



OPTIMAL COST DESIGN APPROACH IN HIGH-RISE STRUCTURE WITH VALUE ENGINEERING: A Review

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Abstract : Keeping the costs low with traditional cost management has been a commonly applied measure to improve competitiveness. Only, keeping cost down alone is not enough, there is an increasing need for improve in schedule as well as efficiency and effectiveness. Value engineering is thus possibly of greater importance than cost management efforts. Value engineering is used to analyse the function of the materials and methods and to obtain its required functions at the lowest total cost without reducing the quality of performance. This method saves money and ensures that projects are cost-effective, time-effective and or improves the quality of the project. The methodology consists of three stages. The first is pre workshop in which the collection of data from an organization is done. The second and core stage is workshop stage with five phases which are (1) information, (2) functional, (3) creative, (4) evaluation and (5) presentation where best alternative recommendations are made. The last is post workshop stage where the recommendations from second stage will be implemented. The main aim of this paper is to develop a Value Engineering methodology that leads to reduce cost of high-rise building projects for people in an applicable way that local professionals can understand and apply.

IndexTerms - Cost efficiency, Cost management, Construction, High-Rise Building, Value Engineering.

I. INTRODUCTION

The construction sector measures a country's progress. With the liberalisation of the economy, the real estate market in India has grown in significance. Construction is currently the second-largest employer of skilled and semiskilled labour after agriculture, and it is crucial to the economy of the country.

Value analysis, value engineering, and value management all refer to a single administrative strategy for identifying workable solutions and cutting down on wasteful spending. Value analysis is a study that's done to finished projects or goods that are already in use to find ways to improve their performance and cut expenses. Value engineering is a technique used before or after the public perception phase of a project to increase the quality and lower the cost of building projects. Value Engineering Workshops or Value Analysis are Part of This Process, While Value Management is a Comprehensive Concept of How to Manage Programmes and How-to Setup Value Studies and Follow-up.

Traditional cost-cutting techniques have been used often to increase competitiveness. Everyone emphasises the idea of saving money while also giving customers more value. Value for money is always the aim of the practise of value engineering. a methodical, organised strategy to delivering the required services for a project at the lowest possible cost. Value engineering suggests using less costly substitutes for materials, processes, or procedures without decreasing their functional criteria. Instead than concentrating on their physical properties, it primarily focuses on the functionalities of diverse processes and materials. Additionally seeks to provide customers with demonstrable value increases through quality and/or cost optimisation as well as by advancing the project's timeline. It is impossible to eliminate these qualities if a business wants to continue satisfying the customer's escalating expectations. will always direct their business to locations where they may find the best combination of quality and pricing.

1.1 SCOPE

This research work is to find the possibility, importance and benefits of applying value engineering in construction project of high rise building.

1.2 NEED OF STUDY

As construction industry require huge amount of investment, and there is less implementation of Value engineering in the industry.

By value engineering we can get all possible alternate option which can be benefit to us with respect to cost, without affecting quality.

At every stage of project life cycle, the principles of pro-activeness and creating the win-win situation is necessary, keeping in mind the client's requirements.

II. LITERATURE REVIEW

No.	Author	Publication year	Title	Remarks
1.	Akintola	2001	Value Engineering and Optimal Building Projects	elements that affect construction project and their costs.
2.	Hee Sung Cha	2005	Optimizing Implementation of Value Management Processes for Capital Projects	Identification and quantification of selection criteria
3.	Philip	2006	Application of Value Engineering Within the Construction Industry	Value engineering studies with independent faciliatory
4.	Simaan	2009	Developing A Knowledge Management System for Improved Value Engineering Practices in The Construction Industry.	VEKMS to support the knowledge creation process
5.	El- Alfy	2010	Design of Sustainable Buildings Through Value Engineering	Classification of each system with sustainable factor
6.	Zarina Isnin et al.	2011	Cost Effectiveness Of Using Low Cost Housing Technologies In Construction	Antifriction of the home modification process
7.	Ferry	2012	Improving Project Performance and Waste Reduction in Construction Projects: A Case Study of a Government Institutional Building Project	Adopting reduce, recycle and reuse principle
8.	Liang et al.	2012	Value Engineering Application in Construction Project Management	Encourage the usage and the growth of value engineering
9.	Hussienb	2012	Value Engineering Analysis for The Educational Buildings in Egypt	Completion of required function with lowest costs
10.	Egyaahal	2015	Value engineering and value analysis of vertical slip form construction system	Enhance decision making resulting in better function and quality
11.	Gowrisankar	2015	Value Engineering in Residential House Construction	Information phase and its importance in value engineering
12.	Mohamed	2015	Value Engineering Applications to Improve Value in Residential Projects	Value engineering is a powerful tools box
13.	Cantwell J	2016	Concept of Value Engineering in Construction Industry	Focusing on function to minimize cost

