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The Success Factors of Green Construction Management Implementation on Building Projects

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Abstract. The importance of implementing green construction has been introduced and campaigned in Indonesia. However, in reality, implementing green construction in Indonesia is still not optimal and has not gone as desired due to several factors. Therefore, it is necessary to identify the factors that affect success in applying green construction. The purpose of this study is to analyze what factors affect the success of the implementation of green construction management. The analysis results of factors that affect the success of the implementation of green construction management are used to determine the dominant success factor in building projects in Malang City. Method data collection in this study is by distributing questionnaires filled out by experts in the Field of Construction Management, Academics, and PUPR Offices in Malang City. Furthermore, the data obtained will be processed using the Simple Additive Weighting method. The results showed that alternative machines and advanced equipment achieved the first rank with a total value of 0,256. The second rank is achieved by material alternatives and implementation methods in green construction with a total value of 0,231. Finally, the third rank is achieved by alternative awareness in green construction with a total value of 0,217. Therefore, the most prevalent factors in applying green construction management are the presence of sophisticated machinery and equipment, the use of materials and methods of implementation, as well as the awareness of contractors to implement green construction. Therefore, these three success factors can be considered when implementing green construction projects in Malang City.

Keywords : Energy, Green Construction Management, Success Factor, Simple Additive Weighting Method, Environment.

1. Introduction

Indonesia is one of the countries currently developing rapidly and experiencing the development process in the construction world, such as housing, industry, offices, commercial, property, etc [1]. The number of Indonesians who occupy a large number of people in the world is one of the causes of the increase in construction development at this time [2]. This opportunity is well utilized by developers and business people in the construction world. A construction project is related to efforts to build an infrastructure building that includes civil engineering and architecture work. Existence construction benefits workers and professionals in the construction. In addition, this sector also contributes significantly to economic development in Indonesia [3]. However, the construction of the construction sector also negatively impacts the environment, which can cause global warming and environmental degradation. Negative environmental impacts happen if green construction management is not implemented correctly. The



output of the development project is in the form of physical buildings and the remaining material waste, so it requires good tuning from the beginning to the end.

The special way minimizing the negative impact of a project is to apply the concept of green construction management [4]. Thus, the green construction is one of the efforts to create construction activities that pay attention to the environment and human health. Green construction aims to maintain environmental balance and utilize needs economically so that the next generation can continue enjoying environmental balance. Unfortunately, facts state that construction waste is quite large as construction progresses. A large amount of waste is caused due to the non-optimal application of green construction management; there is a development project.

The green construction application concept is still not optimally implemented in construction projects. For more than a decade, since it was introduced in Indonesia in 2007, the concept of green construction has not been successfully applied [5]. Based on a survey of 20 buildings using the Green Construction Assessment Model, the achievements of private contractors tend to be below 50% in terms of 142 assessment indicators [6].

An example of a building in Malang City, namely building E of the Faculty of Administrative Sciences, Universitas Brawijaya, has reached the criteria for applying for green building with a bronze rating. A bronze rating is the lowest value in the assessment according to the Green Building Council Indonesia (GBCI), which requires an evaluation of its management. Thus, the identification of the factor success of green construction in the implementation of construction in Indonesia must be carried out, especially in Malang City. Many factors can affect green construction management in project construction, both inhibiting factors, and the green building success factors. Therefore, this research objected to identify the success factors that influence the application of green construction management in building projects in Malang City.

2. Literature review

The research titled "Critical Success Factors of Green Building Retrofitting Ventures in Iraq" showed success factors in green construction using a survey questionnaire as a data collection method [5]. It used ANOVA and tested the coefficient of Kendall of the sample with the SPSS program for gaining success factors in green construction. The research titled "Critical Success Factors in Thailand's Green Building Industry" showed the theme of green construction using the SPSS Program [5]. Conversely, the "Evaluating the Success Factors for Green Building Projects in Nigeria's Built Environment" research presented the success factors in carrying out green construction using hypothesis tests [6]. Another research titled "Key Success Factors of Implementing Green Procurement in Public Construction Projects in Malaysia" presented the vital factors influencing green construction applications using building projects as object research [7]. In addition, the research titled "Critical Success Factors for Sustainable Building Construction-A Review" presented the success factors that affect the application of green construction by using the SAW method [8]. Also, the research titled "Determination of Construction Supervisor Performance with SAW (Simple Additive Weighting) Method" showed the variables of success factors in the application of green construction management by using performance variables for determining the performance of construction supervisors [9].

