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Value Engineering Analysis of a Three-Story Building Construction Project in Mojokerto Regency

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ABSTRACT

Value engineering is a strategy that plays a critical role in enhancing cost-effectiveness and boosting the value of home construction projects. When applied correctly, value engineering can harmonize functional requirements, appearance, quality, and financial efficiency. This research aims to explore the process of applying value engineering in the construction of residential buildings to achieve cost efficiency without compromising the building's quality and functionality. Additionally, it looks into the factors that facilitate or hinder the effective implementation of value engineering in these projects and examines how value engineering influences decisions related to design, material choices, and cost efficiency in residential construction. This study employs a qualitative research approach. The findings indicate that value engineering is an essential tool for enabling intelligent and quantifiable decision-making throughout every phase of residential building projects. Beyond enhancing efficiency, value engineering leads to the development of structures that are more valuable, eco-friendly, and meet homeowner expectations. Implementing value engineering promptly and systematically from the project's outset will yield optimal benefits in technical, economic, and functional areas.

INTRODUCTION

Value Engineering (VE) is a structured method focused on enhancing the value of a construction project while maintaining its primary function by spotting and removing superfluous expenses. In residential construction, implementing value engineering is a crucial tactic for minimizing construction costs without compromising the building's quality, appearance, or utility. (Rahmawan and HS, 2021). The VE methodology consists of several organized steps, which include the information phase, function analysis phase, creative phase, evaluation phase, development phase, and presentation phase. This method emphasizes not just cost savings but also considers the comfort of occupants, practicality, ease of upkeep, and long-term effects on the environment.

During the information phase, comprehensive data about the project is gathered, including the needs of the homeowner, specifications for architectural and structural design, budget constraints, and the timeline for implementation. This information is crucial for understanding the house's intended use, whether it's meant for personal living, as an investment property, or a combination of both (SIREGAR, 2018). This collected data forms the foundation for the subsequent analysis stages, identifying building elements where costs can be reduced without sacrificing quality. For instance, opting for a lightweight steel roofing system as opposed to solid wood can provide a more efficient, lighter, and durable option, along with clearer financial benefits.

In the functional analysis phase, each component of the building is assessed based on its purpose. VE motivates the project team to distinguish between the needs and desires of the owner. As noted by (Harahap et al. , 2022), a thorough examination of the functions of various components like walls, floors, roofs, windows, and mechanical and electrical systems is conducted to explore alternative materials or methods that can achieve similar or superior results at a lower expense. For example, using lightweight masonry (AAC blocks) instead of traditional red bricks can be advantageous, as they are lighter, quicker to install, and offer improved thermal insulation.

The creative phase serves as a brainstorming session where the VE team, which includes architects, engineers, quantity surveyors, and contractors, collaborates to devise as many alternative solutions as they can based on prior analysis results (Ngantung et al. , 2021). In residential builds, this may encompass modifications to the roof shape, optimizing the building's orientation for better natural light, or choosing local finishing materials that match the quality of more expensive options but come at a lower price. The ideas generated during this creative phase will be evaluated and prioritized in the evaluation phase, considering aspects such as technical viability, aesthetics, costs, and environmental sustainability.

In the phase of assessment and development, the top alternative is analyzed further in terms of cost-effectiveness, then outlined in precise technical specifications and design drawings. The Value Engineering (VE) team will develop detailed and practical suggestions, which will include projections for cost reductions and their effects on both project quality and timeline (Annisa et al. , 2019). For instance, when constructing a single-story house of 100 m^2, switching the roofing material from clay tiles to metal spandek roofs could result in savings of up to 15% on the overall roof expense, all while preserving the visual appeal and protective capabilities against weather.

The concluding step is to present the VE findings to the project owner to secure consent for implementation. Although the ultimate decision lies with the owner, VE lays down a solid foundation for both technical and financial analysis. This approach fosters collaboration among all stakeholders involved, enhancing openness and efficiency throughout the construction process. As stated by (Ngantung et al. , 2021), the implementation of value engineering also takes sustainability elements into account, particularly in the choice of eco-friendly materials, energy conservation, and minimizing construction waste. Incorporating recycled materials, natural lighting methods, cross ventilation, and energy-efficient technologies like solar panels are aspects of VE that contribute to building designs that are kinder to the environment. Even if there is a higher initial investment, the substantial long-term savings in operational expenses present a considerable advantage (Khanifah et al. , 2023).

