Indonesian Journal of Advanced Research (IJAR)
Vol. 4, No. 7, 2025: 1271-1282

Analysis of the Application of Value Engineering in Building Project X Kuningan District

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A R T I C L E I N F O

Keywords:
Cost Efficiency, Construction, Life Cycle Cost, Value Engineering.

Received : 13, May
Revised : 27, June
Accepted: 29, July

A B S T R A C T

Construction project efficiency is the key to success amid budget pressures and cost inflation. Value Engineering (VE) is a systematic solution to balance cost, reliability, and project performance. Pareto analysis identified four main works for optimization: walls, frames, floors, and ceilings with cost/worth ratio >1. Alternative solutions included AAC/HEBEL walls, PVC sills, unpolished homogenius tile, and PVC ceiling. The implementation of Value Engineering resulted in significant savings in walls (38.63%), frames (24.21%), ceilings (46.62%), and floors (39.74%). The total savings reached Rp1.481.761.485,10 (38,52% of the initial cost), with Life Cycle Cost as the main consideration.

DOI prefix: https://doi.org/10.55927/ijar.v4i7.14977
ISSN-E: 2986-0768
https://journal.formosapublisher.org/index.php/ijar

INTRODUCTION

In the construction industry, project efficiency is one of the key factors that determine the success of a project. Especially in the midst of budget pressures and increasing costs. Construction projects face various challenges that can affect the sustainability and success of the project.

Building construction projects are often faced with challenges such as budget constraints, material upgrades, resource wastage, increased purchasing power, weather uncertainty, material delivery delays, price fluctuations, as well as difficulties in coordination between various related parties, including suppliers, contractors, and subcontractors. Such factors show that efficiency is not just about cost savings but also about smart management of resources to achieve optimal results in construction projects.

Solutions to construction work require quality control, cost savings and control of implementation time. So it is necessary to have good planning before construction work is carried out. A construction project development cost control is very important in managing costs on construction projects (Khanifah et al. 2023). Value *engineering* in a project has proven to be able to offer a concept of thought in project handling. *Value Engineering (*VE) or value engineering is a technique in management using a systematic approach to find the best functional balance between cost, reliability and performance in the project (Issue et al. 2025).

The purpose of this research is to find out which work can be done efficiently using the VE method to choose the best alternative, and to compare project costs before and after VE analysis. The selection of work items for VE analysis used Pareto law analysis (Khanifah et al. 2023).

With a systematic and data-based approach, it is hoped that this research can make a real contribution to practitioners in the construction industry, as well as support the development of better policies in resource management to achieve optimal results in construction projects.

LITERATURE REVIEW

Construction Project

Construction projects are defined as activities that include a series of stages ranging from planning, procurement of materials, to the physical construction of infrastructure such as buildings, highways, bridges, and other public facilities. This project involves coordination and management of technical and administrative elements to ensure smooth implementation, with the aim of achieving optimal efficiency, minimizing waste, and completing the project in accordance with the specified budget and time (Wismantoro 2022).

The objectives of a construction project typically encompass several elements, including completing the project on schedule, within budget limits, and meeting predetermined quality criteria. Project goals also relate to the ultimate benefits of the project, such as the completion of a building, bridge, or other facility that can be utilized in accordance with its designated role (Wismantoro 2022).

Building

A building is a construction that has a fixed structure and consists of walls, floors, and roofs, designed to be used as a location to live, work, move, or store goods. Buildings are generally larger and more complicated than simple structures such as small houses. The construction of a building or a building construction project is a multidisciplinary activity, where the interaction between various elements will greatly affect the final result.

Building construction consists of several types of work such as structural work, architecture, and mechanical *electrical and* plumbing *(MEP)*. These parts are related to the construction project work where structural work serves to form the elements that make up the building, while architectural work handles the beauty and aesthetic aspects of the building, and mechanical electrical and plumbing (MEP) work takes care of the utilities in the building that support the functions for various activities in it (Yaqin and Priasworo 2023).

Value Engineering

Value Engineering is a management technique that utilizes value analysis related to function. The goal is to use the lowest possible cost to achieve the required function, but stay within the existing functional constraints so that the condition of the product is guaranteed. Value engineering is a creative and systematic approach with the aim of reducing or eliminating unnecessary costs and also as a management method in a way to achieve an optimal functional balance between cost, reliability, and appearance of a product (Yaqin and Priasworo 2023).