The previous research shows the lowest literacy regarding the success factors of green construction management in Indonesia, especially in Malang City. The most inadequate literacy regarding the success factors of green construction management is proven by using previous research studies from international journals, so research on the success factors of the application of green construction management in Indonesia, especially in Malang City, needs to be carried out. The Simple Additive Weighting (SAW) method will apply in this study. The Simple Additive Weighting (SAW) method is due to the method's ability to conduct a more precise assessment. The Simple Additive Weighting (SAW) method is appropriate for decision-making analysis by first setting a weight value for each attribute, then ranking the highest weight to choose the best alternative from a number of alternatives.

A construction project is a series of once-implemented and generally short-term activities. In a group of activities, an activity processes resources as a result of actions in the form of buildings. The processes

in the series of activities involve related parties directly or indirectly. Green Construction is a construction activity that considers the environmental impacts that arise from planning to processing the construction of the building as well as maintenance, renovation, and repair. In the process of building construction projects, it is necessary to have a standard green rating tool also to reduce and minimize negative impacts on the environment [10]. One way is to use the Green Construction Index (GCI), which will guide and provide specific information in the construction process to get to green construction. The concept of green construction is one of the popular concepts in the field of construction development to respond to global warming. Green construction protects natural resources, realizes energy efficiency, and minimizes environmental damage [11].

Based on several standards of green construction assessment factors, each has criteria and factors regarding design, implementation process, and operations. In addition, several existing factors are combined. There are several main factors in implementing green construction, namely the role of managers, environmental management, training, construction equipment, ecological impacts, the part of the government, pollution control, energy use, research, and development. Several main factors of the green construction implementation process are divided into two main aspects: managerial and operational [12].

The managerial aspect is an aspect that focuses more on the management process to influence environmental conditions during the construction process [13]. The managerial aspect consists of the role of the manager, the management of the environment, the role of the government, training, research, and development. The operational aspect is an aspect that focuses more on environmental conditions resulting from the construction implementation process [14]. The operational aspect includes construction equipment, ecological impact, pollution control, and energy consumption.

3. Materials and methods

This research identified a construction project in Malang City, East Java. It uses mixed methods (research methods that combine both of qualitative and quantitative). By using this method in a research activity, it is hoped that more comprehensive, valid, and objective data can be obtained. In addition, the research uses seven success factors variables for implementing green construction obtained from literature studies. The seven success factors for green construction are regulation, government, financial, technical, technology, education, culture and habits. Twenty-seven alternative factors for applying green construction management can be determined and obtained from literature studies. The Simple Additive Weighting (SAW) method is used to determine the ranking of dominant success factors. The SAW method's basic idea is to compute the weighted sum of the performance ratings on each alternative of all attributes [9]. The SAW method requires that the decision matrix be normalized to a scale that can be compared to all existing alternative ratings.

4. Results and discussion

Based on the data obtained from the distribution of questionnaires with respondents of Construction Management Experts, Academics, and public works offices in the field of Cipta Karya Kota Malang, then converted into weighted summation from the selection results using the Simple Additive Weighting (SAW) method. Data on the list of alternative success factors for implementing green construction management is the average value of the assessment results of filling out the questionnaire obtained from respondents. Table 1 presents the average alternative value of respondents.

