The Analysis of Barriers for Implementation of Sustainable Construction in Indonesia

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Abstract. The sustainable development requires the provision of adequate infrastructure, but the construction activities on infrastructure development itself still have been considered as a sector that has a negative impact to the environment. The implementation of the sustainable construction becomes a necessity, but the implementation of the sustainable construction in developing countries is still very limited, since there are still many factors that inhibit the implementation of this concept. This study aims to analyse the barriers in the implementation of sustainable construction in the infrastructure development projects in Palembang, Indonesia. The barriers are identified based on the results of literature studies. The survey using a questionnaire was conducted to state-owned and private companies that were carrying out infrastructure development projects in Palembang and its surrounding areas. The survey confirms the various barriers that may occur based on the perceptions of respondents representing state-owned and private companies. The mean item score was used to determine the ranking of each barrier. This study indicate that the following factors are the main barriers to the implementation of sustainable construction, namely factors related to the limited number of trained and/or certified workers and lack of communication between parties involved in the project.

Keywords: barriers, infrastructure development, sustainable construction

1. Introduction

Sustainable development has become a major issue in global development today. One effort to achieve sustainable development is through the provision of physical infrastructure facilities for society. The construction industry plays a significant role in the development of physical infrastructure [1]. The infrastructure development is believed to be able to provide benefits to the social and economic aspects of the community. Nevertheless, many infrastructure construction activities are claimed to have the potential to cause negative impacts on the environment [2]. Global data shows that the construction industry uses the most natural resources. As an illustration, world construction activities consume an average of 40% of energy, 25% of wood, and 16% of water from the total available resources on earth [3]. In terms of pollution, construction activities contribute to produce 35% of CO2 gas emissions for the planet [4]. Efforts are needed to overcome the negative impacts caused by construction activities. One concrete effort to overcome the negative impact of construction activities is through the application of the concept of sustainable construction.

Sustainable construction is a concept that aims to balance ecological, social, and economic aspects in construction activities [5]. The application of this concept ultimately aims to improve the quality of life of the people [6], so that it becomes the main goal to be achieved by the construction industry in the future [7]. Until now, the implementation of the concept of sustainable construction is still limited, especially in developing countries [2]. Another problem is that many countries have failed to implement the concept of sustainable construction due to various barriers. Various factors related to operations, financial capability, quality and quantity of human resources, experience, technology,

regulations, and many other factors are thought to be the barriers in implementing the concept of sustainable construction in general [7].

Palembang is one of the big cities in Indonesia which is actively conducting infrastructure development. Various strategic infrastructure projects are being developed to improve the local, regional and even national economy. The identification and analysis of the barriers toward the implementation of sustainable construction can provide an accurate picture of the factors inhibiting the implementation of this concept in Indonesia. This study aims to analyze the barriers in the implementation of sustainable construction in Indonesia based on the perceptions of representatives of state-owned and private companies that involved in infrastructure construction projects.

2. Sustainable Construction

Sustainable construction is a construction process that aims to balance the ecological, social, and economic aspects [5]. Many studies equate the concept of sustainable construction with the concept of green construction, but there are fundamental differences between the two [8]. Green construction is a terminology that only focuses on environmental aspects, while sustainable construction covers environmental, social and economic aspects simultaneously, as shown in Figure 1.

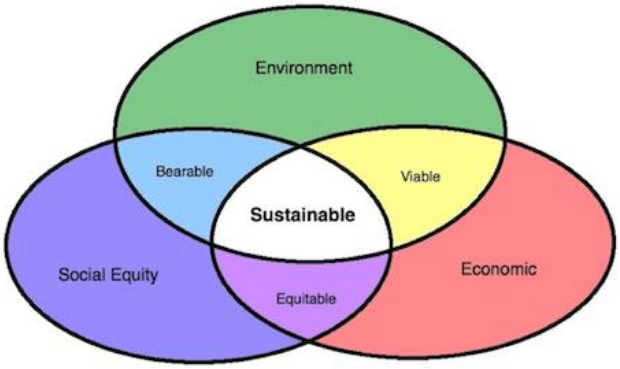

Figure 1. Three issues of sustainable construction concept, adopted from [9]

The study conducted by Ref [9] showed that the construction industry in developing countries generally faced difficulties to adapt and apply the concept of sustainability. Several ASEAN countries have started to implement the concept of sustainable construction in various construction projects. Some agenda in the form of training, seminars, and discussions related to the environment in the construction sector has done frequently [10]. The same thing has been implemented in Indonesia, as shown in Ref [11]. In general, it can be concluded that the implementation of sustainability concept in the construction sector only touches environmental aspects, yet it does not touch the social and economic aspects. Applying this concept is increasingly difficult in developing countries due to various inhibiting factors, such as economic, social, and technical [12].