Value engineering is a planned approach that aims to analyze the function of a part or system to achieve the desired performance at the lowest possible cost. This process is supported by technological advances, including the emergence of various types of materials for building finishes. Therefore, the selection of the right material is very important to support the basic function of each building component (KHAMIM, Utoyo, and Zenurianto 2022).

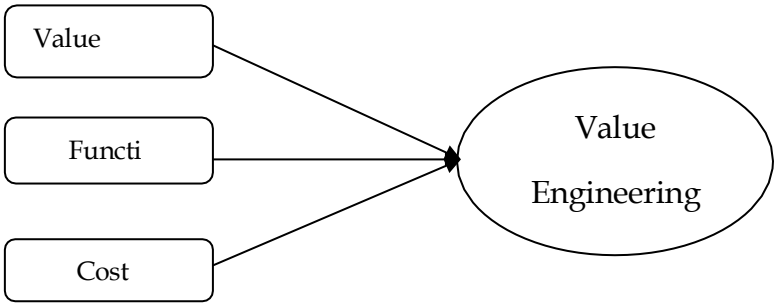

Figure 1. Framework of Thought

METHODOLOGY

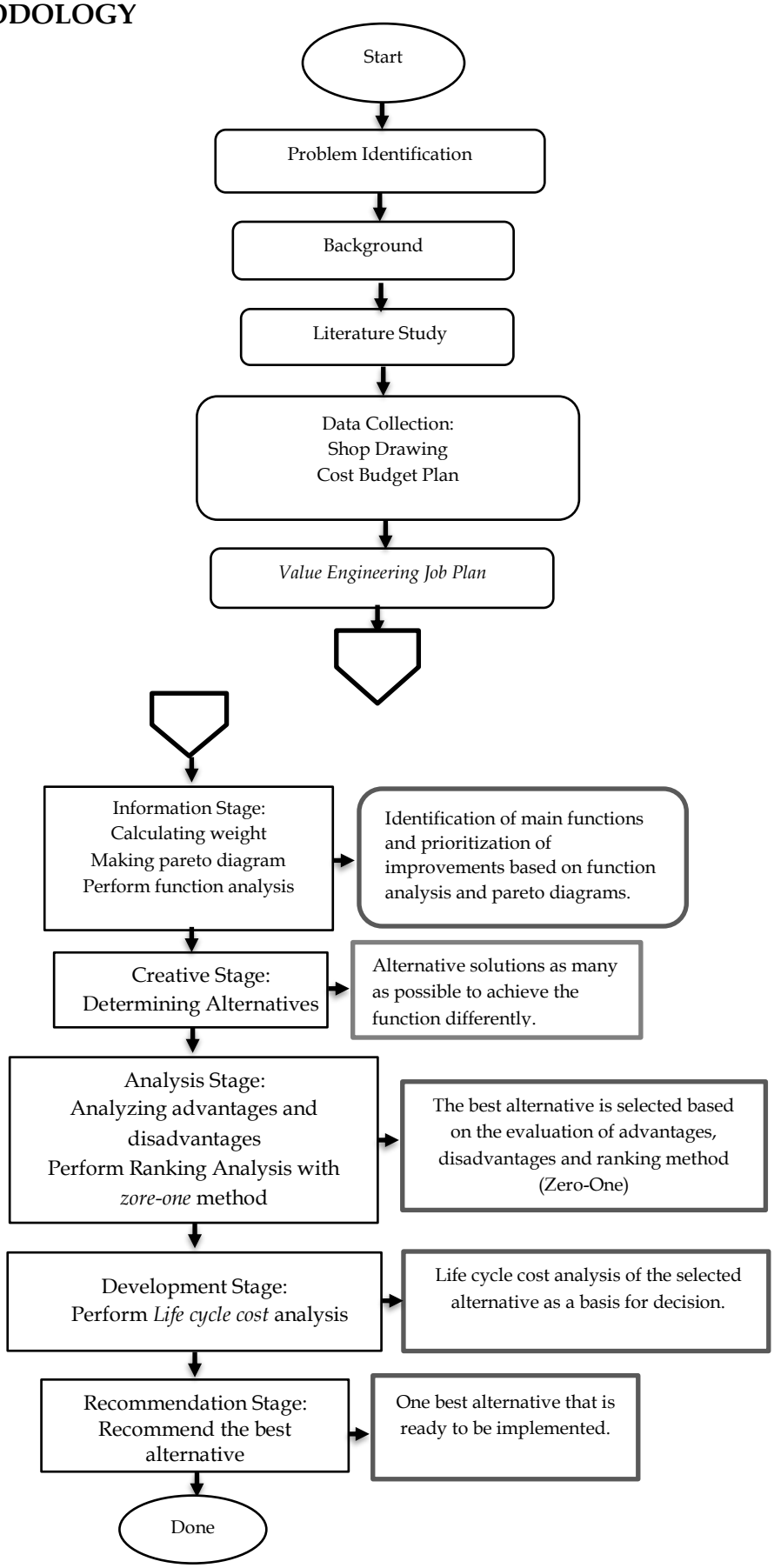

Figure 2. Research Flowchart

This research uses quantitative methods to analyze the effect of cost efficiency on the Kuningan Regency X Building construction project. This research was conducted in Kuningan Regency, West Java Province using secondary data in the form of official archives about the project, project general data, plan drawings, unit prices of work, RAB, and other documents. The data was sourced from the contractor implementing the project. This research uses the value engineering work method to determine the cost efficiency that can be implemented in construction projects.

RESEARCH RESULTS