Regarding residential construction initiatives in Indonesia, the main obstacle in applying VE is the limited awareness among homeowners about its advantages and the insufficient participation of VE specialists from the project's inception. Many homeowners tend to concentrate solely on cutting costs without weighing the repercussions on the quality and durability of the structure. Raising awareness about the significance of VE and ensuring the involvement of VE professionals from the early planning phase are crucial for the effective execution of this approach (Ferianto and Effendy, 2021).

THEORETICAL REVIEW

Value Engineering

Value Engineering is a systematic and structured methodology aimed at improving the value of a project by optimizing the relationship between function, quality, and cost. It focuses on identifying and eliminating unnecessary expenses while maintaining or enhancing the essential functions of a product or project. In the context of construction and development projects, Value Engineering encourages innovative design alternatives, efficient material selection, and collaborative decision-making to achieve optimal performance and cost efficiency without compromising quality or functionality.

Development Projects

Development projects refer to planned and organized activities undertaken to create, improve, or expand physical, economic, or social infrastructure in order to achieve specific objectives. These projects typically involve multiple stakeholders, defined timelines, allocated resources, and measurable outcomes. In the construction and corporate context, development projects include residential, commercial, and industrial developments that aim to generate economic value, enhance service delivery, and support sustainable growth.

Companies

Companies are formal business entities established to conduct economic activities, generate profits, and deliver goods or services to the market. They operate within legal, financial, and organizational frameworks and are responsible for managing resources, including capital, labor, and technology. In development and construction projects, companies play a central role as planners, investors, contractors, or developers, influencing project efficiency, innovation, and value creation through strategic decision-making and operational management.

METHODOLOGY

The qualitative approach utilized in the research project called "Implementation of Value Engineering in Residential Building Construction Projects" aimed to thoroughly investigate the experiences, processes, and considerations of those involved in construction regarding the integration of value engineering principles into actual projects. This descriptive method seeks to comprehend the ways in which decisions about design, choices of materials, and strategies for cost efficiency are executed while maintaining the building's functionality and quality. To gather information, the researchers conducted detailed interviews with architects, contractors, engineers, and project owners, along with reviewing working drawings, technical specifications, and project financial documents.

Additionally, the researchers engaged in direct observation of current residential construction sites to assess how the stages of value engineering are genuinely applied, from the information gathering stage and function analysis to the evaluation of alternatives. The analysis of the collected data was done thematically to uncover trends in the use of value engineering, factors that could hinder or aid this process, and their effects on the efficiency of the projects. By adopting qualitative methodologies, this research aims to offer a comprehensive understanding of the contextual implementation of value engineering, as well as to deliver actionable suggestions for construction professionals to enhance efficiency and add value to residential projects.

RESULTS AND DISCUSSION

The use of value engineering (VE) in home construction projects is a structured method aimed at pinpointing and removing unnecessary expenses while maintaining the building's quality, efficiency, and primary functions. This approach is crucial given the rising demand for cost-effective and functional housing that also adheres to comfort and safety requirements (Ferdinand and Adianto, 2022a). Value engineering is not only about cutting costs but focuses on maximizing the value by increasing functionality or intelligently decreasing expenses in a strategic way. Within the realm of home construction, VE consists of multiple phases intended to assess each project component from both a functional and cost-based view collectively.

The VE process begins with the information stage, where the goal is to thoroughly comprehend the project at hand, including its technical details, financial plan, design goals, and the preferences of the homeowner. During this phase, the project team gathers information regarding the initial design, the materials selected, construction technologies, and methods of execution (Halik, 2018). Recognizing functional needs is a vital aspect, as every building component like structures, walls, roofs, utility systems, and finishes must be evaluated for their roles in fulfilling the core functions of the building, which include structural integrity, thermal comfort, appearance, and energy efficiency.

