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# STAKEHOLDERS' BARRIERS TO GREEN BUILDING PROJECT AT UNIVERSITAS GADJAH MADA INDONESIA

Rencya Pangarungan Rita[1], *Ashar Saputra[2] and Johan Syafri Mahathir Ahmad[3]

[1,2,3]Department of Civil and Environmental Engineering, Faculty of Engineering, Universitas Gadjah Mada, Indonesia

*Corresponding Author, Received: 09 Oct. 2022, Revised: 09 March 2023, Accepted: 02 April 2023

**ABSTRACT:** Green building is vital for reducing the environmental impact of building construction. However, owners and developers are hesitant to implement this building concept into their projects due to its numerous challenges. Therefore, this study aimed to identify the stakeholders' barriers to the green building project at Universitas Gadjah Mada (UGM) from 2018 to 2022. Data were collected from a questionnaire survey to assess stakeholders' perceptions using benchmarks from previous related studies. The collected data were analyzed using descriptive and inferential statistics in SPSS to identify the five most significant barriers. The findings included high costs for green products, materials, and technology (mean = 3.76), an additional cost of obtaining green certification (mean = 3.74), different occupants' perceptions of quality of life and consumption habits (mean = 3.69), a lack of green building technology training for project staff (mean = 3.60), and the cost of operating and maintaining green building is high (mean = 3.45). These results are evaluations for the authorities to optimize the development of green building in Indonesia.

*Keywords: Green building barriers, Green building certification, Green building evaluation, Stakeholders' perceptions.*

## 1. INTRODUCTION

The environmental impact of the building construction process has led to over 40% of the total carbon emissions and energy production, thereby influencing global warming and increasing the number of forest fires, droughts, and floods [1]. As the public's concern about the impact of carbon emissions continues to grow, much emphasis is being placed on implementing sustainable development in the construction industry [2]. However, this is realized through implementing an alternative method referred to as green building. Its practices conserve energy and resources while providing comfort and improving user health [3]. There is already a policy that governs green building development enacted through PUPR Ministerial Regulation No. 21 of 2021, as well as green building certification, namely Greenship and Edge, developed by the Green Building Council Indonesia (GBCI).

In Indonesia, there are Green-certified buildings consist of 26 existing buildings and 50 new buildings that are Greenship certified, as well as 70 Edge-certified buildings [4]. Meanwhile, in 2022, Universitas Gadjah Mada (UGM) in Yogyakarta constructed ten green buildings to achieve Greenship and Edge certification to develop the green campus concept movement. Undoubtedly, the development of green building in the context of educational institutions is relevant, considering that most of these facilities are only commercial buildings and most certified ones are located in Jakarta. Despite its benefits, the government has issued regulations to promote green building development, but certain barriers are encountered. For example, stakeholders in the country need to be more hesitant in incorporating the green building concept into their project development due to higher costs and a lack of sustainability knowledge [5,6]. The previous study on the limitations and barriers of the green building concept was only measured by the stakeholders' perspectives. These individuals are mainly Architectural Engineering and Construction (AEC) industry professionals [7,8]. However, the success of green building is dependent on the construction and operational process.

Previous studies generally discussed the green building concept financially, environmentally, socially, and technically [9]. These include the use of energy in building operations [10], indoor environmental quality [11], and the utilization of building materials [12]. In comparison, [5] the stakeholders' understanding of the theory, practical implementation of sustainability, and the ranking of green building in Indonesia were identified. This study identifies the barriers encountered by stakeholders during the construction and operation of green building at UGM.

## 2. RESEARCH SIGNIFICANCE

This study aimed to address the gaps in previous research by collecting the perceptions of stakeholders involved in the planning and operation stages of the UGM green building project. Previous research identified economic, social, technical, and policy aspects as potential barriers to the implementation of green building. The findings of this study can be used to evaluate the GBCI and provide owners and developers with valuable insight when considering the adoption of green building in Indonesia. Additionally, this study can be used to evaluate the development of green buildings in Indonesia and determine if the same barriers still exist.

## 3. LITERATURE REVIEW

Previous study in Malaysia [21] examines the behavior and practices of the green building industry by identifying barriers, drivers, and strategies to improve green building practices. This cross-sectional study analyzes numerical and quantitative data using descriptive analysis and statistics, including frequency percentages, means, and standard deviations. The finding shows that long-term economic benefits and government policies effectively motivate behavioral change and organizational commitment to green practices. And the barriers to green building in Malaysia are financial cost, technical knowledge and expertise, and demand from clients or investors.