To analyze cost efficiency using the Value Engineering method using several stages, namely the information stage, creative stage, analysis stage, development stage and recommendation stage.

Information Stage

Table 1. Recapitulation of High Cost Work Items

NO	ITEM	COST (Rp)	COST %
A	B	C	D
1	Structure Work	Rp 9,524,539,501.98	32,36%
2	Architectural Work	Rp 7,392,633,422.10	25,12%
3	Mechanical Work	Rp 4,637,564,171.40	15,76%
4	Electrical and Plumbing Land maturation and Fencing	Rp 2,070,760,872.96	7,04%
5	Roof Work	Rp 1,186,160,430.00	4,03%
6	Facade	Rp 1,074,840,306.00	3,65%
7	Infrastructure Works And Landscape	Rp 953,880,942.00	3,24%
8	Generator Room Work	Rp 795,015,136.83	2,70%
9	Sticky Interior	Rp 391,854,697.50	1,33%
10	Preparatory Work	Rp 367,592,506.20	1,25%
11	Smk3 Construction	Rp 335,828,280.00	1,14%
12	Septic Tank Area Work	Rp 291,081,194.00	0,99%
13	Ground Water Tank and Pump Area Work Room	Rp 269,729,700.30	0,92%
14	Guard Post Work	Rp 99,411,402.42	0,34%
15	Earthwork	Rp 42,123,034.80	0,14%
	TOTAL	**Rp 29,433,015,598.49**	**100,00%**

From the summary of the total project cost above, it can be seen that architectural work has the second largest cost budget compared to other jobs.

