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Original Article

Impact of Application Value Engineering on Cost Reduction for High-Rise Buildings in Egypt

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***Abstract* - *Because of the low level of awareness about this field, there are many obstacles that hinder value engineering in addition to cost factors in the construction sector in many emerging countries, so this study used a questionnaire to assess the level of awareness of value engineering in Egypt in addition to a questionnaire about the factors behind the low cost. Most of the previous studies dealt with only a few factors, but this study dealt with 18 factors that affect the cost, and some of these factors are the lack of knowledge of this engineering, the lack of local adoption of this engineering, and the lack of investment and operation. Workers in contracting companies, the study analyzed these factors, which led to four factors: the lack of sufficient experience of qualified employees, the difficulty of providing workshops, and the lack of awareness of this engineering field so this study adds to the knowledge available in this field how overcoming the factors that directly affect the cost.*

Keywords - *Value engineering, Obstacles, Construction projects, Building industry, Reduced cost.*

1. Introduction

Many researchers and scholars have been motivated by the massive investments in construction projects over the last two decades. They are now obligated to propose instructions for an optimal system for multi-storey buildings that save time and money, as structural engineering has changed over the last two decades [1]. There is no agreement on examining factors and gaps in knowledge to propose a decision-making model that will contribute to these recommendations in the cost and design phases of the life cycle [2]. Value engineering finds a solution to this challenge, as it was initially employed in fabrication during WWII and then in the construction industry [3]. The history of this field dates back to 1947, when Lawrence Miles proposed the methodology of value analysis at General Electric Company, and his concepts served as a foundation for problem-solving in many countries and sectors around the world, including industry, health care, and government service [4]. These techniques have saved millions of dollars by shedding light on unimportant costs that do not add any value to clients, and he has announced that many decisions are made based on incorrect ideas, whereas his methods have gained the consent of clients at a low cost, and he has proven that reaction suggests solutions based on their desire rather than what should be done and that value management can be used in a variety of constructive projects such as the study of telecommunications [5].

2. Review of Former Studies

2.1. An Overview

The researcher conducted a review of studies on the history, meaning, and goals of this engineering, as well as the success factors from the perspective of teamwork, with a special emphasis on analysis, which is one of the critical success factors, and the causes of low achieved value based on rating systems from specialized organizations such as the green globes [6].

In addition to a review of decision-making approaches in selection by advantages and neuron-linguistic programming in the final summary of these investigations in the last part [7].

2.2. History of Value Engineering Methodology

Lawrence Miles has been credited with developing the VE technique since he pioneered value management, value analysis, and value planning [4]. Lawrence Miles, a contractor to this company, came up with the idea of value management through his conception of analysis, for he firmly believed that clients purchase products for their specific purpose.

At the same time, a bunch of practitioners had founded the concept of an aware society in order to spread their ideas in the name of America in 1947.

VE became a common term in 1959, but the official implementation of the programme was delayed until 1961, when this ministry recruited competent engineers with the addition of VE clause in construction contracts, while in 1965 this ministry conducted a study to find opportunities for the application of this method, which caused the VE method to be adopted across the United States in the interest of cost savings, and in 1988 it was introduced to federal departments and agencies [4].

2.3. Meaning and Goal within Value Engineering

The phrases value analysis, value planning, and management all mean the same thing, and the VE technique is also known as value control, value assurance, and value amelioration [8].

The British standards ASTM refer to system and project analysis as value planning; however, the major purpose of using these terminologies is to reduce costs without sacrificing quality [9].

The Society of American Engineers defined VE as the application of techniques that assess the function of a product or service at a low cost through the elimination of non-value costs and achieve higher value to public projects, whereas Abdul-Aziz emphasized the human factor as the pillar behind the success of VE, believing that teamwork must analyze the advantages of the project as a step towards a solution that meets or exceeds the needs of the customer.

Communication skills are required, and team members should have diverse and complementary expertise in order for the team to be capable of identifying the function of a product or service and suggesting alternatives through creative thinking at a lower cost [10].