Meanwhile, [35] examines barriers to adopting green building technology in China's rural housing development and examines the causal linkages. This study uses the method of grey-DEMATEL, with the result that there is limited demand for green building technology from rural residents, and the high cost of green building technology is the main obstacle to adopting green building technology in rural areas.

Recent research [36] conducted a systematic literature to identify various risks in green building projects including financial, material and equipment, design, technical, stakeholders, management, environmental, legal, and regulatory risk, by developed a hierarchical structural model. The findings of this research are linked to the shortage of funding and resources; unavailability and shortage of approved green materials and technologies; poor communication and information sharing between the project team members; inadequate professional knowledge and expertise in efficient green building methods, technologies, and eco-products; and inflation and changes in prices of green construction materials.

Following a thorough review of previous studies on the construction of green building in various countries, the present one identified 17 potential barriers that hinder the adoption of green building, as shown in Table 1. This study used the identified potential barriers as a benchmark for stakeholder perceptions of green building barriers.

Table 1 List of barriers encountered during the green building construction, identified from diverse literatures

| Code | Barriers | References |
|---|---|---|
| B1 | Less experienced designers, contractors, or suppliers of green building projects | [16–20] |
| B2 | Lack of knowledge and technical expertise about green building | [2,21,22] |
| B3 | Lack of understanding of green technology | [2,21–23] |
| B4 | Lack of awareness about green building and its benefits | [2,5,17,22,24,25] |
| B5 | Inadequate communication and cooperation among project stakeholders | [16,17,20,23] |
| B6 | Resistance to change from the use of traditional technologies | [2,20,26] |
| B7 | Lack of green building technology training for project staff | [2,22,26] |
| B8 | Stakeholders are excluded, or included too late, in the development process to implement sustainability measures | [2,22] |
| B9 | Lack of availability of green materials and equipment | [7,17,27] |
| B10 | Lack of interest from clients and market demands | [21,27] |
| B11 | High costs of green products, materials, and technologies | [3,7,17,21,23,24,28] |
| B12 | Additional costs to obtain green certification | [21,29] |
| B13 | Complicating green building project laws and regulations | [7,20,22,23,27] |
| B14 | Troublesome government approval procedures | [16,24,26] |
| B15 | Lack of pilot projects | [2,7,22,26] |
| B16 | High operating and maintenance costs for green building | [3,16,21] |
| B17 | Different occupants' perceptions of quality of life and consumption habits | [16,17,20,29] |

## 4. METHODOLOGY

### 4.1 Data Collection

In this present study, questionnaire surveys were used to obtain feedback from stakeholders involved in the UGM green building development to determine the barriers or limitations encountered during the construction and operation processes. Questionnaire surveys have been widely used in green building studies to solicit expert opinion [13]. As a result, this quantitative study focused on the situation as viewed by the respective stakeholders.

Nominal and ordinal scales were used to assess the respondents' agreement with the indicators provided in the Likert format comprising strongly disagree, disagree, neutral, agree, and strongly agree. The questionnaire was divided into two sections, the first for demographic information about the respondents, comprising work experience, role in the UGM green building project, involvement in green building training, and whether they were certified by professionals. The second is for the indicators of green building barriers. Meanwhile, before distributing the questionnaire, five pilot surveys were conducted by experts to ensure the validity of its design [14,15]. The respondents were selected using a purposive sampling technique to ensure that they met the required criteria in the stakeholder group [7].

The stakeholders were divided into five groups, namely owner, consultant, contractor, user, and maintenance operator. As a determinant of green building concept adoption, the owner comprises all the decision-makers involved in the construction of campus buildings, such as the Rector and the staff. As AEC industry professionals, consultants and contractors are responsible for realizing green building practices in accordance with the mandated requirements and criteria and applicable standards. Users are perceived as residents of the green building as well as policymakers with respect to the operational activities of the Dean of each faculty. Furthermore, the maintenance operator is responsible for sustaining green building technology while ensuring its absolute performance. The user and maintenance operator groups at UGM were found in eight faculties alongside a list of buildings, as shown in Table 2. The survey was conducted online and offline using Google Forms and questionnaires.

