Application Of Value Engineering To The Manufacture Of Block Paving At CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District

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Abstract: The manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District in fulfilling the demand with fierce price competition, should find a new breakthrough. It is performed by finding a cheap substitute material in good quality. The application of value engineering to the manufacture of block paving is performed by replacing the use of stone ash material with natural stone ash. This research aims: 1) to analyze the type of material that can be used to produce block paving more effectively and efficiently after the application of value engineering in the manufacture of block paving, 2) to calculate the cost savings before the application of value engineering using stone ash and after the application of value engineering using natural stone ash in the manufacture of block paving, 3) to know the quality of block paving's compressive strength before the application of value engineering and after the application of value engineering. The result of the research in the application of value engineering conducted to the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District, East Java Province is the stone ash material. The amount of the cost saving or cost reduction after the application of value engineering is IDR 2,145,000.00 with the percentage of 72.22%. Next, the total funding is 24.07%..

Index Terms: engineering, manufacture, block paving

1 INTRODUCTION

Block paving company, CV.Tirto Mas, is a block paving company located in Watukebo Village, Blimbingsari Sub-District, Banyuwangi District. In fulfilling the demand of price and quality competition, a new breakthrough is needed. One of the ways is by finding a cheap substitute material. In addition, it still maintains the production quality of block paving. Value engineering is a creative and well-planned approach that aims to streamline the costs needed in manufacturing the block paving, [1]. Value engineering is also used to find alternatives that aim at generating the more appropriate/ lower costs than the pre-planned cost with the limit of compressive strength, quality and cost at least equal to the original planning, [2]. By using an evaluation method analyzing techniques and values of a project or product involving: owners, planners and experienced experts in their respective fields with a systematic and creative approach, it aims to produce quality and cost as low as possible, namely with the functional limits and the stage of plan tasks that can identify unnecessary or less supportive costs and efforts,[3;4].

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Value engineering (VE) can also be defined as a creative and systematic approach aiming at reducing unnecessary costs, [5]. These unnecessary costs are costs that do not provide quality, usability, or something that enables a good appearance or the characteristics desired by consumers, [6]. Another definition mentions that value engineering is a systematic approach to obtain optimal results of any costs incurred. A creative effort is required to analyze the function by removing or modifying the addition of unnecessary price in the process of financing the construction, operation or execution, maintenance, the change of equipment and others, [7]. In value engineering, an evaluation method is used to analyze the techniques and values of an activity, in this case, new alternatives are found out for the purpose of generating more efficient costs with functional limits and plan stages that can identify and optimize the costs. It is by having an improvement to the value of the product without reducing any of its quality. In the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District, one of the materials uses stone ash that costs expensively. It is about 25% of the total production cost of the block paving because it is mostly used for the mixture of ready mix. Therefore, savings can be carried out with several alternatives to be analyzed in applying value engineering with correct calculation concept in order to obtain cheap alternative materials with the same block paving strength to the initial planning of K-300 block paving. The application of value engineering should be undertaken at the planning concept stage, [8]. Soon, it will have the maximum flexibility to make changes without incurring additional costs for re-planning. By the development of the planning process, the cost of making changes will increase, until it finally arrives at a point where no saving is achievable, [9]. An important factor to believe is that almost all designs of activity always contain unnecessary costs, however good the planning team is, [10]. It is due to the impossible way to concurrently accomplish a large number of details for a project and maintain a functional balance between cost, performance and quality of reliability in the same time without having a

