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"Value Engineering in Affordable Housing: A Study on Cost Optimization and Sustainable Construction Practices with Case Analysis in Nasik City"

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ABSTRACT:
The construction industry is one of the largest employment-generating sectors in India after agriculture and plays a crucial role in the nation's economic development. However, rapid urbanization has intensified the demand for affordable housing, exposing challenges such as land scarcity, high construction costs and limited financing. According to the 2011 census, India faced a shortage of nearly 19 million housing units, leading the government to implement several affordable housing initiatives. Affordable housing aims to ensure that housing costs do not exceed 30% of household income while maintaining livability, safety and inclusivity. This paper explores the application of Value Engineering (VE) as a systematic approach to balance cost, quality and time in affordable housing projects. By identifying unnecessary costs without compromising performance, VE enhances decision-making and optimizes resource allocation. The study emphasizes the significance of affordable housing in reducing homelessness, promoting social justice, generating employment and improving community health. A case analysis of housing projects in Nasik City highlights how VE principles can be applied to select construction systems, reduce wasteful expenditure and improve housing quality. The findings demonstrate that modular construction methods, standardized designs and collaborative planning with urban authorities can significantly contribute to resolving India's housing shortage while ensuring sustainability.

KEYWORDS: Affordable Housing, Value Engineering, Cost Optimization, Modular Construction, Sustainable Development, Housing Policy, Urban Planning, Nasik Case Study

INTRODUCTION

The building sector serves as a barometer for a country's level of development. In India, real estate is growing significantly as a result of economic liberalization. These days, the construction industry employs the second greatest number of skilled and semi-skilled workers after agriculture and contributes significantly to the national economy. The rise in employment prospects and labor migration has also led to a rise in the demand for housing space. The fast urban population growth that is causing housing shortages and subpar living conditions is a significant challenge for the Indian government. The twelfth five-year plan states that, as of the 2011 census, there is a shortage of about 19 million need-based housing units in the nation. Many affordable housing schemes have been introduced by the government. Affordable housing is generally understood to be housing that

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meets the needs of households whose incomes are too low to allow them to access the affordable housing market.

It is widely acknowledged that one of the most important needs for individuals, families and the environment is decent housing. A commonly accepted standard for affordable housing is that it should not surpass thirty percent of a family's gross income. Owners' taxes, insurance and maintenance costs are included in housing expenses. Household returns on housing expenses are used to calculate housing affordability, which is one of the accepted definitions of affordability. The application of logical methods and procedures, as well as the analysis and application of novel techniques through the utilization of technological advancements in various industries, including the manufacturing sector, have been facilitated by the current economic conditions. Overspending control must be accounted for from the very beginning of the building's construction.

It is essential to thoroughly examine the project and take into account all realistic options in order to attain the lowest possible costs. Value engineering is a management approach that determines the best feasible trade-off between price, performance and quality for a given good, service, process, or operation. VE is a cost-effective method of solving problems that maintains and enhances performance and quality standards while minimizing costs. Decision-making will be improved by VE, leading to the best owner fund investment while maintaining the required standard of capability and quality. The cycle's prosperity relies upon its ability to recognize chances to reduce pointless expenses while safeguarding adequacy, reliability, execution and other imperative parts that meet or surpass client necessities. This is recognized by the Indian government also, which expresses that "reasonable lodging" alludes to any lodging that meets any requirements for moderateness, including those connected with family pay, the quantity of units, EMI size, or the proportion of house cost to yearly pay.

Significance of Affordable Housing

- **Reduction of Homelessness and Conditions in Slums:**

Initiatives to provide affordable housing directly address the problems of homelessness and slums, or unofficial settlements. These initiatives offer a means of escape from substandard and unstable living conditions for individuals and families by providing them with viable housing options.

- **Social Justice and Inclusive Environments:**

Affordable housing promotes social equity by guaranteeing that people from a range of socioeconomic backgrounds have access to respectable and safe places to live. By tearing down barriers and establishing settings where people of various income levels can coexist, it promotes inclusive communities and a sense of shared resources.

- **Economic Growth and the Creation of Jobs:**

Economic activity is stimulated by the building and development of affordable housing projects. They contribute to the creation of jobs and revenue by creating employment opportunities,

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especially in the construction sector. This is not just a construction-related stimulus; it also benefits related industries like manufacturing, transportation and retail.

- **Wellness and Health:**

Better health outcomes are closely associated with having access to high-quality, reasonably priced housing. Reducing the burden on healthcare systems, stable housing conditions are necessary for both physical and mental well-being. Sufficient housing offers a safe haven, which is especially important for vulnerable groups like children, expectant mothers and the elderly. It also promotes general community health.

Difficulties in Building Affordable Housing

The Purchase of Land and Zoning Regulations:

Restricted Stock: Land that is suitable for affordable housing is often hard to come by in urban areas, which drives up competition and drives up land prices.

