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Research Article

Investigating Electrical Operational in Green Building: A User and Expert Perspectives

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ARTICLE INFO	ABSTRACT

Green buildings are designed to reduce negative environmental impacts through energy efficiency, the use of eco-friendly energy and building materials, and the reduction of carbon emissions. To measure the extent to which these goals are achieved, objective and measurable evaluations are necessary. The aim of this study is to assess and compare the opinions of users and green building experts regarding the operational energy efficiency of cooling and lighting systems in the Politeknik Negeri Samarinda campus building in implementing energy savings. This research was a quantitative study using the Independent T-Sample Test. The results of the study conclude that there was no significant difference between the opinions of building users and green building experts regarding the building's performance related to the efficiency level of the cooling system in term of the operational energy use in the Politeknik Negeri Samarinda Campus Building. This means that the use of cooling and lighting systems has already followed the Indonesian National Standard (SNI).

Keywords: Green building, Energy operational, Energy efficiency, Investigation

Introduction

All standard In this modern era, sustainability and energy efficiency have become the main focus in building and managing structures. Green buildings which is designed to reduce environmental impact and also to enhance energy efficiency (Chen et al., 2024). This phenomenon is becoming increasingly popular worldwide. One important aspect of green buildings is the use of efficient and environmentally friendly electrical equipment (Allouhi et al., 2015). The efficiency of electrical equipment in buildings is a crucial factor in achieving sustainability and reducing energy consumption (Akram et al., 2022). With the increasing demand for environmentally friendly and energy-efficient buildings (Ali et al., 2019), it seems important to understand the perspectives of building users and green building experts regarding the efficiency of electrical equipment. This journal aims to compare the opinions of building users and green building experts on the effectiveness and efficiency of electrical equipment which is used in the Polytechnic State Campus Building in Samarinda, Indonesia.

By analyzing the perspectives of both building users and green building experts, this study aims to provide valuable insights into the challenges and opportunities in achieving energy efficiency in buildings. The opinions and experiences of building users can offer practical insights into daily usage and the performance of electrical equipment, while the expertise of green building professionals can provide a broader understanding of energy-efficient building design and operation based on technical and scientific standards (Syarifudin & Imran, 2024), (Hirzel, 2019).

This Several references which include academic articles, industry reports, and case studies, those sources have been cited to support the findings and conclusions of this journal. Comparing opinions on the efficiency of electrical equipment between building users and green building experts will contribute for existing

knowledge on sustainable building practices and also help identify areas for improvement in energy management (Wags Numoipiri Digitemie & Ifeanyi Onyedika Ekemezie, 2024), (Mastelic et al., 2018).
Overall, this study purposes to highlight the importance of considering various perspectives when assessing the operational energy efficiency of cooling systems in buildings, and how these insights can inform better practices for the design and operation of sustainable buildings (Schiller et al., 2022). By understanding these differences and similarities in perspectives, it is hoped that better solutions can be found to improve energy efficiency and user comfort in green buildings.

Literature Review

The Energy Efficiency Theory

In recent decades, global attention to energy efficiency has increased due to climate change issues and the scarcity of energy resources. The building sector, which accounts for about 40% of total global energy consumption (Nejat et al., 2015), it has become a major focus. Therefore, improving energy efficiency in buildings is an important step to reduce greenhouse gas emissions and achieve environmental sustainability (Jaradat et al., 2024). In addition, by cutting energy consumption and regulating related carbon emissions are the way to improve building performance (Fathi, 2024).

Energy efficiency in sustainable buildings involves the use of technologies and practices that reduces energy consumption without compromising the comfort and functionality of the building (Labaran et al., 2024). Common strategies include improving thermal insulation, using energy-efficient lighting systems, cooling systems, and appliances, as well as implementing building designs that maximize the use of natural light and ventilation. (Chen et al., 2024).

Additionally, stricter energy efficiency regulations and standards in various countries have driven innovation in building design and construction. Certification programs such as LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method) also play a significant role in promoting the adoption of sustainable building practices. (Kent et al., 2024)

Despite the many benefits, implementing energy efficiency in buildings still faces various challenges. These challenges include high initial costs, lack of awareness and knowledge among building owners and managers, and limitations of available technology. Therefore, further research is needed to address these challenges and develop more effective and affordable solutions. Additionally, increasing knowledge, awareness, and encouraging occupants to adopt energy efficiency practices can reduce energy demand and consumption, as well as mitigate negative environmental impacts. Awareness of building energy users and energy conservation provides a framework for future development plans that integrate energy efficiency elements in accordance with religious moderation, particularly Islamic teachings. (Muszaffarsham et al., 2022).