value engineering review, [11]. The characteristics of the construction design demand so many variables and the settlement is limited in a short time so that the planners do not have time to review the hidden things that may lead to unnecessary costs. However, it should be realized that the incidence of unnecessary costs in a design does not reflect the professional level of a planner's ability, but it is a managerial problem, [12]. To make the value engineering achieve the desired results, it is necessary to use certain techniques based on the definition that value engineering deals directly with human attitudes and behavior, and issues of decision making and problem solving. This technique is mainly used for work of engineering design at the beginning of the project. Experts initially argued that the project is already the best alternative. All works are directed by using problem analysis on specific sections or areas, [13]. It is to select a specific area to be studied in depth, to concentrate on this issue until encountering the core of the problem, then draw up a proposal or alternative. General suggestions will be easily disputed or refuted. On the other hand, if a special problem is supported by facts, it will get a positive response. To get the right and best source of information, it should be taken from various sources, and then it should be reviewed and filtered. In this high level of development of science and technology, the experts will be considered to comprehend special things. Therefore, they can be considered as the best source for obtaining the required information. Relationship between human beings has equal weight with the mastery of technical aspects. The success of the value engineering program depends on the basic understanding of human relationships and how to cooperate with all people playing their roles. The importance of the relationship depends on the degree of dependence on each side. In the activities of value engineering, the degree of dependence is relatively high, so the mastery of a good relationship will obviously determine the success of the value engineering program. The characteristics of value engineering require joint efforts of various parties, so the value engineering process is performed by a team. Developing a value engineering team that can work effectively is just as important as the value engineering process itself. In this case, at least there are 4 criteria that need to be considered, namely the discipline that is represented, the role, the number of members, and the competence of each member concerned. The type of object (problem) determines the composition of someone's discipline who is assigned to handle it. Barriers are familiar to progress. For example, efforts to change the daily work that has been accustomed for a very long time, it will generally experience challenges or obstacles. Thus, this research aims: 1) to analyze the types of materials that can be used to produce block paving more effectively and efficiently after the application of value engineering in the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District, 2) to calculate the amount of cost savings before the application of value engineering using stone ash and after the application of value engineering using natural stone ash in the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District Banyuwangi District, 3) to know the quality of block paving's compressive strength before the application of value engineering and after the application of value engineering.

2 Research Method

The data source, collected in this research, consists of two kinds of data namely secondary data and primary data. Primary data is the data obtained from various sources including company owners and literature review, such as cost of production (HPP), mixed production composition, and laboratory test results of previous compressive strength. Secondary data is the data obtained from related agencies and also literature review in library and internet. The literature review is conducted to obtain the data, the linking and supporting theories to the research, and the results of the research on the research object in order to solve problems in the research process and further analysis. The data that have been collected are then analyzed by using value engineering analysis to get a saving cost. Value engineering analysis is performed through three stages, namely: information stage, speculation stage, analysis stage. The emerging alternatives are formulated. The next is eliminating the less practical ideas and assessing the creative ideas in terms of profit and loss by looking for the potential cost savings for each of the evaluated ideas. The selection can be performed by zero-one method, evaluation matrix and so on. After that, a ranking of the assessment results is made. The selected alternatives from the previous stage of the development program are then set up to the development program to be a complete proposal with consideration of possible technical and economic implementation. The final stage of value engineering process consists of preparation and presentation of value engineering conclusions to the related parties. The reported results are: the mixed material that is used, alternative options, alternative selection concepts, and current savings.

2.1 Review Stage

Detailed submission guidelines can be found on the author resources Web pages. Author resource guidelines are specific to each journal, so please be sure to refer to the correct journal when seeking information. All authors are responsible for understanding these guidelines before submitting their manuscript. For further information on both submission guidelines, authors are strongly encouraged to refer to http://www.ijstr.org.

3 Finding and Discussion

3.1 Information Stage

In conducting value engineering (VE) research, the data of original planning on value engineering in the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District, East Java Province, is highly needed. It aims to gain a thorough understanding of the research items and identify the work to be reviewed by collecting as much supporting data as possible. The data are used as a reference so that the function and compressive strength will not move from the original plan. This stage includes collecting activity information and necessary data such as:

Activity Name : The application of value engineering in the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District, East Java Province

Company Owner: H. Buasir

Company Location : Krajan RT.02/RW.03, Watukebo Village, Blimbingsari Sub-District

3.2 Planning Criteria

Material
Technical specification : Stone ash material from the stone crusher
Price : Expensive
Retrieval Location : Far
Material Availability : Not meeting the needs
Material Provider: Not too much
Need Volume/day : 16.5 m3/day

The following is the information of activity data; it is presented in Table 1 (the complete data is in the appendix)

TABLE 1: *DATA INFORMATION*

Activity : The application of value engineering in the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banywangi District.
Item : The manufacture of block paving – compressive strength

No.	Information Source	Received Information Data
1.	CV. Tirto Mas	1. Mixed Composition 2. Material of the manufacture of the block paving
2.	Laboratory of Polytechnic of Banyuwangi	1. The laboratory result of compressive strength

Source: CV. Tirto Mas and Laboratory of Polytechnic of Banyuwangi

3.3 The Condition of Initial Activity

The real/initial condition, on the manufacture of paving – compressive strength on the application of value engineering on the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District, East Java Province, can be seen in Table 2 below,

TABLE 2: *ACTIVITY INITIAL CONDITIONS*

NO		TYPE OF ACTIVITIES
I		**THE MANUFACTURE OF BLOCK PAVING**
	1.	The stone ash material from the stone crusher
	2.	The sand used comes from the local location of Banyuwangi
	3.	The cement used is Gresik cement
	4.	The mixes used are PC 1: AB: 2: Psr: 4
II		COMPRESSIVE STRENGTH OF BLOCK PAVING
	1.	Quality plan of K 300
	2.	Number of test object of 6bh

Source: CV. Tirto Mas

3.4 Reviewing the Function

Function is identified by using descriptions consisting of two words, namely verb and noun. The verb used is the active verb and the noun used is a measurable noun. The following Table 3 presents the function identification of the type of work to be analyzed by value engineering.