Table 1. The Average Alternative Value of Respondents

No.	Success Factors for The Green Construction Management Implementation	Valuation
1.	Regulations (C1)	
	1. Detailed regulations regarding the green construction implementation in Indonesia (A1)	66
	2. A guideline that is comprehensive in implementing green construction (A2)	64
2.	Government (C2)	
	1. Support from the government in implementing green construction (A3)	56
	2. Regional arrangement in support of green construction (A4)	72
	3. Socialization from the government regarding saving energy sources that support construction (A5)	61
	4. Priorities created by outside pressures to which the government must respond (A6)	44
	5. Procedural of an institution or organization (A7)	41
3.	Financial (C3)	
	1. Financing and maintenance of green construction felt by the project owner (A8)	75
	2. Risk of financial failure felt by the project owner (A9)	72
4.	Technical (C4)	
	1. The existence to obtain a certificate that can ensure that the material used is environmentally friendly (A10)	64
	2. Contactor competence (A11)	69
	3. Supervisory consultant competence (A12)	71
	4. Planning consultant competence of (A13)	73
	5. Contract conditions (A14)	89
	6. Utilization of existing assessment and measurement tools such as GBCI (A15)	80
	7. Communication and cooperation between project participants (A16)	76
	8. Support from top management (A17)	68
	9. Initial involvement of stakeholders (A18)	68
5.	Technology (C5)	
	1. Alternative materials and implementation methods in applying green construction (A19)	76
	2. Advanced machinery and equipment (A20)	83
6.	Education (C6)	
	1. The existence of experts in the government regarding green construction (A21)	68
	2. Knowledge, experience, and contractors regarding green construction (A22)	76
	3. Consultant knowledge and expertise regarding green construction (A23)	76

No.	Success Factors for The Green Construction Management Implementation	Valuation
4.	Best practice dan lesson learned about green construction (A24)	74
7.	Culture and Habits (C7)	
	1. Caring attitude toward implementing green construction (A25)	78
	2. Awareness to implement green construction (A26)	81
	3. Necessary feelings about the application of green construction (A27)	74

Table 1 shows the weight of seven factors that impact the green construction management implementation. The preference weight of each criterion that has been averaged will be used to assess the green construction management application success factors. Figure 1 shows the average criteria for determining success factors for implementing green construction management.

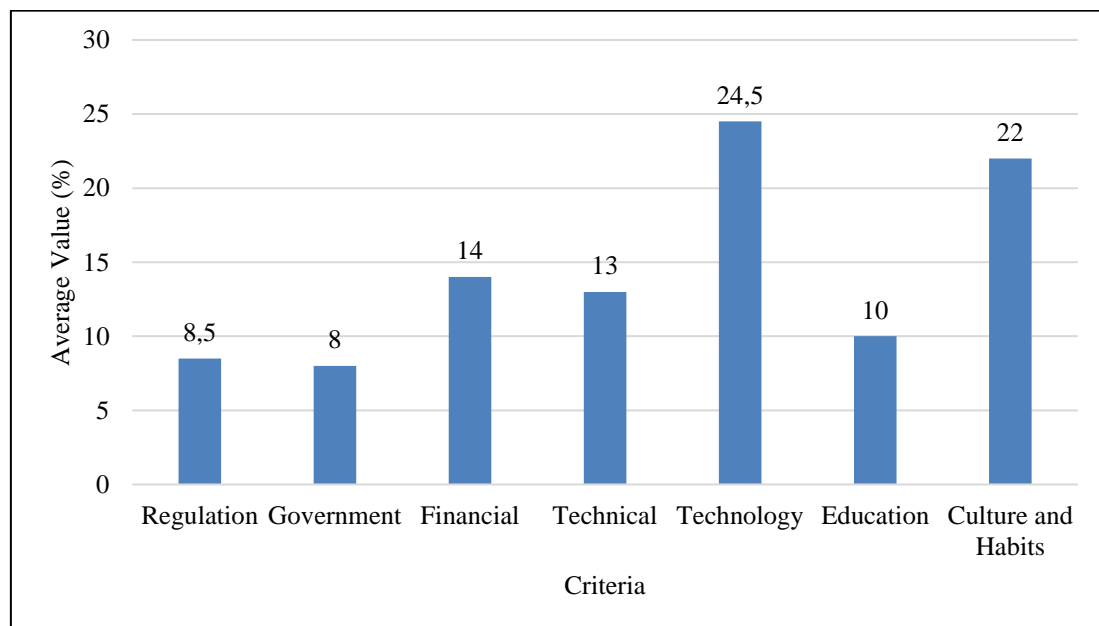


Figure 1. Average Criteria for Assessing Success Factors for The Implementation of Green Construction Management

