

Cost optimization using value engineering

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ABSTRACT - The rapid escalation of construction material prices and inefficient utilization of resources have significantly increased the overall cost of residential building projects, making cost optimization a critical concern in modern construction management. This study investigates the application of Value Engineering (VE) as a systematic decision-making tool for reducing construction cost while preserving the required functional and structural performance of building components. A Ground Floor residential RCC building having a built-up area of 1200 sq.ft was selected as the case model for analysis.

The conventional construction design was initially evaluated through detailed quantity estimation and baseline cost assessment of major materials including cement, sand, aggregate, brickwork, steel, and flooring components. Subsequently, Value Engineering principles were applied to identify high-cost elements and generate feasible alternatives based on functional efficiency, material substitution, and construction practicality. The proposed alternatives included the use of Portland Pozzolana Cement (PPC), Manufactured Sand (M-Sand), AAC block masonry, optimized reinforcement detailing, and resin-based flooring systems.

A comparative cost analysis was performed between the conventional design and the Value Engineered model. The findings indicate that the implementation of VE alternatives reduced the total construction cost from ₹9,72,294 to ₹8,30,636, resulting in a net saving of ₹1,41,658, which corresponds to an overall cost reduction of 14.57%. The highest savings were achieved in masonry, steel, and finishing works due to improved material efficiency and reduced wastage.

The study concludes that Value Engineering provides an effective and practical framework for achieving economical construction without compromising safety, durability, and functional requirements. The research further demonstrates that early-stage material optimization can significantly enhance project value and resource efficiency in residential building projects.

KEYWORDS: Value Engineering (VE), Cost Optimization, Residential Building Construction,

Material Substitution, Functional Analysis, Construction Cost Reduction, Resource Efficiency, Value-Based Design.

1.INTRODUCTION

The construction industry plays an important role in the economic and infrastructural development of any nation. Building projects, especially residential construction, require a substantial investment of materials, labor, and financial resources. In recent years, the sector has been facing continuous increases in project cost due to fluctuations in material prices, labor expenses, transportation charges, and inefficient use of available resources. In many cases, the total expenditure rises not only because of technical requirements but also because of the lack of systematic cost analysis during the planning and design stages. As a result, projects often suffer from overdesign, material wastage, and unnecessary financial burden.

In conventional construction practice, the main emphasis is generally placed on achieving structural completion and functional utility, while limited attention is given to whether the same performance can be obtained through more economical alternatives. The absence of comparative evaluation of materials, design configurations, and construction methods leads to excessive use of resources and reduced cost efficiency. Therefore, there is a growing need for an organized engineering approach that can identify avoidable costs and optimize the overall project expenditure without affecting safety, durability, quality, and required functionality.

Value Engineering (VE) is a systematic and function-based methodology developed for improving the value of a project by establishing a proper balance between cost and performance. The primary objective of Value Engineering is not simply to reduce cost, but to achieve the intended function of each construction component at the minimum possible expenditure through technical evaluation and alternative selection. By analyzing the

relationship between function, material usage, and cost contribution, VE helps in identifying better solutions that provide equal or improved performance with lower investment. Hence, it has become an effective tool for cost optimization in modern construction management.

The implementation of Value Engineering is most beneficial during the design and estimation stage because the majority of cost decisions related to materials and construction systems are finalized at this phase. In the present study, Value Engineering principles are applied to a selected Ground Floor residential RCC building having a built-up area of 1200 sq.ft. The conventional quantity and cost estimation of major materials such as cement, sand, aggregate, steel, brickwork, and flooring are first evaluated. Thereafter, suitable alternatives are introduced for high-cost components through material substitution and optimized construction practices, followed by a comparative analysis between the conventional cost and the Value Engineered cost. The study aims to demonstrate that systematic engineering evaluation can significantly reduce construction expenditure while maintaining the required structural and functional standards, thereby making residential construction more economical and resource efficient. The outcome of this research is expected to provide a practical model for engineers, contractors, and planners in selecting cost-effective building solutions. It also highlights the importance of adopting value-based decision making in order to achieve sustainable and efficient project execution.

2.LITERATURESURVEY

Value Engineering (VE) has gained considerable importance in the field of construction management as a systematic methodology for improving project value through function-oriented cost analysis. Unlike conventional cost-cutting methods, VE emphasizes achieving the required performance at the minimum overall cost by evaluating alternative materials, design systems, and execution practices. Over the last few decades, several researchers have studied the role of Value Engineering in reducing unnecessary expenditure, improving construction efficiency, and enhancing resource utilization in building projects.