The previous studies revealed that there were various barriers in the implementation of sustainable construction, as shown in Table 1. There are 16 factors that have the potential to inhibit the implementation of sustainable construction. These factors are grouped into economic/financial, regulatory, management, technical, and understanding aspects regarding the concept of sustainable construction itself.

Table 1. Identification of barriers for the implementation of sustainable construction

No.	Barriers	Ref [7]	Ref [13]	Ref [1]	Ref [6]	Ref [10]
X1	**Economic/Financial Aspect**					
X11	Potential increase in total project costs	√	√	√	√	√
X12	Potential increase in the project duration	√	-	√	-	-
X13	Limited capacity of the country's economy	√	-	√	-	√
X2	**Regulation Aspect**					
X21	Limited regulations and/or standards that encourage the application of the concept of sustainable construction	√	√	√	√	√
X22	The low implementation of regulations that encourage skills/expertise training to support sustainable construction	√	-	√	-	√
X3	**Management Aspect**					
X31	Lack of preparation and preparedness of the company in facing the demands of the implementation of sustainable construction	√	-	-	√	√
X32	Lack of communication between parties involved in the project	√	-	√	-	-
X4	**Technical Aspect**					
X41	The limited number and types of equipment and materials that meet the criteria of sustainable construction	√	√	√	-	√
X42	The limited amount of trained/certified workers	-	√	√	-	√
X43	Limited guidelines/modules regarding the concept of sustainable construction.	√	-	√	-	√
X44	Limited rating tools or benchmarks to assess the level of sustainability	√	√	√	-	√
X5	**Social-Culture Aspect**					
X51	The conventional construction method is preferable compared to sustainable construction method	√	√	√	√	√
X52	Limited demand for projects that use the concept of sustainable construction	√	√	-	-	√
X6	**Understanding aspect**					
X61	Limited knowledge regarding	-	√	√	√	√

	the advantage of sustainable construction					
X62	A perception that sustainable construction is a similar concept to the green construction	-	-	√	√	√
X63	The implementation of sustainable construction concept is more risky than conventional concept.	-	-	√	√	√

3. Methodology

This study identifies barriers to the implementation of sustainable construction from various previous studies. Based on the factors that have been identified, a questionnaire is then prepared to confirm whether these factors are also contributed as barriers to the implementation of sustainable construction in Palembang. Validity and reliability tests were performed on each factor included in the questionnaire. This questionnaire is also intended to obtain respondents' perceptions on how much they agree with each inhibiting factor. The assessment of respondents' perception uses Likert scale with a range of perceptions such as strongly disagree, disagree, agree, and strongly agree. The data was collected at a contractor company in Palembang City that was carrying out infrastructure construction projects and was recorded in the Directory of Construction Companies in South Sumatra Province.

Non-probability sampling technique was used in this study because of the limited number of contractor companies implementing the infrastructure construction projects in Palembang and its surrounding areas. As many as 35 respondents came from state-owned and private company contractors with the company classification of medium to large. Respondents' positions include project managers, site managers, site engineers, and field supervisors. Mean item score is used to determine the average value of respondents' perceptions of each inhibiting factor. Based on the mean item score of each inhibiting factor, ranking is then performed to obtain the main barrier to the implementation of sustainable construction.

4. Results and Discussion

This study employed a questionnaire as a data collection instrument. The questionnaire contained 16 questions related to the barriers for the implementation of sustainable construction. The validity and reliability of the questionnaire were tested before the questionnaire was distributed to respondents. The validity test is conducted using product moment correlation. Each question is valid if the product moment correlation shows that r arithmetic greater than r table. System analysis is used in testing the validity of each question, by correlating the score of each question with the total score. Having 35 respondents as sample for a significance level of 5%, a product moment correlation value of 0.334 was obtained. The result of the validity test of factors inhibiting the implementation of sustainable construction is shown in Table 2. This validity test showed that all questions used in the questionnaire were declared valid because the value of r arithmetic greater than r table, so that the questionnaire could be used to determine the barriers for implementation of sustainable construction.

