Implementation of Green Building Concepts Through Value Engineering in Architectural Works

Kadek Adi Suryawan[1], Ni Made Sintya Rani[2]

[1,2] Civil Engineering Department, Politeknik Negeri Bali, Bali, Indonesia
adisuryawan@pnb.ac.id

Abstract. The Green Building Council Indonesia (GBCI), as stated by Ratnaningsih outlines six aspects of Green Building implementation based on the Green Ship for New Buildings version 1.2. These aspects are Appropriate Land Use, Energy Efficiency and Conservation, Water Conservation, Material Resources and Cycles, Indoor Environmental Quality and Comfort, and Building Environmental Management. One method for implementing Green Building aspects is through value engineering. Value Engineering analysis is a systematic, organized, and planned approach to analyzing the value of a project concerning its function or utility while maintaining its appearance, quality, and maintenance. The long-term goal of this research is to develop a draft guideline for implementing architectural work with the Green Building concept through Value Engineering. The specific objectives of this research are to identify alternative material recommendations based on the Green Building concept, and determine the most economical and efficient implementation costs during the architectural work execution phase. The research method used is descriptive quantitative, with primary data collection methods including price surveys and implementation method interviews. Secondary data used include RAB (Budget Plan), AHSP (Standard Unit Price Analysis), and time schedules. Based on the analysis results, the recommended alternative material is lightweight brick. The alternative cost for implementing architectural work in wall finishing is IDR 1,658,938,657.

Keywords: Cost, Green, Alternative, Material

1 Introduction

Global warming and climate change occur globally due to massive technology usage, lifestyle, and human needs for instant gratification (Ainurrohmah & Sudarti, 2022). This climate change results from increased greenhouse gas emissions, with the largest contributors being the industry, transportation, and household sectors (Wau et al., 2022). According to data from the World Green Building Council, buildings contribute at least 33% of CO2 emissions, 17% of clean water consumption, 25% of wood product usage, 30-40% of raw material usage, and 40-50% of energy use for their construction and operation (Munawir, 2021). This global warming phenomenon underpins the importance of implementing the Green Building concept in the construction industry sector (Ratnaningsih et al., 2019). The Green Building Council Indonesia (GBCI) states

A. A. N. G. Sapteka et al. (eds.), *Proceedings of the International Conference on Sustainable Green Tourism Applied Science - Engineering Applied Science 2024 (ICoSTAS-EAS 2024)*, Advances in Engineering Research 249,
https://doi.org/10.2991/978-94-6463-587-4_40

that there are six aspects of Green Building implementation based on the Green Ship device for New Buildings version 1.2: Land Use Efficiency, Energy Efficiency and Conservation, Water Conservation, Material Source and Cycle, Indoor Air Quality and Comfort, and Building Environment Management (Ratnaningsih et al., 2019). One method of implementing Green Building aspects is through value engineering. Value engineering is a method used to conduct cost-saving studies (Atabay & Galipogullari, 2012). The advantage of the Value Engineering method is its systematic, neat, and planned approach in analyzing the value of a problem concerning its function or utility while remaining consistent with the project's appearance, quality, and maintenance (Diputera et al., 2018). The use of value engineering techniques is to identify the function of a design, determine alternative functions as desired, and minimize costs (Yusuf et al., 2021). Additionally, value engineering is used to seek ideas or alternatives with better or lower costs while maintaining the function and quality of a job (Pratiwi, 2014). Several studies on Value Engineering have been conducted. For example, a study on alternative designs for bridge buildings using value engineering concluded that the savings between conventional concrete bridge structures and steel frame bridge structures amounted to IDR 18,668,778 or 2.87%. Between conventional concrete bridges and precast concrete bridges, there were savings of IDR 66,704,416 or 9.54% (Hasan Busri, 2014). A study on value engineering of architectural work in Navalunit Building Planning in West Papua found cost savings of 7.7% for architectural work and 2.6% for all work (Dinariana et al., 2021). A study on Value Engineering for the Auditorium Building at the Polytechnic of Marine Science (PIP) Salodong Makassar concluded that optimizing structural elements in the planning stage could result in savings of up to 11.05% (Karim et al., 2023). Another study on value engineering in apartment construction projects in Cikarang found that the existing wall work cost IDR 10,189,035,186, and after value engineering, the cost with alternative 1 was IDR 8,052,748,444, saving IDR 2,136,286,741 (20.97%). With alternative 2, the cost was IDR 8,134,383,474, saving IDR 2,054,651,711 (20.17%) (Kartohardjono, 2017). Furthermore, a study on plumbing work in green markets based on value engineering reported a cost efficiency of 9.8% for clean and dirty water installation work. These studies demonstrate that applying the Value Engineering method can save work costs. Denpasar City is one of the centers of economic growth and community development in Bali (Suamba & Nurdiantoro, 2014). This is evident from the numerous multi-story building constructions for social and economic needs in Denpasar. Current development needs to consider the principles of sustainable development to reduce environmental damage without sacrificing economic development and social justice (Widyawati, 2019). Based on the background above, a Value Engineering analysis was conducted to find other alternative recommendations considering the Green Building concept to obtain more economical and efficient alternatives. This study aimed to determine the work that can be done with Value Engineering in architectural work. The Value Engineering method is carried out in stages, starting from collecting the latest project RAB data, followed by function analysis using the F.A.S.T diagram method, and then the creativity stage to produce alternative material recommendations and determine the Value Index for each alternative. After selecting the best alternative, calculations are made to determine the most economical and efficient implementation costs.