Following this is the function analysis phase, in which each construction component is examined according to its primary role and categorized into primary and secondary functions. For instance, the primary purpose of a wall is to act as a barrier and support the overall structure, while its secondary role might involve enhancing the interior visual appeal (Sumarda et al. , 2022a). The objective is to determine if alternatives exist that can provide similar functions but at reduced costs or improved efficiency. This analysis demands critical evaluation and a willingness to consider novel solutions.

In the creative stage, the VE team devises different alternative solutions or innovative strategies that can substitute current elements or techniques. For instance, in building residential homes, typical reinforced concrete structures might be replaced with precast elements or lightweight steel frameworks based on functionality, labor costs, and the timeline for implementation (Andreeva et al. , 2019). The exploration of lightweight bricks or composite materials for walls often results from this creative phase, as they can lower material costs and shorten installation periods. This stage emphasizes generating a wide array of ideas without prematurely assessing their practicality.

After multiple options are created, the process moves to the assessment stage. Each option is examined for its costs, functions, technical risks, availability of materials, and its influence on quality and implementation duration. The option that offers the best function at the lowest cost is chosen for recommendation in the execution phase (G. Harb et al. , 2023). For instance, selecting corrugated metal roofs with thermal insulation instead of traditional clay tiles can be a wise choice in hot tropical regions, as they are lighter, more straightforward to install, and extremely durable.

In the development stage, a detailed technical plan for the chosen option is prepared, which includes working drawings, specifications for materials, and a revised work schedule. These documents are then evaluated against the original plan to highlight any cost reductions, functional enhancements, or risk mitigations. For instance, in a residential setting, swapping out conventional lighting systems for energy-efficient LED lights and incorporating cross-ventilation can lower long-term utility expenses, offering additional benefits despite a slightly higher initial cost (Nanda et al. , 2023).

The concluding phase is focused on recommendations and the implementation (presentation and execution phase). The outcomes from the value engineering (VE) process are presented to the project owner or construction manager to aid their decision-making. During this phase, it's essential to communicate both technical and financial reasoning clearly, ensuring all parties understand the advantages of the proposed modifications. Implementation of VE occurs in stages aligned with the construction timeline, with close oversight to guarantee that changes do not compromise the overall quality and functionality of the structure (Wei and Chen, 2020).

When applying value engineering to residential projects, considerations for sustainability and long-term user comfort must also be taken into account. This indicates that while the primary goal of VE is to save costs, design choices should still prioritize energy efficiency, maintenance simplicity, and spatial flexibility. As stated by (Youssef et al. , 2023), the final outcome of the VE procedure should not only yield an economical building but also create a livable and comfortable home that has a long lifespan. The success of implementing value engineering (VE) in residential construction is significantly affected by various interconnected factors. VE is a methodical strategy aimed at achieving cost reductions without compromising the quality and functionality of the building. However, during execution, there are numerous supporting and hindering elements that need careful consideration to ensure VE is genuinely effective and adds value (WY El-Nashar and Elyamany, 2018).

One of the key elements contributing to the effectiveness of Value Engineering (VE) is the dedication of all parties involved. The active participation and support from project stakeholders such as owners, architects, engineers, contractors, and consultants are vital for successfully implementing the VE process. (W. El-Nashar and Elyamany, 2023). This dedication manifests in an openness to fresh concepts, a readiness to reconsider original design choices, and a willingness to embrace modifications that enhance the project's value. When everyone aligns on the primary goal of efficiency and functionality, the VE process tends to progress more fluidly, free from psychological obstacles or conflicting interests.

Having complete and precise technical data is an important supporting element. Sufficient information regarding building specifications, construction expenses, implementation timelines, and homeowner requirements is critical for the VE assessment and analysis phase. Clear data helps the VE team pinpoint which components can be altered or substituted without compromising functional value. In cases where the data is lacking or incorrect, the decision-making process becomes uncertain, potentially leading to unsatisfactory outcomes (Gunarathne et al. , 2022).

The effectiveness of human resources (HR) significantly influences the achievement of Value Engineering (VE). A group made up of skilled, inventive, and knowledgeable experts in construction is more adept at delivering creative and practical alternative solutions. Possessing strong technical expertise along with critical thinking skills is essential at all phases of VE, ranging from function analysis to cost assessment. The more proficient the team is, the higher the likelihood of successfully applying VE in housing projects.

