

The usage of a value engineering method for implementing green construction on the post graduate's building at Warmadewa University

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The usage of a value engineering method for implementing green construction on the post graduate's building at Warmadewa University

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Abstract. Green construction is a planning and implementation construction project with adjustment of construction methods and materials in order to minimize the negative effects from implementation of a construction project to the environment so that it can provide a balance between the environment ability and the needs of human beings. Each project construction certainly produce waste due to the construction method or material selection, therefore needed adjustment for construction method and material selection to reduce trash produced at the construction project. Replacement of construction methods and materials we're not immediately be done to achieving green construction but first thorough analysis of value engineering. On this research, value engineering methods were used because it will conduct a systematic and creative approach and aims to obtain the best value a project with green construction used as a parameter to reach the required target values. This research takes places at Post Graduate's Building on Warmadewa University where review focused on item or work that potentially produce waste construction waste. Obtained from this research that reducing the usage of wood like materials such as conventional formwork and lambersering solid wood were able to provide solid savings at least 11.50 % and also reducing construction waste.

1. Introduction

The building is an infrastructure that was a combination of several elements such as structure, utility and architecture that built in a location which is generally got more than 1 level for the purpose of supporting all human's activities. In a process, development of a building will surely produce construction waste as a result of the working methods and material selection so the adjustment of both factors is needed to create an environmental friendly construction behaviours to reduces the amount of waste that is produced during the construction and the lifespan of the building. Generally, the wooden junk often found in a construction site as a result of construction methods, as for example is a waste from formwork that using plywood to create a concrete floor for a multistoried building which is at the end tends to be garbage [1].

The definition of green construction is a planning and managing a construction project in accordance with the contract document in order to minimize the impact of the construction process on the environment in order to create a balance between the needs of human life for generations and nature itself [2]. Green construction is a holistic process to replenish and keep the balance between natural and artificial environment [3], to create a green building that is an outcome of a design philosophy which focuses on increasing the efficiency of resource use [4,5]. The definition of environmental support is the



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capability of the environment to give life support for human being and other living creatures. The environmental support are categorized into 2 which are capable of supply and capacity of containment which are in line with sustainable construction concept [6,7].

In an attempt to achieve the green construction itself, it need approach to analyze a working methods or working items that have the potential to substitute in order to applies a working methods or working items that ideal from economic and environmental aspect hence the use of fast diagram of value engineering's method is used to get an alternative design. Using this alternative methods for the purpose of the green construction doesn't change the basic function, requirement functions, and the value of architectural design but also able to compare the costs that affecting the items due to the Value Engineering (VE) not just a method for a cost-cutting process but also to review the basic function as a baselines for the selection of alternative designs so the replacement doesn't necessarily reduce the quality and the function of the building itself [1]. Using value engineering methodology in early stages of a construction project's conceptual planning is called value planning in projects. In this stage, conceptual designing is unconditioned and value improvement techniques, especially function analysis can be used for optimal and primary selection of design progress [8].

In this research, analysis and the application of VE method have done in a construction project of postgraduate building of Warmadewa University. The application of a VE method in order to provide an alternative choices of working methods and material to support the implementation of green construction so that it can compare the existing design with available alternatives which it can give the calculation in terms of costs so that this research's results could provide help based on available alternative working methods and the selection of work items in the future.

7 Value engineering concept

Value Engineering (VE) is a creative perspective to optimize life cycle costs, save time, increase profit, improve quality, increase market share, solve problems, and optimally use resources [9]. Value engineering is not:

- A *Design Review*, which is correcting mistakes made by a planner or do recounting things that already made by a planner.
- A *Cost-Cutting Process*, which is reducing the cost regardless of its effect on quality reliability, display, and security.
- A *Requirement Done All Design*, which is the regulation which must be in each design but oriented in the actual cost and analysis of function.
- *Quality Control*, which is a control of the quality of the product [10].