TABLE 3: *IDENTIFICATION OF MATERIAL FUNCTIONS*

No.	Component	Verb	Noun
1.	Stone ash	covering	paving pores
2.	Sand	filling	paving mix
3.	Cement	binding	sand and stone ash

3.5 Speculation/Creative Stage

At this stage, the emerging ideas may be proposed for the application of value engineering in the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District East Java Province. Previously, it is a must to know the type of high cost material. The following is a table showing the amount of cost for each type of material per day for production in the application of value engineering in the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District East Java Province.

TABLE 4: *COST OF MATERIAL TYPE*

No.	Types of Material	Cost (IDR)	Percentage (%)
I.	Stone ash material	2,970,000.00	33.33
II.	Sand material	3.300,000.00	37.04
III	Cement material	1,584,000.00	17.78
IV	Wages	1,056,000.00	11.85
	Total	8,910,000.00	100.00

3.6 Selection of Material Item

Determining the material items, that will be selected as an alternative of value engineering, is to pay attention to the quality of materials that will be used as an alternative; by prioritizing the quality and surely with more economical price. In addition, the material items used as an alternative should be able to reduce the cost in the manufacture of block paving thoroughly, as well as to save materials and production costs and not to change the compressive strength of block paving. After observing the amount of material cost in the Table 4 above, the order of high-cost material is stone ash material 33,33%, sand material 37,04%, cement material 17,78% and wages 11,85% per day. Due to the high proportion value of the stone ash material, and the analysis of value engineering will be known after testing the compressive strength, then the type of material that will be processed in value engineering is stone ash material. It is planning the use of the new materials in the manufacture of block paving. It is replacing the use of the stone as material with natural stone ash and there are cost savings on the use of the new/proposed materials.

3.7 Analysis Stage

This stage performs an analysis of ideas or alternatives. Inappropriate ideas are eliminated. The emerging alternatives or ideas are formulated and considered its advantages and disadvantages, in which are viewed from various angles, then a ranking of the assessment results is made. In evaluating process, some techniques that can be used are zero-one method and evaluation matrix.

3.8 Analysis of Profit and Loss

Analysis of profit and loss is the crudest filtering stage among the assessment methods used in the assessment phase, as presented in the following table:

TABLE 5: *ANALYSIS OF PROFIT AND LOSS*

No.	Selected Ideas	Potential Benefit	Potential Loss
1	Natural stone ash material	No need to crushed Cheaper Easy to get Same color with the stone ash	Too subtle Spherical shape Easy to blow

2	Fly as material	Sent from the factory Packed in sack Same color with cement No raw material needed	A bit expensive Far location More subtle No rough material
3	Stone ash material	Possible to self-production Very good result The split is crushed in the 3 sides	Expensive Difficult raw material Rare supply Far location

3.9 Determining the Ranking of the Alternatives

One form of analysis of these creative ideas discusses assessment very subjective because it is difficult to get an ideal value. Therefore, the ranking of the material to be used is taken into account. The calculated aspects include: cost, mixed composition, technology, quality control, compressive strength.

TABLE 6: *ZERO-ONE METHOD FOR DETERMINING WEIGHTS*

Criteria	No.	Criteria					Total	Weigh t
		A	B	C	D	E		
Cost	A	X	1	1	1	1	4	0.40
Mixed composition	B	0	X	1	1	0	2	0.20
Technology	C	0	0	X	1	0	0	0
Quality control	D	0	0	1	X	0	1	0.10
Compressive strength	E	0	1	1	1	X	3	0.30

Description: 1 = more important, 0 less important, x = the same function

The method of implementing this zero-one method is by collecting the functions of the same level, and then it is arranged in a square-shaped zero-one matrix. After that, the assessment of the functions is performed in pairs, so that the matrix will be filled by X. The values of this matrix are then added by its line and are collected in the sum column.

