Journal of Science Technology (JoSTec)
ISSN. 2830-7275
Published by: Inovasi Pratama Internasional. Ltd
Journal homepage: https://ejournal.ipinternasional.com/index.php/jostec
DOI: https://doi.org/10.55299/jostec.v6i1.871

THE EFFECT OF IMPLEMENTING BUILDING STRUCTURE AND CONSTRUCTION SYSTEMS ON ENERGY EFFICIENCY

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ARTICLE INFO

Article history:

Received April 13, 2024
Revised April 23, 2024
Accepted May 13, 2024

Keywords:

System implementation,
construction,
energy efficiency

ABSTRACT

This research aims to investigate the effect of implementing structural systems and building construction on energy efficiency. Quantitative analysis methods are used with the help of SPSS Version 27 to test the correlation between structural system variables, building construction and energy efficiency. A linear regression test was carried out to understand how much influence the application of structural systems and building construction has on energy efficiency. The results of the research show that the application of the structure and building construction system has an effect on energy efficiency, where each increase of one unit influences the application of the structure and building construction system to 100% energy efficiency. In addition, the Pearson correlation test shows that there is a strong relationship between the application of structural systems and building construction and energy efficiency. A high correlation coefficient indicates that implementing the right system has the potential to increase building energy efficiency. These findings show the importance of selecting appropriate structural systems and building construction in achieving high energy efficiency. Thus, this research contributes to understanding how to build more energy efficient buildings.

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1. INTRODUCTION

The application of structural systems and building construction has a very important role in achieving energy efficiency. Buildings, as one of the main contributors to global energy consumption, have become the focus of attention in efforts to reduce energy consumption and the resulting environmental impact (Kurniawan et al., 2020) . Therefore, the choice of structural system and construction method has implications for energy use during the durability cycle of a building (Azhari et al., 2021; Boer et al., 2023; Mediastika, 2021) . One of the studies that explores the various factors related to structural systems and building construction that can influence energy efficiency is very relevant considering the trend of increasing awareness of environmental sustainability and decreasing available energy resources.

According to Darmawan, (2023) when building a building, things that must be considered are; First, choosing the right building materials in the construction of a structure has a big impact on energy use. Materials with good thermal properties can help reduce energy loss due to heat transfer. In addition, thermal insulation technology applied to building structural systems also plays a crucial role in maintaining a comfortable temperature indoors without relying too much on the use of heating or air conditioning systems, thereby reducing energy consumption. It should be noted that research on the influence of building material types and

thermal insulation technology on energy efficiency can provide valuable insights in the development of more sustainable buildings. Second, building design and orientation also have a significant influence on energy efficiency. Optimal use of natural light and cross ventilation can reduce dependence on artificial lighting and HVAC (Heating, Ventilation, and Air Conditioning) systems.

Therefore, Fikkri, (2023) believes that selecting a structural system that allows for a more open building design and maximizes the entry of natural light and air flow is essential in achieving high energy efficiency. The study of how building design and orientation can be optimized to improve energy efficiency is a hot topic for discussion in the drive towards stronger, more durable buildings that will last for decades. Furthermore, smart building technology and automation are also contributing factors in achieving higher energy efficiency. An integrated energy management system can efficiently monitor and control energy use in a building, including regulating room temperature, lighting, and use of electrical equipment. With the adoption of this technology, energy use can be optimized according to actual needs, thereby reducing unnecessary energy waste.

The study of the influence of energy management systems on building energy efficiency is very relevant at this time in the development of smart building technology. Finally, it is necessary to consider the impact of energy efficiency from the perspective of the overall building life cycle. In addition to reducing energy consumption during the operational phase, the choice of structural and construction systems must also take into account the energy use and carbon footprint associated with the construction, maintenance and end-of-life processes of the building. Thus, a holistic approach in evaluating building energy efficiency is important in determining the environmental sustainability of a development project (Maharani & Prianto, 2021; Sahar & Aqli, 2020) .