14.	Darshan	2017	Application of Value Engineering in Construction Project: Case Study on Residential Project in Ahmedabad	Reducing project costs and suggesting advance materials
15.	Mohammad	2017	Value Engineering Practices in Infrastructure Projects: A Case Study of Ilam Gas Refinery's Water Transmission System at Reno Mountain, Iran	Investigation of all option for the transmission pipeline
16.	Gohil	2018	Review of Value Engineering in Indian Construction Industry	Budgetary control material management, technique for cost reduction

Akintola (2001) According to research, there are two categories of elements that affect construction projects and their costs: those that are particular to engineering systems and those that are more general and affect the entire structure. Value engineering works effectively because its techniques allow for raising design challenges related to the last set of elements and facilitating peer assessment of the designs [6].

Hee Sung Cha (2005) discovered that the identification and quantification of the selection criteria, such as PVO, time of commencement, relative effect, and project features, provide the basis for the choice of the value management process (VMP). From a business standpoint, this computerised selection tool makes it easier to apply VMPs in the construction sector and maximises the advantages of a certain project [11].

Philip (2006) the private construction sector does value engineering studies with an independent facilitator rarely and combines cost-cutting strategies with value engineering [21].

Simaan (2009) proposes a value engineering knowledge management system (VEKMS) to support the knowledge creation process, code and retain ideas from historical value engineering (VE) studies, and share this valuable information in the construction industry [22].

El-Alfy (2010) proposes a database of available systems with a classification of how each system complies with the various sustainability factors is suggested to be used during the system selection process, and the database needs to be updated on a regular basis with new and improved systems and materials [7].

Zarina Isnin (2011) projected that It is anticipated that the home modification projects will present a chance to improve the property's social, economic, and environmental performance, which is essential to many sustainable development theories. It provides the technique for a field research that investigates whether or not homeowners are happy with the work done through initial on-site observations and interviews. The overall backdrop of the housing project is crucial. Low cost home frequently has poor design quality and lacks basic infrastructure and facilities that satisfy people [5].

Ferry (2012) stated that Adopting "Reduce-Reuse-Recycle" (RRR) principles, intelligent excavation techniques, and straightforward "environmentally-aware" on-site practises can help reduce the amount of waste generated and local environmental consequences during project execution. In order to modernise the Indonesian construction sector and create a sustainable construction industry, green building design must use Value Engineering and Lean Construction ideas [10].

Liang et al. (2012) found that In order to encourage the usage and growth of value engineering in the construction sector, linked departments, businesses, and specialists should work closely together to assess circumstances, identify reasons, and take appropriate action [15].

Husseinb (2012) studied that The most valuable alternative is not necessarily the one with the lowest cost; rather, it is the one that accomplishes the majority of the required functions for the lowest cost. Each school building has its own criteria, and its alternatives are given different weights in relation to each criterion, even if the environment or users are similar [12].

Eqyaabal (2015) stated that value engineering may enhance decision-making that results in the best use of owner money while maintaining the necessary level of function and quality. The VE process's success is a result of its capacity to spot chances to cut wasteful expenses while guaranteeing quality, dependability, performance, and other crucial aspects that match or exceed customer expectations [29].

Gowrisankar (2015) stated that information phase has much importance to know the problem well, the idea generation will be easier if the information is wide and plenty, Decisions on idea selection may vary upon the relevancy of the information collected [18].

Mohamed (2015) Value engineering is a powerful toolbox for lowering costs while maintaining or improving quality. VE is not applied in Egypt despite known of its benefits. SAVE, the official association for value engineering practitioners, released a paper that showed their VE technique. By using VE approaches, 19% of the project's total cost was attained, which is incredibly effective [30].