Creative Stage

Table 2. Job Design Recommendations

No	Job	Recommended Job Design
1	Wall Work	A0= Initial Design: Local Red Brick ½ thick Brick, (camp 1 PC : 5 PS) A1= Alternative 1: Lightweight Brick (AAC or Hebel) A2= Alternative 2: Precast Concrete Panels
2	Frame Work Window	A0= Initial Design: 4" Aluminum Frame A1= Alternative 1: Aluminum 3" A2= Alternative 2 : UPVC Frame A3= Alternative 3: Light Steel Frame A4= Alternative 4: Wooden Frame
3	Floor Work	Floor Work A0= Initial Design : Niro Granite Unpolish 80 x 80 Unpolish 80x80 A1 =Alternative1: Homogeneous Tile Non-Polished tile nonpolished A2= Alternative 2: Andesite Stone (Honed/Burnt) A3= Alternative 3: Ceramic Anti-Slip Patio A4= Alternative 4: Acian Coating Step Nosing Floor Work A0= Initial Design: Step Nosing HT uk. 10x20 cm A1= Alternative 1: Stainless steel nosing A2= Alternative 2: Aluminum nosing A3= Alternative 3: PVC nosing A4= Alternative 4: Rubber nosing Stair Floor Work A0= Initial Design: HT Floor A1= Alternative 1: Solid Wood Floor A2= Alternative 2: Vinyl Flooring A3= Alternative 3: SPC Flooring A4= Alternative 4: Marble Flooring Self Adhesive Membrane Waterproofing Work A0= Initial Design: Self-adhesive bitumen membrane adhesive A1= Alternative 1: Sika TopSeal-107 A2= Alternative 2: PU Coating (Polyurethane) A3= Alternative 3: Acrylic Waterproofing A4= Alternative 4: Crystal Waterproofing Floor Work Room Area A0= Initial Design: Niro Granite A1= Alternative 1: PVC Flooring A2= Alternative 2: Homogeneous Tile Local Grade A A3= Alternative 3: Granite Tile 60x60 Local A4= Alternative 4: Marble Floor Plint Work A0= Initial Design: HT Floor Plint uk.10 x 80 Unpolish 80x80 A1= Alternative 1: Ceramic Plint 10 x 80 A2= Alternative 2: PVC plint A3= Alternative 3: Wooden plint A4= Alternative 4: Granite plint
4	Ceiling Work	Ceiling Work (Roof Covering) A0= Initial Design: Kalsi Board Ceiling

	A1 = Alternative 1: PVC Ceiling A2= Alternative 2: Woven Ceiling A3 = Alternative 3: Fiber cement ceiling A4 = Alternative 4: GRC Ceiling Ceiling Work (Top Installation Cover) A0 = Initial Design: Kalsi Board Ceiling List A1 = Alternative 1: PVC Ceiling List A2 = Alternative 2: Wooden Ceiling List A3 = Alternative 3: Fiber cement ceiling list A4= Alternative 4: GRC Ceiling List

Based on Table 2, the creative stage recommends work designs that aim to minimize construction costs. These recommendations include selecting more economical materials, more efficient construction methods, and optimizing the use of resources, so as to reduce expenses without sacrificing the quality and function of the project being implemented.

Analysis Stage

Table 3. Analysis of Work Design Recommendations

No	Work	Recommended Job Design	Weight Assessment
1	Wall Works	A1= Alternative 1: Lightweight Brick (AAC or Hebel)	66
		A2= Alternative 2: Precast Concrete Panels	58
2	Frame Work Window	A1= Alternative 1: Aluminum 3"	76
		A2= Alternative 2: UPVC frame	80
		A3= Alternative 3: Light Steel Frame	54
		A4= Alternative 4 : Wooden Frame	50
3	Floor Work	Floor Work	56
		A1= Alternative 1: Homogeneous Tile Non-Polished	
		A2= Alternative 2: Andesite Stone (Honed/Burnished)	52
		A3= Alternative 3: Ceramic Anti-Slip Patio	54
		A4= Alternative 4: Acian Coating	48
		Step Nosing Floor Work	50
		A1= Alternative 1: Stainless steel nosing	
		A2= Alternative 2: Aluminum nosing	48
		A3= Alternative 3: PVC nosing	59
		A4= Alternative 4: Rubber nosing	54
		Staircase Floor Work	40
		A1= Alternative 1: Solid Wood Floor	
		A2= Alternative 2: Vinyl Flooring	58
		A3= Alternative 3: SPC Flooring	62
		A4= Alternative 4: Marble Floor	50
		Work Waterproofing Membrane Self Adhesive	38
		A1= Alternative 1: Sika TopSeal-107	
		A2= Alternative 2: PU Coating (Polyurethane)	58
		A3= Alternative 3: Acrylic Waterproofing	60
		A4= Alternative 4: Waterproofing Crystal	50
		Floor Work Room Area	56
		A1= Alternative 1: PVC flooring	