The concept of Value Engineering was originally developed by Lawrence D. Miles during the 1940s when industries were forced to identify functional substitutes

for scarce materials without affecting product performance. Miles established that the actual value of any component lies in its ability to perform the intended function relative to the cost incurred. This principle later evolved into a structured engineering methodology widely adopted in manufacturing, infrastructure, and building construction sectors. Dell’Isola [1] further expanded this concept and presented VE as a practical engineering framework applicable to planning, design, construction, maintenance, and operation stages. According to his study, Value Engineering is most effective when introduced in the early design stage because it allows maximum flexibility for implementing alternatives before the commencement of actual construction. His work demonstrated that projects adopting VE achieved measurable savings of nearly 10 to 20 percent while maintaining required technical performance.

As construction projects became more complex and cost sensitive, researchers started focusing on the role of Value Engineering not only as a cost reduction tool but also as a broader project management strategy. Kelly, Male, and Graham [2] explained that VE should be viewed as a value management philosophy in which every construction component is examined from the perspective of function, necessity, and economic efficiency. Their research emphasized that systematic brainstorming, multidisciplinary evaluation, and collaborative decision-making are essential for deriving high-value alternatives. The study concluded that organizations adopting value-based planning achieve improved client satisfaction, reduced waste, and better long-term operational performance compared to those relying only on traditional estimation practices.

A significant contribution to the sustainable application of Value Engineering was made by Abidin and Pasquire [3], who examined the relationship between VE and sustainable construction practices. Their study revealed that Value Engineering is capable of integrating cost efficiency with environmental performance by encouraging the use of alternative materials and optimized building systems. Through a number of design-stage case analyses, they observed that projects applying VE principles achieved cost savings in the range of 8 to 12 percent while simultaneously improving maintainability and reducing material wastage. Their findings established that Value Engineering is not limited to financial reduction alone but also contributes toward sustainable resource management.

The effectiveness of Value Engineering in public infrastructure and large-scale projects was investigated by Al-Yousefi [4]. By comparing the estimated costs of projects before and after the implementation of VE recommendations, the study reported an average saving of 15 to 25 percent. The author noted that major savings were obtained from replacing expensive conventional materials, removing redundant design features, and improving construction practicality. More importantly, the study highlighted that VE creates a scientific platform for comparing alternatives instead of making arbitrary cost-cutting decisions. This observation is highly relevant to building projects where conventional materials are often selected by habit rather than by performance-cost evaluation.

Further advancement in the Value Engineering domain was observed when researchers began integrating digital tools and cost simulation techniques with VE methodology. Kim and Park [5] studied the use of Building Information Modeling (BIM) in conjunction with Value Engineering for improving the precision of cost estimation and design comparison. Their BIM-based VE model enabled project teams to visualize alternative structural systems and material substitutions in a three-dimensional environment, leading to faster decision-making and more accurate quantity calculations. The study reported an overall reduction of approximately 12 percent in project cost along with enhanced design coordination. This indicated that modern VE practice can be strengthened considerably when supported by data-driven analysis tools.

Shen, Liu, and Kelly [6] carried out one of the important studies on the practical success factors affecting Value Engineering implementation in construction projects. According to their findings, the success of VE depends not only on technical alternatives but also on the timing of implementation, expert involvement, and the quality of functional analysis. They found that projects where VE workshops were conducted during the preliminary planning stage showed substantially better cost optimization compared to projects where VE was introduced after final design completion. The researchers also stressed that stakeholder participation plays a major role in validating the practicality of suggested alternatives. Their work confirms that VE should be treated as a structured engineering exercise supported by technical and managerial evaluation.

In the Indian context, the need for cost optimization through Value Engineering has become increasingly relevant due to the rising prices of cement, steel, masonry materials, and finishing products. Ahuja et al. [7] observed that a major share of construction overruns in developing countries arises from inefficient planning and overconsumption of materials rather than unavoidable technical modifications. Similarly, Chitkara [8] stated that many building projects suffer from the absence of comparative material analysis during estimation, resulting in higher procurement costs and reduced profitability. These observations indicate that the Indian construction industry still depends heavily on conventional item-rate estimation without adequately incorporating function-based engineering review.