Cantwell J (2016) studied that value engineering focuses on accomplishing the function which is required should be at the lowest cost. it helps in minimizing wastage of materials, unnecessary costs and time which provide value to customer [14].

Darshan (2017) found that Value engineering concepts are those with a primary goal of reducing project costs by merely suggesting more advanced substitute materials that are locally accessible to increase the project's value. The project cost may be decreased by 8% simply by switching to the correct materials, which, if the project has high construction costs, can be viewed as a significant savings when compared to the project's entire cost [9].

Mohammad (2017) surveyed a case study and found that after investigation of all options for the transmission pipeline, it is possible to reduce up to 41% of construction costs by adopting a different alternative track to cross the Reno Mountain. Future studies can focus on the proposal of novel strategies in order to achieve the best results in the VE practice [17].

Gohil (2018) studied that VE is cost saving techniques but it doesn't mean that VE is cheapening process. This technique was derived during World War II. It is not adopted widely in India. To overcome cost reduction, there are many techniques such as budgetary control, material management, and waste management [24].

III. METHODOLOGY

The **first** is pre workshop stage in the value engineering is to collect the data from an organization.

The **second** and core stage is workshop stage with five phases which are information, functional, creative, evaluation and presentation where best alternative recommendations are made.

1. **Information phases:-** This phase's goal is to pinpoint the limitations affecting the project's choices. The group gathers information on the project's scope, timeline, budget, expenses, risk, strategic goals, and logistical requirements. To achieve effective data collecting and project knowledge, this phase makes use of tools like Pareto analysis, tear down analysis, and SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats). The major goal of this stage is to make sure that everyone in the team is on the same page about the project, which will improve the development of creative solutions in subsequent phases while minimising mismatches.
2. **Function phases:-** This phase's goal is to comprehend the project from a practical point of view and determine the functions that are intended for it. The functions are categorised and identified in this stage. It is required that functions follow a certain syntax and contain just a verb and a noun. For instance, the "comfort user" feature of an HVAC system. "Enhance inner view" is another illustration of an interior design purpose. The Function Analysis System Technique (FAST), created by Mr. Charles W. Bytheway in 1964 [32], is the most widely used function model. The FAST diagram connects the verb-noun functions that may be described simply to represent complicated systems. The notations and symbols are many. However, the fact that it provides an explanation for the three main questions of how, why, and when is possibly the most important information to know.
3. **Creative phases:-** This phase's goal is to generate a variety of options that can carry out the same tasks. It is advised to apply certain well-known approaches at this stage, including brainstorming, the Gordon technique, the nominal group technique, TRIZ, and Syntetics. Since this stage is the most creative of all the others, there are few regulations in place.
4. **Evaluation phases:-** This phase's goal is to examine the collected ideas and condense them into a manageable number of suggestions that have the best chance of enhancing the project. Then, in the latter stages, one of the options on this short list will be thoroughly examined. Since there are numerous ideas and many of them are not even good for the project value, it would be extremely inefficient to completely examine each alternative right after the creative phase. This is why the evaluation step is necessary to weed out the unhelpful ideas. Pugh analysis, the Kepner-Tregoe matrix, life cycle costing, selecting by advantages, and value metrics are some of the instruments that may be utilised in this phase.
5. **Presentation phases:-** The results of the evaluation phase are provided to decision makers in this phase to help them have a better knowledge of the many VE possibilities and their short-term and long-term advantages. An projected implementation plan is also defined during this phase.

The **last** is post workshop stage where the recommendations from second stage will be implemented. The main aim is to develop a Value Engineering methodology that leads to reduce cost and improve quality of projects for people in an applicable way that local professionals can understand and apply.