Table 2 List of green buildings at UGM

| No | Building's Name | Location (Faculty) |
|---|---|---|
| 1 | Smart and Green Learning Center (SGLC) | Engineering |
| 2 | Engineering Research Innovation Center (ERIC) | Engineering |
| 3 | Law Learning Center (LLC) | Law |
| 4 | Animal Science Learning Center (ASLC) | Animal Science |
| 5 | Integrated Forest Farming Learning Center (IFFLC) | Forestry |
| 6 | Agrotropical Learning Center (AGLC) | Agriculture |
| 7 | Dental Learning Center (DLC) | Dentistry |
| 8 | Advanced Pharmaceutical Science Learning Center (APSLC) | Pharmacy |
| 9 | Teaching Industry Leaning Center (TILC) | Vocational College |
| 10 | Field Research Center (FRC) | Vocational College |

### 4.2 The Technique of Data Analysis

Reliability analysis was performed to demonstrate the dependability of the constraint indicators provided on the questionnaire. Assuming the value of Cronbach's Alpha is greater than 0.70, it is acceptable [30]. The Kolmogorov-Smirnov test was used to determine whether the data distribution was parametric or nonparametric. Descriptive statistics were then used to analyze reliable data, such as percentage, mean, and standard deviation. The mean value was used to rank 17 green building barriers. When two or more barriers have the same mean value, the one with the lowest standard deviation (SD) tends to have the highest value. Kendall's W coefficient of concordance was calculated to ascertain whether the respondents from different groups agreed on the ranking barriers. Furthermore, Kendall's W Test null hypothesis states that "there is no agreement between the ratings made by the respondents". Kendall's W ranged from zero to one, indicating "disagree" and "completely agree", respectively.

According to [2], assuming Kendall's W value has low significance (significance level $\leq 0.001$), then the null hypothesis is rejected, and it was concluded that there is an agreement among the respondents. Furthermore, a follow-up analysis of the Kruskal-Wallis H test was conducted to determine the differences among groups responding to green building barriers. The Kruskal-Wallis test is a nonparametric approach to the one-way ANOVA test because it compares three or more sets of dependent variables measured at the ordinal level [31]. The final result is the barriers encountered while implementing the green building following the applicable certification in Indonesia and those encountered by stakeholders in green building projects at UGM. The SPSS software was used for all calculations and data analysis in this study.

## 5. RESULT AND DISCUSSION

### 5.1 Respondents Demographic Characteristics

The total number of respondents was 62 green building stakeholders at UGM. The respondents comprised 9 owners, 11 consultants, 10 contractors, 22 users, and 10 maintenance operators. Compared to the original target, virtually all respondents in each stakeholder group exceeded the targeted number, except that of the maintenance operator, also referred to as the UGM green building lower stakeholder group, as shown in Fig. 1.

Table 3 shows that the majority of the owners, consultants, and contractors have more than five years of experience. Most users and maintenance operators have less than five years of experience, while some have none because several buildings have been completed and scheduled to begin operations in 2022. Most respondents were directly involved in the construction (56%), while others (44%) played a relevant role when it was operational, as shown in Table 4.

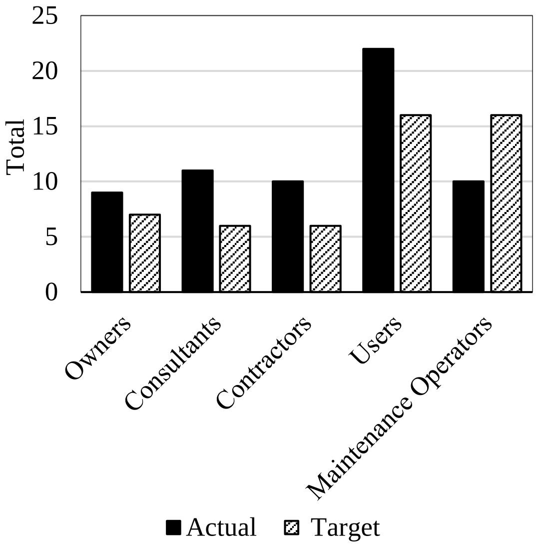


Fig. 1 Role of respondents in the UGM green building project (n = 62)

Table 3 Stakeholders work experience

| Stakeholders | Working Period (years) | | | | |
|---|---|---|---|---|---|
| | 0 | <5 | 5-9 | 10-15 | >15 |
| Owners | 0% | 44% | 33% | 22% | 0% |
| Consultants | 0% | 9% | 20% | 68% | 70% |
| Contractors | 0% | 20% | 20% | 40% | 20% |
| Users | 32% | 68% | 0% | 0% | 0% |
| Maintenance Operators | 30% | 70% | 0% | 0% | 0% |

Table 4 Stakeholders' involvement in green building construction projects

| Stakeholders | Been involved in the green building construction project | |
|---|---|---|
| | Yes | No |
| Owners | 89% | 11% |
| Consultants | 100% | 0% |
| Contractors | 100% | 0% |
| Users | 23% | 77% |
| Maintenance Operators | 10% | 90% |
| Total | 56% | 44% |