Figure 1 presents the highest value of the seven factors: technology and cultural habits. After obtaining alternative values and weights of criteria that have been averaged, the data will be processed using the Simple Additive Weighting (SAW) method. Finally, each criterion of success factors for implementing green construction management will be calculated with preference values. Table 2 presents the final results of preference values for each alternative.

Table 2. Final Results of Preference Values

Criteria Rankings	Success Factors for The Green Construction Management Implementation	Preference Value	Alternative Rankings
1.	Technology (C5)		
	1. Advanced machinery and equipment (V20)	0,245	1
	2. Alternative materials and implementation methods in applying green construction (V19)	0,2243	2
2.	Culture and Habits (C7)		
	1. Awareness to implement green construction (V26)	0,22	1
	2. Caring attitude toward implementing green construction (V25)	0,2119	2
	3. Necessary feelings about the application of green construction (V27)	0,201	3
3.	Financial (C3)		
	1. Financing and maintenance of green construction felt by the project owner (V8)	0,14	1
	2. Risk of financial failure felt by the project owner (V9)	0,1169	2
4.	Technical (C4)		
	1. Contract conditions (V14)	0,13	1
	2. Utilization of existing assessment and measurement tools such as GBCI (V15)	0,1169	2
	3. Communication and cooperation between project participants (V16)	0,111	3
	4. Competence of planning consultants (V13)	0,1066	4
	5. Competence of supervisory consultants (V12)	0,1037	5
	6. Competence of contactors (V11)	0,1008	6
	7. Support from top management (V17)	0,0993	7
	8. Initial stakeholder engagement (V18)	0,0993	8
	9. The existence to obtain a certificate that can ensure that the material used is environmentally friendly (V10)	0,0935	9
5.	Education (C6)		
	1. Knowledge, experience, and contractors regarding green construction (V22)	0,1	1
	2. Consultant knowledge and expertise	0,1	2

Criteria Rankings	Success Factors for The Green Construction Management Implementation	Preference Value	Alternative Rankings
	regarding green construction (V23)		
	3. Best practice dan lesson learned about green construction (V24)	0,0974	3
	4. The existence of experts in the government regarding green construction (V21)	0,0895	4
6.	Regulations (C1)		
	1. Detailed regulations regarding the application of green construction in Indonesia (V1)	0,085	1
	2. A guideline that is comprehensive in implementing green construction (V2)	0,0824	2
7.	Government (C2)		
	1. Regional arrangement in support of green construction (V4)	0,08	1
	2. Socialization from the government regarding saving energy sources that support construction (V5)	0,0678	2
	3. Support from the government in implementing green construction (V3)	0,0622	3
	4. Priorities created by outside pressures to which the government must respond (V6)	0,0489	4
	5. Procedures of an institution or organization (V7)	0,0456	5

It produces fast and accurate calculations based on the results obtained from research in assessing the most dominant green construction management success factors using the Simple Additive Weighting (SAW) method [9]. Figure 2 shows a graph amount of values for each alternative.

