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Dominant Factors in Value Engineering Aims for Improving Function and Cost Reduction in Jakarta Green Building Project

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Abstract

The concept of green building becomes the basis for efficiency resources and environmentally friendly. The concept is carried out through the planning, construction and building operation by minimizing waste and negative impacts on the environment. The application of this concept potencially for increasing costs. The risk of increasing costs especially in initial building cost needs to be eliminated by improving function with the Value Engineering (VE) method. The effectiveness for implementation of VE important to know about dominant factors about VE method through development stages. The reseach objective is to find out the relationship between variables VE aims (Y), VE stages (X1), Development stages (X2) and VE methods (X3). Research implementation by survey with quetioner to responden in Jakarta green building project. Data compiling from owner, consultant and contractor staff organization. Correlation result between variables calculated with mean value at 21 indicators. Calculation proceed by SPSS signify, strongly correlation variables Y and X1, Y and X3, X1 and X3. The result indicate all VE factors are important to be implementation. In development stages, VE implementation are important in the planning stage of cost estimation and operational efficiency.

Keywords Dominant Factors, Value Engineering, Green Building

1. Introduction

The understanding of the importance of environmental safety in the construction sector is increasing through the implementation of green construction. The construction sector needs to have an advantage through performance that is oriented on environmental factors to create cost efficiency and effectiveness, innovation and expertise and timely implementation of work. In the construction sector, with the increasing development of buildings and infrastructure in Indonesia, exploitation of natural resources that are used as a source of materials and the use of materials that are not environmentally friendly is one of the causes of global warming. According to Widjanarko (2009), the biggest user of natural resources is in the construction sector.

One effort to reduce global warming is by selecting and using the right materials, saving energy and environmentally friendly, which is expected to improve the quality of buildings not only in terms of the physical building but also its ecological use.

According to Budi Suanda (2011), environmentally friendly construction (green construction) is more intended as the process of building buildings, which takes into account environmental aspects of preservation. Whereas Ervianto (2013) states that green construction in developing countries consists of 3 (three) main pillars namely, environment, economy, and social. Until now there has been no standard definition of green construction, so some rating standards (rating) on environmentally friendly buildings have generally been accepted as parameters for achieving the conditions of green construction (Chong et all, 2009).

In Indonesia, there is a Greenship rating system developed by the Green Building Council Indonesia (GBCI), as one of the efforts to apply the principles of green construction so that a building that is energy efficient and environmentally friendly can be achieved starting from the planning, construction to operation and maintenance of buildings. On the other hand, the construction of construction projects is unique, complex, has a high risk so that many factors can result in increased costs. The bigger a project, the more complex the mechanism means more problems to be faced. If not handled properly, these problems can result in increased costs, quality deviations, waste of resources, and failure to achieve the desired goals and objectives.

Dominant factors that affect cost overrun are management group factors, project financial factors and their resource factors. One of the problems that arise in the implementation of building construction is an increase in cost or cost overrun of the total project cost ranging from 5% - 7% due to variation orders (Nurmala and Hardjomuljadi. 2015). While the results of research by Syafriani (2018) showed an increase in costs by 37.16% of the value of the initial contract, which was caused by rework.

Based on the background of the problem described above, the problems related to the title can be identified as follows. What kinds of dominant variables and indicators in the application of the value engineering in green building construction; How is the relationship between variables to achieve the main goal of VE namely increasing function and reducing costs. he bigger a project, the more complex the mechanism means more problems to be faced. If not handled properly, these problems can result in increased costs, quality deviations, waste of resources, and failure to achieve the desired goals and objectives.

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2. Material and Methods

This study appointed a methodology based on field sur- veys, principally brainstorming sessions and semi-structured interviews. In this study, identify variables and data collection techniques are an important factor for the success of the study. This is related to how to collect data, data sources, and data collection devices used. The type of data source is about where the data is obtained. Is the data obtained from direct sources (data quesionaire) or data obtained from indirect sources (project data).