2 Methodology

This study uses a descriptive quantitative research method, which involves solving problems by describing, investigating, and explaining something as it is and drawing conclusions from observable phenomena using numbers (Sulistyawati et al., 2022). The data collection method used is the collection of primary data, which involves interviews with project managers regarding the implementation methods and a survey of current material prices at material stores. Once the data is obtained, an identification of high-cost work items is conducted, followed by a FAST analysis. Alternative designs will be generated based on Green Building concept criteria. The next phase is the development phase, where the best alternative options are compared and developed, followed by the presentation phase, which involves presenting the best implementation cost alternatives. The analysis method used in this study is the Value Engineering Method. The stages of Value Engineering are as follows:

Information Phase. According to the work plan in VE, the initial phase involves gathering information related to the initial project design, from general data to the desired constraints of the project. This information is obtained by directly requesting it from the project contractor. Then, high-cost work items are identified using a Pareto diagram.

Function Analysis Phase. After gathering information, the next step is function analysis, which is the most crucial phase in VE. This phase involves analyzing the desired functions using a F.A.S.T Diagram to determine the lowest cost needed to identify the main functions, supporting functions, and costs that can be reduced or eliminated without affecting the building's quality. This phase distinguishes VE from other cost-saving analyses.

Creative Phase. In the creative phase, alternatives are generated as comparisons to the existing design. The more alternative ideas presented, the more solutions are available for cost, quality, and time savings. The alternatives can include materials, implementation methods, and execution time

Evaluation Phase. During the evaluation phase, suitable alternatives are selected from the options generated in the creative phase. Selection is done by analyzing which alternatives offer the highest savings in terms of costs and quality, ease of implementation, and lowest costs compared to the other alternatives identified in the creative phase. This phase uses the zero-one method

Development Phase. Activities in this phase include comparing study conclusions with previously established conclusions, preparing alternatives for the selected ideas for further development, managing risks and costs accordingly, conducting cost-benefit analyses, and developing an action plan to define the steps, schedule, and responsibilities for each selected alternative. This phase involves technical analysis and Life Cycle Cost (LCC) calculations to achieve cost savings in the work items analyzed in detail through VE

Recommendation Phase. In the recommendation phase, the results of the analysis are reported or presented. The presentation is directed to the owner or developer, including the chosen alternatives, the reasons for their selection, the price difference between the initial plan and after VE, the advantages and disadvantages of the selected alternatives, and the lifecycle cost savings from the initial plan after VE. This presentation is used to convince the owner or developer, who plays a role in decision-making

3 Result and Discussion

3.1 Information Phase

In this phase, information is collected to determine the Cost Estimation Plan, unit prices, and project data, which will later be analyzed using Value Engineering based on criteria from GBCI (Green Building Council Indonesia) regulations. The recapitulation of the Cost Estimation Plan for the Sumitra Hotel and Magnum Residence projects is presented in the following Table 1.