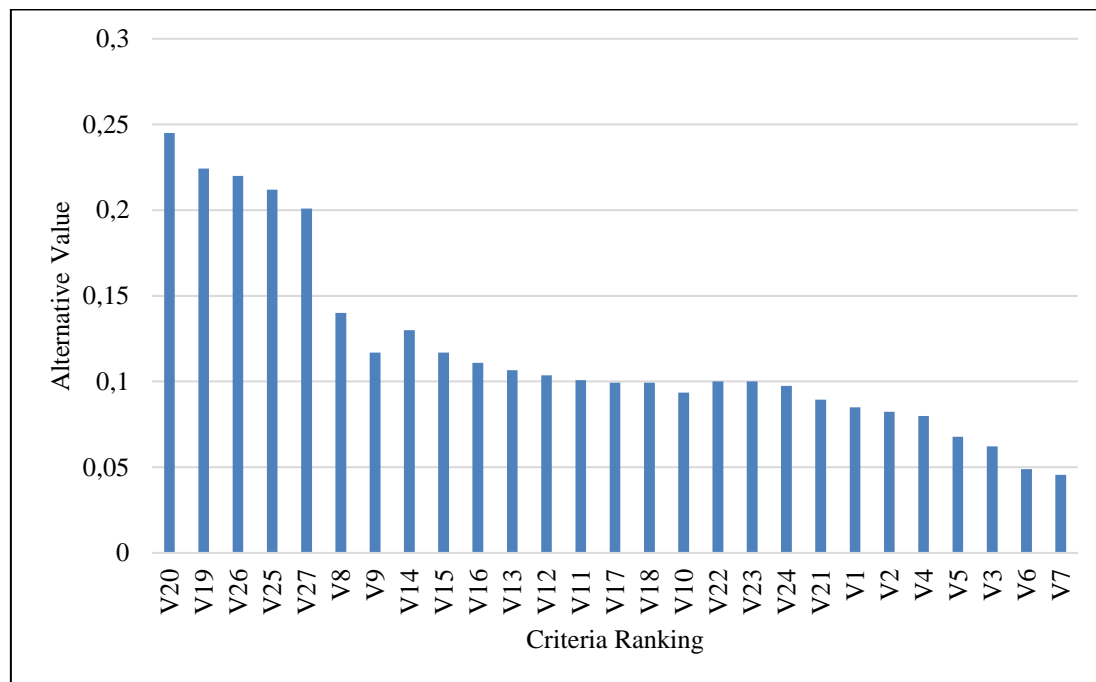


Figure 2. Average Alternative Value for Assessing Success Factors for The Implementation of Green Construction Management

The top three ranks for assessing the application of green construction management in building projects in Malang City using the Simple Additive Weighting (SAW) method are:

- Amount of value (V) = 0,245 explains that sophisticated machines and equipment are included in the criteria (Technology) that help successfully implement green construction. Owners' willingness to allocate a higher budget to green construction buildings than conventional buildings can greatly encourage project participants. It can happen if innovative technology is applied and advanced equipment; good performance and technological advances can help participants succeed in green construction [15].
- Amount of value (V) = 0,2243. Another factor that boosts green construction is alternative materials and implementation methods in applying green construction. The use of alternative fuels, recycling technology, the availability of environmentally friendly leveling in terms of noise levels, the implementation of prefabricated components, and the variety of renewable materials is an obstacles to green construction [12]. However, green construction can succeed if alternative materials and implementation methods can be met. Therefore, it is included in the criteria (Technology).
- Amount of value (V) = 0,22. The third rank that helps to increase green construction implementation is awareness of green construction. It is included in the criteria (Culture and habits). Strategies for implementing green construction are increasing knowledge about green construction and educating owners on the importance of green construction [16].

5. Conclusions

Based on research, the result for the assessment of green construction management implementation in Malang City building projects are:

- The highest score is the Technology criteria, with a value (V) of about 0,245. It explains that the use of sophisticated machines and equipment can help the implementation of green construction management. Owners' willingness can greatly encourage project participants to allocate a higher budget to green construction buildings than conventional buildings. It can happen if innovative technology is applied and advanced equipment; good performance and technological advances can help participants succeed in green construction.

- b. Optimizing factors from Technology criteria by increasing the use of alternative materials and implementation methods in applying green construction. The use of alternative fuels, recycling technology, the availability of environmentally friendly leveling in terms of noise levels, the implementation of prefabricated components, and the variety of renewable materials is an obstacles to green construction. However, increasing alternative materials and implementation methods can optimize green construction management implementation.
- c. Culture and habits are another criterion that optimizes green construction management implementation. Increasing green construction awareness as a strategy for green construction management implementation aims to gain knowledge about green construction and educate owners on its importance.

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