Zoning Regulations: Zoning regulations may complicate the development process by limiting the types of housing that can be built on available land.

Prices of materials and construction costs:

Changing Prices: Factors like inflation, market conditions and geopolitical events can all have an unpredictable impact on construction costs.

Material Price Volatility: The cost of building materials can fluctuate, which can have an effect on the project's overall budget and possibly result in overspending.

Constraints related to funding and financing:

Restricted Access to Capital: Because of lowered profit margins and perceived risks, developers of affordable housing projects frequently struggle to obtain financing.

Dependence on Government Funding: Because projects primarily depend on grants or subsidies from the government, they are susceptible to adjustments in the budget or in public policy.

2. OBJECTIVE

- Examine how VE helps the construction industry today to maintain a balance between the three important factors: money, time and quality.
- Analyze how VE affects building projects' ability to reduce costs and increase value.
- Examine misunderstandings that are frequently held about value engineering in the construction industry and explain how it differs from conventional cost-cutting strategies.
- Examine how important multidisciplinary engineering teams are to maximizing Value Engineering's advantages.
- Value engineering can be used to examine a housing project in Nasik City with an emphasis on locating and cutting out wasteful expenses.

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3. LITERATURE REVIEW

Jadhav (2018) The primary focus of is on applying lean construction principles to affordable housing. Lean construction methods and their potential to reduce costs and improve efficiency in affordable housing projects are likely the subject of the study.

Jegede and Taki (2022): investigate how to maximize building envelopes in affordable housing, particularly in Abuja, Nigeria, by utilizing locally produced materials to achieve thermal comfort. It's likely that the study covers methods for improving thermal performance in homes built with locally sourced materials.

Joglekar et al. (2018) investigate brickwork's sustainability in relation to affordable housing. The study offers insights into sustainable building techniques for affordable housing by contrasting the environmental effects of traditional burnt clay bricks and waste-based bricks.

Khan.et. al. (2022) Examined are the variables influencing the use of modular integrated construction for reasonably priced and ecologically friendly homes. Total Interpretive Structural Modeling (TISM) is probably used in the study to identify the main factors influencing the adoption of modular construction methods.

Kineber et al. (2023) carry out a stationary analysis and multi-criteria evaluation of the obstacles preventing value management from being implemented in sustainable residential building projects. The study most likely points out difficulties and roadblocks in incorporating value management techniques to make residential construction sustainable.

Kineber et al. (2022) examines sustainable urban management with a particular focus on sewer projects. The purpose of this paper is to present a new value engineering decision-making model that will improve sewer project sustainability and efficiency. It is likely that the work will investigate novel ways of making decisions in urban infrastructure development that integrate smart technologies and sustainable practices.

Kineber et al. (2022) address the difficulties in implementing value management in the Indian construction sector in this paper. This study employs a Partial Least Squares Structural Equation Modeling (PLS-SEM) methodology to examine and assess the obstacles that impede the effective implementation of value management strategies. It seeks to offer guidance on how to get around these challenges so that the construction sector can operate more sustainably and efficiently in India.

4. RESEARCH METHADOLOGY

- Five steps are involved in achieving the previously mentioned goal: Determine the method of evaluation;
- Examine the different construction methods has employed to build affordable housing;
- ascertain the most crucial evaluation criteria and the degree to which they matter;

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- order the options according to the given set of standards; Form the scoring matrix based on the criteria and assess the construction systems utilized for the case studies that are accessible.

Evaluation Technique: Value Methodology is an evaluation technique that encompasses the processes of Value Engineering, Value Analysis and Value Management. It can also be referred to as value assurance, control, or improvement. The term most frequently used to describe the entire corpus of knowledge related to enhancing value across all application domains is "value methodology." Its formal definition is a methodical approach that uses function analysis to increase the value of projects. Nonetheless, value engineering is a function-oriented methodology that employs established procedures to investigate less expensive alternatives for carrying out the system, product, or service's functions.

Depending on how accurate the decision-making process is, different evaluation techniques are used: 1) High levels of accuracy are achieved by quantitative methodologies, which rely on precise digital assessments; 2) Low levels of accuracy are achieved by qualitative methodologies, which apply numerical evaluations first to individual experiences. The qualitative method known as the weighted evaluation technique for value engineering will be utilized. Making the best decisions in an area where there are numerous engineering and financial factors requires following a formally structured process.

Value engineering principles were applied in a study to assess the development frameworks chose for significant scaffold projects in Egypt. Esteem designing procedures were utilized to decide the monetary range for three particular chunk and three unmistakable lobby structure types. A worth procedure model was created to streamline profit from speculation for building frameworks development. A man-made consciousness choice emotionally supportive network that applied the worth procedure deliberate work plan was made to decide the best boxgirder span development strategy inside the likelihood of utilizing every technique.