Methods of data collection are carried out through project documents, etc. The following are compiled and classified in a particular arrangement. Evaluation methods, data analysis, are arranged as a description of the relationships between fuction factors that determine the construction cost. Based on the results of the analysis, interpretations and conclusions are prepared.

In carrying out scientific research, it is necessary to have a sequence following the frame of mind which is formed in a flow diagram based on the formulation of the problem and the objectives to be achieved. The flowchart can be seen in Figure 1.

While function analysis and cost reduction oriented as VE implementation and effort to obtain environmental friendly choice as Green approach. The researcher determined main variables there are:

Y = Value Engineering Aims
X1 = Value Engineering Stages
X2 = Development Stages
X3 = Value Engineering Methods

Concept model relationship is shown in Figure 1..and research flowchart in Figure 2.

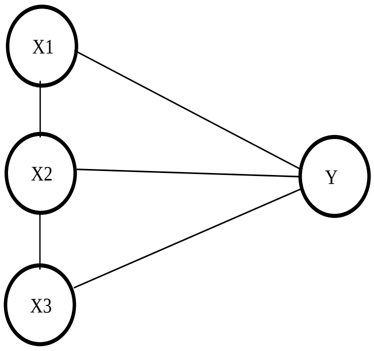

Figure 1. *Concept Model Relationship Between Variables*

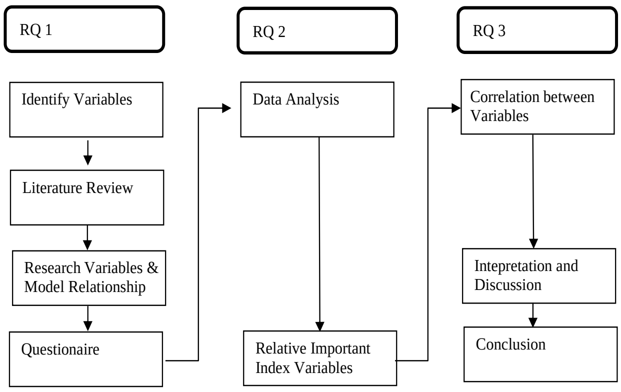

Figure 2. *Research Flowchart*

2.1 Green Building In Construction

The understanding of the importance of environmental safety in the construction sector is increasing through the implementation of green construction. The construction sector needs to have an advantage through performance that is oriented on environmental factors to create cost efficiency and effectiveness, innovation and expertise and timely implementation of work. In the construction sector, with the increasing development of buildings and infrastructure in Indonesia, exploitation of natural resources that are used as a source of materials and the use of materials that are not environmentally friendly is one of the causes of global warming. The biggest use of natural resources is in the construction sector. One effort to reduce global warming is to select and use appropriate, energy-efficient and environmentally friendly materials, which are expected to improve the quality of buildings from the physical aspects of buildings and their ecological use.

The application of the concept of green construction on the one hand has great opportunities in the conservation of natural resources, but on the other hand has the challenge of increasing the project investment costs. These additional costs can be caused by various factors such as changes in material types, changes in quality determination, and changes in work procedures. To anticipate these challenges a research effort is needed.

Implementation of green construction can be done by selecting environmentally friendly materials (Ezhilmathi, 2017; Jiaxu, 2017). Value engineering methods are used to achieve systematic cost reduction (Berawi, 2011 and 2013; Del Younker, 2003). And quality control can be done with lean six-sigma to achieve the specified cost and time performance. Value engineering and lean six-sigma have potential synergies to achieve cost and quality performance (Shekari, 2006; Mandelbaum, 2010).

Based on a survey, Indonesia and the city of Jakarta have not shown good environmental performance and quality of life. So it is necessary to improve environmental quality through the construction of environmentally sound infrastructure and facilities in the form of various types of buildings. Planning a building is generally calculated by paying attention to cost standards. Job cost analysis is a method of analysis to obtain the amount of cost of a particular job based on the calculation of the price of materials or materials, wages, overheads and profits.