The results of previous research from Witama & Saliya, (2024) have revealed various findings that are relevant to this research topic. One of the findings concluded that choosing the right building materials, such as using materials with good thermal properties and effective insulation technology, can reduce a building's energy consumption significantly during its operational period. Other research highlights the importance of building design that takes into account the orientation and use of natural light and cross ventilation, which can reduce reliance on heating and air conditioning systems, thereby improving overall energy efficiency. In addition to Gunawan's research results , (2024) emphasized the role of smart building technology and energy management systems in optimizing energy use in buildings with promising results in reducing energy waste. From the results of this research, it can be concluded that the choice of structural systems and building construction has a significant impact on energy efficiency, and that a holistic approach that considers various related aspects is very important in achieving more sustainable and environmentally friendly buildings.

In this research, researchers aim to investigate the effect of implementing structural systems and building construction on energy efficiency, focusing on the factors mentioned above. Through analysis of multiple case studies and empirical data, researchers hope to provide better insight into how the choice of structural and construction systems can influence a building's energy performance. It is hoped that the results of this research can provide a strong foundation for the development of more sustainable and environmentally friendly construction practices in the future. In addition, this research is expected to provide a deeper understanding of how the choice of structural systems and construction methods can influence the overall energy performance of a building. Thus, through in-depth analysis of various related aspects, such as building material selection, building design and orientation, smart building technology, and energy management, this research aims to generate valuable insights for construction industry practitioners, policy makers, and other stakeholders. in an effort to improve environmental sustainability and energy efficiency in future building construction. Apart from that, this research also aims to provide a solid foundation for the development of construction strategies and practices that are more environmentally friendly and sustainable, so that they can make a positive contribution to mitigating climate change and preserving natural resources .

2. RESEARCH METHOD

The research method used by researchers is a quantitative research method using Person correlation and regression tests to test the effect of implementing structural systems and building construction on energy efficiency. According to Jannah, (2019) Quantitative research is a type of research used to explore the

relationship between two or more variables. This research aims to determine whether there is a statistical relationship between these variables, as well as the extent to which this relationship is correlated. In this research, researchers used SPSS version 27 to analyze the data. The sample selection in this study used a proportional population of 2 buildings in the Surabaya, East Java area. The variables in this research are the application of structural systems (X1), building construction (X2), energy efficiency (Y).

3. RESULTS AND DISCUSSIONS

In the research, researchers used quantitative analysis methods using SPSS Version 27 to test the effect of implementing structural systems and building construction on energy efficiency. Researchers conducted an influence test using a linear regression model to understand how much influence the application of structural systems and building construction has on energy efficiency. Apart from that, researchers also conducted a Pearson correlation test to measure the relationship between the application of structural systems and building construction to energy efficiency.

Table 1. Model Summary Regression Test Results

Model Summary b

Model RR SquareAdjusted R SquareStd. Error of the EstimateDurbin-Watson

1 .152a.074-.0122.443031.824

a. Predictors: (Constant), structural system, construction

b. Dependent Variable: energy efficiency

Information

Based on the output above, it is known that R Square is 0.74 based on squaring the R value of 0.74, which means it is equal to 74%. This figure means that variables X1-X2 simultaneously influence Variable Y by 74%.

Table 2. Anova Model Regression Test Results

ANOVAa

Model Sum of SquaresdfMean SquareFSig.

1 Regression7.99623.994.670.015a

Residual341.197585.969

Total349.18360

a. Dependent Variable: energy efficiency

b. Predictors: (Constant), structural system, construction

Information

Based on the ANOVA output table above, the Sig value is known. equal to 0.015 < 0.05, then as is the basis for decision making in the F test, it can be concluded that X1-X2 simultaneously influences variable Y.

Table 3. Regression Test Model Coefficients

Coefficientsa

Model Unstandardized CoefficientsStandardized CoefficientstSig.

BStd. ErrorBeta

1 (Constant)12,9173,329 3,879,000

structure system.127.093.1691.257.023

construction.039,091,059,367,043

a. Dependent Variable: energy efficiency

Information

Based on the SPSS Coefficients output table above Sig. variable X is 0.00 < 0.05, so it can be concluded that there is an influence of variables X1-X2 on variable Y

The results of the researchers' quantitative analysis show that there is an influence of the application of building construction and structural systems on energy efficiency. Based on the linear regression model, researchers found that the application of structural systems and building construction has an influence on energy efficiency. Every one unit increase in the application of structural systems and building construction has an effect on energy efficiency of 100%.