Tabel 2. The result of validity test

Question item	$r_{calculate}$ Value	r_{table} Value	Description
Economic/Financial aspect			
X11	0,780	0,334	Valid
X12	0,859	0,334	Valid

X13	0,624	0,334	Valid
Regulation Aspect			
X21	0,851	0,334	Valid
X22	0,779	0,334	Valid
Management Aspect			
X31	0,793	0,334	Valid
X32	0,879	0,334	Valid
Technical Aspect			
X41	0,758	0,334	Valid
X42	0,656	0,334	Valid
X43	0,821	0,334	Valid
X44	0,694	0,334	Valid
Social-Culture Aspect			
X51	0,868	0,334	Valid
X52	0,848	0,334	Valid
Understanding Aspect			
X61	0,585	0,334	Valid
X62	0,589	0,334	Valid
X63	0,839	0,334	Valid

The Reliability tests were also carried out to ensure the consistency of the assessment. This reliability test used Cronbach Alpha [14]. In this study, the questionnaire was declared reliable if the Cronbach Alpha value for each question item was greater than 0.7. The reliability test results of the questionnaire are shown in Table 3. The reliability test shows that the Cronbach Alpha for each aspect has a value between 0.80 - 0.87 so that the questionnaire is declared reliable and it can be used to determine the barriers for implementation of sustainable construction.

Tabel 3. The result of reliability test

Criteria	Cronbach's Alpha value	Description
Barriers related to economic aspect (X_1)	0,83	Reliable
Barriers related to regulation aspect (X_2)	0,83	Reliable
Barriers related to management aspect (X_3)	0,83	Reliable
Barriers related to technical aspect (X_4)	0,80	Reliable
Barriers related to social-culture aspect (X_5)	0,85	Reliable
Barriers related to conscious aspect (X_6)	0,87	Reliable

Data collection resulted in 35 responses from 42 questionnaires distributed to contractor companies. A total of 7 questionnaires were not filled because the company was not willing to be a research respondent. Overall, the reasons of refusal were related to respondents' lack of understanding of the sustainable construction concept. The profile of respondents is shown in Table 4. Out of the 35 respondents, 62.86% came from private companies and the rest of the respondents came from state-owned companies. In terms of company grade, 51.43% came from medium grade companies and 48.57% of companies came from large grades.

In general, respondents had a sufficient understanding regarding the sustainable construction concept and also had adequate practical experience in the construction field. More than 82% were less than 40 years old and they had a tertiary level of education, thus the respondents are quite updated with the concept of sustainable construction. As many as 42% of respondents had at least work experience in construction projects for more than 5 years, even 22% more respondents had work

experience of more than 10 years. In this way, the respondents are considered to be quite knowledgeable related to the problems and potential barriers on the implementation of the sustainable construction concept. This is also supported by the roles and positions of respondents in the project.

Tabel 4. Profile of respondents

Category	Respondents	
	Number	%
Ages		
20 – 30 years	24	68,57
30 – 40 years	5	14,29
40 – 50 years	4	11,43
> 50 years	2	5,71
Latest Academic		
Highschool	6	17,14
Undergraduated	27	77,14
Post Graduate	2	5,71
Working experience in construction project		
< 5 years	20	57,14
5 – 10 years	7	20,00
> 10 years	8	22,86
Respondent's Profile		
Project Manager	2	5,71
Site Manager	3	8,57
Site Engineer	16	45,71
Others	14	40,00
Company's Status		
BUMN	13	37,14
Private	22	62,86
Company's Grade		
Grade-4 (Middle 1)	3	8,57
Grade-5 (Middle 2)	10	28,57
Grade-6 (Middle 3)	5	14,29
Grade-7 (Big1)	5	14,29
Grade-8 (Big 2)	12	34,29

The result of the survey related to the respondents' perception to the factors inhibiting the sustainable construction concept in Palembang is shown in Table 5. The respondents' perception related to the inhibiting factor is scored using likert scale ranging from 1 to 4. Scale 1 to 4 each shows a perception of strongly disagree, disagree, agree, and strongly agree to the statement that the factors reviewed are barriers for the implementation of sustainable construction.

Table 5. The respondents' perception regarding the barriers for sustainable construction implementation