All respondents in the consultant and contractor groups were involved in the implementation of UGM green building construction. This involved 89%, 23%, and 10% of owners, users, and maintenance operators. Meanwhile, more than half of the respondents (55%) had attended green building training, as shown in Fig. 2. The majority of the stakeholders who had attended the green building training were owners (89%), followed by consultants (73%), contractors (70%), and maintenance operators (60%), while users had the lowest percentage (23%). Therefore, the development of the UGM green building was handled by trained planners and implementers. Most users who act as policymakers for UGM green building operations need to be properly trained.

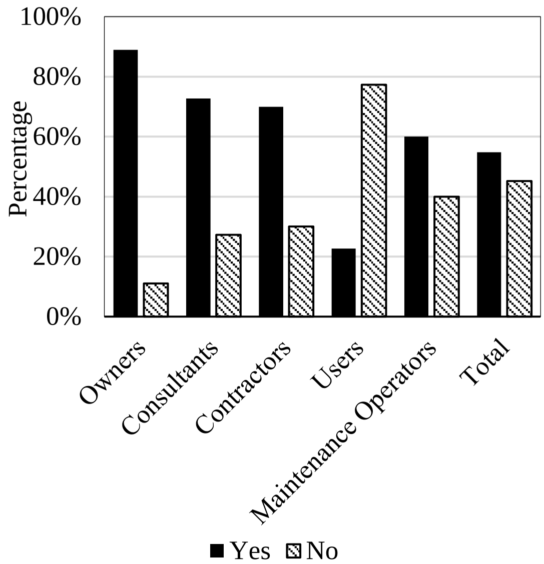


Fig. 2 Stakeholder's participation in green building training

It is expected that green building training will involve all relevant stakeholders in terms of maximizing the achievement of the set goals in the future. A total of 94% of the respondents were uncertified green building professionals, and only 6% were certified. In this green building project, UGM formed a green team to review the progress of their building certification, planning consultants, and contractors.

### 5.2 Barriers to Green Building

The Cronbach's Alpha value obtained from the reliability test was 0.891 ($\propto > 0.7$), therefore, the data were considered reliable. The data on all barrier indicators were distributed using the Kolmogorov-Smirnov test, and a significance value of $< 0.05$ was obtained, meaning it was nonparametric. The calculated mean showed that the respondents considered the high cost of green products and technology, including materials (mean= 3.76, rank 1), as the main barrier encountered during the implementation of green building, as shown in Table 5. The owners, consultants, and contractors involved in green building construction expressed serious concern about the high costs required to implement green building in accordance with Indonesian standards (Greenship). These results are consistent with several previous studies conducted in China [23,32-35]. It is undeniable that the cost of green materials in the market is quite high compared to conventional ones, even though one of their primary goals is to reduce energy and water consumption.

The second most significant barrier is the additional cost of obtaining green certification (mean= 3.74, rank 2). This is because to obtain

Greenship certification, one must pay a large nominal amount based on the area and function of the building, with a validity period of three years, and certain conditions can extend it without making any physical changes to the building. Green building certification stakeholders in the country need to assess this issue to consider the cost perceived as a burden to both owners and developers. However, compared to previous studies, this is not one of the significant barriers in their country [21,29,36]. This occurs when stakeholders' perspectives differ without considering the overall savings or cost of the green building life cycle [26].

The subsequent barriers encountered are the different occupants' perceptions of quality of life and consumption habits (mean= 3.69, rank 3). This finding aligns with previous research that differences in occupant behavior hinder the development of green buildings [37]. Even though occupants' behavior has an important influence on green building performance, specifically its sustainability [38]. Validated by previous research that with changes in occupant habits, optimizing green technology will reduce around 30-50% of total energy consumption in buildings [39]. Previous studies acknowledged comprehensive education programs as examples of green building training required to increase knowledge and awareness of green building practices [6]. The residents of several green buildings at UGM need to get used to the novelty of implementing sustainable behavior. Therefore, regular outreach is needed to educate building occupants to implement and get used to sustainable behavior. Differences in occupants' perceptions and consumption habits are one of the barriers usually considered by all stakeholders.

However, one of the major barriers encountered remained the lack of green building technology training for project staff (mean = 3.60, rank 4). This finding is supported by the low number of UGM users who have received green building training (Fig. 2). Research in Ghana [22] stated that the most significant barriers are the government-related ones, such as lack of green building technology training. One of the current needs for training is to share knowledge through short courses or trainings on green building technology during workshops. These are intended to benefit everyone, from the owner to the users and maintenance operators.