2.4. Success Factors of Value Engineering

The success of VE is dependent on directed teamwork, management support, client participation, and the designation of a project manager; therefore, haggadic noted a key component, which is that VE should be responsible for a team of specialists in many disciplines and fields [11].

Other scholars believe that success is determined by the team leader's personality, client feedback, and good cooperation with the design team of a large number of participants; however, the effort of the team will be fruitful through good communication and strategic actions of the members; however, male on 2007 believed that success is determined by elements of the VE process such as study, devotion of the members, and effective support [12].

3. The Methodology

The study should have included a questionnaire about the factors affecting the cost with the adoption of a comparison between these factors, and the choice of the survey is justified by the exploratory explanatory nature of this study, as this method allows the inclusion of many subjects in a limited time frame, compared to an interview [13].

4. Collection of Data

The study was conducted in Egypt's residential area. The building business was chosen in Egypt due to the availability of access to necessary knowledge regarding these projects [14].

The researcher developed a questionnaire regarding cost factors in the execution of construction projects in Egypt, as indicated in the first table, which shows eighteen components, while the second portion of the questionnaire displays the degree of influence of these cost factors on the five-point scale. As this scale is used in many previous studies, one is for the ineffectual factor, and five is for the highly influential.

Table 1. Factors affecting cost

CODES	Factors	References
VE 1	Very scarce construction projects apply this engineering.	Opinion of experts
VE 2	The complexity of projects that apply this engineering.	Opinion of experts
VE 3	Shortage of awareness about this engineering.	[15,16,17,18,19,20,21,22,23,24]
VE 4	Absence of support from owners and stakeholders.	[18,19,20,21,25,26,27]
VE 5	Non-inclusion of this engineering in contracts.	[19, 28]
VE 6	Contractors are not qualified.	Opinion of experts
VE 7	Teamwork lacks awareness of this engineering.	[29, 30,19]
VE 8	Shortage of investment and personnel in companies.	Opinion of experts
VE 9	Scarcity of experts	[30,31]
VE 10	Ineffective cooperation with teamwork.	[32]
VE 11	Incompetency of the team in the estimation of costs.	[32]
VE 12	Incompetency of the team in this engineering.	[33, 34]
VE 13	Incompetent coordinator.	[21]
VE 14	The scarcity of information is the reason behind the suggestion of solutions.	[35, 36]
VE 15	Problems in the analysis and assessment of cost reduction alternatives.	[29]
VE 16	Shortage of time in the conduct of studies.	[30,18,28,37,38,39]
VE 17	Absence of technical standards and instructions.	[40,28]
VE 18	Scarcity of information about costs.	[19,31,41]

Note: The scale for all criteria is 1 to 5, with 1 being "not a hindrance" and 5 being “extreme hindrance."

Table 2. The data of the subjects

Variable	Category	Frequency	Percentage
Nature of Work	Owner	38	19.38
	Contractor	61	31.12
	Designer	55	28.06
	Consultant	42	21.42
	Total	196	100
Profession of Subjects	General Manager, Project Manager, Engineering Manager, and Assistant Director.	24	12.24
	Construction Supervisor	44	22.44
	Specialist and Civil Engineer	86	43.87
	Quantity Surveyor	20	10.23
	Site Supervisor	22	11.22
	Total	196	100
Years of Experience	Less than five	46	23.4
	Between five and ten	98	50
	More than ten	52	26.53
	Total	196	100

Table. 3 Ranking of factors affecting cost during the application of value engineering

