



## Application of Value Engineering in Residential Building Construction Projects

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### ABSTRACT

Value engineering is an approach that contributes significantly to cost efficiency and increasing the value of residential projects. With proper implementation, VE can balance functional needs, aesthetics, quality, and economic efficiency. The purpose of this study is to determine the process of implementing value engineering in residential building construction projects to achieve cost efficiency without reducing the quality and function of the building, the factors that support and inhibit the success of implementing value engineering in residential building construction projects and to determine the impact of implementing value engineering on design decision making, material selection, and cost effectiveness in residential building projects. The method used in this study is the qualitative method. The results of this study are that VE is a very strategic tool in supporting smart and measurable decision making in every stage of residential construction. Not only does it provide efficiency, VE also creates buildings that are more valuable, sustainable, and in accordance with the expectations of homeowners. The timely and planned implementation of VE from the early stages of the project will produce maximum benefits both in terms of technical, economic, and functional.

## **INTRODUCTION**

Value Engineering (VE) is a systematic approach that aims to increase the value of a construction project without reducing its main function, by identifying and eliminating unnecessary costs. In the context of residential building construction projects, the application of value engineering is an important strategy in efforts to optimize construction costs without sacrificing the quality, aesthetics, or function of the building. The VE process is carried out through systematic stages, including the information phase, function analysis phase, creative phase, evaluation phase, development phase, and presentation phase. This approach not only emphasizes cost efficiency, but also pays attention to aspects of occupant comfort, technical feasibility, ease of maintenance, and long-term environmental impact.

In the information phase, all project data is collected in detail, including homeowner needs, architectural and structural design specifications, budget, and implementation schedule. This data is important to understand the purpose of building the house, whether it is used as a private residence, investment property, or a combination of both. This information will be the basis for analysis in the following stages, including identifying building elements that have the potential for cost savings without reducing quality. For example, the use of a lightweight steel roof structure system compared to solid wood can be a more efficient, lightweight, and durable alternative, with more measurable costs.

In the functional analysis phase, each building component is reviewed based on its function. VE encourages the project team to separate the owner's needs and wants. According to (Harahap et al., 2022) The functions of components such as walls, floors, roofs, windows, and mechanical and electrical systems are analyzed in depth to see if there are alternative materials or implementation methods that can provide the same or better results at a lower cost. For example, walls with lightweight brick masonry (AAC block) can replace red bricks because they are lighter in weight, faster installation, and better thermal insulation.

The creative phase is a brainstorming phase where the VE team consisting of architects, engineers, quantity surveyors, and contractors work together to find as many alternative solutions as possible from the results of the previous analysis. In residential projects, this can include adjusting the shape of the roof, the orientation of the building for natural lighting, or replacing finishing materials with local products of equal quality but cheaper. The ideas developed in the creative phase will be assessed and sorted in the evaluation phase, considering technical, aesthetic, cost, and environmental sustainability aspects.

In the evaluation and development phase, the best alternative is further studied from the cost-benefit analysis side and then detailed in technical specifications and working drawings. The VE team will prepare comprehensive and realistic recommendations, including estimates of cost savings and their impact on project quality and schedule. For example, in the construction of a 100 m<sup>2</sup> single-story house, replacing the roof material from clay tiles to metal spandex roofs can save up to 15% of the total roof cost, while maintaining aesthetics and weather protection functions.

The final phase is the presentation of the VE results to the project owner to obtain approval for implementation. The final decision remains with the owner, but VE provides a strong basis for technical and economic considerations. This process creates collaboration between all parties involved and increases transparency and efficiency in the construction process. According to (Ngantung et al., 2021) the application of value engineering also considers aspects of sustainability, especially in the selection of environmentally friendly materials, energy efficiency, and reduction of construction waste. The use of recycled materials, natural lighting systems, cross ventilation, and energy-saving technologies such as solar panels, are part of VE that led to environmentally friendly buildings. Although the initial investment may be higher, the long-term savings obtained from the operational costs of the house are a significant added value.

In the context of residential construction projects in Indonesia, the biggest challenge in implementing VE is the limited awareness of homeowners about the benefits of VE and the low involvement of VE professionals from the early stages of the project. Many owners only focus on reducing costs without considering the impact on the quality and lifespan of the building. Education about the importance of VE and the involvement of VE experts from the planning stage are the main keys to the successful implementation of this method.