As well as high operating and maintenance costs (mean = 3.45, rank 5). These experts are required to maintain certain green building technologies, which are quite expensive [21]. The Kendall's W value and significance for ranking the 17 barriers were 0.081 and 0.000, respectively. Therefore, there is a fairly large level of agreement between all respondents in the stakeholders' group. The Kruskal-Wallis test results showed that the significance value of 17 indicators of green building barriers was greater than 0.05. This means that the owners, consultants, contractors, users, and maintenance operators' perceptions of green building barriers had no significant difference, as shown in Table 5.

Table 5 Barriers to the implementation of green building

| Code | All Respondents | | | Owner | | Consultants | | Contractors | | User | | MOP | | Kruskal-Wallis Sig. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Rank | Mean | Rank | Mean | Rank | Mean | Rank | Mean | Rank | Mean | Rank | |
| B11 | 3.76 | 1.051 | 1 | 4.44 | 2 | 4.18 | 1 | 3.40 | 2 | 3.55 | 6 | 3.50 | 5 | 0.092[a] |
| B12 | 3.74 | 1.055 | 2 | 4.56 | 1 | 4.09 | 2 | 3.00 | 10 | 3.68 | 2 | 3.50 | 6 | 0.015 |
| B17 | 3.69 | 0.861 | 3 | 4.22 | 3 | 3.64 | 3 | 3.40 | 3 | 3.68 | 1 | 3.60 | 2 | 0.310[a] |
| B7 | 3.60 | 0.839 | 4 | 3.67 | 12 | 3.55 | 7 | 3.40 | 1 | 3.59 | 4 | 3.80 | 1 | 0.649[a] |
| B16 | 3.45 | 1.051 | 5 | 3.67 | 11 | 3.64 | 5 | 2.80 | 14 | 3.68 | 3 | 3.20 | 12 | 0.266[a] |
| B5 | 3.44 | 0.842 | 6 | 4.00 | 4 | 3.27 | 13 | 3.10 | 7 | 3.36 | 8 | 3.60 | 3 | 0.155[a] |
| B2 | 3.37 | 0.834 | 7 | 3.89 | 5 | 3.64 | 6 | 3.20 | 4 | 3.23 | 11 | 3.10 | 14 | 0.110[a] |
| B15 | 3.37 | 1.059 | 8 | 2.89 | 17 | 3.36 | 10 | 3.20 | 5 | 3.59 | 5 | 3.50 | 4 | 0.527[a] |
| B4 | 3.35 | 1.073 | 9 | 3.89 | 7 | 3.45 | 8 | 3.00 | 8 | 3.18 | 13 | 3.50 | 7 | 0.250[a] |
| B3 | 3.32 | 0.901 | 10 | 3.67 | 13 | 3.64 | 4 | 3.20 | 6 | 3.27 | 10 | 2.90 | 16 | 0.154[a] |
| B8 | 3.27 | 0.772 | 11 | 3.56 | 14 | 3.27 | 14 | 2.90 | 11 | 3.32 | 9 | 3.30 | 9 | 0.358[a] |
| B14 | 3.26 | 0.904 | 12 | 3.56 | 15 | 2.91 | 16 | 2.90 | 12 | 3.41 | 7 | 3.40 | 8 | 0.281[a] |
| B6 | 3.23 | 0.895 | 13 | 3.89 | 6 | 3.27 | 12 | 3.00 | 9 | 3.05 | 14 | 3.20 | 13 | 0.214[a] |
| B13 | 3.18 | 0.967 | 14 | 3.67 | 10 | 3.09 | 15 | 2.90 | 13 | 3.18 | 12 | 3.10 | 15 | 0.569[a] |
| B10 | 3.11 | 0.943 | 15 | 3.78 | 8 | 3.36 | 11 | 2.50 | 17 | 2.91 | 15 | 3.30 | 10 | 0.033 |
| B1 | 3.11 | 0.977 | 16 | 3.78 | 9 | 3.45 | 9 | 2.70 | 15 | 2.82 | 17 | 3.20 | 11 | 0.037 |
| B9 | 2.87 | 0.932 | 17 | 3.33 | 16 | 2.91 | 17 | 2.60 | 16 | 2.86 | 16 | 2.70 | 17 | 0.492[a] |

*Note: [a]The results of the Kruskal-Wallis are not significant at the 0.05 significance level. SD = standard deviation. MOP = maintenance operator*

However, the groups had different perceptions of several statistically significant barriers (significance value < 0.05). These included additional costs to obtain green certification (sig. 0.015), lack of interest from clients and market demand (sig. 0.033), and need for experienced designers, contractors, or suppliers of green building projects (sig. 0.037).