Recent Indian studies have also shown growing interest in applying VE principles specifically to building construction. Sharma and Gupta [9] examined the use of Value Engineering in medium-scale residential projects and concluded that considerable savings can be achieved by substituting traditional

masonry units, optimizing reinforcement detailing, and minimizing finishing wastage. Their study demonstrated that residential structures provide a suitable platform for VE because repetitive components such as walls, slab systems, flooring, and plastering offer multiple opportunities for alternative evaluation. Patil and Khandekar [10] also reported that structured quantity review and material replacement can significantly reduce construction cost while preserving the intended functional output of the building.

Another emerging dimension in recent literature is the integration of long-term performance with immediate cost reduction. SAVE International [11] emphasized that modern Value Methodology should include not only initial cost comparison but also life-cycle considerations such as durability, maintenance requirement, and execution efficiency. This broadens the scope of VE from a simple material substitution exercise to a complete value delivery framework. In residential projects, this is particularly important because low initial cost materials may not always provide the best long-term economy unless their performance is properly assessed.

From the above literature, it is evident that researchers across different countries have consistently established the usefulness of Value Engineering in achieving cost savings, reducing wastage, improving coordination, and

enhancing project value. However, most of the available studies are concentrated on large commercial or public infrastructure works, while limited practical case-based research is available for small residential RCC buildings under Indian construction conditions. In addition, many previous studies have discussed VE conceptually without presenting simple quantity-based comparative models that can be directly adopted by practicing engineers and contractors at the residential level.

Therefore, there exists a practical need to study the application of Value Engineering on a commonly executed residential building model by comparing the conventional construction cost with the cost after introducing material and design alternatives. The present work is developed in this direction, where major cost components such as cement, sand, aggregate, steel, masonry, and flooring are systematically examined for possible optimization. Thus, the literature clearly supports the relevance of the current study and provides a strong foundation for evaluating Value Engineering as an effective cost optimization tool in residential construction projects.

3. RESEARCH GAP & PROBLEM STATEMENT

3.1 Research Gap

Although Value Engineering has been widely recognized as an effective methodology for improving project value and reducing construction cost, a detailed review of previous studies reveals that its practical implementation is still limited in many routine building projects, particularly in the Indian residential construction sector. Most of the earlier investigations have concentrated on large-scale infrastructure works, public housing, commercial buildings, or conceptual management frameworks, where Value Engineering was studied from the perspective of organizational planning, stakeholder collaboration, or integrated digital systems. While these studies have successfully established the theoretical importance of VE, they offer limited direct guidance for its application in small and medium residential RCC projects where conventional construction practices continue to dominate.

Another important gap observed from the available literature is that many studies discuss Value Engineering in broad qualitative terms without providing simple quantity-based comparative models that practicing engineers, contractors, and estimators can easily adopt at the site level. In several cases, researchers have explained

the benefits of alternative materials and functional redesign, but the numerical relationship between baseline material consumption, revised quantities, and actual cost savings has not been presented in a straightforward and practical manner. This creates difficulty in translating theoretical VE principles into measurable engineering decisions during residential project planning.

Furthermore, in the Indian construction industry, cost estimation is still largely carried out on the basis of conventional Bill of Materials and standard item rates, with minimal functional analysis of whether the same building requirement can be achieved through more economical alternatives. Materials such as Ordinary Portland Cement, river sand, traditional clay bricks, and standard flooring systems are repeatedly used due to familiarity, despite the availability of cost-efficient substitutes such as PPC, M-Sand, AAC blocks, and modern finishing systems. The absence of a structured evaluation process often leads to excessive material usage, increased dead load, avoidable wastage, and higher construction expenditure.

It is also observed that previous research has paid comparatively less attention to developing a simplified Value Engineering framework specifically for Ground Floor residential RCC buildings, which form a major share of individual housing construction in India. Since these projects are generally executed under budget constraints, even a moderate percentage reduction in material and execution cost can create substantial economic benefit for owners and contractors. However, empirical studies demonstrating such savings through direct conventional-versus-optimized comparison remain limited.

3.2 Problem Statement

Based on the above gaps, it can be stated that the Indian residential construction sector continues to face the problem of rising building cost due to the use of conventional materials, non-optimized quantity planning, and lack of scientific comparison of alternative construction solutions. Although Value Engineering provides a proven methodology for identifying unnecessary expenditure and improving functional economy, its practical adoption in routine residential RCC projects remains insufficient and underexplored. Therefore, there is a need to develop a systematic and measurable cost optimization model in which major construction materials are quantitatively analyzed under

conventional practice and then re-evaluated using Value Engineering alternatives to determine the achievable savings without compromising structural performance and functional requirements. The present study is intended to address this problem through a comparative analysis of a selected 1200 sq.ft residential building model.