Environmental Efficiency Theory

Environmental efficiency in the use of electrical energy in buildings is a crucial aspect of sustainable development. Smart building design plays an important role in reducing energy consumption. For example, the use of passive design such as proper building orientation, efficient facade shapes, and good building material selection can significantly reduce the need for electrical energy like lighting and cooling.

Additionally, the implementation of energy-saving technologies is a strategic step in achieving energy efficiency. The use of more efficient LED lights and electronic devices with low energy consumption can help reduce overall electricity usage. These technologies not only save energy but also diminish the operational costs of buildings.

Environmental efficiency is a measure of how well a system or device minimizes its impact on the environment while achieving its goals. In the context of electrical energy operations in cooling systems, the theory of environmental efficiency states that devices and systems that can operate with minimal environmental impact, such as reduced energy consumption and emissions are considered more efficient. This theory is supported by the principles of sustainable development and environmental management which emphasizes the need to minimize resource consumption and environmental degradation. (Shove et al., 2020). According to Fatima, the drivers of by the environmental footprint (EFT) adoption include technological awareness, perceived environmental importance, perceived behavioural control, and perceived benefits (Fatima et al., 2022).

Building cooling systems have several significant environmental impacts. Firstly, the energy consumption of cooling systems is usually very high. In Indonesia, cooling systems can account for up to 40-70% of a building's total energy consumption. This high energy usage contributes to increased carbon emissions, especially if fossil fuels as energy sources.

Green Building Theory

The theory of green building encompasses various principles and concepts aimed at reducing the negative impact of buildings on the environment and improving resource efficiency. One of the main principles is energy efficiency. Green buildings are designed to reduce energy consumption through the use of energy-efficient technologies, passive design, and the utilization of renewable energy. (González-Torres et al., 2022). This not only reduces operational costs but also decreases carbon emissions. Additionally, the wise use of natural resources becomes a primary focus. This includes the use of environmentally friendly building materials,

recycling materials, and managing construction waste. Thus, green buildings contribute to waste reduction and the preservation of natural resources (Weisheng Lu et al., 2019).
Indoor air quality is also an important concern in green building theory. Ensuring good air quality inside buildings is achieved by using good ventilation, non-toxic materials, and indoor plants. This is important for the health and comfort of the occupants. Lighting systems play a crucial role in the concept of green buildings. In an effort to achieve energy efficiency, green buildings use energy-efficient lighting technologies, such as LED lights, which consume less electricity instead of conventional lights (Shamri et al., 2022). Additionally, green building designs often maximize the use of natural light to reduce the need for artificial lighting during the day. This is achieved by strategically placing windows, using skylights, and selecting materials that can reflect light. Good lighting not only enhances the comfort and productivity of occupants but also ensures that the lighting is efficient and comfortable for the eyes, supporting the health of the occupants. By reducing energy consumption through efficient lighting, green buildings also help detract greenhouse gas emissions. (Norasyiqin et al., 2021), (Tan et al., 2018).

The Economic Efficiency

Economic efficiency is a measure of the effectiveness of resource allocation in achieving the desired outcome at the lowest cost. In the context of electrical equipment, economic efficiency theory states that devices and systems that can provide the desired level of performance with the lowest operating cost are considered more efficient. This theory is supported by the concept of cost-benefit analysis which weighs the costs and benefits of different options to determine the most economically efficient choice (Saunders et al., 2021). Firstly, Jinlin found that the digital economy has significantly improved the efficiency of the green economy in the region. Secondly, the digital economy has a greater impact on the efficiency of the green economy in the eastern region and large cities than in the central and western regions and small cities. Thirdly, technological innovation is an important way for digital economy to improve the efficiency level of green economy (Jinlin Li, 2021).

towards a low-carbon energy landscape. Research by Jacobson et al. (2020) demonstrates the feasibility of achieving 100% renewable energy systems through a combination of wind, solar, and other renewable sources. Similarly, studies by Wu et al. (2017) and Zhang et al. (2019) highlight the potential of integrating solar photovoltaic (PV) systems with energy storage technologies, such as batteries and pumped hydro, to enhance grid stability and reliability.

Research Methodology

Research Design:

This research carried out a quantitative research design to collect and analyze numerical data related to individuals' opinions on the operational efficiency of electrical energy. Indicators of electrical equipment were explored and a questionnaire was designed to collect relevant data.