CODES	Factors	Mean	Normative Deviation	Rank
VE9	Scarcity of experts.	4.1786	0.890	1
VE3	Shortage of awareness about this engineering.	4.1480	0.973	2
VE17	Absence of technical standards and instructions.	4.1327	0.967	3
VE8	Shortage of investment and personnel in companies.	4.0816	1.120	4
VE18	Scarcity of information about costs.	3.8980	1.062	5
VE4	Lack of backing from owners and other stakeholders.	3.8929	1.078	6
VE14	Lack of information is the cause of the remedies being proposed.	3.8724	1.032	7
VE6	Contractors are not qualified.	3.8571	1.123	8
VE5	Non-inclusion of this engineering in contracts.	3.8367	1.097	9
VE12	Incompetency of the team in this engineering.	3.8265	1.100	10
VE13	Incompetent coordinator.	3.8061	1.124	11
VE10	Ineffective cooperation with teamwork.	3.4541	1.245	12
VE1	Very scarce construction projects apply this engineering.	3.4335	1.202	13
VE11	Incompetency of the team in the estimation of costs.	3.4235	1.154	14
VE7	Teamwork lacks awareness of this engineering.	3.3980	1.208	15
VE2	The complexity of projects that apply this engineering.	3.1480	1.302	16
VE15	Problems in the analysis and assessment of cost reduction alternatives.	3.1173	1.293	17
VE16	Shortage of time in the conductance of studies.	3.0969	1.322	18

The survey sample includes contractors, owners, consultants, and designers who attended VE seminars, while the questionnaire sample includes stakeholders ranging from 150 to 300 for factor analysis, which must fall within the parameters specified by EFA [42]**.**

The final sample size was 196, and the acquired data was analyzed for statistics as in social sciences, with the scale's validity determined by the Cranach alpha coefficient, while Nova assessed the null hypotheses. As a result, the dependent variable's mean was the same for all groups. The sample's similar opinion with the use of a mean index for cost factor ranking to extract the relevant factors based on professional opinion.

5. Results and Discussion

5.1. Analysis and Results: The Second Questionnaire

This section exhibits the data analysis findings, as well as a discussion of the findings of sample characteristics, ranking of cost factors, and discussion of findings.

5.2. Data of the Sample

The table 2 displays the sample data, with the highest number of responses coming from consultants (21.42%), followed by owners (19.38%), contractors (31.12%), and finally designers (28%). In comparison, 34.68% of the subjects were construction managers. Civil engineers and specialists, site supervisors, and quantity surveyors represent 43.87%, 11.22% and 10.23% of the sample, respectively, and the number of years of experience varies from five to ten for 50%.

5.3. Classification of Factors Affecting Cost

The preliminary analysis classified the mean value of the cost variables and determined their worth. The statistical means, standard deviations, and rankings of these values are shown in Table 3. The mean of the scale answer reflects the importance of the influencing factor in relation to other influencing variables.

However, the standard deviation of the influence factor indicates the level of agreement among respondents [43] — values of the influencer's standard deviation.

The factors are close to or less than one, indicating some agreement among the responses [44]. According to Table 3, 11 factors are classified as "severe influencers" (3.5 means 4.5), while the remaining elements are classified as "moderate effectors" (2.5 means 3.5) [45]. According to respondents' views of value engineering experts as the primary cost influencers, value engineering specialists are critical to advancing value engineering and greatly impact cost within the construction sector. According to similar studies, the lack of virtual machine professionals substantially impacts the expansion of virtual machines in China [30]. Value engineering specialists must have extensive experience and certification as a value expert or associate value specialist and technical knowledge of value engineering/ analysis [46]. While value engineering workshops are the major arena for communicating practical knowledge to participants, practical experience in these workshops is essential [47]. As a result, Egypt's scarcity of value engineering professionals may significantly impact how value engineering methods are executed. Value engineering implementation must be directed by value engineering specialists' first-hand experiences rather than textbooks or scholarly publications. Value engineering experts can also lay the groundwork for the development of local virtual machines, disseminate information about value engineering, train human resources in its use, and collaborate with the government to develop appropriate legislation regarding the implementation and financial impact of value engineering.

A lack of understanding of value engineering was identified as the second most significant cost influencer. This result was consistent with [48] scarcity of practitioners who are familiar with value engineering and may opt to ignore its presence. Practitioners desire to stick with traditional ways because they do not completely understand the benefits of value engineering and how it influences expenses. Furthermore, owners who do not understand value engineering are less likely to insist on using value engineering methodologies in their projects [49]. As a result, value engineering in the construction industry is not commonly employed or acknowledged.