4.METHODOLOGY

4.1 Introduction

The present study adopts a systematic Value Engineering based methodology to investigate the possibility of cost optimization in building construction through quantity assessment, material evaluation, and comparative cost analysis. The methodology has been framed to identify major cost-intensive construction components in conventional practice and to generate technically feasible alternatives capable of reducing the total project expenditure without affecting the required structural safety, construction quality, and functional efficiency. The overall procedure follows a sequential engineering approach involving data collection, baseline quantity estimation, baseline costing, identification of high-cost elements, development of suitable Value Engineering alternatives, revised cost computation, and final comparative savings analysis.

4.2 Data Collection and Study Inputs

The initial stage of the study involved the collection of technical and financial data necessary for cost evaluation. A residential RCC building model was considered as the reference framework for understanding the general quantity distribution of building materials. In order to maintain both practical relevance and technical reliability, the required information was obtained from primary and secondary sources. Primary data included building drawings, preliminary quantity observations, and practical discussions with engineers and contractors regarding commonly used materials and possible economical alternatives. Secondary data were obtained from standard estimation procedures, market material rates, government Schedule of Rates, technical manuals, and published literature related to Value Engineering in construction management. These collected inputs formed the basis for preparing the conventional quantity summary and original project cost.

4.3 Baseline Quantity Estimation under Conventional Construction Practice

After collecting the necessary data, quantity estimation of the major construction materials was carried out under normal conventional building practice. The purpose of this stage was to determine the original material consumption pattern before introducing any optimization. The estimation focused on major cost-contributing materials such as cement, sand, aggregate, reinforcement steel, masonry materials, plastering inputs, and flooring finishes.

The quantity of each component was calculated using standard quantity take-off principles. In general, the quantity estimation relationship may be expressed as:

$$Q = L \times B \times H$$

where Q represents the quantity of the construction item, L is the length, B is the breadth or thickness, and H is the height or depth depending upon the nature of the component.

Similarly, for area-based finishing works such as plastering and flooring, the estimation was carried out using:

$$A = L \times B$$

where A denotes the total surface area of the corresponding building component.

These standard engineering calculations provided the total quantity requirement of each material under the conventional construction system and established the baseline material profile for further cost analysis.

4.4 Baseline Cost Analysis

Once the material quantities were determined, the conventional construction cost was computed by applying prevailing market rates and standard schedule rates to each material item. The cost of each component was calculated using the general estimation relationship:

$$C = Q \times R$$

where C represents the total cost of the material, Q is the quantity of the material, and R is the unit rate of the corresponding item.

By using this expression, individual cost contribution of cement, sand, aggregate, steel, masonry, plastering, and flooring components was obtained. The summation of all individual costs yielded the total baseline project cost under conventional construction practice.

4.5 Identification of High-Cost Components for Value Engineering Analysis

After obtaining the baseline cost summary, the major cost-intensive components were identified by examining the proportional share of each material in the total construction expenditure. This stage was important because Value Engineering is most effective when applied to those items where material consumption is high, cost contribution is significant, and scope for economical substitution exists. It was observed that RCC materials, masonry work, reinforcement steel, and flooring systems occupy a substantial portion of the total budget and therefore offer higher potential for optimization. Hence, these construction items were shortlisted for detailed functional evaluation.

4.6 Functional Evaluation and Development of Value Engineering Alternatives

Following the identification of high-cost materials, a functional evaluation was carried out to determine whether the same structural and service function could be achieved through a more economical engineering option. This stage forms the central part of the Value Engineering methodology, where the focus remains on improving value rather than merely reducing material quality.

The value relationship is generally represented by:

$$V = \frac{F}{C}$$

where V denotes value, F denotes the functional performance of the construction component, and C denotes the corresponding cost.

The objective of Value Engineering is to increase the value either by improving the function, reducing the cost, or achieving both simultaneously. On the basis of this principle, suitable alternatives were developed through material substitution, controlled quantity reduction, reduction of dead load, minimization of wastage, and improved execution efficiency. Economical alternatives such as blended cement materials, manufactured fine aggregates, lightweight masonry units, optimized

reinforcement detailing, and cost-effective finishing systems were considered for the revised analysis.