Respondent	The Respondents' Score															
No	**X11**	**X12**	**X13**	**X21**	**X22**	**X31**	**X32**	**X41**	**X42**	**X43**	**X44**	**X51**	**X52**	**X61**	**X62**	**X63**
R1	4	4	3	3	4	3	4	4	4	4	3	4	4	4	3	3
R2	3	3	4	2	4	4	4	3	4	2	3	3	4	3	3	3
R3	2	2	2	3	2	2	4	2	3	2	3	3	4	1	3	1
R4	3	3	3	3	3	2	2	2	4	3	3	2	2	3	3	3
R5	4	3	2	3	3	4	4	4	4	3	2	2	2	3	2	2
R6	4	4	3	4	3	3	4	3	3	3	3	4	2	4	3	3
R7	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3	3
R8	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	2
R9	3	3	4	3	4	3	3	3	3	4	4	2	3	4	3	2
R10	3	3	3	2	3	3	2	3	4	2	2	4	2	3	3	2
R11	3	4	3	4	4	4	4	4	4	4	4	4	3	3	3	3
R12	1	1	1	1	2	1	1	1	1	1	1	1	1	3	3	1
R13	2	3	3	4	3	3	4	2	4	3	3	3	3	3	3	2
R14	3	4	3	4	4	4	4	4	4	4	4	4	3	3	4	3
R15	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
R16	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
R17	3	2	3	3	3	3	3	3	4	3	3	3	3	4	4	3
R18	3	3	4	4	4	3	4	4	3	3	3	3	3	3	3	2
R19	3	3	4	4	4	3	4	4	3	3	3	3	3	3	3	2
R20	2	2	4	3	3	3	3	2	3	3	3	3	3	3	3	2
R21	2	3	3	3	4	3	4	3	4	4	3	3	4	4	2	3
R22	2	3	3	2	3	3	3	3	4	3	3	4	4	3	4	3
R23	3	2	2	3	4	4	3	3	4	3	3	3	3	4	2	3
R24	1	2	3	3	3	4	2	3	3	3	3	3	3	3	2	2
R25	3	2	3	3	3	3	4	2	2	3	4	3	3	4	1	2
R26	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	3
R27	4	3	2	4	3	3	4	4	3	3	3	4	4	3	3	2
R28	3	3	3	3	4	3	4	3	3	4	3	3	3	3	3	2
R29	3	3	3	3	3	3	3	3	3	3	3	4	3	2	2	2
R30	3	3	3	3	3	3	2	3	3	3	3	3	2	3	3	3
R31	3	3	3	3	4	3	3	2	4	3	2	3	3	4	2	2
R32	2	2	3	3	4	3	4	2	3	4	4	2	3	3	3	2
R33	3	3	3	4	3	3	3	3	3	3	4	3	3	3	4	3
R34	3	3	2	3	3	3	4	3	4	3	3	2	3	3	3	3
R35	3	2	3	3	3	2	3	2	3	3	2	2	2	3	2	2

The data from barriers assessment in the above table are then analysed using the mean item score. Mean Item Score is employed to rank the barriers, thus the dominant factor that inhibits the implementation of sustainable construction based on the respondents' perception is found. The mean item score analysis is employed using the equation as follows:

$$MIS = \frac{1n_1 + 2n_2 + 3n_3 + 4n_4}{\Sigma N};$$

Where n_1 = The number of respondents who answered strongly disagree (score on a scale of 1)
n_2 = The number of respondents who answered disagree (score on a scale of 2)
n_3 = The number of respondents who answered agree (score on a scale of 3)
n_4 = The number of respondents who answered strongly agree (score on a scale of 4)
N = The total number of respondents

The result of the mean item score analysis and the ranking of inhibiting factors are shown in Figure 2. There are 9 factors that are generally assessed as barriers for the implementation of sustainable construction with a mean item score greater than 3. A total of 7 other factors are generally regarded as factors that do not become barriers to the implementation of sustainable construction, with a mean item score of less than 3. Factors related to the limited number and types of equipment and materials that meet the criteria of sustainable construction (X41), limited demand for projects that use the concept of sustainable construction (X52) and factors related to understanding aspects regarding the sustainable construction concept (X62 and X63) are not considered as barriers for the implementation of sustainable construction. Factors related to economic/financial aspects are also assessed as factors that does not become a barriers to the implementation of sustainable construction in infrastructure development projects. This can be understood as the financial and economic aspects are not a burden for the contractor, but rather a burden for the owner.