Evaluation Criteria: When assessing low-cost housing construction systems, eight criteria are thought to be the most crucial because they take into account both engineering and economic factors. This data will be collected via questionnaires from a sample of thirty-one people, including professionals from the Housing and Building National Research Centre, consultants from Egypt's New Urban Communities Authority and various levels of experienced engineers from Arab Contractors. These criteria are explained in Table (2) along with their respective weights. The engineer responsible for each sample must distribute the total of 100% for each criterion to show the general significance of every basis. By registering the typical level of significance regarding the example assessments' figures, the overall load of the assessment not entirely set in stone. While other rules' overall still up in the air by subjective measures, development cost and execution time models' general not entirely set in stone by quantitative measures.

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- **R: Rank**
- **S: Score**

RESULTS AND DISCUSSION

It is significant to observe that the ranking process's outcomes are consistent with the viewpoints expressed in written works. A structural system with many joints, for example, has been found to be significantly less durable than monolithic systems in terms of service life. Hence, in comparison to other conventional systems, flat slab is ranked higher for service life. For service life, on the other hand, the tunnel form achieves the highest ranking, while the two bearing wall systems receive the least favourable ranking.

It was expressed that the need for choosing the most financial piece framework relies upon network size range as follows: a) for lattice size range [4.2-6.7m] the need was [flat, strong, then, at that point, empty blocks] subsequently; b) for matrix size range [6.7-7.5m] the need was [solid, level, then, at that point, empty blocks] thusly; c) for matrix size range [7.7-8.4m] the need was [hollow blocks, level, then, at that point, solid] thusly. Be that as it may, for minimal expense lodging, the network size runs not exactly the examined. Thus, results at Table (4) which show intently needs of strong chunk framework then level section one are rationale and comfort with writing.

It was expressed that the determination of the development framework utilized for minimal expense lodging in Nasik is principally founded on expertise, information and experience without having a predetermined reference helping in this cycle. In any case, the choice cycle in creating and high level nations depends on their uniqueness and conditions.

Case Assessment: In the following contextual analysis, the choice of development frameworks utilized for as of late two minimal expense lodging projects in City, as a feature of Nasik Maharashtra, will be assessed to survey whether they line up with the ongoing outcomes. Units were executed by Brutal Development Organization in huge simultaneous efficiency, each at one sit

Case Study 1: The Most Favoured Families Initiative

Typical units are included in the Most Favoured Families project. There were five distinct construction systems utilised: coffor, reinforced block bearing walls, solid slab, flat slab and tunnel form. The units arrived fully assembled. Every structure has five stories. Every floor comprises 5-7 units, each with a 42.7 m^2 area.

All of the choices for this project are in line with the outcomes, with the exception of the Coffer alternative. Additionally, the limited three building height for bearing brick walls is overcome by using the reinforced block bearing walls system. Although the ranking of the construction systems was based on field data gathered from the aforementioned case study sites, it was still done in relation to the intended criteria. The scoring matrix for the criteria is updated. The selection

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priorities are different based on this analysis of field data. The optimal option is the tunnel form system, which is superior to the flat slab and solid slab systems.

5. CONCLUSION:

Affordable housing is not only a social necessity but also an economic catalyst in India. The research demonstrates that applying Value Engineering in housing projects ensures an optimal trade-off between cost, quality and time while reducing wasteful expenditure. Case analysis from Nasik City highlights that construction systems such as tunnel form and flat slab methods align with VE principles and enhance durability, service life and efficiency. The study concludes that widespread adoption of modular construction methods, standardization of design and materials and collaboration with local authorities are essential to overcome barriers in affordable housing. Furthermore, awareness and training programs in urban communities can promote acceptance of innovative construction practices. By strategically implementing VE, India can address its housing shortage sustainably, ensure inclusivity and improve the overall quality of urban life.

RECOMMENDATION

- **Encourage and Expand Modular Construction Methodologies:**

To effectively address the housing shortage, promote the broad adoption of modular construction techniques, as exemplified in the dissertation. Encourage the use of factory-made modular components in housing projects by advocating for policies and incentives.

Planning similar projects will lower manufacturing and assembly costs because manufacturing similar factory products requires the same mould, design parameters and materials. This will be helpful because ordering different materials in bulk will lower the cost of purchasing materials.

- **Work Together with Local Authorities and Urban Planners:**

To ensure that the suggested model is in line with city infrastructure and services, work together with local authorities and urban planners to integrate it into urban development plans.

- **Training and Community Engagement Initiatives:**

Run community engagement initiatives to inform impoverished urban areas about the advantages and viability of rapid casting and assembly methods.

- **Design and material standardization:**

Encourage the standardization of manufacturing procedures, materials and designs in order to reduce costs by utilising shared resources and bulk purchases.

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