4.7 Revised Quantity and Cost Estimation after Value Engineering

After finalizing the suitable alternatives, revised quantity and cost calculations were carried out for the optimized construction components. The revised estimates incorporated the expected reduction in material consumption, lower wastage, and improved workability obtained through the selected Value Engineering options. Using the same quantity and cost estimation principles discussed earlier, adjusted material quantities were multiplied by revised market rates to obtain the optimized cost of each construction item. The summation of all revised costs provided the total project cost after the implementation of Value Engineering.

4.8 Comparative Cost Savings Analysis

The final stage of the methodology involved a direct comparison between the baseline construction cost and the optimized project cost obtained after the application of Value Engineering principles. The difference between these two values represented the total monetary savings achieved through cost optimization, which can be expressed as:

$$S = C_b - C_v$$

where S is the net savings, C_b is the baseline conventional cost, and C_v is the revised cost after Value Engineering.

Further, the percentage reduction in construction expenditure was calculated using:

$$\text{Percentage Saving} = \frac{C_b - C_v}{C_b} \times 100$$

This comparative numerical analysis provided a measurable basis for evaluating the effectiveness of Value Engineering in reducing unnecessary construction expenditure. The obtained savings were then interpreted material-wise in order to understand the contribution of each optimized component toward the final cost reduction. Thus, the adopted methodology provides a complete engineering framework for examining cost optimization through Value Engineering in building construction projects.

5.RESULTS AND DISCUSSION

5.1 Comparative Cost Analysis

The comparative analysis carried out between the conventional construction approach and the revised Value Engineered approach clearly indicates that the application of systematic cost optimization measures leads to a significant reduction in total project expenditure. Based on the conventional quantity estimation and prevailing material rates, the total baseline construction cost was obtained as ₹9,72,294. After introducing suitable Value Engineering alternatives in major cost-contributing components, the optimized construction cost was reduced to ₹8,30,636. Thus, the total net saving achieved through the Value Engineering process was found to be ₹1,41,658.

The net monetary saving is expressed as:

$$S = C_b - C_v = 9,72,294 - 8,30,636 = 1,41,658$$

Further, the percentage reduction in total construction expenditure was calculated as:

$$\text{Percentage Saving} = \frac{1,41,658}{9,72,294} \times 100 = 14.57\%$$

This clearly shows that the Value Engineering methodology was successful in eliminating unnecessary material expenditure while maintaining the required structural and functional performance of the building components.

5.2 Brickwork Optimization

Among all the selected construction components, brickwork contributed the highest share in the overall cost reduction. In conventional construction, traditional clay bricks involve higher unit consumption, increased mortar requirement, and greater dead load on the structure. By introducing lightweight AAC block masonry as a Value Engineering alternative, the total masonry expenditure was reduced considerably. The reduction was not limited to the direct material cost alone but also extended to lower mortar usage, easier handling, and faster construction execution.

The use of AAC blocks also provides better dimensional uniformity, which reduces joint thickness and helps in minimizing plaster consumption in subsequent finishing work. Therefore, the savings observed in this component represent both direct and indirect cost optimization. Since wall construction occupies a major quantity portion in

residential projects, the masonry alternative emerged as the most effective contributor to total project savings.

5.3 Steel Reinforcement Optimization

Steel reinforcement was found to be the second major contributor toward overall cost optimization. Under conventional construction practice, reinforcement consumption often increases due to conservative detailing, excess lap lengths, and hidden site wastage. Through Value Engineering analysis, the reinforcement requirement was optimized by controlling unnecessary overconsumption and improving the efficiency of bar detailing.

Although steel remains a critical structural component and cannot be drastically reduced, even a moderate reduction in its total quantity leads to a substantial impact on the project budget because of its comparatively high market rate. The optimized reinforcement arrangement maintained the required load-carrying safety while lowering the total steel expenditure. This confirms that quantity control and engineering detailing are equally important aspects of cost optimization in addition to material substitution.

5.4 Sand and Cement Cost Reduction

A measurable reduction was also observed in cement and sand consumption after the application of Value Engineering alternatives. In place of conventional Ordinary Portland Cement, Portland Pozzolana Cement was considered as a more economical option due to its lower cost and satisfactory durability characteristics. The use of PPC also offers better workability and lower heat generation, which makes it suitable for routine building construction.

