient technologies, such as annual energy audits or green investment incentives (Rizal & Haryanto, 2018).

Low Environmental Awareness: The hospital organisational culture that has not been geared towards a sustainable approach is also a barrier. An internal campaign program is required to change the behavior of building users.

The implementation of the green building concept in Palu City still faces various obstacles that hinder its optimal implementation. First, the current infrastructure is not adequate to support community activities efficiently, thus hindering the creation of an environment that is friendly to the principles of green buildings. Second, the environmental conditions in this city are also not supportive, with problems such as traffic congestion that causes high levels of air pollution. Third, limitations in human resources (HR) are also an obstacle, because in general, people are more likely to build new facilities without paying attention to the aspects of maintenance and sustainable management of buildings that have been built. This leads to unpreparedness in applying green building principles as a whole in building construction and operations (Rizal & Haryanto, 2018; Wibowo et al., 2020; Lestari & Iskandar, 2022).

Analysis and Implications The application of energy-efficient lighting systems such as the use of LEDs has been shown to make a major contribution to efficiency. However, other aspects such as the use of elevators and air conditioning are still a challenge because they are not supported by energy-saving systems. Limitations in infrastructure and human resources are the main inhibiting factors (Rizal & Haryanto, 2018). To optimize the implementation of green building in health facilities, cross-disciplinary collaboration, continuous training, and integration of renewable energy technology are needed.

CONCLUSION

Based on the research objectives and the results of the research and discussion, the researcher can draw the following conclusions:

Conclusion This study concludes that the implementation of energy efficiency in hospital green buildings in Palu City still varies. Anutapura Hospital AMC Building showed the best performance with the achievement of 58% of the total assessment standards. This research emphasizes the need to strengthen policies, increase human resources, and utilize technology to encourage more optimal energy efficiency.

The results of the research obtained through surveys and interviews with related parties in the construction of the project at three hospitals in Palu City show that factors that affect energy efficiency in green building systems include building envelopes, ventilation systems, air conditioning systems, lighting systems, transportation systems in buildings, energy efficiency calculations, and electrical systems.

Based on the results of the interview checklist with the respondents involved, Anutapura Hospital AMC Palu Building obtained 27 points out of 46 standard points, with a score percentage of 58%. Undata Hospital Gedung IGD Palu obtained 21 points out of 46 standard points, with a score percentage of 46%. Meanwhile, Tadulako University Hospital Building A Palu, which is still in the construction stage, received 23 points out of 46 standard points, with a score percentage of 50%. From the results of the evaluation, it can be concluded that the application of energy efficiency in the green building system, which is 58%, is found at Anutapura Hospital, AMC Palu Building.

For the development and refinement of future research, it is hoped that researchers can delve deeper into theories about green buildings and establish collaborations with related disciplines, such as architectural engineering and electrical engineering, especially in terms of energy efficiency. This will allow for the use of other aspects of the green building concept more comprehensively in future research.

In order for the principle of green building to be applied more optimally in hospitals in Palu City, the following strategies are recommended:

Revitalize Energy Infrastructure by prioritizing low-emission technologies and real-time energy monitoring systems.

Strengthening Human Resources Technical Training through cross-disciplinary collaboration, especially electrical engineering and architecture.

Annual Energy Audit and the establishment of an energy management team at each hospital facility.

Collaboration with the private sector and donor institutions to finance the installation of renewable energy systems.

Integration of Digital Technologies such as Building Management System (BMS) and automated sensors to improve the efficiency of hospital facility operations.

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