There were different perceptions of the additional cost barrier in terms of obtaining green certification between the owner (mean= 4.56, rank 1) and contractor's groups (mean= 3.00, rank 10). This is because the owner was required to pay for their building's certification, which was considered burdensome due to its high nominal fee. Concerning the barriers of lack of client interest and market demand, the owner (mean= 3.78, rank 8), contractors (mean= 2.50, rank 17), and users (mean= 2.91, rank 15) had different perspectives. In this case, the clients, also known as the owners, considered several factors influencing their willingness or interest in adopting green building. For example, a fairly high cost was detected, as reported in this study. The designers, contractors, and suppliers lack experience and have distinct opinions about green building projects. The consultant (mean= 3.45, rank 8), contractor (mean= 2.70, rank 15), and users' groups (mean= 2.82, rank 17) had different opinions. The consultant ascertained the fulfillment of Greenship certification requirements. It was reported that they faced several barriers due to quite inexperienced in green building projects.

Based on the results of this study, the top five barriers encountered during the implementation of green building in Indonesia were mostly triggered by the stakeholders' experiences at the UGM's green building projects. Furthermore, these challenges contrast with those encountered in Malaysia and Singapore, as shown in Table 6. Previous studies compared the top five barriers using the same analytical method, namely the mean rank. Reviewing the work of [2], which focuses on a developing-country perspective, can provide policymakers and stakeholders in both developed and developing nations with useful insights.

Therefore, this study compared the perspectives of Indonesia, Malaysia, and Singapore. Table 6 shows the barriers encountered during the implementation of green building in developing and developed countries, with their respective criticality rankings. The indicators used to measure barriers that did not exist in the two countries analyzed are denoted with a "-" symbol. Table 6 also shows the corresponding rankings in these countries. It is worth noting that the higher cost of green products, materials, and technology is a major barrier in Indonesia and Malaysia [21]. However, in Singapore, a developed country, high costs are not the main impediment to green building implementation, rather, poor cost management is the most serious risk [20]. According to the findings, developing green building that are less expensive and have effective management tends to promote the adoption in the construction market, particularly in developing countries.

The additional cost barrier for obtaining green certification is not among the top five in Singapore, but is close to the top five in Malaysia. Similar to the earlier barriers, those relating to residents' perceptions of quality of life and consumption patterns that differ from one country to the other are not ranked among the top five in either of the other two countries, but is close to the top five in Singapore. Furthermore, it should be noted that in Malaysia and Singapore, the top five barriers do not include or not even close to including the two additional challenges faced by project staff, namely lack of training in green building technology and the high cost of operating and maintaining these facilities.

Table 6 Top barriers to green building implementation in Indonesia and certain countries

| Top five barriers of green building implementation In Indonesia | Indonesia (this study) | Malaysia [21] | Singapore [20] |
|---|---|---|---|
| High costs of green products, materials and green technologies | Rank 1 | Rank 4 | Rank 19 |
| Additional costs to obtain green certification | Rank 2 | Rank 6 | – |
| Different occupants' perceptions of quality of life and consumption habits | Rank 3 | – | Rank 6 |
| Lack of green building technology training for project staff | Rank 4 | – | Rank 10 |
| High operating and maintenance costs for green building | Rank 5 | Rank 7 | – |

## 6. CONCLUSION

This study found that the most significant impediment to green building adoption is the high cost of green products, materials, and technologies (mean=3.76), followed by the additional cost of getting green certification (mean=3.74). The third, fourth, and fifth most prominent barriers are different occupants' perspectives on quality of life and consumption habits (mean=3.69), the absence of green building technology training for project staff (mean=3.60), and the high operating and maintenance costs for green building (mean=3.45).

This research is restricted as only 6% of the respondents are certified green building professionals and not all users and maintenance operators are aware of Greenship certification. To gain a better understanding, further studies should be conducted in Indonesia by reaching out to a wider range of stakeholders from different cities and economies. Moreover, cross-cultural studies should be conducted to identify the green building practices that are most suitable for Indonesia and other similar nations, and to expedite the adoption of these practices.

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## 8. REFERENCE

[1] Yas Z. and Jaafer K., Factors influencing the spread of green building projects in the UAE, Journal of Building Engineering, Vol. 27, 2020, pp. 100894.