Third was the lack of local norms, legislation, and technology standards. To promote the widespread use of value engineering and its cost-cutting impacts in the construction industry, guidelines, technical standards, and local value engineering must be developed [39, 28]. Because not all practitioners know value engineering and its cost impact when they first seek to implement it, practical guidance for its application and cost impact is required. Furthermore, providing practitioners with valuable guidance aids in ensuring compliance and adherence to regional construction sector peculiarities.

Then, although it had not been identified or confirmed in previous studies, respondents in this study ranked a lack of investment, supportive policies, and human resources for value engineering as the fourth most important factor, emphasizing the importance of assisting contracting companies in engineering implementation. Adopting and applying the value engineering method in enterprises can gradually transform the conventional routines and techniques commonly utilized in businesses, hence increasing the advantages of businesses. Value engineering companies can partner with other firms and groups to exchange experiences and lessons learned. Finally, effective value engineering applications can drastically lower construction business costs.

The Egyptian government has not widely promoted or developed value engineering. This is supported by the fact that the absence of a law requiring the use of value engineering in the building sector was the fifth-ranked factor. Prior American experiences, however, demonstrated that government aid was comparatively important for the successful application of value engineering [30]. Owners and stakeholders can implement value engineering in projects with the support of legislation, which may include incentive mechanisms for equitable savings and risk sharing [48].

On the other hand, the development of virtual machines necessitates the support and active engagement of all parties, as evidenced by the owners' and stakeholders' sixth-place position in support and participation. Other impediments to widespread value engineering use, which have varying effects on cost, include owners' refusal to pay for value engineering services and resistance from design consultants [50]. Owner support has been found to be the most important component.

Table. 4 Ranking of the top six factors affecting cost

Code	Mean	Rank
VE9	4.1786	1
VE3	4.1480	2
VE17	4.1327	3
VE8	4.0816	4
VE18	3.8980	5
VE4	3.8929	6

When value engineering is utilized in the construction industry, the findings of the important cost-influencing factors are shown in Table 4. Given that the rankings are based on averages, it is not surprising that the top six influencers include a lack of value engineering experts (VE9), knowledge of value engineering (VE3), local value engineering guidelines (VE17), and a lack of investments and policies. Owner and stakeholder participation that is ineffective (VE4), the cost ramifications of missing information (VE18), and support and human resources for value engineering implementation in contracting companies (VE8) are all issues that need to be addressed.

5.4. Factor Analysis of Factors Affecting Cost

Another purpose of this work is to examine the links between the cost-influencing variables to develop a more manageable list of influencing variables for use in practice. Factor analysis was used to capture the multidimensional correlations between the influencing components.

Before beginning the factor analysis, the correlation matrix was scanned to ensure it was applicable to the data. Suppose any of the variables exhibit multiple correlations. Four cost-related elements with poor correlations were excluded, as evidenced by the correlation coefficient data. Value engineering implementation challenges in proposed projects (VE2) are excluded, as are the absence of value engineering implementation clauses in contracts between owners and stakeholders (VE5), the inability to develop concepts and innovative solutions (VE14) due to a lack of information gathered early in the process, and a lack of time to implement value engineering (VE16).

Both Bartlett's sphericity test and the Kaiser-Meyer-Olkin [51]. Tests were used to determine whether the survey data was adequate. The dataset is eligible for factor analysis if the [51] index has a value larger than 0.5 and a value of (p = 0.05) is returned by Bartlett's test of sphericity.[52]. In this investigation, the KMO index score was 0.747, a significant result for the Bartlett test of sphericity (p = 0.000). (Greater than 0.5). The outcomes thus supported the idea of whether the information is suitable for factor analysis.