Value engineering objective in construction projects is to present strategies that can be implemented to solve problems, decrease cost and increase quality (performance) and all these depend on attention to project function; however, the considered objectives in the shortest possible time is very important [11]. The value was a statement of the relationship between functions and resources. there are 3 basic elements that need to measure a value such as function, quality, and cost. These 3 elements relationship can be interpreted with this equation [12].

$$\text{Value} = \frac{\text{Function} + \text{Quality}}{\text{Cost}} \dots \dots \dots (1)$$

8 2.1. Function Analysis System Technique (FAST) diagram

FAST diagram is a picture of subsystem functions of a component that shows the specific relationship between all the functions and shows clearly what the subsystem do [13], as it shows at the following picture.

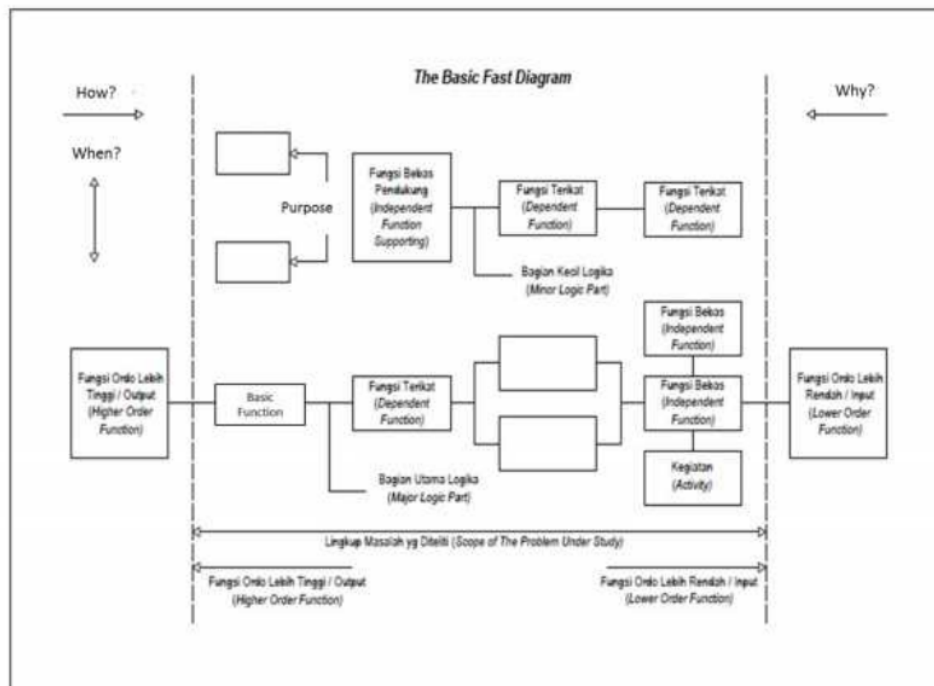


Figure 1. The basic FAST diagram.

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2.2. Life Cycle Cost (LCC)

Life cycle cost is the cost about a product for the cycle of his life which includes the cost of development (planning, design, and testing), production cost, and logistic support costs such as advertising, distribution, and maintenance [14]. The cost Elements that calculated for value engineering consist of initial cost, annual recurring cost, nonrecurring cost [15].

3. Research method

This research is using descriptive quantitative methods which is a method of describing the subject or object under study with data analysis using the form of numbers, where each stage is the part determined to go on to the next stage. This research begins by collecting preliminary data in the form of secondary data which can be obtained from the project's stakeholders and several research that can be associated with the subject.

After secondary data obtained the data then processed with analysis function to determine the basic functions of the selected items, in order to create ideas about alternative design on the creativity and innovation stage without changing its basic functions. After several alternative designs collected hence continued to stage which every alternative design evaluated and compared with an existing design so that will yield a choice of design as to bring the concept of green construction itself.

4. Assessment and result

To obtained the best alternative design, each design must be evaluated based on the comparison subject between existing and alternative one.

4.1. Concrete floor plate's formwork

On the stage of function analysis, conventional concrete floor plate was chosen because the potential to generate a great construction waste [1]. The approach of the functions carried out on formwork job by making one of an alternative method as an object for comparison against conventional method of working using the plywood.