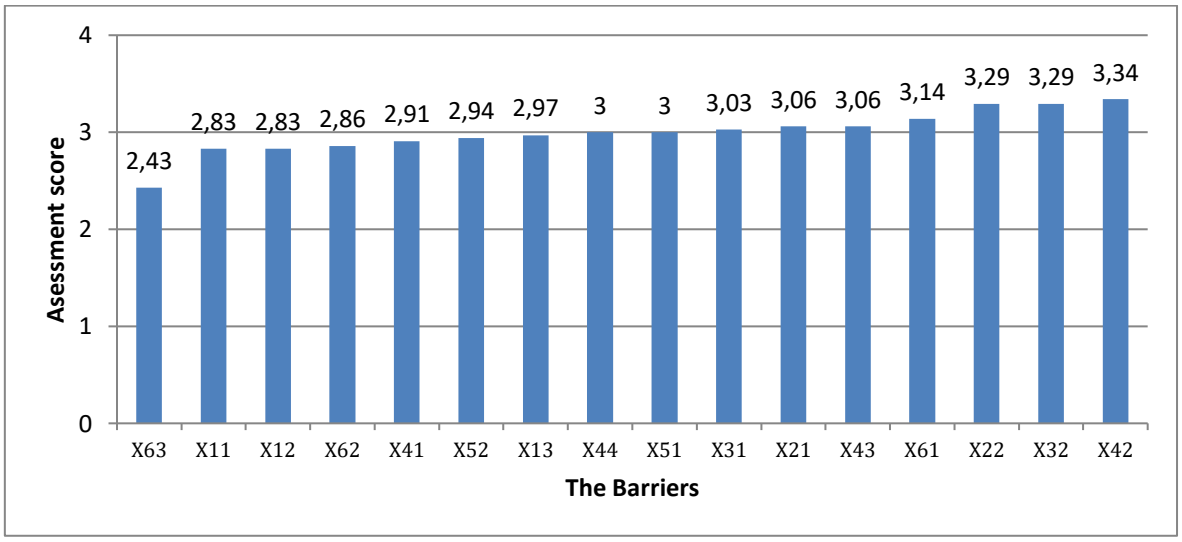

Figure 2 The Ranking of the Barriers for Sustainable Construction Implementation

There are 3 factors that are generally considered by respondents as barriers to the implementation of sustainable construction in Palembang. The factor with the highest mean item score is at X42, stating the limited number of trained or certified workers in construction project. Based on the understanding of the majority of respondents, the skills and expertise of workers at the company and project level will greatly influence the process and the final result of the work. Workers' skills and experience have an impact on decreasing defects, reworks, waste, duration of work, project costs, and work safety. This is consistent [14] and [15], and [16] the inhibiting factor named X42 is closely related to the low implementation of regulations that encourage training for workers, as mentioned in factor X22.

The limited number of workers who have the skills and expertise to support the implementation of sustainable construction in Indonesia is due to the uniqueness in the procurement of workers themselves. Some field workers in the construction sector are seasonal workers who come from the agricultural sector. In addition, there is a local government policy that requires contractor companies to involve field workers who come from residents around the project site. The limited number of

skilled workers is also due to the limited information obtained by workers about the concept of sustainable construction itself. This problem reflects the need to improve skills and expertise for all workers in the construction sector. Efforts that can be proposed to overcome these barrier are through training, workshops, seminars, and formal education to improve the skills and expertise of construction project workers regarding the concept of sustainable construction.

Another factor that has a high mean score as a barrier to the implementation of sustainable construction is related to the lack of communication between the parties involved in the project, as referred to factor X32. Based on respondents' perceptions, good communication and coordination between project team members is an important aspect to respond to the complexity of the work and answer the specific requirements for implementing sustainable construction in infrastructure projects. The various levels of understanding of the project team regarding the concept of sustainable construction also require good communication, so that ideas and practices of sustainability can be understood by all parties involved in the project. Ref [17] and [18] also show that good communication between all project teams can prevent problems related to sustainable construction implementation. Efforts to overcome these inhibiting factors are through the assignment of project managers who have the awareness and ability to convince all team members to jointly achieve sustainable construction.

5. Conclusion

This research has provided an overview of various factors that are considered as the barriers in implementing the sustainable construction for infrastructure development projects in Indonesia. The results of this study can illustrate the barriers in implementing the concept of sustainable construction in Indonesia, bearing in mind that this case study was conducted not only at medium and large grade contractor companies, but also at state-owned companies. Based on the perception of the contractor, as many as 7 factors are assessed as insignificant barriers for implementation of sustainable construction. These factors are dominantly related to financial and economic aspects. A total of 9 other factors are considered as high barriers in implementing the sustainable construction. The factors related to the limited skill and expertise of workers and the lack of communication between parties involved in the project have the highest value as a barrier to the implementation of sustainable construction in infrastructure development projects.

This research determines the barriers in implementing sustainable construction in various infrastructure projects. Given the unequal complexity of projects, further analysis is needed to determine the barriers in implementing the sustainable construction concepts that are specific to certain types of construction projects. Determination of barriers to the implementation of sustainable construction in this study was carried out only from the perspective of the contractor. It is also necessary to identify barriers from the perspective of the owner and project designer, so that a comprehensive picture of the barriers regarding the implementation of the concept of sustainable construction in infrastructure construction projects in Indonesia can be obtained.

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