The communities for each variable were used to confirm the factor model's validity. Because there were approximately 196 participants in the study, all groups with values greater than 0.5 were considered legitimate [52]. Untrained and incompetent contractors (VE6) and a lack of cooperation and involvement with the internal value engineering team were two influencing factors that were usually neglected (VE10) in this test. The factor model is correct for this inquiry because the sum of all other cost factors was found to be significantly more than 0.547. The condition-to-variable ratio was around 8 observations per variant (98:12), which is consistent with the desired ratio of 5 observations per variant [53].

Following the original analysis, the remaining twelve cost-influencing components were subjected to Varimax rotation, Principal Components Analysis, and Factor Analysis. A variety of parameters can be used to calculate the amount of components to be removed. The most extensively used standard was the Kaiser criterion, sometimes known as the lowest eigenvalue. Table 5 shows the results of the principal component analysis, which was used to determine how many components to preserve. The Kaiser criterion was met by four components, which implies keeping four components with eigenvalues greater than 1.0. [52].

Table 5. The results of the analysis of the main components affecting the cost

Component	Initial Eigenvalues		
	Eigenvalues	% of variance	Cumulative %
1	10.564	61.522	61.522
2	1.852	10.785	72.307
3	1.337	7.784	80.091
4	1.077	6.270	86.361
5	0.687	4.002	90.363
6	0.544	3.169	93.532
7	0.397	2.309	95.842
8	0.297	1.729	97.571
9	0.187	1.088	98.659
10	0.120	0.701	99.360
11	0.060	0.352	99.712
12	0.049	0.288	100.000

Table 6. Matrix of cost-influencing factors following varimax turnover

Codes	Component 1	Component 2	Component 3	Component 4
VE9	1.122			
VE12	1.088			
VE11	1.017			
VE8	0.932			
VE7		1.112		
VE15		1.072		
VE13		0.941		
VE1			0.811	
VE3			1.082	
VE4			0.520	
VE18				1.058
VE17				0.988

Table 7. The four components are factors affecting cost

Components of the Obstacles	Ratio of Variation	COD	Preventing Factors
First point is about the lack of skilled workers in VE.	16.23	VE 9	Shortage of VE experts.
		VE 12	Incompetent team members in VE.
		VE 11	Incompetency of the team in the precise evaluation of costs.
		VE 8	Shortage of investments and human resources to apply VE procedures in the companies.
Second component is about problems in VE workshops.	12.5	VE 7	The design team are not fully aware of VE.
		VE 15	Difficulties in analysis and estimation of cost reduction solutions.
		VE 13	Incompetent VE coordinator
Third component is about lack of knowledge about VE existence.	9.65	VE 1	Hardly any construction projects use VE.
		VE 3	Knowledge gap regarding VE.
		VE 4	Lack of backing and active involvement of owners.
Fourth argument is that there are no VE-related documents.	8.18	VE 18	Shortage of information about costs and inexistence of VE guidelines.

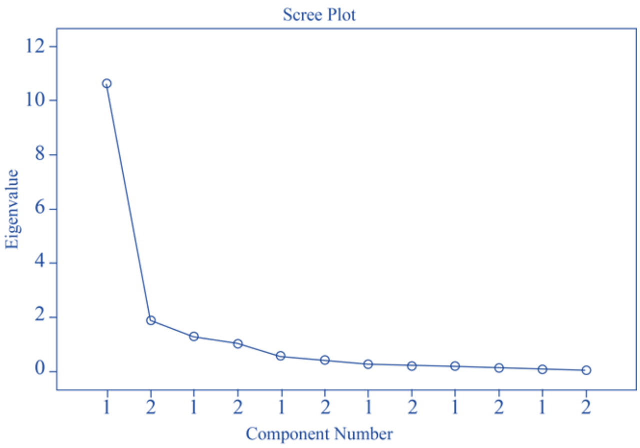

Fig. 1 Scree plot

According to the pebble plot in Fig. 1, four components were preserved to the left of the inflection point [52, 53]. These four constraints explained 86.36% of the total variation in the data.

The rounded component matrix and the cost factor load factors on these four components after varimax rotation are shown in Table 7. Variables with loads greater than 0.5 are useful in interpreting the component; those with loads less than 0.5 are considered non-significant [53]. As seen in Table 6, all factor loadings are more than 0.5.