Value engineering is an organized effort to analyze a problem that aims to achieve the desired functions that can increase the value of a project and obtain optimal results with the concept of management and management technology. Also, improving performance, quality, and life cycle costs. The VE process itself includes the process of structural planning, construction methods during project implementation, and material/material selection (Endah and Budi Susetyo, 2020). Lean Six Sigma that is carried out will create a system that minimizes waste or reduces the amount of waste that occurs and achieves the fastest improvements in customer satisfaction, cost, quality, process speed, and invested capital.

Environmentally-friendly construction is a movement from sustainable construction with development principles that create building construction starting from the stages of raw material utilization, planning, infrastructure, implementing and using environmentally friendly building construction material products, and waste management. Environmentally friendly materials are materials that can be recycled, healthy for the environment, and minimize pollution or waste.

2.2. Value Engineering For Green Building

Value Engineering (VE) is an organized effort directed at analyzing the function of goods and services for the purpose of achieving basic functions, the lowest overall cost and consistent with the achievement of essential characteristics. VE is a process that uses multidisciplinary teams to conduct project reviews and standards to identify functions and costs with potential for increased functionality and cost efficiency. The VE team will conduct a systematic and creative study to obtain optimal values and selected functions. It is necessary to develop an alternative, the most economical of the initial costs through evaluation of the cost cycle, taking into account consistency of requirements for safety, quality, operation, maintenance, and aesthetics (Younker, 2003).

There are several reasons why the VE concept is deemed necessary and important to be applied in a construction project, including:

- Limited Project Budget, the problem of budget constraints in the project becomes an element that can pose a risk to the continuity of the implementation of a construction project because cost is an important element for realizing a project. With the constraints of limited costs that are often found in projects, the VE concept can be an effective and efficient solution to be implemented so that it has the potential to reduce unnecessary costs (Save Potential).
- Increasing price of project resources, this means resources in the form of materials, equipment / machines, worker salaries (man power) and work methods, which in reality tend to increase from year to year. Seeing this problem, the application of the VE concept can be an option in solving these problems.
- Inflation and Interest Rates that continue to increase, this can also be an obstacle in implementing a construction project because the ever-increasing inflation rate has the potential to increase the budget for a project from year to year for both private and government projects, which of course is also directly proportional to the increase in the value of interest rates.
- Advancing Technology, with the development of technological advances both from the aspects of material technology, work methods, machines, equipment etc., this can be a source of opportunities for innovation and creativity for the VE team in realizing the application of a VE concept in construction projects.

The stages in VE analysis include:

a. Information Stage

The information stage is used to obtain optimal information from the project design stage. At this stage, high-cost work is identified and unnecessary work costs are identified, by creating a cost model to describe the distribution of the total project costs.

b. Function Analysis Stage

At this stage, a functional analysis is carried out by identifying work elements that have the potential to have a high cost level by first doing a breakdown cost with reference to Pareto law.

c. Creative Stage

At this stage, as many material or work alternatives as possible will be collected that can produce the best cost. This process is carried out in discussions with experienced parties to maximize ideas.

2.3. Variables and indicators

Based on literature review research variables and indicators describes on Table 1. In this study there were 4 variables and 21 indicators.