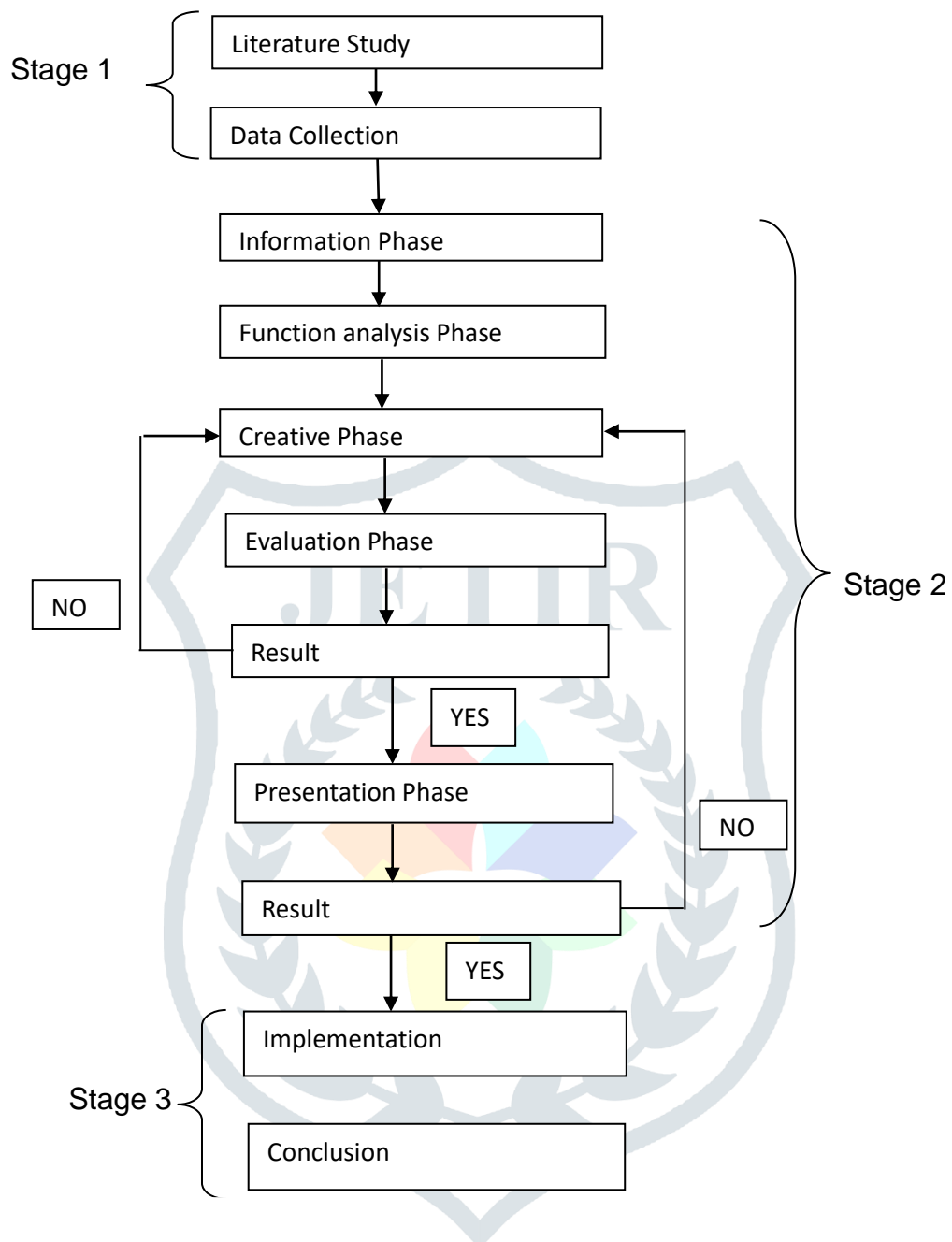


Fig 1 Methodology study process flow diagram

Steps involve:-

- Literature collection and study
- Selection of case study
- Data collection
- Interpretation of data
- Identification of feasible alternatives
- Recommendations / conclusion

IV. Case Studies

Use of acrylic paint with ceramic tiles in the walls of wet areas in residential compounds.

The VE team studied the original design versus the two following alternatives: -

- Alternative 1: The ceramic cladding covering 65% of the wall height to be covering the part of the walls in direct contact with the water and the rest will be acrylic paint.
- Alternative 2: The complete wall height will be acrylic paint.



Fig 2 Acrylic Paint



Fig 3 Ceramic Wall

Conclusion: After the study it was clear that: - The acrylic paint has an initial cost much lower than the ceramic tiles in the walls.

- Acrylic paint supply, apply and overhead = 35 SAR/m².
- Ceramic Tiles Supply, apply and overhead (considering the tile sizes specified by the consultant 40*40) = 94 SAR/m².
- The savings achieved from applying Alternative No.1 reached 50%.

When Applying the Proposed Design with the same criteria to any space there will be savings achieved reaching 40-50% according to the ceramic tiles sizes while maintaining the function and quality of the original design.