Utilizing advanced technologies and software is also a crucial aspect. Tools like design software, cost estimation apps, and Building Information Modeling (BIM) enable project teams to accurately and swiftly simulate and evaluate different design options. With these technological resources, the identification of VE solutions can proceed more effectively and reliably, thus reducing the chances of mistakes during field implementation.

However, various hindrances can impede the successful application of VE. A primary challenge is the reluctance to change from both the project owners and the teams executing the VE. When certain stakeholders are comfortable with or attached to the original design, they may resist better alternatives related to function and expense. This cautious mindset often stems from concerns about risk, time limitations, or a misunderstanding of VE concepts.

Time restrictions for project execution represent a considerable challenge as well. In numerous instances, residential projects are under strict deadlines, leaving minimal opportunity for conducting VE assessments. If the VE process isn’t incorporated from the project's inception, integrating modifications later can disrupt the overall timeline. Hence, effective planning for VE must be a priority from the initial design phase.

A lack of comprehension regarding VE among some stakeholders presents an additional barrier. Many people still view VE solely as a means to reduce expenses without regard for quality, despite VE’s focus on balancing function and value. This misunderstanding can result in poor communication, dismissal of proposals, or even incorrect VE application. It is vital to educate both project owners and technical implementers about VE principles and advantages.

Limited availability of alternative materials or technologies poses a significant challenge, particularly if the project is executed in regions lacking diverse material options or skilled workers to utilize innovative construction techniques. As noted by Septiani et al. in 2023, while effective value engineering concepts may seem sound in theory, they often cannot be put into practice due to constraints in logistics and local resources. It is crucial to account for the factors of availability and access during the value engineering process. Furthermore, the absence of documentation and assessment of previous projects serves as a significant hindrance. Without any records or examples demonstrating how value engineering has either succeeded or failed in earlier housing projects, the VE team may struggle to create an effective strategy. This documentation is essential for evaluation, learning, and enhancing the quality of future value engineering applications, as highlighted by Nicolas Mario Gomos Pandiangan and Dwi Dinariana in 2024.

By taking into account all the facilitating and restraining elements, the implementation of value engineering in home construction should be performed in an organized and deliberate way, while actively engaging all stakeholders. The effectiveness of value engineering does not rely solely on a single factor; instead, it rests on a combination of dedication, team skills, the accessibility of information, and the willingness to innovate and tackle both technical and non-technical challenges that arise throughout the process. When these elements are effectively managed, value engineering can serve as a powerful strategy to create buildings that are efficient, functional, and of high quality (Kencana and Waty, 2021).

The use of value engineering in residential building projects greatly influences various key facets during project execution, particularly in areas like design choices, material selection, and cost efficiency. By employing a systematic approach, value engineering seeks to enhance the overall value of a project, not just by cutting costs, but also by boosting functionality at a more manageable expense (Tanoni et al. , 2023). This method highlights innovative efforts to reassess all design components to ensure every technical choice maximally benefits the project owner.

Regarding design decision-making, value engineering motivates designers to move beyond traditional solutions and explore multiple design options that can provide the same or even superior functionality through alternative means. The value engineering process necessitates a functional evaluation of each building design element (Ferdinand and Adianto, 2022b). For instance, when designing a residential roof, the value engineering approach can uncover alternative roof structures and configurations that remain robust and weather-resistant while utilizing a more cost-effective and easily installed roof truss and covering system. At this juncture, design choices become more logical, grounded in data, and consider the overall value and advantages. This approach aids in reducing unnecessary or simply aesthetic design choices that overlook efficiency.

Value engineering fosters cooperation among specialists, including architects, structural engineers, mechanical and electrical professionals, and contractors, to engage deeply in assessing the preliminary design. Each participant can share insights based on their specialized knowledge to generate design alternatives that satisfy user requirements, aesthetic values, and technical standards, all while keeping costs in check. Hence, value engineering is crucial in forming smarter, more efficient, and effective design choices (Woodhead and Berawi, 2022).