Table 1. Comparison of the existing and alternative method of using formwork for concrete floor plate.

No.	Comparison of Subject	Existing	Alternative
		Conventional Concrete Floor Plate	Metal Deck Plate
	Formwork	1.283.628.600	1.166.505.681
	Concrete K-250	332.176.009	282.349.607
	Bar Reinforcement	336.665.268	251.024.050
	Initial Cost (Rp)	1.952.469.877	1.699.879.338
	Savings (Rp)		252.590.538
1	Waste material	√	-
2	Material efficiency	-	√
3	Working time	-	√
4	Material strength	-	√

It can be seen in table 1 comparative costs from the use of the conventional bekisting with twice usage and metal plates decks where a plate of metal decks give cost savings Rp 252.590.538,00 or as much 12.94 %. The savings occur due to the efficiency of the use of material on bar reinforcement because of metal plates use only 1 layer of reinforcement due to its own strength.

Besides, waste material that's a result from the conventional gives cost about Rp 43.890.000,00 derived from use with plywood as bekisting where at the end of the construction phase will be discarded as junk.

Efficiency also occurred in the metal plate's decks method who spent less time to cast compared to the conventional method because of the use of only 1 layer reinforcement bar.

4.2. Ceiling cover works

On the analysis function stages, the ceiling cover works were chosen because of that cover still using lambersiring that made of solid wood where there are advances in technology that currently provides a more alternative option of material that can use as a substitute of solid wood.

The approach of the functions carried out on ceiling cover work by make one of the alternative method as an object for comparison against conventional method of working using the lambersiring of solid wood. The comparison of existing an alternatif design of ceiling cover works can be seen in the following Table 2.

Table 2. Comparison of the existing and alternative method of ceiling cover works.

No.	Comparison Subject	Existing	Alternative 1	Alternative 2
		Lambersering	Cementitious Fiber	PVC
	<i>Initial Cost (Rp)</i>	1.036.200.585,00	917.037.047,25	828.716.897,25
	<i>Maintenance Cost (Rp)</i>	324.791.540,46	287.440.365,84	259.756.886,42
	<i>Life Cycle Cost (Rp)</i>	1.361.329.101,26	1.204.775.636,52	1.088.743.285,10
	Savings (Rp)	-	119.163.537,75	207.483.687,75
1	termites and rats resist	-	√	-
2	Water & humidity resist	-	√	√
3	Working time	-	-	√
4	Material weight	-	-	√
5	Finishing	√	√	√

It can be seen in table 2 that PVC plafond has the lowest LCC value among the others that gives cost savings about Rp 207.483.687,75 with regular maintenance every 5 years for about 30 years with the assumption damage is 10 % by taking into account inflation by 5.5 % and bank interest as much as 12%. While for comparison the advantages and disadvantages of a whole, the fibre cement plafond are more resistant to termites and rats than lambersiring and pvc plafond. Same with PVC plafond, fiber cement plafond has more endurance for water and humidity but have some shortcomings in terms of finishing and the weight of the material. the processing time of using fiber cement plafond as a cover as long as using lambersering solid wood because of application of protective and finishing coating on their surface, while on PVC plafond already have a wooden look so it doesn't have to do finishing coating on its surface.

In the terms of the final result after finishing coating applied it can be said that all identical because fibre cement plafond having fabrication wood fibre on the surface so when it coated with wooden colouring paint then the result will be same as well as lambersering solid wood.

5. Conclusion

Based on the results of research done, as for some drawing conclusions that can be given, among of them:

- The implementation of green construction set by using the value engineering method that the replacement of conventional material with the alternative material can be compared based on cost, quality and time, for an option on the site.
- By replacing conventional bekisting into a metal decks plate, gave positive contributions to the environment by reducing the amount of waste produced on a construction project at once capable of giving the savings in terms of the cost of quality and time.
- By replacing lambersiring solid wood plafond to fiber cement plafond or PVC plafond can give positive contribution to the environment by reducing wood cutting and reduce waste especially timber waste that produced on the maintenance process as long as the building operates and could give the savings in terms of the cost of quality and time.

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