		A2= Alternative 2: Local Homogeneous Tile Grade A	64
		A3= Alternative 3: Granite Tile 60x60 Local	58
		A4= Alternative 4: Marble	44
		Floor Plint Work	58
		A1= Alternative 1: Ceramic Plint 10 x 80	
		A2= Alternative 2: PVC plint	68
		A3= Alternative 3: Wooden plint	47
		A4= Alternative 4: Granite plint	56
4	Ceiling Work	Ceiling Work (Roof Covering)	62
		A1= Alternative 1: PVC Ceiling	
		A2= Alternative 2: Woven Bamboo Ceiling	38
		A3= Alternative 3: Fiber Cement Ceiling	48
		A4= Alternative 4: GRC Ceiling	54
		Ceiling Work (Top Installation Cover)	62
		A1= Alternative 1: PVC Ceiling List	
		A2= Alternative 2: Wooden Ceiling List	38
		A3= Alternative 3: Fiber Cement Ceiling List	44
		A4= Alternative 4 : GRC Ceiling List	54

Based on the weight table in the advantages and disadvantages analysis rating scale, the results obtained can be seen in Table 3. This table presents comprehensive information regarding the weight given to each of the criteria analyzed. Each criterion is rated according to its importance in the context of the analysis being conducted, making it possible to get a clearer picture of the associated advantages and disadvantages. By using this rating scale, it is expected that more informed and measured decisions can be made in the ongoing evaluation process.

Recommendation Stage

Table 4. Recapitulation of Job Design Recommendations

No	Work	Recommended Work Design
1	Wall Work	Light brick wall (AAC or Hebel) with size 10 x 20 x 60 cm with adhesive MU-380 and mortar acian with finishing using wall paint
2	Frame Work Window	using window sills made of PVC on window types J3, J4, J5, and J6.
3	Floor Work	• Terrace floor work using Homogenius Tile Unpolished • Floor room using Homogenius Tile Local Grade A • stair floor using Floor SPC • Alternative step nosing is PVC Nosing • Waterproofing using Waterproofing Acrylic plint floor using PVC Plint.

4	Ceiling Work	PVC (Polyvinyl Chloride) Ceiling

The alternative design for wall work is a lightweight brick wall (AAC or Hebel) measuring 10 x 20 x 60 cm with MU-380 adhesive. For window frames, the alternative is PVC frames in types J3, J4, J5, and J6. The terrace floor uses Homogenius Tile Unpolished, while the room floor uses Homogenius Tile Local Grade And the ceiling uses PVC (Polyvinyl Chloride) ceiling.

Additional Analysis of Selected Material Alternatives

1. Durability
   Lightweight Bricks (AAC/Hebel) is Earthquake-resistant, non-rotting, and water-resistant. However, they are susceptible to sharp impacts. For PVC Frames Resistant to termites and corrosion, do not require paint finishing. For PVC Ceilings Water and moisture resistant, mold-resistant, suitable for tropical areas. And for Homogeneous Tiles Scratch-resistant, load-bearing, suitable for high-traffic areas.
2. Ease of Installation
   Materials such as lightweight bricks and PVC are lightweight, precise in size, and easy to install, thus speeding up work times and reducing labor costs.
3. Environmental Impact
   For Lightweight bricks have a lower carbon footprint than red bricks because they do not undergo a clay-fired process. And for Modern PVC and tile materials are partly made from recycled materials, but attention must be paid to the production process and waste.
4. Field User Reviews
   For Builders and contractors state that lightweight bricks are lighter and quicker to install, but require special skills when plastering. For PVC frames are quicker to install and cleaner, although they are limited to light-duty buildings. And for PVC ceilings are popular for quick projects because they are cost-effective and do not require painting.

Table 5. Price Comparison
Before and After Value Engineering

No	Work Item	Initial Design	Total Price of Initial Design	Value Engineering Design	Total Price After Value Engineering
1	Work Wall	Red Brick	Rp2,252,604,807.00	Brick Wall Lightweight	Rp1,382,445,420.00
2	Work Frame (J3, J4, J5, J6)	Frame Aluminum 4"	Rp190,143,000.00	PVC Frame	Rp144,113,520.00
3	Work Plafond	Ceiling & List Plafond Kalsi Board	Rp113.318.767,80	Plafond & List PVC Plafond	Rp60.486.090,95
4	Work Flooring	Niro Granite Unpolish 80 x 80	Rp1,006,745,524.50	Homogeneous Tile Non-Polished	Rp615,370,125.00
		Niro Granite	Rp133,534,110.00	Flooring Homogenius Unpolished Tile (Terrace)	Rp375,177,000