Significant impacts are also seen in material selection. Material choice is notably affected as Value Engineering (VE) creates opportunities to assess the types of materials utilized in a project, aiming to discover more cost-effective options while maintaining strength, durability, and functionality. For instance, when constructing wall components, VE enables owners and technical teams to consider replacing traditional red bricks with lighter bricks, which offer reduced weight, quicker assembly, and improved efficiency in time and labor costs (Haryanto, 2023). Similarly, when selecting materials for floors, ceilings, or roofs, VE can pinpoint local or alternative options that meet the same technical requirements but come at a lower cost, thus lowering the total expense of the project.

In addition to material prices, considerations in VE also include ease of installation, market availability, service life, and long-term maintenance.

Besides the costs of materials, VE takes into account factors like installation simplicity, availability in the market, longevity, and ongoing maintenance needs. Materials initially chosen for their popularity or aesthetic appeal may prove to be impractical over time if they demand excessive upkeep or are hard to replace if damaged (Priambudhi et al. , 2019). Through VE, the selection of materials becomes more analytical, factoring in not just the upfront price but also the overall life cycle costs. This is particularly important in residential construction, where homeowners desire comfort and simplicity in ongoing upkeep.

In terms of cost effectiveness, VE has proven to have a significant influence in controlling the project budget.

Regarding financial efficiency, VE significantly impacts budget management for projects. By pinpointing and removing costs that do not notably enhance the building's functionality, VE can greatly reduce expenditures without compromising the quality of the end product. For example, by adjusting the construction approach or sequence for greater efficiency, savings can be achieved in execution time, labor requirements, and logistics. This indicates that VE affects not just the materials but also the construction methodology and project management (Fachmi Fajar Kurniawan et al. , 2022).

The VE process also helps prevent waste from occurring due to emotional or uninformed decisions.

The VE process aids in minimizing waste caused by impulsive or poorly informed decisions. With its methodical approach, VE allows for tracking every expense to its purpose, making it possible to eliminate or substitute costs that do not significantly contribute to the building's performance or visual appeal with more economical alternatives. Consequently, VE serves as a decision-making framework that prioritizes value over mere cost or traditional practices (Sombah et al. , 2016).

The influence of Value Engineering (VE) on overall project expenses can also lead to lasting advantages for homeowners, since structures created using VE methods often display improved efficiency in terms of energy use, water consumption, and maintenance expenditures. For instance, by switching out traditional lighting with LED alternatives or adding effective natural airflow options, VE not only lowers the upfront building costs but also diminishes the homeowner's recurring monthly expenses. The beneficial effects of VE on both financial aspects and design choices require meticulous planning to be realized. VE should be applied from the outset of the design phase to ensure a comprehensive approach to identifying and evaluating value. Delaying its implementation, such as starting it when construction has already begun, reduces the chance for efficiency gains as many elements become fixed and harder to modify.

CONCLUSION AND RECOMMENDATION

The use of Value Engineering (VE) in home construction projects has shown to greatly enhance cost efficiency while maintaining the quality and functionality of the structure. By employing a thorough method and functional analysis, VE facilitates the development of more sensible and inventive design choices, which focus not just on appearance or traditional practices, but on achieving the highest possible value. This method promotes teamwork among architects, engineers, and contractors to explore design options that are still practical yet more cost-effective.

When it comes to selecting materials, VE assists in identifying better building material choices that are cost-effective, readily available, easy to install, and economical over the long term. This leads to substantial budget savings without affecting the overall quality of the final construction. VE positively influences overall cost efficiency during the building phase and in resource management, ensuring that projects are completed on schedule with ideal outcomes.

FURTHER STUDY

Future research is recommended to examine the application of Value Engineering across different types and scales of residential construction projects to evaluate its effectiveness under varying design and budget constraints. Further studies could explore the integration of Value Engineering with sustainable construction practices, such as green materials and energy-efficient designs, to assess its impact on long-term environmental and economic performance. In addition, empirical research involving post-construction evaluations may provide deeper insights into the life-cycle cost benefits and user satisfaction resulting from Value Engineering implementation. Expanding these research directions will help strengthen the evidence base for Value Engineering as a strategic tool in improving efficiency, sustainability, and value in the housing construction sector.

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