Table 1. *Research Indicator*

No	Indicators	Description	References
1	X1-1	Problem Identification	SAVE Standar, 2007, Berawi, 2011, Shen, 2003 and Imam Soeharto, 1999.
2	X1-2	Scope of Work	SAVE Standar, 2007, Berawi, 2011, Shen, 2003 and Imam Soeharto, 1999.
3	X1-3	Team Determination	SAVE Standar, 2007, Berawi, 2011, Shen, 2003 and Imam Soeharto, 1999.
4	X1-4	Information Gathering	SAVE Standar, 2007, Berawi, 2011, Shen, 2003 and Imam Soeharto, 1999.
5	X1-5	Function Analysis	SAVE Standar, 2007, Berawi, 2011, Shen, 2003 and Imam Soeharto, 1999.
6	X1-6	Cost Analysis	SAVE Standar, 2007, Berawi, 2011, Shen, 2003 and Imam Soeharto, 1999.
7	X1-7	Alternative Development	SAVE Standar, 2007, Berawi, 2011, Shen, 2003 and Imam Soeharto, 1999.
8	X1-8	Alternative Evaluation	SAVE Standar, 2007, Berawi, 2011, Shen, 2003 and Imam Soeharto, 1999.
9	X1-9	Life Cycle Cost Analysis	SAVE Standar, 2007, Berawi, 2011, Shen, 2003 and Imam Soeharto, 1999.
10	X2-1	DED Drawing	Jiaxu Wang, 2017
11	X2-2	Cost Estimation	Jiaxu Wang, 2017
12	X2-3	Skill of Team Work	Jiaxu Wang, 2017
13	X2-4	Project Performance	Jiaxu Wang, 2017
14	X2-5	Operational Efficiency	Jiaxu Wang, 2017
15	X3-1	Construction Method	Ezhilmathi, 2017
16	X3-2	Material Selection	Ezhilmathi, 2017
17	X3-3	Aesthetic Considerations	Ezhilmathi, 2017
18	Y1-1	Budget Eficiency	Shekari, 2016
19	Y1-2	Changes Order Improvement	Shekari, 2016
20	Y1-3	Designer-Builder Competence	Del Younker, 2003
21	Y1-4	Design-Construct Quality	Del Younker, 2003

2.4. Research survey by quesioner

The survey with questionnaire was made by released 1 question related for 1 indicator. The questionnaire form is circulated in two stages, the first stage is the pilot survey and the second stage is the respondent survey. In the questionnaire respondents will answer by choosing the answers that have been provided consisting of a Likert scale of 1-5. The scale is made in such a way that a scale of 1 is the most unexpected answer choice and a scale of 5 is the most expected answer choice. Rating scale indicators for answer the questions can be seen in Tabele 2.

Table 2. *Several Types Rating Scale Indicators for Answer the Questions*

1	Most Unexpected	Very Uninfluential	Very Unimportant	Very Low
2	Unexpected	Uninfluencial	Unimportant	Low
3	Quite Expected	Quite Influencial	Quiet Important	Middle
4	Expected	Influencial	Important	High
5	Most Expected	Very Influential	Very Important	Very High

2.5. Population and sample

Population is a construction project that applies the concept of green building. Based on population target sample was calculated (Slovin Method), minimum sample is 32. Questionnaire were distributed for 45 and 40 were returned. Complete quesionaires obtained as many as 35 respondents. In this study there are 4 target groups of respondents; Owner representatif; Design consultant; Cost appraisal consultant; Project construction management, including Project Manager, Deputy Manager, Site Manager, Engineering, Quantity Surveyor, Quality Control, Supervisor and Supplier team member.

2.6. Data and analysis

The results of filling out the questionnaire by the respondents were arranged as tabulated data. Data analysis by statistical analyst RII (Relative Importance Index). RII to determine the level of importance of indicators on research variables. The RII calculation formula is as follows.

$$RII = \frac{\sum W}{(A \times N)}$$

Where:
W = Weights on indicators (with a range of 1-5)
A = The highest weight (in this study 5)
N = Total respondent

RII calculation for all indicator can be seen in the Table 3. Rangking of Mean score calculate for indicator in group of variables can be seen in the Table 4. Calculation of Validity and Reliability for Indicators in Table 5. List of Indicator After Validity and Reliability Test in Table 6. Validity Standar (Alpha Cronbach) is 0,60. Reliability Standar is 0,30.