To facilitate future debate, each component must be given a new name. Following a study of the correlations between the cost-impacting items under each component, the four extracted components can be interpreted as follows: Components 1 through 3 indicate the lack of trained employees to use Value Engineering, the difficulty in scheduling Value Engineering workshops, and the lack of awareness.

Component 4 refers to the lack of value engineering application documents in the presence of value engineering. Table 7 provides the names of the four components and the percentages of changes after the varimax rotation that each component indicates.

5.5. The Results of the Factor Analysis

In order to facilitate the discussion, each component or factor was given a specific name, and after studying the relationships between the factors affecting the cost, it was possible to extract the final four components which is the first component, which is the shortage of qualified personnel when using value engineering. VE procedures and the third component is the lack of awareness of value engineering.

The first factor is a lack of skilled labour when using value engineering, in addition to team members' inability to accurately estimate expenditures, a lack of investments, and a lack of qualified human resources in the adoption of VE in contracting companies, as this component has the highest variance of 16.23% of all subjects.

This factor represents a lack of qualified VE experts, the main barrier to adopting VE in construction projects. Because inaccurate cost estimation has a strong effect on cost, it is necessary to provide training for personnel who should acquire the necessary knowledge and skills to succeed in applying VE that achieves a positive effect on cost.

In Egypt, it is critical to establish the foundation of VE in the construction industry to gain sufficient labour with good knowledge and expertise to spread value engineering and produce a positive cost impact.

The second component discusses the complications in the value engineering workshop and their financial implications.

This factor justifies 12.5% of the data diversity, as three factors influence the cost necessary to establish the workshops competent in value engineering: a lack of knowledge about the benefits of VE, difficulties in the analysis and evaluation of alternatives, and the incompetence of the VE coordinator.

The actual studies on VE confirm the challenges in implementing value engineering that have a negative impact on costs, in addition to the subject's negative attitudes, the coordinator's incompetence, the lack of effective communication and cooperation among stakeholders, and the lack of innovative ideas, as all of these factors point to VE's inefficiency in failing to deliver the desired benefits to the project, as all of these factors point to VE's inefficiency in failing to deliver the desired benefits to the project.

The design team acknowledges that the extensive experience and technical skills do not necessitate cost estimating since the team believes that VE is an unnecessary waste of time and has doubts about the technical skills; therefore, the design team is hesitant to implement value engineering.

Adoption of value engineering necessitates the presence of a representative and a cooperative group of members, as the design team is critical to the effective implementation of value engineering and its impact on cost reduction.

To guarantee that the workshop adheres to the VE protocols, the value engineering coordinator must be innovative and motivated despite the challenges of analysis and evaluation. He or she should also communicate hope to the VE workshop participants that the workshop will yield excellent results because the coordinator is a significant cost component and can motivate team members to collaborate on projects.

The third component is a lack of understanding regarding the presence of VE and its impact on costs.

This component is made up of three cost variables: a lack of VE-adopting building projects, a lack of VE knowledge, and a lack of ownership and shareholder backing for the growth of VE and its cost-cutting effects, as this component justifies 9.65% of the total diversity of data, but the lack of awareness about the existence of value engineering is due to a lack of knowledge about VE in addition to a lack of qualified value engineering adoption.

Previous project results show that these parties' interests necessitate the support and involvement of stakeholders, as there is much evidence about the success and failure of value engineering adoption shows that owners will accept value engineering if they are interested in the cost savings that VE can provide.

The lack of support and active participation of these parties is likely due to competing benefits, which also result in their negative attitudes towards the adoption and application of value engineering in their projects.

For example, designers believe that the consumption of time and human resources is out of the question because it will reduce their profits for the fee of design, which is very low, as designers typically adhere to the routine.

The majority of owners believe that designers adopt value engineering as a component of the design phase because those designers take responsibility for the quality of the design and meet or exceed the specifications required by the owner requesting value engineering from designers. However, the owner does not accept the cost of adopting value engineering and that new building methods are adopted based on the results of various studies.