Table 1. RAB recapitulation of architectural work of Sumitra Resort Hotel project

No	Work	Total price (IDR)
1	Finishing Dinding	926,934,188
2	Floor Finishing	560,838,586
3	Finishing Plafond	246,056,249

recap of the budget for the wall finishing work in the Magnum Residence project, with the total cost being over 1.7 billion Rupiah.

3.2 Pareto

After a recapitulation was carried out in the RAB, especially in Architecture work, then continued by measuring the dominant value. This dominant value is determined using the Pareto Diagram method. This diagram helps to group work items that fall into criteria with an accumulated cost of 80% of the total work items. The work items included in these criteria are then determined by the material with the largest implementation cost using a similar method. The results of the pareto diagram are presented in the following Table 2.

Table 2. Percentage of architectural work value from the highest to lowest in the Sumitra Hotel project

No	Work	Total price (IDR)	%	Cumulative
1	Finishing Dinding	929,920,708	51.13 %	51.13 %
2	Floor Finishing	639,813,512	35.29 %	86.43 %
3	Finishing Plafond	246,056,249	13.57 %	100 %

Highest to lowest percentage of architectural work in the Magnum residence project, the wall finishing work constitutes 100% of the total architectural costs in this specific project. This suggests that the table might only be summarizing a single item, making up the entirety of the architectural budget in this case.

In the architectural work, the two projects obtained the same work items that are included in the criteria with an accumulated cost of 80%, namely wall finishing work and floor finishing. For the Sumitra Hotel project, the cumulative value of wall and ceiling finishing work is 85.83% and for the Magnum Residence project, it is 100% on wall finishing work. After determining the work item, it is then continued to determine the material with the highest value in each work item. The wall finishing work is presented in the following Table 3.

Table 3. Highest to lowest percentage of material value in the finishing work of the Sumitra Hotel Project Wall

No	Work	Total price (IDR)	%	Cumulative
1	Stone wall times random slate	290,007,294	31.29%	31.29%
2	homogenus tile walls	231,503,543	24.98%	56.26%
3	weathershield wall paint	75,456,474	8.14%	64.40%
4	waterproofing coating	68,430,426	7.38%	71.78%
5	Wall skim coat	9,317,429	10.71%	82.50%
6	external wall paint	42,013,334	4.53%	87.03%
7	Ceramic flooring sz.30x30 cm Ex. Asia Tile	39,461,740	4.26%	91.29%
8	Internal wall paint	35,946,127	3.88%	95.17%
9	Andesite Stone Toppings 400 x 400 x50	21,867,326	2.36%	97.53%
10	Toping Andesit 300 mm tebal 3 mm	21,452,200	2.31%	99.84%
11	Geotextile	1,478,295	0.16%	100.00%

The results of the ranking can be depicted on the Pareto diagram which shows the work items that are included in the criteria with an accumulation cost of 80% as shown in Figure 1 below.

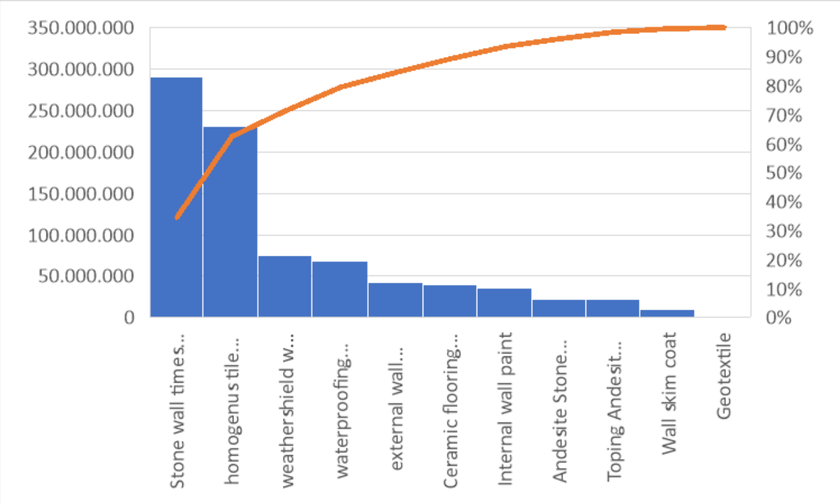

Figure 1. Pareto chart of Sumitra Hotel's wall work

Table 4. Highest to lowest percentage of material value in the finishing work of the Sumitra Hotel project wall