TABLE 7: *ANALYSIS OF FEASIBILITY*

No	Alterna tives	Criteria					Total	Ranki ng	Sele ction
		A	B	C	D	E			
1.	Natura	4	3	4	3	3	17	1	1
2.	l Stone	2	3	1	1	3	10	3	2
3.	Ash Fly As Stone Ash	2	3	2	2	3	12	2	3

Based on the analysis of feasibility, the following are values obtained from the criteria assessed:

A : Cost
1 = Very expensive 2 = Expensive
3 = Cheap 4 = Very cheap
B : Mixed Composition
1 = Very difficult 2 = Difficult
3 = Easy 4 = Very easy
C : Technology
1 = Very complicated 2 = Complicated
3 = Simple 4 = Very simple
D : Quality Control
1 = Very difficult 2 = Difficult
3 = Easy 4 = Very easy
E : Compressive Strength
1 = Very weak 2 = Weak
3 = Strong 4 = Very strong

From 3 of the selected alternative ranking, the weight of each criterion is looked for by using the Zero-One method as seen in Table below:

TABLE 8: *WEIGHTING*

Criteria	No.	Weight	Ranking
A : Cost	A	0.40	1
E:Compressive Strength	E	0.30	2
B : Mixed Composition	B	0.20	3
D : Quality Control	D	0.1	4
C : Technology	C	0	5

According to Hutabarat (1995), determining the weight by taking total weight scale of 100 and the weight are calculated by the following formula: = {ranking number/total of ranking number} x 100. And the results of the calculation can be seen in the table below:

TABLE 9: *WEIGHING THE RELATIVE OF ALTERNATIVE SELECTION*

No	Alternatives	Criteria					Total	Ranking	Selection
		A	B	C	D	E			
		0.40	0.20	0	0.10	0.30			
1	Natural Ash	4 1.60	3 0.60	4 0	3 0.3	3 0.9	3.40	1	1
2	Fly as	2 0.8	3 0.60	1 0	1 0.1	3 0.90	2.40	3	
3	Stone Ash	2 0.80	3 0.60	2 0	2 0.20	3 0.90	2.50	2	

a. Number 1, 2, and 3 are work items that are analyzed by using value engineering
b. The criterion lines from A to E are the work items that are analyzed by using value engineering
c. Weight lines are taken from Zero-One method
d. The index value is taken from the analysis of feasibility
e. The selected alternative work can be seen from those having index total multiplied by the largest weight (ΣY).

3.10 Function Analysis

To determine the unnecessary costs in the work item, a way of calculating is used by comparing the cost and worth of the items analyzed. If the result of the division between cost and worth is more than one, the work item has a high unnecessary cost. The following are the functional analysis tables showing the cost/worth ratio.

TABLE 10: *FUNCTION ANALYSIS OF STONE ASH*

No.	Component	Verb	Noun	B/S	Cost	Worth
1	Stone Ash	Covering	Paving Pores	B	2,970,000.00	825,000.00
		Total			2,970,000.00	825,000.00

Function: Covering paving pores
Description: B = Basic, S = Secondary

The function analysis at this stage only describes the work items to be analyzed and the function definitions of the measured verb and noun. Cost value obtained from existing cost plan.

$$Ratio = \frac{cost}{worth}$$

$= \frac{2{,}970{,}000.00}{825{,}000.00} = 3{,}600 > 1$ → indicates the savings and is feasible to be analyzed by value engineering

3.11 Analysis Stage

At this analysis stage, alternatives for material item are extracted on the application of value engineering in the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District East Java Province which will be analyzed further. The following are the material items in the application of value engineering in the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District East Java Province which are included in the value engineering planning that can be seen in the following table.

TABLE 11: *WORK ITEMS THAT ARE ANALYZED BY USING VALUE ENGINEERING*

Initial Design	Value Engineering Design
MATERIAL	MATERIAL
1. Stone ash	1. Replaced by natural stone ash
2. Sand	2. Sand
3. Cement	3. Cement

Description:

The italics sentence is work item that is analyzed by using value engineering. The following is the application of value engineering on the type of material that indicates a high cost.

Stone Ash Material
Item material to be analyzed using value engineering is stone ash material,
Information
Initial design : using stone ash
Initial cost : IDR 2,970,000.00/day
VE design : replacing the initial design material with natural ash

TABLE 12: *ANALYSIS OF STONE ASH MATERIAL*

Need/day						
Material						
16,500	M3	Natural ash	IDR	50,000	IDR	825,000
Force						
			IDR	0	IDR	1,056,000
		Total			IDR	825,000

Need = IDR 825,000.00/day

3.12 Development Stage

In this stage, the alternatives are selected from the analysis stage, the costs are calculated. More details of the cost analysis results after the application of value engineering can be seen in the following table.