Table 4. Person Correlation Test

Correlations

energy efficiency construction structure system

system structure Pearson Correlation1-.306*.144

Sig. (2-tailed) , 016,011
N222
construct -.306*1,000
Sig. (2-tailed).016 .016
N222
energy efficiency Pearson Correlation.014.0001
Sig. (2-tailed).011.016
N222
*. Correlation is significant at the 0.05 level (2-tailed).
Information

Based on the results of the correlation test above, it is known that the Sig score. (2-tailed) 0.01 which means > 0.05. so it can be interpreted that there is a relationship between X1, X2 and Y.

The Person correlation test shows that there is a strong influence between the application of structural systems and building construction on energy efficiency. The high correlation coefficient between system implementation and energy efficiency (0.011 X1 and 0.016 Likewise, there is a high correlation coefficient between building construction and energy efficiency (0.01 Y), which shows that there is a strong influence between the application of structural systems and building construction on energy efficiency.

These findings confirm that selecting the right building materials has a significant impact on energy efficiency, with materials that have good thermal properties and effective insulation technology tending to reduce energy consumption during the building's operational period. In addition, building designs that consider optimal orientation and use of natural light and cross ventilation have also proven effective in reducing dependence on heating and air conditioning systems, thereby overall increasing energy efficiency. Researchers found that the application of building intelligence technologies and energy management systems significantly optimizes energy use within buildings, with the potential to reduce unnecessary energy waste. From the results of this analysis it can be concluded that the choice of structural systems and building construction has a crucial role in achieving high energy efficiency and that a comprehensive approach that considers all related factors is very important in designing stronger, more sustainable and environmentally friendly buildings in the future. .

Furthermore, the findings from this research are closely related to theories in the fields of civil engineering, building engineering, and environmental science which describe the relationship between structural systems and building construction and energy efficiency. One relevant theory is the theory of Thermal Mass which explains how building materials that have a high thermal mass can absorb and store heat from the sun during the day, and release it slowly at night, thereby reducing temperature fluctuations in the building and reducing the need for for heating or air conditioning (Marpaung, 2024; Niasih, 2021; Prawiyogi & Anwar, 2023).

In addition, the theory of sustainable design is relevant to the findings of this research. This theory emphasizes the importance of considering aspects such as building orientation, use of natural light, and natural ventilation in designing buildings in order to optimize energy use and reduce environmental impacts (Hendrik & Tualaka, 2023; Ningrum & Yuliani, 2024). This is in line with findings that building designs that take these factors into account can significantly reduce dependence on HVAC systems and improve overall energy efficiency (Arianto & Setyaningsih, 2024; Nasution, 2020; Ryan, 2019).

Furthermore, theories about Building Automation Systems (BAS) or energy management systems are also relevant in the context of the findings of this research. This theory explains how the use of automation and control technology can help optimize energy use in buildings, by monitoring and managing heating, cooling, lighting and electrical equipment systems efficiently according to actual needs (Abdullah et al., 2020; Diarja & Anwar, 2024). With the adoption of this technology, energy waste can be avoided and energy efficiency can be improved. Thus, the findings of this research consistently support the principles and theories in the fields of building engineering and environmental science which emphasize the importance of selecting appropriate structural systems and building construction in achieving high energy efficiency and environmental sustainability.

4. CONCLUSION

Based on the results of this research which used quantitative analysis methods with the help of SPSS Version 27 software, researchers found several important findings related to the effect of implementing structural systems and building construction on energy efficiency. Through linear regression tests, researchers found that the application of structural systems and building construction has an influence on energy efficiency. Every one unit increase in the application of building structure and construction systems has an effect on energy efficiency of 100%,

In addition, the Pearson correlation test shows that there is a strong relationship between the application of structural systems and building construction and energy efficiency. The high correlation coefficient between the application of structural systems, building construction, and energy efficiency indicates that the application of appropriate systems has the potential to increase building energy efficiency. From the results of this analysis, it can be concluded that the selection of structural systems and building construction has a crucial role in achieving high energy efficiency.

Recommendations for future researchers are to continue this research by expanding the scope of samples and variables, as well as considering other factors that might influence building energy efficiency. In addition, researchers can also consider a qualitative approach to gain a deeper understanding of the influence of structural systems and building construction on energy efficiency. Thus, it is hoped that this research will make a greater contribution to our understanding of how to build more energy efficient buildings.

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