No	Work	Total price (IDR)	%	Cumulative
1	HT uk.600x600mm Unpolish floor	555,344,207	86.80%	86.80%
2	Natural stone (Marmer TBA) floor	25,126,876	3.93%	90.73%
3	100 mm high wood HT plin	21,595,200	3.38%	94.10%
4	600x600mm non slip homogenous ceramic flooring (F7)	16,641,004	2.60%	96.70%
5	100 mm high ceramic plin with HT finish	10,035,475	1.57%	98.27%
6	100 mm high plin stone with natural finish	6,776,460	1.06%	99.33%
7	Drainite cell	4,294,290	0.67%	100.00%

From the results of the ranking, it can be depicted in the Pareto diagram which shows the work items that are included in the criteria with an accumulation cost of 80% as shown in Figure 2.

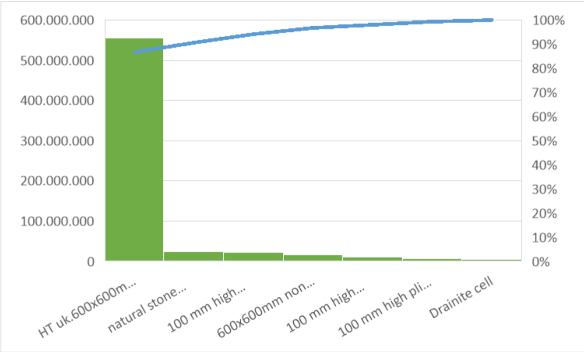

Figure 2. Pareto chart of Sumitra Hotel floor work

Table 5. Percentage of the highest to lowest material value in the finishing work of the Magnum Residence project wall

No	Work	Total price (RIDR	%	Cumulative
1	Brick wall	897,240,540	52.71%	52.71%
2	Plaster	471,777,305	27.71%	80.42%
3	Curve cover ACP t = 4mm ex. seven	214,006,429	12.57%	92.99%
4	Practical Coloumn & Lintel Beam	119,356,723	7.01%	100.00%

From the results of the ranking, it can be depicted on the Pareto chart which shows the work items that are included in the criteria with an accumulation cost of 80% as shown in Figure 3 below.

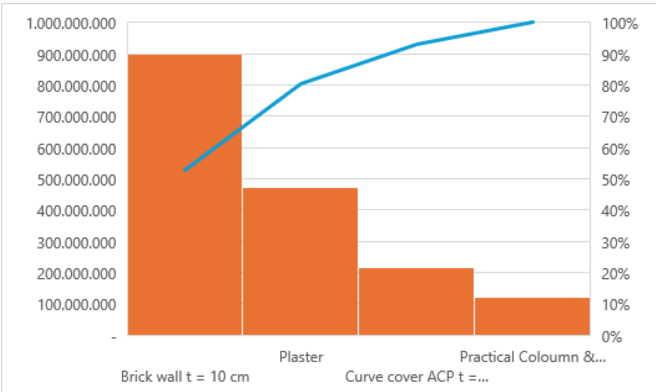

Figure 3. Pareto graph of Magnum Residence wall work

3.3 GBCI Categories and Criteria

Furthermore, determine the criteria for value engineering analysis. The criteria used refer to the Greenship Assessment Tool by the Green Building Council Indonesia on Greenship for New Buildings. Since the work items reviewed are only architectural work, not all criteria are used in this Value Engineering analysis. The criteria used are as in the following Table 6.