[2] Chan A. P. C., Darko A., Olanipekun A. O., and Ameyaw E. E., Critical barriers to green building technologies adoption in developing countries: The case of Ghana, Journal of Cleaner Production, Vol. 172, 2018, pp. 1067–1079.

[3] Zhao X., Hwang B. G., and Gao Y., A fuzzy synthetic evaluation approach for risk assessment: A case of Singapore's green projects, Journal of Cleaner Production, Vol. 115, 2016, pp. 203–213.

[4] PT. Sertifikasi Bangunan Hijau, Certified Building, Available Online at https://sertifikasibangunanhijau.com/sbh/project, Accessed on December 9, 2022.

[5] Berawi M. A., Miraj P., Windrayani R., and Berawi A. R. B., Stakeholders' perspectives on green building rating: A case study in Indonesia, Heliyon, Vol. 5, No. 3, 2019, pp. e01328.

[6] Wimala M., Akmalah E., and Sururi M. R., Breaking through the Barriers to Green Building Movement in Indonesia: Insights from Building Occupants, Energy Procedia, Vol. 100, 2016, pp. 469–474.

[7] Doan D. T., Wall H., Hoseini A. G., Ghaffarianhoseini A., and Naismith N., Green Building Practice in the New Zealand Construction Industry: Drivers and Limitations, International Journal of Technology, Vol. 12, No. 5, 2021, pp. 946–955.

[8] Nduka D. O., Stakeholders Perception of Factors Determining the Adoptability of Green Building Practices In Construction Projects In Nigeria, Journal of Environment and Earth Science, Vol. 5, No. 2, 2015, pp. 188–197.

[9] Shad R., Khorrami M., and Ghaemi M., Developing an Iranian green building assessment tool using decision making methods and geographical information system: Case study in Mashhad city, Renewable and Sustainable Energy Reviews, Vol. 67., 2017, pp. 324–340.

[10] Gan V. J. L., Lo I. M. C., Ma J., Tse K. T., Cheng J. C. P., and Chan C. M., Simulation optimisation towards energy efficient green buildings: Current status and future trends, Journal of Cleaner Production, Vol. 254, 2020, pp. 120012.

[11] Altomonte S., Schiavon S., Kent M. G., and Brager G., Indoor environmental quality and occupant satisfaction in green-certified buildings, Building Research and Information, Vol. 47, No. 3, 2019, pp. 255–274.

[12] Tsai W. T. and Tsai C. H., Interactive analysis of green building materials promotion with relevance to energy consumption and greenhouse gas emissions from Taiwan's building sector, Energy & Buildings, Vol. 261, 2022, pp. 111959.

[13] Wong J. K. W., Chan J. K. S., and Wadu M. J., Facilitating effective green procurement in construction projects: An empirical study of the enablers, Journal of Cleaner Production, Vol. 135, 2016, pp. 859–871.

[14] Goh Y. M. and Chua S., Knowledge, attitude and practices for design for safety: A study on civil & structural engineers, Accident Analysis and Prevention, Vol. 93, 2016, pp. 260–266.

[15] Abdelaal F. and Guo B. H. W., Knowledge, attitude and practice of green building design and assessment: New Zealand case, Building and Environment, Vol. 201, 2021, pp. 107960.

[16] Guan L., Abbasi A., and Ryan M. J., Analyzing green building project risk interdependencies using Interpretive Structural Modeling, Journal of Cleaner Production, Vol. 256, 2020, pp. 120372.

[17] Nguyen H. T., Skitmore M., Gray M., Zhang X., and Olanipekun A. O., Will green building development take off? An exploratory study of barriers to green building in Vietnam, Resources, Conservation & Recycling, Vol. 127, 2017, pp. 8–20.

[18] Afshari H., Issa M. H., and Peng Q., Barriers to the Design, Construction, Operation and Maintenance of Green Building: A State-of-the-Art Review, in 4th Construction Specialty Conference, 2013.

[19] Gurgun A. P., Arditi D., and Vilar P. C., Impacts Of Construction Risks On Costs In LEED-Certified Projects, Journal of Green Building, Vol. 11, No. 4, 2016, pp. 163–181.