Respondents of the Study

The research respondents include campus building users consisting of teaching staff, administrative staff, technicians, students, and selected experts in the field of green building. A random sample of individuals from various demographics and backgrounds was selected to ensure diverse opinions. The sample size was determined to ensure statistical significance, making the research results reliable

Data Collection :

Data collection was conducted through a specially designed survey to gather opinions on the efficiency of electrical appliances. This survey included questions about perceptions of appliance efficiency, preferences for energy-efficient appliances, and factors influencing opinions on this topic.

Instrument of the Study:

Ethical the survey instrument was developed based on established scales and measures to assess opinions and preferences. questions was designed to convert qualitative data into quantitative data using the likert scale, making data analysis easier and more accurate.

Ethical Considerations:

The obtained data were analyzed by using statistical methods, including descriptive and inferential statistics. This analysis focuses on identifying patterns and differences in opinions based on demographic variables such as age, gender, education, and occupation. Additionally, this research compared the operational energy efficiency of cooling and lighting systems in buildings based on the opinions of building users and green building experts using the Independent T-Sample Test in SPSS Version 29.00.

Limitations:
The study acknowledged any limitations in the methodology, such as potential biases in the sample selection or survey instrument, and addressed how these limitations might impact the validity of the results.

Hypothesis Parameter:
The hypothesis in this study was tested by using the t-test. If the t-test > t-table, or t-test >= 1.960, it means there was a significant difference between the opinions of building users and green building experts. Therefore, Ho was accepted and Hi was rejected. Conversely, if the t-test < 1.960, it could be assumed that there was no significant difference between the opinions of building users and green building experts, thus Ho was rejected and Hi was accepted.

Results and Discussion

The questionnaire data was collected through out Google Forms by the researcher. Moreover, this study processed and analyzed utilizing the Independent T-Sample Test with SPSS version 29.00. The results of the analysis of the building's electrical energy operations for the average assessment related to the use of cooling and lighting systems between users and expert users are presented in the following description:

A. Independence T Test on Cooling System
For the output of the independence T test on the assessment of the use of the cooling system, it can be presented in Table 1 and Table 2 as follows:

Table 1: The average score of Users and Expert's opinions for cooling systems

Respondents	N	Mean	Std Deviation	Std Error Mean
Building Users	118	3.8407	.60964	.05612
Green Building Experts	60	3.7917	.40934	.05285

Source: Questionnaires, Author's calculation 2024

From Table 1 above, it can be seen that the average assessment of the operational aspects of electrical energy in the use of cooling systems in buildings between user assessments and green building expert assessments were different. Those evidences were evaluated based on scientific knowledge. In the analysis results, it was known that building user's assessments of the use of cooling systems were higher than the use of supporting equipment by experts, although the difference was not significant.

From the table above, it is evident that the average assessment of the operational aspects of electrical energy in the use of cooling systems by users was 3.841, while according to experts it was only 3.792. However, both facts could be said to indicate that the implementation of electrical energy operations in the use of cooling systems was good. This difference in values because of the fact that experts have knowledge about proper temperature and air regulation based on their knowledge and competence, while users only assess from the comfort they feel when using the building, feeling cool and experiencing good air circulation, providing thermal comfort as confirmed by research (Mokhtariyan Sorkhan et al., 2024), That was why respondents gave good ratings. On the other hand, experts use methods and formulations they master academically, so it was not quite surprising that expert assessments were lower compared to user assessments.

Table 2: The Independence T-Sample Test for cooling system

Description	F	Sig	t	df	One Sided P	Two Sided P
Equal variances assumed	8.696	<.004	.753	176	.288	.4901
Equal variances not assumed			.860	172.022	.263	.4901

Source: Questionnaires, Author's calculation 2024

From Table 2 above, it can be monitored that by testing the Two-Side p (two-tailed), there was a significance of 0.4901, which was greater than 0.05. This means that with a 95 percent confidence level, it has proven that there was no significant difference between the opinions of building users and green building experts. Based on the results of this T-Sample Test, it could be concluded that Ho was rejected and Hi was accepted, or there was no significant influence between the opinions of building users and green building experts.

In terms of the adequacy and availability of cooling system equipment and air circulation when needed, and adjusted to meet the needs of building users They felt comfortable and gave good ratings for the adequacy of the equipment. Meanwhile, experts also calculated using supporting formulas and theories, so there was no significant difference in assessments between the two groups of questionnaires.