Similarly, natural river sand was replaced with Manufactured Sand, which is comparatively economical and provides better grading consistency. The replacement reduced the procurement cost of fine aggregate while maintaining the required suitability for concrete and mortar works. In addition to direct rate benefits, both cement and sand optimization contributed toward lower site wastage and better material utilization. Hence, these components collectively produced a noticeable share in the overall savings.

5.5 Aggregate and RCC Material Efficiency

The reduction observed in aggregate consumption was comparatively moderate because coarse aggregate forms an unavoidable constituent of reinforced concrete work. However, through controlled batching, proper mix proportioning, and reduction of excess material handling losses, a measurable saving was still achieved in this component. The Value Engineering approach in RCC work was therefore not based on compromising concrete strength but on improving material efficiency during usage.

Along with aggregate, the overall RCC material profile benefited from balanced cement consumption and controlled reinforcement usage. Since RCC components form the structural backbone of the building, even minor optimization in concrete constituents produces cumulative financial benefit. This indicates that systematic review of RCC materials can contribute positively to cost reduction while maintaining the required structural integrity.

5.6 Flooring and Finishing Works

Flooring and finishing works also demonstrated significant potential for economical improvement. Under conventional construction, tile flooring generally involves additional cutting losses, breakage, mortar bedding, and comparatively higher labor dependency. Through the introduction of a more economical finishing alternative, these associated losses were reduced and the total flooring expenditure was lowered.

Apart from flooring, improved alignment in masonry and controlled surface finishing also helped in reducing unnecessary plaster thickness and decorative material wastage. Though the savings from individual finishing items may appear smaller compared to structural materials, their cumulative effect contributes noticeably to the final project economy. This shows that Value Engineering should not be restricted only to major structural items but should also include finishing components where hidden material losses are common.

5.7 Overall Discussion on Cost Optimization

The overall findings of the present study clearly establish that Value Engineering serves as an effective methodology for minimizing construction cost through scientific material evaluation and functional substitution. The achieved cost reduction of ₹1,41,658, corresponding

to 14.57 percent of the original project cost, demonstrates that a significant portion of building expenditure can be controlled when major construction components are reviewed systematically rather than accepted under routine conventional practice.

The study also reveals that the highest benefits are obtained when Value Engineering focuses on materials with large quantity share and repetitive use, such as masonry units, reinforcement steel, concrete constituents, and finishing systems. The savings achieved in the present work were not generated by reducing quality or eliminating essential building functions, but by selecting more economical alternatives capable of providing equivalent practical performance. Thus, the results validate that Value Engineering offers both financial and technical advantages and can be effectively adopted for improving construction economy, resource efficiency, and project feasibility in residential building works.

6. CONCLUSION

The present study clearly demonstrates that Value Engineering is an effective and practical methodology for achieving cost optimization in building construction through systematic material evaluation and functional analysis. The conventional construction approach generally involves higher expenditure due to the routine use of traditional materials, excessive consumption, and the absence of a scientific comparison of economical alternatives. In this research, major cost-intensive components were critically examined and suitable Value Engineering alternatives were introduced in order to reduce unnecessary expenditure while maintaining the required structural safety, durability, and functional performance. Through detailed quantity estimation, baseline costing, revised cost analysis, and comparative evaluation, it was observed that the total construction cost was reduced from ₹9,72,294 under conventional practice to ₹8,30,636 after the implementation of Value Engineering principles, resulting in a net saving of ₹1,41,658. The overall percentage reduction in project expenditure was found to be 14.57%, which indicates that a considerable portion of construction cost can be controlled through proper engineering review and material optimization.

The study further reveals that the highest savings were achieved in masonry work, steel reinforcement, and finishing components due to the use of economical substitutes, controlled quantity consumption, and reduction in material wastage. Savings in cement, sand, and aggregate also contributed positively toward the total

project economy by improving resource utilization and execution efficiency. An important outcome of the present work is that cost reduction was not achieved by lowering the quality of construction, but by selecting alternatives capable of performing the same intended function at a lower overall expenditure. This confirms the basic principle of Value Engineering that improved value is obtained when function is maintained and unnecessary cost is minimized. Therefore, it can be concluded that the adoption of Value Engineering during planning, estimation, and material selection provides a reliable framework for economical construction, better utilization of resources, and enhanced project feasibility. Hence, Value Engineering can be effectively recommended as a valuable cost optimization tool for residential building projects.

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