	HT Floor uk 20 x 80 cutting size, Unpolish (Stairs)	Rp12,744,576.00	SPC Floor	Rp11,040,000.00
	Membrane bitumen self adhesive	Rp27.052.032,00	Waterproofing Acrylic	Rp16,320,000
	Floor Plint HT uk.10 x 80	Rp92.418.378,00	PVC Plint Floor	Rp64,459,200
	Step HT Nosing uk. 10x20 cm	Rp17.767.659,00	Step Nosing PVC Nosing	Rp5,496,875

The alternative design for the wall work is a lightweight brick wall (AAC or Hebel) measuring 10 x 20 x 60 cm with MU-380 adhesive. For window frames, the alternative is PVC frames in types J3, J4, J5, and J6. The terrace floor uses Homogenius Tile Unpolished, while the room floor uses Homogenius Tile Local Grade and the ceiling uses PVC (Polyvinyl Chloride) ceiling. The savings from the alternative design reached Rp870,159,387.00 (38.63%) for walls, Rp46,029,480.00 (24.21%) for frames, Rp52,832,676.85 (46.62%) for ceilings, and Rp512,739,941.35 (39.74%) for floors. The total savings in this project are Rp1,481,761,485.10 or 38.52% of the total initial design.

DISCUSSION

Based on the results of the total project cost research analysis, it can be seen that architectural work has the second largest cost budget compared to other work. At the creative stage, design recommendations aim to streamline construction costs through economical material selection, efficient construction methods, and resource optimization. The alternative design for wall works uses lightweight brick walls (AAC or Hebel) measuring 10 x 20 x 60 cm with MU-380 adhesive, as well as PVC frames for types J3, J4, J5, and J6. The terrace floor uses Homogenius Tile Unpolished, while the room floor uses Homogenius Tile Local Grade, and the ceiling uses PVC. The savings from the alternative design reached Rp870,159,387.00 (38.63%) for walls, Rp46,029,480.00 (24.21%) for frames, Rp52,832,676.85 (46.62%) for ceilings, and Rp512,739,941.35 (39.74%) for floors. The total savings in this project are Rp1,481,761,485.10 or 38.52% of the total initial design.

CONCLUSION AND RECOMMENDATION

Based on the analysis using the Breakdown Cost Model (BCM) and Pareto diagram, four high-cost work items that require value engineering were identified, namely for wall work at 2.06; frame work at 1.157; floor work at 1.101 and ceiling work at 1.250. The alternative design for wall work is a lightweight brick wall (AAC or Hebel) measuring 10 x 20 x 60 cm with MU-380 adhesive. For window frames, the alternative is PVC frames in the type J3, J4, J5, and J6. The terrace floor uses Homogenius Tile Unpolished, while the room floor uses

Homogenius Tile Local Grade and the ceiling uses PVC (Polyvinyl Chloride) ceiling. The savings from the alternative design reached Rp870,159,387.00 (38.63%) for walls, Rp46,029,480.00 (24.21%) for frames, Rp52,832,676.85 (46.62%) for ceilings, and Rp512,739,941.35 (39.74%) for floors. The total savings in this project are Rp1,481,761,485.10 or 38.52% of the total initial design. This approach shows significant potential efficiency in project cost management.

ADVANCED RESEARCH

The implementation of value engineering in construction projects is increasingly relevant with the times and technology. With advances in design and analysis software, such as Building Information Modeling (BIM), it is possible to create more accurate simulations to evaluate various design and material alternatives. This technology enables the identification of potential cost savings and performance improvements more quickly and efficiently. In addition, the use of data analytics and artificial intelligence (AI) in the decision-making process helps project teams to optimize resources and minimize risks. Thus, value engineering focuses not only on reducing costs, but also on increasing the overall value of the project, making it more sustainable and adaptive to changing market needs.

ACKNOWLEDGMENTS

We would like to express our deepest gratitude to all those who have contributed to this research. Thanks to our parents and supervisors who have provided valuable direction and guidance, as well as to colleagues who have provided support and input during the research process. In addition, we are grateful to the institutions and organizations that have provided the necessary resources and facilities. Hopefully this research can provide benefits and positive contributions to the development of science and society.

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