Table 3. *RII Calculation for All Indicator*

No	Indicators	Description	Quetionaire Recapitulation					W	RII
			1	2	3	4	5		
1	X1-1	Problem Identification	0	0	13	13	9	136	0,781
2	X1-2	Scope of Work	0	0	14	12	9	135	0,773
3	Y1-1	Budget Eficiency	0	0	14	13	8	134	0,769
4	X1-3	Team Determination	0	0	14	13	8	134	0,762
5	X1-4	Information Gathering	0	0	15	12	8	133	0,758
6	X3-2	Material Selections	0	0	15	13	7	132	0,754
7	Y1-2	Changes Order Improvement	0	1	14	13	7	131	0,750
8	X1-5	Function Analysis	0	1	16	11	7	129	0,746
9	X2-2	Cost Estimation	0	1	17	10	7	128	0,742
10	X1-6	Cost Analysis	0	2	16	10	7	127	0,738
11	X2-1	DED Drawing	0	2	17	10	6	126	0,723
12	X1-7	Alternative Development	0	3	17	9	6	124	0,715
13	X2-5	Operational Efficiency	0	3	19	7	6	122	0,692
14	X1-9	Life Cycle Cost Analysis	0	4	19	6	6	120	0,685
15	X3-3	Aesthetic Considerations	0	4	20	6	5	117	0,677
16	X2-4	Project Performance	0	4	21	5	5	116	0,665
17	X2-3	Skill of Construction Team	0	5	20	5	5	115	0,662
18	Y1-3	Designer-Builder Competence	0	4	23	4	4	113	0,654
19	Y1-4	Design-Construct Quality	0	5	22	4	4	112	0,650
20	X3-1	Construction Methods	0	5	23	4	3	110	0,642
21	X1-8	Alternative Evaluation	1	5	22	4	3	108	0,631

Table 4. *List of Variables and Rating by Mean Score for All Indicators*

No	Variables	Subvariables	Description	Mean Score	Rating
1	Value Engineering Stages	X1-1	Problem Identification	3,90	1
2		X1-2	Scope of Work	3,86	2
3		X1-3	Team Determination	3,80	3
4		X1-4	Information Gathering	3,79	4
5		X1-5	Function Analysis	3,78	5
6		X1-6	Cost Analysis	3,73	6
7		X1-7	Alternative Development	3,57	7
8		X1-8	Alternative Evaluation	3, 15	9
9		X1-9	*Life Cycle Cost Analysis*	3, 42	8
10	Development Plan	X2-1	DED Drawing	3,61	2
11		X2-2	Cost Estimation	3,72	1
12		X2-3	Skill of Construction Team	3,31	5
13		X2-4	Project Performance	3,32	4
14		X2-5	Operational Efficiency	3,46	3
15	Value Engineering Methods	X2-8 X3-1	Construction Methods	3,21	3
16		X3-2	Material Selections	3,76	1
17		X3-8 X3-3	Aesthetic Considerations	3,38	2
18	Value Engineering Aims	Y1-1	Budget Eficiency	3,84	1
19		Y1-2	Changes Order Improvement	3,75	2
20		Y1-3	Designer-Builder Competence	3,26	3
21		Y1-4	Design-Construct Quality	3,25	4

Table 5. *Calculation of Validity and Reliability for Indicators*

No	Variables	Subvariables	Description	Validity	Reliability
1	Value Engineering Stages	X1-1	Problem Identification	0,597	0,797
2		X1-2	Scope of Work	0,610	0,821
3		X1-3	Team Determination	0,601	0,857
4		X1-4	Information Gathering	0,592	0,816
5		X1-5	Function Analysis	0,606	0,788
6		X1-6	Cost Analysis	0,602	0,834
7		X1-8 X1-7	Alternative Development	0,649	0,451
8		X1-9 X1-8	Alternative Evaluation	0,710	-0,074
9		X1-12 X1-9	*Life Cycle Cost Analysis*	0,689	0,071
10	Development Plan	X2-2 X2-1	DED Drawing	0,805	-0,443
11		X2-7 X2-2	Cost Estimation	0,682	0,349
12		X2-5 X2-3	Skill of Construction Team	0,573	0,742
13		X2-3 X2-4	Project Performance	0,586	0,668
14		X2-4 X2-5	Operational Efficiency	0,660	0,417
15	Value Engineering Methods	X2-8 X3-1	Construction Methods	0,450	0,450
16		X3-2	Material Selections	0,648	0,446
17		X3-8 X3-3	Aesthetic Considerations	0,600	0,620
18	Value Engineering Aims	Y1-1	Budget Eficiency	0,652	0,492
19		Y1-3 Y1-2	Changes Order Improvement	0,664	0,501
20		Y1-4 Y1-3	Designer-Builder Competence	0,690	0,419
21		Y1-5 Y1-4	Design-Construct Quality	0,711	0,368