TABLE 13: *MATERIAL COST ANALYSIS AFTER THE APPLICATION OF VALUE ENGINEERING*

	WORK DESCRIPTION	VE DESIGN IDR
	1	2
Material Replacement		
1	Natural stone ash material	825,000.00
	Total	825,000.00

3.13 Presentation Stage and Follow-up Program

As the final stage of the value engineering method, a proposal is made at this stage which presents a large savings cost and a substantial percentage of savings from the application of value engineering in the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District East Java Province. The proposal can be seen in the following table.

TABLE 14: *COST ANALYSIS AFTER THE WORK ITEM IS ANALYZED USING VE*

No.	WORK DESCRIPTION	INITIAL DESIGN IDR	No.	WORK DESCRIPTION	VE DESIGN IDR	(3) - (6) IDR
1	2	3	4	5	6	7
I.	MATERIAL REPLACEMENT		I.	MATERIAL REPLACEMENT		
1	Stone ash material	2,970,000.00	1	Natural Stone Ash Material	825,000.00	2,145,000.00
Total		2,970,000.00			825,000.00	2,145,000.00

Based on Table 14, it is obtained:
Initial design = IDR 2,970,000.00
VE Design = IDR 825,000.00

The number of the cost saving or cost reduction after the application of value engineering in the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District East Java Province is IDR 2,145,000.00/day with percentage of 72.22% for the stone ash material. The total activity cost/day = IDR 8,910,000.00 The number of percentage of the total activity after the application of value engineering is 24.07%.

4 CONCLUSION

Based on the analysis of value engineering that has been done in the previous chapter, the writers can take some conclusions, namely:

1. The application of value engineering in the manufacture of block paving at CV. Tirto Mas, Watukebo Village, Blimbingsari Sub-District, Banyuwangi District East Java Province on stone ash material is IDR 2,970,000.00/day. It is replaced by the natural stone ash of IDR 825,000.00/day with the percentage of 72.22% from the need of stone ash.
2. The amount of cost savings after the application of value engineering is IDR 2,145,000.00/day with the percentage of 24.07% of the work value of IDR 8,910,000.00/day in one machine.
3. The average of compressive strength of the stone ash is 304.46 kg/cm2, the natural stone ash is 312.47 kg/cm2 and fly as is 312.47 kg/cm2.

5 SUGGESTION

1. It is necessary to consider aspects related to activity planning in order to obtain an economically qualified work.
2. The application of value engineering is not only performed on stone ash material but it can also be performed on material that have potential to be analyzed by value engineering, as in the material of sand and cement.
3. Further research may try various alternatives in engineering the value to overcome the waste of production costs or other scope of work.

6 REFERENCES

[1] Cooper, R. (2017). Target costing and value engineering. Routledge.

[2] Ingle, K. A. (1994). Reverse engineering. McGraw-Hill Professional Publishing.

[3] Omigbodun, A. (2001). Value engineering and optimal building projects. Journal of architectural engineering, 7(2), 40-43.

[4] Dipohusodo, I. (1995). Manajemen Proyek dan Konstruksi. Edisi Ketujuh. Yogyakarta: Penerbit Kanisius

[5] Coyle, E. J., Jamieson, L. H., & Oakes, W. C. (2005). EPICS: Engineering projects in community service. International Journal of Engineering Education, 21(1), 139-150.

[6] Miles, L. D. (2015). Techniques of value analysis and engineering. Miles Value Foundation.

[7] Dell'Isola, A. (1997). Value Engineering: Practical Applications... for Design, Construction, Maintenance and Operations (Vol. 35). RSMeans.

[8] Tohidi, H. (2011). Review the benefits of using value engineering in information technology project management. Procedia Computer Science, 3, 917-924.

[9] Humphreys, K. K. (2004). Project and cost engineers' handbook. CRC Press.

[10] Barber, P., Graves, A., Hall, M., Sheath, D., & Tomkins, C. (2000). Quality failure costs in civil engineering projects. International Journal of Quality & Reliability Management, 17(4/5), 479-492.

[11] Wilkinson, M. (1995). A comparison of two methods of character construction. Cladistics, 11(3), 297-308.

[12] Zimmerman, L. W., & Hart, G. D. (1982). Value engineering: a practical approach for owners, designers, and contractors. Van Nostrand Reinhold Company.

[13] Walker, A. (2015). Project management in construction. John Wiley & Sons.