It is well known that value engineering can lead to creativity and achieve many benefits such as cost reduction; however, it is difficult to get used to change or new habits, and in order to solve the problem of a lack of knowledge about value engineering, it is critical to adopt value engineering in companies through VE seminars, training, and the adoption of value engineering models. As a result, stakeholders will understand the benefits of VE and will be willing to support and participate in its deployment.

The fourth component is the absence of documentation, which may have a negative impact on the cost.

This component justifies 8.18% of the total data difference, aside from the lack of laws that impose the application of value engineering, which has a negative effect on cost, while the other factor is the lack of documents about the application of value engineering, and the lack of practical guidelines about the adoption of VE, which prevents the spread of VE as theoretical knowledge from books and articles does not ensure the right adoption of value engineering.

Legal documents play a positive role in the application of value engineering because they organize the adoption of VE in projects and the positive participation of stakeholders who will benefit from the adoption of VE, as the promulgation of laws will augment the benefits and may discard the unimportant costs, while governments in developing countries must play a role in the promotion of VE according to law.

American law, for example, stipulates value engineering according to public law, as this law requires companies to follow the procedures of VE, while federal regulations 18 and 52 include the procedures for the inclusion of value engineering techniques in contracts, as all of the above factors have an impact on costs.

6. Plan for the Reduction of Costs

We can see from the preceding results that the most important cost-influencing aspects during the application of value engineering are classified into four components. A lack of experienced employees to apply value engineering, obstacles in the value engineering workshop and how they affect costs, and a lack of knowledge of value engineering and how it affects costs are all factors to consider. Because there are no papers on value engineering applications, value engineering must be applied in Egypt's construction projects to minimize costs and eliminate these factors at the outset.

To do this, stakeholders must be educated on the importance of incorporating new ideas into efforts through lectures and seminars. Value engineering can then be utilized to reduce components that affect expenses. As a consequence of this research, owners or business owners will be able to understand the key factors determining cost. As a result, home building professionals must know the philosophies, concepts, and tools mentioned in value engineering methodologies to reduce cost issues.

Furthermore, Stakeholder Agencies in Egypt's residential complexes should regularly offer value engineering training seminars for their members and incorporate the issue into their continuing evaluation of staff development. Along with implementing public projects, the government creates and enforces rules and regulations for various enterprises. As a result, the government will encourage the use of value engineering by developing regulations and legislation to encourage its usage in residential construction projects across the country.

Residential construction institutions are unable to use value engineering on a corporate level. Similarly, top management's approval is essential for employee training appropriate implementation procedures for these requirements must also be provided to ensure compliance within a structured plan to help eliminate the most cost-influencing components during the application of value engineering.

Based on the study's findings, the following recommendations can be made to improve the efficacy of value management strategies in Egyptian construction projects:

- Raise awareness of the value management benefits among Egyptian construction professionals through workshops, seminars, and training programmes.
- Create guidelines and standards for implementing value management in Egyptian building projects.
- Encourage collaboration and communication among all stakeholders in building projects to ensure that value management practices are successfully applied and monitored.
- Create a culture of continuous improvement in Egypt's construction industry by reviewing the efficiency of value management practices regularly and making necessary modifications.
- Create a legislative framework to ensure that value management practices are implemented effectively in Egyptian building projects.
- While the recommendations call for promoting value engineering, efforts should be made to teach and educate practitioners and owners on value engineering. The government should play a positive role in promoting value engineering and pass legislation requiring value engineering.

7. Conclusion

The researcher used the questionnaire to determine the cost-cutting factors, and the results show 18 factors in order of importance; however, the four primary factors are a lack of experts, ignorance of VE, a lack of guidelines, a lack of personnel, and a lack of personnel, as well as the absence of laws that govern the application of VE.

The conclusions of this study can assist Egyptian construction sector decision-makers in adopting value engineering and developing the plans required to put engineering measures into effect. As a result, this study adds to the corpus of information about the application of value engineering.

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