[20] Hwang B. gang, Shan M., and Supa'at N. N. B., Green commercial building projects in Singapore: Critical risk factors and mitigation

measures, Sustainable Cities and Society, Vol. 30, 2017, pp. 237–247.
[21] Mustaffa N. K., Isa C. M. M., and Ibrahim C. K. I. C., Top-down bottom-up strategic green building development framework: Case studies in Malaysia, Building and Environment, Vol. 203, 2021, pp. 108052.
[22] Darko A., Chan A. P. C., Yang Y., Shan M., He B. J., and Gou Z., Influences of barriers, drivers, and promotion strategies on green building technologies adoption in developing countries: The Ghanaian case, Journal of Cleaner Production, Vol. 200, 2018, pp. 687–703.
[23] Zhang X., Shen L., and Wu Y., Green strategy for gaining competitive advantage in housing development: A China study, Journal of Cleaner Production, Vol. 19, No. 2–3, 2011, pp. 157–167.
[24] Samari M., Godrati N., Esmaeilifar R., Olfat P., and Shafiei M. W. M., The investigation of the barriers in developing green building in Malaysia, Modern Applied Science, Vol. 7, No. 2, 2013, pp. 1–10.
[25] Liu G., Li X., Tan Y., and Zhang G., Building green retrofit in China: Policies, barriers and recommendations, Energy Policy, Vol. 139, 2020, pp. 111356.
[26] Ametepey O., Aigbavboa C., and Ansah K., Barriers to Successful Implementation of Sustainable Construction in the Ghanaian Construction Industry, Procedia Manufacturing, Vol. 3, 2015, pp. 1682–1689.
[27] Yang R. J. and Zou P. X. W., Stakeholder-associated risks and their interactions in complex green building projects: A social network model, Building and Environment, Vol. 73, 2014, pp. 208–222.
[28] Hwang B. G., Shan M., Phua H., and Chi S., An exploratory analysis of risks in green residential building construction projects: The case of Singapore, Sustainability (Switzerland), Vol. 9, No. 7, 2017, pp. 9–11.
[29] Tao X. and Xiang-Yuan S., Identification of Risk in Green Building Projects based on the Perspective of Sustainability, in IOP Conference Series: Materials Science and Engineering, Vol. 439, No. 3, 2018.
[30] Shaikh P. H., Nor N. B. M., Sahito A. A., Nallagownden P., Elamvazuthi I., and Shaikh M. S., Building energy for sustainable development in Malaysia: A review, Renewable and Sustainable Energy Reviews, Vol. 75., 2017, pp. 1392–1403.
[31] Elliott A. C. and Hynan L. S., A SAS® macro implementation of a multiple comparison post hoc test for a Kruskal-Wallis analysis, Computer Methods and Programs Biomedicine, Vol. 102, No. 1, 2011, pp. 75–80.
[32] Zhang X., Platten A., and Shen L., Green property development practice in China: Costs and barriers, Building and Environment, Vol. 46, No. 11, 2011, pp. 2153–2160.
[33] Shi Q., Zuo J., Huang R., Huang J., and Pullen S., Identifying the critical factors for green construction - An empirical study in China, Habitat International, Vol. 40, 2013, pp. 1–8.
[34] Chakravarthy P. R. Kalyana, Suganya R., Nivedhitha M., Parthiban A., and Sivaganesan S., Barriers and project management practices in green buildings, in Materials Today: Proceedings, Vol. 52, 2022, pp. 1131–1134.
[35] Gan X., Liu L., Wen T., and Webber R., Modelling interrelationships between barriers to adopting green building technologies in China's rural housing via grey-DEMATEL, Technol Soc, Vol. 70, 2022, pp. 102042.
[36] Wuni I. Y., Bao Z., Yevu S. K., and Tetteh M. O., Theorizing the path dependencies and hierarchical structure of the multidimensional risks in green building projects, Journal of Building Engineering, Vol. 68, 2023, pp. 106069.
[37] Hafez F. S., Sa'di B., Safa-Gamal M., Taufiq-Yap Y. H., Alrifaey M., Seyedmahmoudian M., Stojcevski A., Horan B., Mekhilef S., Energy Efficiency in Sustainable Buildings: A Systematic Review with Taxonomy, Challenges, Motivations, Methodological Aspects, Recommendations, and Pathways for Future Research, Energy Strategy Reviews, Vol. 45, 2023, pp. 101013.
[38] Mediastika C. and Lie K., Occupants' Perception on Green-rated Office Building in Surabaya, Indonesia, Procedia Engineering, Vol. 118, 2015, pp. 546–553.
[39] Limphitakphong N., Chaikatetham N., Khaimook T., and Chavalparit O., Performance of air conditioning system in educational building for energy conservation, International Journal of GEOMATE, Vol. 16, No. 56, 2019 pp. 177–182.