## **METHODOLOGY**

The qualitative method in the study entitled "Implementation of Value Engineering in Residential Building Construction Projects" was used to explore in depth the process, considerations, and experiences of construction actors in applying value engineering principles to real projects. This approach is descriptive, with the aim of understanding how design decisions, material selection, and cost efficiency strategies are implemented without reducing the function and quality of the building. Data collection techniques were carried out through in-depth interviews with architects, contractors, engineers, and project owners, as well as documentation studies of working drawings, technical specifications, and project cost reports.

The researchers also conducted direct observation of ongoing residential construction projects to identify the actual application of value engineering stages, starting from the information phase, function analysis, to alternative evaluation. Data analysis was conducted thematically to identify patterns of VE application, inhibiting and supporting factors, and their impact on project efficiency. By using qualitative methods, this study is expected to provide a complete picture of the contextual application of VE, as well as provide practical recommendations for construction actors in increasing efficiency and added value to residential projects.

## **RESULTS AND DISCUSSION**

The application of value engineering (VE) in residential building construction projects is a systematic approach that aims to identify and eliminate unnecessary costs without reducing the quality, performance, and main function

of the building. This process is important amidst the increasing need for affordable, efficient housing that still meets comfort and safety standards. Value engineering does not only focus on budget reduction but emphasizes optimizing value through increasing function or reducing costs intelligently and in a planned manner. In the context of residential construction, VE involves a series of stages designed to evaluate each component of the project from a functional and cost perspective.

The VE process begins with the information phase, which aims to understand in detail the project to be worked on, including technical specifications, budget, design objectives, and homeowner needs. At this stage, the project team collects data on the initial design, materials used, construction technology, and implementation methods. Identification of functional needs is a crucial point, because each building element such as structure, walls, roofs, utility systems, and finishing must be assessed based on their contribution to the basic functions of the building, such as structural safety, thermal comfort, aesthetics, and energy efficiency.

The next stage is the function analysis phase. In this stage, each construction element is analyzed based on its main function and categorized into basic function and secondary function. For example, the basic function of a wall is to provide a room divider and support the structure, while its secondary function may be to provide interior aesthetics (Sumarda et al., 2022a). The goal is to identify whether there are other alternatives that can perform similar functions but at a lower cost or higher efficiency. This analysis requires critical thinking and openness to innovative solutions.

In the creative phase, the VE team develops various alternative solutions or new approaches that can replace existing elements or methods. For example, in the construction of residential houses, the use of conventional reinforced concrete for structures can be replaced with precast or lightweight steel structures depending on functional needs, labor costs, and implementation time. The use of lightweight bricks or composite materials for walls is also often the result of this creative process because it can reduce material costs and speed up installation time. This stage emphasizes exploring as many ideas as possible, without immediately judging their feasibility.

After various alternatives are generated, the process enters the evaluation phase. Each alternative is analyzed in terms of cost, function, technical risk, material availability, and its impact on quality and implementation time. The most valuable alternative, namely the one that provides optimal function at the most efficient cost, is selected to be recommended in the implementation phase. For example, choosing corrugated metal roofing with thermal insulation over conventional clay tiles can be an efficient choice for hot tropical areas, because it is lighter, easier to install, and has high durability.

The development phase is carried out to prepare a technical plan for the selected alternative, including working drawings, material specifications, and a new work plan. All of these documents are then compared to the initial plan to show cost savings, increased functionality, or risk reduction. In a residential project, for example, replacing conventional lighting systems with energy-efficient

LED lighting and cross-ventilation systems can reduce long-term operating costs, providing added value even though the initial investment is slightly higher.

The final stage is the recommendation and implementation (presentation and implementation phase). The VE results recommendations are submitted to the project owner or construction manager to be used as consideration in decision making. At this stage, technical and economic arguments must be conveyed clearly so that all stakeholders understand the benefits of the proposed changes. VE implementation is carried out in stages according to the construction schedule with strict supervision to ensure that changes do not disrupt the overall quality and function of the building.

The application of value engineering to residential projects must also consider aspects of sustainability and long-term user comfort. This means that although the focus of VE is cost savings, design decisions must still consider energy efficiency, ease of maintenance, and flexibility of space use. According to (Youssef et al., 2023) the final result of the VE process is not only a cost-effective building, but also a habitable, comfortable house with a long technical life. The success of implementing value engineering (VE) in residential building construction projects is greatly influenced by various interrelated factors. VE is a systematic approach that aims to achieve cost efficiency without reducing the quality and function of the building, but in its implementation, there are a number of supporting and inhibiting factors that must be considered carefully so that VE is truly effective and produces added value (WY El-Nashar & Elyamany, 2018).