Table 5. *List of Indicator After Validity and Reliability Test*

No	Variables	Subvariables	Description	Validity	Reliability
1	Value Engineering Stages	X1-2	Scope of Work	0,610	0,821
2		X1-3	Team Determination	0,601	0,857
3		X1-5	Function Analysis	0,606	0,788
4		X1-6	Cost Analysis	0,602	0,834
5		X1-7	Alternative Development	0,649	0,451
6	Development Plan	X2-2	Cost Estimation	0,682	0,349
7		X2-3	Operational Efficiency	0,660	0,417
8	Value Engineering Methods	X3-2	Material Selections	0,648	0,446
9		X3-3	Aesthetic Considerations	0,600	0,620
10	Value Engineering Aims	Y1-1	Budget Eficiency	0,652	0,492
11		Y1-2	Changes Order Improvement	0,664	0,501
12		Y1-3	Designer-Builder Competence	0,690	0,419
13		Y1-4	Design-Construct Quality	0,711	0,368

2.7. Variables Correlation

Correlation between variables calculated with mean value at 3 main indicators. Calculation proceed by SPSS. Analyze with correlations coefficient with spearman, test of significant with two tail. The result describe in Table 6. and graphical representation in figure 3.

Table 6. *Correlation Variables*

		Y	X1	X2	X3
Y	Pearson Correlation	1	,965	,620	,828
	Sig. (2-tailed)		,168	,575	,379
	N	3	3	3	3
X1	Pearson Correlation	,965	1	,803	,945
	Sig. (2-tailed)	,168		,407	,211
	N	3	3	3	3
X2	Pearson Correlation	,620	,803	1	,953
	Sig. (2-tailed)	,575	,407		,195
	N	3	3	3	3
X3	Pearson Correlation	,828	,945	,953	1
	Sig. (2-tailed)	,379	,211	,195	
	N	3	3	3	3

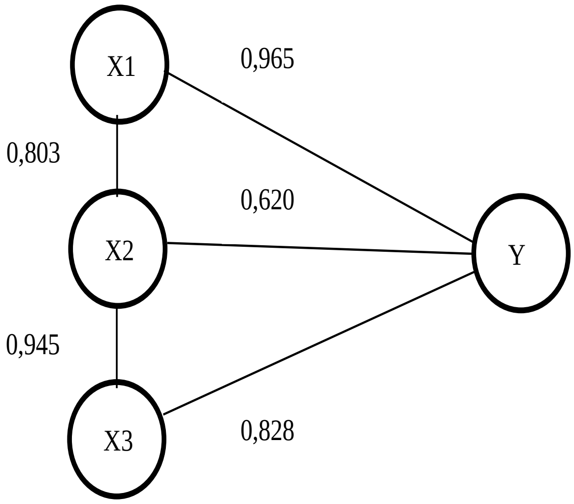

Figure 3. *Graphical Representation Correlation Between Variables*

2.8. Model limitations

Since models only approximate natural phenomena, most of them are characterized by some limitations.

3. Conclusions

1. Variables and Indicators are important for Value Engineering (VE) in green building construction project implementation are; VE Stages, with indicators; Scope of Work, Team Determination, Function Analysis, Cost Analysis and Alternative Development. Development Plan, with indicators; Cost Estimation and Operational Efficiency. VE Methods, with indicators; Material Selections and Aesthetic Considerations. VE Aims, with indicators; Budget Eficiency, Changes Order Improvement, Designer-Builder Competence and Design-Construct Quality.
2. The correlation between variables shows that VE Aims has a stronger correlation with VE Stages dan VE Methods than with Development Plan.

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