Table 6. GBCI categories and criteria

Categories	Criteria
Material source and cycle	Fundamental Refrigeration
	Use of Used Buildings and Materials
	Eco-friendly materials
	Material Regional

3.4 Creative and Alternative Stage

Based on the criteria, the creative stage is then carried out by coming up with alternative designs that will later be used as comparison materials with the initial design. The alternatives that appear are as in the Table 7 below

Table 7. Alternatives based on criteria

No	Initial design	Alternative 1	Alternative 2
1	Stonewall times random slate	*Gamping* stone	*Paras* stone
2	dinding homogenus tile	Natural stone	Ceramics
3	Weathershield wall paint	Aquashield wall paint	*Powerflexx* wall paint
4	waterproofing coating	Waterproofing mortar	Waterproffing membran
5	Wall plaster	Sistem stick on wall	
6	Floor homogeneous tile	Natural stone	Ceramics
7	Brick wall	Concrete	Lightweight brick
8	Plaster	Sistem stick on wall	

3.5 Recommendations for Alternative Materials Based on The Concept of Green Building

Based on the results of the evaluation and alternative design, recommendations for alternative materials based on the Green Building concept were obtained. Alternative recommendations Combination is a combination of alternative designs that have the highest weight value at the evaluation stage. The existing alternative designs are juxtaposed with the initial design with the comparative subjects of fundamental refrigerants, the use of buildings and used materials, environmentally friendly materials and regional materials. In each project, alternative recommendations are obtained as in the following Table 8.

Table 8. Recommendations for alternative materials based on the concept of green building in the Sumitra Hotel project

No	Initial design	Alternative recommendation
1	Stonewall times random slate	Stonewall times random slate
2	homogeneous tile wall	Ceramic wall
3	Weathershield wall paint	Aquashield wall paint
4	Waterproofing coating	Waterproffing coating
5	Acian wall	Acian wall
6	Floor homogenous tile	Ceramic flooring

Table 9. Recommendations for alternative materials based on the concept of green building in the Magnum Residence project

No	Initial desaign	Alternative recommendation
1	Brick wall	Lightweight brick
2	Plaster	Plaster

3.6 The most economical alternative to implementation costs

The most economical alternative implementation cost is obtained from the lowest cost based on the cost comparison of each material. The cost of implementing the initial design on the wall finishing work of the Sumitra Hotel project is IDR 929,920,708 after value engineering is carried out, the cost of implementing the wall finishing work is IDR 903,671,568. there is a saving of IDR 23,262,620 or 2.51%. The cost of implementing the initial design on the floor finishing work of the Sumitra Hotel project is IDR 639,813,512 after value engineering is carried out, the cost of implementing the floor finishing work is IDR 510,799,447, there is a saving of IDR 129,014,065 or 20.16%. The cost of implementing the initial design on the wall finishing work of the Magnum Residence project is IDR 1,702,380,997 after value engineering is carried out, the cost of implementing wall finishing work is IDR 1,658,938,657, there is a saving of IDR 43,442,340 or 2.55%. Alternative costs for each job and each project are presented in the following Table 10.

Table 10. Alternative implementation costs in the Sumitra Hotel project

No	Work	Initial value	Alternative value	% saving
1	Finishing dinding	IDR 929,920,708	IDR 903,671,568	2.51 %.
2	Floor finishing	IDR 639,813,512	IDR 510,799,447	20.16 %.

The cost of implementing the initial design on the wall finishing work of the Magnum Residence project is IDR 1,702,380,997 after value engineering is carried out, the cost of implementing wall finishing work is IDR 1,658,938,657, there is a saving of IDR 43,442,340 or 2.55%.

4 Conclusion

Based on the results of the analysis that has been carried out, the following conclusions can be drawn: a. Recommendations for alternative materials based on *the concept of Green Building* in architectural work are; b. In the Sumitra Hotel Project, there are recommended materials, namely ceramic walls, aquashield wall paint and ceramic floors; c. In the Magnum Residence Project, there is a material recommendation, namely Light Brick; d. The most economical and efficient alternative implementation costs at the stage of implementing architectural work; e. In the Sumitra Hotel project, the alternative cost of implementing architectural work on wall finishing work is IDR 903,671,568 and for floor finishing work IDR 510,799,447; f. In the Magnum residence project, the alternative cost of carrying out architectural work on wall finishing work is IDR 1,658,938,657.

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