One of the main factors that support the success of VE is the commitment of all stakeholders. Support and active involvement from project owners, architects, engineers, contractors, and consultants are important foundations in running the VE process optimally. This commitment is seen in openness to new ideas, willingness to reevaluate initial design decisions, and readiness to accept changes aimed at increasing the value of the project. When all parties agree that the main goal is efficiency and function, the VE process can run more smoothly without any psychological barriers or conflicts of interest.

The availability of complete and accurate technical information is a crucial supporting factor. Adequate data on building specifications, construction costs, implementation time, and homeowner needs are essential in the VE analysis and evaluation process. Clear information will make it easier for the VE team to identify which elements have the potential to be changed or replaced without reducing the functional value. When the available data is incomplete or inaccurate, the decision-making process will be speculative and risk producing results that are not as expected.

The quality of human resources (HR) also plays an important role in the success of VE. A team consisting of competent, creative, and experienced professionals in the construction field will be better able to produce innovative and applicable alternative solutions. Strong technical knowledge and the ability to think critically are needed at every stage of VE, from function analysis to cost evaluation. The stronger the team's capabilities, the greater the chances of successful VE implementation in residential projects.

The use of supporting technology and software is also a very helpful factor. Design software, cost estimation, and Building Information Modeling (BIM) allow project teams to simulate and compare various design alternatives more accurately and quickly. With this technology, the process of identifying VE solutions can be carried out more efficiently and confidently, and minimize the risk of errors in implementation in the field (Kormomolin et al., 2020).

Behind the potential for success, there are also several inhibiting factors that often hinder the success of VE implementation. One of the main factors is resistance to change, both from the project owner and the implementation team. When certain parties feel comfortable or tied to the initial design, they tend to reject the proposed alternatives even though they are better in terms of function and cost. This conservative attitude often arises due to concerns about risk, time constraints, or a lack of understanding of the VE concept itself.

Time constraints for project implementation are also a significant obstacle. In many cases, residential projects have tight implementation schedules, so the space for conducting VE analysis is very limited. If the VE process is not planned from the beginning of the project, it is likely to be difficult to integrate changes without disrupting the overall timeline. Therefore, time is a critical factor that must be anticipated with thorough VE planning from the early design stage.

Lack of understanding of VE from some parties is also an obstacle. Many still consider VE as a way to cut costs without considering quality, even though VE actually prioritizes function and value in a balanced way. This ignorance can lead to miscommunication, rejection of ideas, or even misguided implementation of VE. Education about the principles and benefits of VE is very important, both for project owners and technical implementers.

Limited access to alternative materials or technologies is also a barrier, especially if the project is implemented in an area that does not have a variety of material choices or competent workers to apply new construction methods. According to (Septiani et al., 2023) good VE ideas in theory may not be applicable in the field due to limited logistics and local resources. The aspects of availability and accessibility must also be considered in the VE process. The lack of documentation and evaluation of previous projects is also an inhibiting factor. When there are no records or references on how VE has succeeded or failed in previous residential projects, the VE team will have difficulty in developing the right strategy. This documentation is very important as material for evaluation, learning, and improving the quality of VE implementation in the future.

By considering all the supporting and inhibiting factors, the application of value engineering in residential construction must be carried out in a structured, planned manner, and actively involve all parties. The success of VE does not only depend on one aspect, but on a combination of commitment, team competence, data availability, and readiness to innovate and face technical and non-technical challenges that arise during the process. When all these factors are managed well, VE can be a strategic tool to produce efficient, functional, and quality buildings.

The application of value engineering (VE) in residential construction projects has a significant impact on various important aspects in project implementation, especially in design decision making, material selection, and cost

effectiveness. VE as a systematic approach aims to optimize the value of a project, not only by reducing costs, but by increasing function at a more efficient cost. This approach emphasizes creative efforts to review all design elements so that every technical decision taken truly provides maximum value for the project owner.

In terms of design decision making, VE encourages designers not to just focus on conventional solutions, but to consider various design alternatives that can achieve the same or even better function with a different approach. The VE process requires a functional analysis of each component of the building design. For example, in the design of a residential roof, through the VE process, alternative roof structures and shapes can be found that remain strong, weather-resistant, but use a more economical and easy-to-install roof truss and covering system. At this stage, design decisions become more rational, data-based, and consider aspects of value and benefits as a whole. This helps minimize wasteful or purely aesthetic design decisions without considering efficiency.

VE encourages collaboration between professionals, such as architects, structural engineers, mechanical electrical experts, and contractors to discuss intensively in evaluating the initial design. Each party can provide input based on their respective expertise to produce design alternatives that still meet user needs, aesthetics, and technical requirements, but at a more controlled cost. Thus, VE plays an important role in creating wiser, more efficient, and more effective design decisions.