V. Future scope

This kind of value engineering exercise may be performed for a variety of projects, including those involving commercial buildings, bridges, and road transportation, and it provides the client, owner, or investor with an accurate outcome. By doing these kinds of exercises for infrastructure projects, the construction sector should be encouraged to impose a VE department inside their company, which will assist the nation's economy.

VI. Conclusion

By analysing the critical literature review we can conclude:-

- a) Value engineering has been accepted as an efficient strategy for reducing excessive project costs caused by factors such as a lack of time, knowledge, ideas, and charges.
- b) Poor value is caused by any inefficiency of the designer or other stakeholders, but it is also caused by habits, obstructions, and attitudes. By applying value engineering techniques to a project, this bad value may be mitigated.
- c) The functional requirements of users must be met, and the construction design must achieve the most reasonable cost function. However, using the traditional method based on experience is out of step with the current economic climate and the real estate environment.
- d) Value engineering aims to provide measurable value increases through cost reduction, quality improvement, and improvement of design elements for the client. This has been methodically implemented in the building's architectural, structural, and material elements. In this study, the options adopted produce cost reductions as well as schedule and quality improvements.
- e) This shows the huge scope and applicability of value engineering in building development, from the perspectives of both developers and customers. It is highly hoped that this study would open up new avenues for the building sector in order to provide the end user with the greatest possible facilities.

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REFERENCES

1. Thamarai Selvan. P, Jagannathan. P, "Developing a Module Helping to Optimize the Cost of Construction of Residential Buildings using the Concept of Value Engineering", *International Journal of Engineering Research & Technology (IJERT)* ISSN: 2278-0181 Vol. 4 (03)d, March-2015.
2. N. Tarun and N. Lokeshwaran, "A Case Study on Assessing Energy Efficiency of Existing Residential Building and Recommendations Ensuring Green Efficiency in Building Construction Projects", *International Journal of Civil Engineering and Technology*, 8(3), 2017, pp. 921–927.
3. New Age International Publishers "Value Engineering A How To Manual".
4. Brijesh Ramani, Dr. Jayeshkumar Pitroda, "A Study on Application of Value Engineering in Housing Project" *International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)* Volume 4, Issue 5, May-2018, e-ISSN: 2455-2585, Impact Factor: 3.45 (SJIF-2015)
5. Vivian W. Y. Tam "Cost Effectiveness Of Using Low Cost Housing Technologies In Construction" *Procedia Engineering* 14 (2011) 156–160.
6. Akintola Omigbodun (2001), "Value Engineering and Optimal Building Projects", *Journal of Architectural Engineering*, Volume 7, PP 40-43.
7. Alaa El Dean El-Alfy (2010), "Design of Sustainable Buildings Through Value Engineering", *Journal of Building Appraisal*, ISSN: 1742–8262, Volume 6, Issue 1, PP 69 – 79.
8. Ahmed AlBughdadi, Amr Fathy, Ibrahim Abotaleb, Mohamed Abdelghany, Racha Rahwan, (2015), "Value Engineering Applications to Improve Value in Residential Projects", Conference Paper, May 27–30, 2015.
9. Darshan Parakhiya, Jitendra Patel (2017), "Application of Value Engineering in Construction Project: Case Study on Residential Project in Ahmedabad", *International Journal for Scientific Research & Development (IJSRD)*, ISSN: 2321- 0613, Volume 5, Issue 2.
10. Ferry Firmawan, Fadil Othman, Khairulzan Yahya (2012), "Improving Project Performance and Waste Reduction in Construction Projects: A Case Study of a Government Institutional Building Project", *International Journal of Technology*, ISSN 2086-9614, Volume 2, PP 182-192.
11. Hee Sung Cha, James T. O'Connor (2005), "Optimizing Implementation of Value Management Processes for Capital Projects", *Journal of construction engineering and management*, ISSN: 0733-9364, Volume 131, Issue 2, PP 239-251.
12. I.M. Husseinb, A.N. Ibraheemb, I.A. Mohammedb, M.A. Youssef, (2012), "Value Engineering Analysis for The Educational Buildings in Egypt ", *International Journal of Optimization in Civil Engineering (IJOCE)*, ISSN 2228-7558, Volume 2, Issue 1, PP 103-113.
13. K. Ilayaraja, MD. Zafar Eqyaabal (2015), "Value Engineering in Construction", *Indian Journal of Science and Technology*, ISSN: 0974-6846, Volume 8, Issue 32.
14. Khaled Ali Alabd Ahmed, R. K. Pandey (2016), "Concept of Value Engineering in Construction Industry", *International Journal of Science and Research (IJSR)*, ISSN: 2319-7064, Volume 5, Issue 4.
15. Liang Yan (2012), "Value Engineering Application in Construction Project Management", *International Conference on Industrial Control and Electronics Engineering*.
16. Li Ning (2015), "Cost Control Application Research of Value Engineering in the Design Phase of Construction Project", *International Conference on Economics, Social Science, Arts, Education and Management Engineering (ESSAEME)*.
17. Mohammad Reza Afshar, Omid Amiri, Vahid Shahhosseini, (2017), "Value Engineering Practices in Infrastructure Projects: A Case Study of Ilam Gas Refinery's Water Transmission System at Reno Mountain, Iran", *International Journal of Construction Management*, ISSN: 2331-2327.
18. Nayana Tom, V. Gowrisankar (2015), "Value Engineering in Residential House Construction", *International Journal of Civil Engineering and Technology (IJCIET)*, ISSN: 0976 – 6316, Volume 6, issue 6, PP 46-52.
19. Nitin L. Rane, P.M. Attarde (2016), "Application of Value Engineering in Commercial Building Projects", *International Journal of Latest Trends in Engineering and Technology(IJLTET)*, ISSN: 2278-621X, Volume 6, Issue 3.
20. O. Arivazhagan, P. Partheeban, P. Priya Rachel, V. Guru (2017), "Application of Value Engineering in Construction Job Sites – A Case Study", *International Journal of Engineering Research & Technology (IJERT)*, ISSN: 2278-0181, Volume 6, Issue 2.
21. Philip D., Stephen Mansfield, Udo-Inyang (2006) "Application of Value Engineering Within the Construction Industry" *ASC Proceedings of the 42nd Annual Conference*, Colorado State University Fort Collins, Colorado, April 20 - 22, 2006.
22. Simaan M. AbouRizk, Xiaoming Mao, Xueqing Zhang (2009), "Developing A Knowledge Management System for Improved Value Engineering Practices in The Construction Industry", *Article in Automation in Construction*, October 2009.
23. Ryosuke ANDO (2005), "Evaluation for Improvement Plan of Highways by Applying Value Engineering", *Journal of the Eastern Asia Society for Transportation Studies*, Volume 6, PP 1021 – 1035.
24. Gohil P, Patel S "Review of Value Engineering in Indian Construction Industry", *International Journal of Advanced in Management, Technology and Engineering Sciences*, Volume 8, Issue III, march-2018.