B. Independence T Test (Difference Test) on Lighting System

For the output of the independence T test on the assessment of the lighting system usage, it can be presented in Table 3 and Table 4 as follows:

Table 3: The average score of Users and Expert's opinions for lighting systems

Respondents	N	Mean	Std Deviation	Std Error Mean
Building Users	118	3.9656	.52715	.04853
Green Building Experts	60	3.9170	.32214	.04159

Source: Questionnaires, Author's calculation 2024

From Table 3 above, it can be observed that the average assessment of the use of the building lighting system between user assessments and expert assessments were mathematically distinct. Where the building user's assessment of lighting was higher than the expert's assessment, even though the difference was not really significant. From the mentioned table, it was evident that the average lighting assessment by users was 3.966, while according to experts it was only 3.917. According to those numbers, the implementation of arrangement and lighting were expressed in good manner. This was sensible because of experts had knowledge about the rules of good use and lighting based on their competence, while users only assessed from the comfort in their activities when they use the building, or more from the convenience of using it. On the other hand, experts use methods and formulas that they master academically, so it was not surprising that the expert's assessment was lower than the user's assessment.

Table 4: The Independence T-Sample Test for lighting system

Description	F	Sig	t	df	One Sided P	Two Sided P
Equal variances assumed	8.794	<.003	.654	176	.257	.5140
Equal variances not assumed			.760	172.061	.224	.4480

Source: Questionnaires, Author's calculation 2024

From Table 4 above, it can be seen that with the Two-Side p test, there was a significance of 0.514, which was greater than 0.05. This means that with a 95 percent confidence level, there is no significant difference between the users' ratings and the expert's ratings. This was because the comfort level which was provided by the lighting arrangement that matches the building conditions makes users feel comfortable and give good ratings for the lighting. Meanwhile, the experts also calculated by using supporting formulas and theories. So, there was no significant difference in the ratings between the two groups of respondents. Based on the results of this T-Sample Test, it could bre be concluded that Ho was rejected and Hi was accepted, or there was no significant influence between the opinions of building users and green building experts regarding the lighting system assessment.

Based on the average assessment results of the operational aspects of electrical energy in the use of cooling and lighting systems in the buildings of the campus of Politeknik Negeri Samarinda, it could be summarized that they were relatively efficient, as suggested by (Allouhi et al., 2015), (Zakari et al., 2022), dan (Prafitasiwi et al., 2022) related to energy efficiency.

This also confirms the research (Shove et al., 2020) and (Fatima et al., 2022) related to environmental efficiency. Finally, this also supports the research related to green building system theory, and (Abdelaal, 2019), (Wei Lu et al., 2022) related to the theory of sustainable development of green buildings for universities.

The operational use of electrical energy at the Politeknik Negeri Samarinda has its own Standard Operating Procedures (SOP) that must be obeyed by all building users. Electrical equipment such as lights, air conditioners, computers, and other practical electrical equipment will be employed according to the necessity of the building users, including students. Practically, lights will be used from the evening when the room is in use, air conditioners will be used when the room is in use, and practical electrical equipment will be used according to the practice schedule. This is supported by the principles of sustainable development and environmental management, which emphasize the need to minimize resource consumption and environmental degradation. (Shove et al., 2020).

Based on this explanation, it could be deduced that the operational use of electrical energy at the Politeknik Negeri Samarinda is already efficient and in accordance with national green building standards in terms of cooling and lighting systems. This is confirmed by Wags Numoipiri, who stated that in the context of electrical equipment, the theory of technological efficiency asserts that devices and systems that can accomplish specified tasks with the least energy loss and material waste are considered more efficient. This theory is supported by the concept of technological innovation and advancement, which aims to improve the performance and efficiency of electrical equipment through the use of new materials, designs, and processes. Research (Wags Numoipiri Digitemie & Ifeanyi Onyedika Ekemezie, 2024) Regarding the concept of technological innovation and progress, as well as research. (Li et al., 2024) Regarding productive and economical practices, supporting these findings

Conclusion

This study pointed out the importance of communication and mutual understanding between users and experts to achieve optimal sustainability goals in green buildings. Based on the analysis, results, and discussion, it can be wrapped up that there was no significant difference between the opinions and perceptions of building users and green building experts regarding the efficiency and effectiveness of electrical energy operations in the use of cooling and lighting systems at the Politeknik Negeri Samarinda Campus Building. Additionally, it can be determined that all electrical energy operations for cooling and lighting systems were in accordance with the Indonesian National Standards (SNI) for green building implementation.

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