Significant impacts are also seen in material selection. VE opens up space for evaluation of the types of materials used in a project, with the aim of finding more economical materials without sacrificing strength, durability, and function. For example, in building wall elements, VE allows owners and technical teams to evaluate whether red brick materials can be replaced with lightweight bricks, which have a lighter weight, faster installation process, and better time and labor cost efficiency. Likewise, with the selection of floor, ceiling, or roof materials, VE can identify local or alternative materials with equivalent technical specifications but lower prices, thereby reducing overall project costs.

In addition to material prices, considerations in VE also include ease of installation, market availability, service life, and long-term maintenance. Materials that were initially chosen because they were popular or had an attractive appearance may be inefficient in the long term because they require high maintenance or are difficult to obtain if damaged. With VE, the material selection process becomes more objective, considering not only the initial cost but also the life cycle cost. This is very crucial in the construction of residential homes, where homeowners expect comfort and ease of long-term maintenance.

In terms of cost effectiveness, VE has proven to have a significant influence in controlling the project budget. By identifying and eliminating costs that do not contribute significantly to the function of the building, VE can cut expenses substantially without reducing the quality of the result. For example, by changing the work method or the sequence of construction implementation to be more efficient, savings can be made in terms of implementation time, labor usage, and project logistics. This shows that VE not only touches on the material aspect, but also the construction process and management.

The VE process also helps prevent waste from occurring due to emotional or uninformed decisions. With the systematic approach of VE, every expense can be traced to its function, and if it does not have a real contribution to the performance or aesthetics of the building, it can be eliminated or replaced with other more economical options. This makes VE a decision-making tool that is based on value, not just cost or habit.

The impact of VE on project costs can also provide long-term benefits to homeowners, as buildings designed with VE tend to be more efficient in energy consumption, water use, and maintenance costs. For example, by replacing lighting systems with LED models or installing effective natural cross ventilation, VE not only saves initial construction costs but also reduces the homeowner's monthly operating costs. The positive impact of VE on costs and design decision-making cannot be achieved without careful planning. VE must be carried out from the beginning of the design stage so that the process of identifying and analyzing value can be carried out thoroughly. If implemented too late, for example when construction is already underway, the potential for efficiency becomes smaller because many components are already locked and difficult to change.

## **CONCLUSIONS AND RECOMMENDATIONS**

The application of Value Engineering (VE) in residential construction projects has proven to provide a significant contribution in increasing cost efficiency without sacrificing the quality and function of the building. Through a systematic approach and functional analysis, VE allows the creation of more rational and innovative design decisions, not only based on aesthetics or technical habits, but oriented towards the maximum value that can be achieved. This process encourages cross-disciplinary collaboration between architects, engineers, and contractors to find design alternatives that remain functional but more economical.

In material selection, VE helps to choose more efficient building material options in terms of price, availability, ease of installation, and long-term maintenance costs. This allows for significant savings in the project budget without compromising the final quality of the building. VE has a positive impact on overall cost effectiveness, including in the construction implementation process and resource management, so that the project can be completed on time with optimal results.

Based on the positive impacts identified, it is recommended that the application of Value Engineering (VE) be integrated as a standard practice in the planning and implementation stages of residential construction projects. Project owners, consultants, and contractors should establish clear VE procedures early in the project cycle to ensure all design and construction decisions are evaluated from a value perspective. Additionally, regular VE workshops and cross-disciplinary reviews should be conducted to explore potential alternatives and optimize resource use. It is also advisable to provide training and capacity building for project teams to improve their understanding and application of VE principles, ensuring that cost efficiency, functionality, and quality are always balanced and maximized.

## FURTHER STUDY

To strengthen the implementation of Value Engineering (VE) in residential construction projects, further research is needed to explore several key aspects. Future studies can focus on developing quantitative models to measure the precise impact of VE on cost savings, project timelines, and building performance across different project scales and types. Comparative studies between projects that apply VE and those that do not can provide more concrete evidence of its benefits and challenges. Additionally, research on the integration of VE with emerging technologies – such as Building Information Modeling (BIM), sustainable materials, and smart construction methods – can offer insights into how VE can evolve to meet the demands of modern, sustainable, and digitally-driven construction. Finally, investigating the behavioral and organizational factors that affect the success of VE implementation, such as stakeholder attitudes, team dynamics, and decision-making processes, will be essential to formulate effective VE strategies in practice.

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