25. Ahuja., Hira, N., and Michael A Walsh, Successful Methods in Cost Engineering, A Wiley Interscience Publication, New York, 2000.
26. Khodeir, Laila M., and Alaa El Ghandour. "Examining the role of value management in controlling cost overrun [application on residential construction projects in Egypt]." *Ain Shams Engineering Journal* 10.3 (2019): 471-479.
27. Aigbavboa, C., A. E. Oke, and S. Mojele. "Contribution of value management to construction projects in South Africa." *Conference Proceedings*. 2016.
28. Rad, Kaveh Miladi, and Omid Aminoroayaie Yamini. "The methodology of using value engineering in construction projects management." *Civil Engineering Journal* 2.6 (2016): 262.
29. Mahdi, I., Khaled Heiza, and N. Abo Elenen. "Value engineering and value analysis of vertical slip form construction system." *International Journal of Application or Innovation in Engineering & Management (IJAIEM)* 4.6 (2015).
30. Tom, Nayana, and V. Gowrisankar. "Value Engineering in Residential House Construction." *International Journal of Civil Engineering* 6.6 (2015).
31. Perera, Srinath, Gayani Karunasena, and Kaushalya Selvadurai. "Application of value management in construction." *Built Environment Sri Lanka* 4.1 (2006).
32. Mohamed Abdelghany, Racha Rahwan, Ibrahim Abotaleb, Amr Fathy, Ahmed AlBughdadi, "Value Engineering Applications to Improve Value in Residential Projects" *International Journal of Application or Innovation in Engineering & Management (IJAIEM)* (2015).

