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Case Study

Value engineering in the construction sector in Egypt

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Abstract

Value engineering is considered a managing tool to accomplish the required function of a product, and service of the project while achieving the lowest cost possible. The concept developed dramatically during the past few years and became a major idea and evolution that could change the entire construction projects around the world. Then, most of those construction projects that seek to increase their value and function started to use value engineering and enhance the overall outcome and profits of the project. The idea became more familiar in Egypt as most construction projects developed this technique and seek a final improvement in the functions offered. This research aims to indicate these major value engineering elements and develop this idea on a real construction project that is located in Cairo. The case study of this research was a residential project located in Cairo where several construction elements were chosen to be the topic of this case study. The results of this analysis showed that the use of flat slab can be quite costly in the project, but at the same time can offer the required beautiful value needed and can be the best structural option available if compared to the elements. The other investigated method was the concrete pouring process which can be either the manual or the use of ready mix plant. It was indicated that the use of ready mix plant can be much easier and provide better quality control. The insulation technique and flooring were also investigated in order to determine the best alternative that could offer the needed value and at the same time can be less in cost.

Keywords: Value engineering, value analysis, value engineering in the construction sector, case study in Cairo.

Introduction

Value engineering is basically used as a tool to enhance the product's functions, and serviceability while achieving the lowest possible cost. The initial introduction of the concept of value engineering dates back to the beginning of 1950s, and then became a common practice for private sectors and multiple governmental authorities. Then, it became more commonly applied in the construction industry especially during the last decade where its purpose was about enhancing the value of products and activities. Outstandingly, only a few number of studies that were presented during the past few years that proposed the real practice of applying value engineering even though that this concept started around 50 years ago. The achievement of value engineering goals depends mainly on the team assigned and their previous experience. Previous studies showed that value engineering if applied effectively could help in generate around five to ten percent of cost savings. However, there are no clear results about the influence of value engineering in several construction projects[1].

Problem Statement: The construction sector is a critical industry in any developing or developed country and has a direct influence on the economic development. Due to the presence of multiple parties in each project, it is expected to suffer from various problems and issues during projects regardless of its types. These issues could then lead to projects delay and cost overrun, while the possibility of having waste is also high. Hence, a tool or a system might be required to enhance the overall function, while aiming at reducing the total cost of works. Most construction projects that are conducted in Egypt suffer from a huge amount of waste that could be reduced or prevented through involving the concept of value engineering.

Literature Review: Value engineering is a new methodology proposed as a tool to improve the function of products or services while considering the possibility of reducing its cost. Involving value engineering became a common practice for multiple organizations and engineering sectors since its initial introduction in 1950s. Moreover, it became widely used in the construction sector in developed countries. VE was used in various construction firms to offer solutions to their products in terms of function and overall cost. However, only limited number of studies that specifically tackled the use of value engineering in the construction sector while taking into consideration the involvement of a real project and accurate values[1].

Ilayaraja et. al.[2] indicated that value engineering is a methodology that helps in determining the expected balance between the cost, and function of a product, in addition to understanding its performance and reliability.

The concept of value engineering can be applied to offer alternative solutions to reduce the product's cost, and accomplish the desired quality and performance. Moreover, VE could be considered as a major factor to enhance the decision making criteria and offer an optimum funding for projects while considering the required quality from products. The success of this approach is having the capability of detecting and eliminating any unnecessary costs, while accomplishing the desired quality and performance by customers. This goal can be accomplished through investigating customer's needs, and then analyse each element during its entire life cycle to find alternative solutions or items[3].

Case Study

The project that will be examined using value engineering analysis is "New Cairo Housing Project" which is located New Cairo resident. The owner of this project is the Egyptian Saudi Company where the main idea of the project is to provide a newer and more developed real estate project. i. Start date of construction: January 2017, ii. End date of construction: December 2018, iii. Owner: Egyptian Saudi Company, iv. Contractor: Port said company for urban development, v. Consultant: Ehaf Company, vi. Designer: SABB our consultant, vii. Project is: residential building, viii. Project Cost: 3.5 million for each building, ix. Total project cost = 56,000,000, x. Number of apartment: 16 buildings, xi. Total area of project: 5152 m^2.

Value Engineering for Design of Slabs: Current Situation Type of slab: Solids lab.

Direct cost of solid slab for basement floor: Materials Cost
$1m^3$ ready mixed concrete= 660 LE
$1m^3$ wood for carpenter work= 120 LE 1 ton of steel = 12000LE
Quantity of steel in solids labs = $120kg/m^3$
Total material cost = ($1m^3$ ready mixed concrete x QRC) + ($1m^3$ of wood x QRC)+

$$\left(1\ ton * \frac{quantity\ of\ steel(kg)}{1000} xQ\right)$$

$$= (660\ x\ 156) + (120\ x\ 156) +$$

$$(12000\ x\ 120 * 156) + \left(12000 * \frac{120}{1000} * 156\right) =$$

$$102{,}960 + 18{,}720 + 224{,}640 = 346{,}320\ LE$$

Labours cost: Expected time of carpentry work = $\frac{\text{Q for one floor slab}}{\text{production rate per day}} = \frac{156}{21} = 8$ days
Expected time of steel work = $\frac{\text{Q for one floor slab}}{\text{production rate per day}} = \frac{156}{21} = 8$ days
Expected time of concrete pouring work = $\frac{\text{Q for one floor slab}}{\text{production rate per day}} = \frac{156}{250} = 1$ day
Labour cost for carpentry work = [(6 carpenter x 160) + (4 carpenter helpers (90)] x 8 days = 10560 LE.
Labour cost for steel work = [(4 steel fixers x 160) + (4 steel fixer helper x 90)] x 8 days = 8000 LE.
Labour cost for concrete pouring work = [(1 pump worker x 160) + (2 worker x 160) + (2 unskilled x 60) + (2 vibrators worker x 160)] x 1 days = 920 LE.
Total Labour cost = 10560 + 8000 + 920 = 19480 LE.

Equipment cost: Total equipment cost for pouring work = [(2 vibrator x 160) + (1 pump x 2000)] x 1 days = 2320 LE.
Final cost for slab = 346320 + 19840 + 2320 = 368480 LE.

Finding Alternative for Slab Design: i. Type of work: Slabs, ii. Type of executed slab: Solid Slab, iii. Alternatives - Hardy (Hollow Block) slab, Panelled Beams, Flat slab, Waffle slab.

FAST Diagram for Slab: Definition of FAST Diagram: The Function Analysis System Technique (FAST) it is a graphical representation of the dependent relationships between functions within a project.
Objectives of Fast Diagram: i. Identifying the scope of the project by showing the logical relationships between functions. ii. FAST diagram enables participants to identify of all the required functions. iii. Verify, and illustrate how, a proposed solution achieves the needs of the project. iv. Identify unnecessary, duplicated or missing functions.

Table-1: Basic and secondary functions of slabs.

Item	Basic Function	Secondary Function
Slabs	Resist loads	Avoid leakage
	Transfer loads	Provide surface
		Insulate sound
		Separate Floors
Formwork	Provide mold	-
Reinforcement	Carries tension	-
Concrete	Carries compression	-

Listing All Alternatives: Total score for Flat Slab = (5x20) +(3x12) +(5x4) +(5x3) +(4x3) = 183.
Total score for Hollow Block Slab = (4x20) +(4x12) +(4x4) +(4x3) +(3x3) = 165.
Total score for Paneled Beams = (4x20) + (4x12) +(3x4) +(3x3) +(4x3) = 161.
Total score for Waffle slab = (3x20) +(3x12) +(4x4) +(4x3) +(3x3) = 133

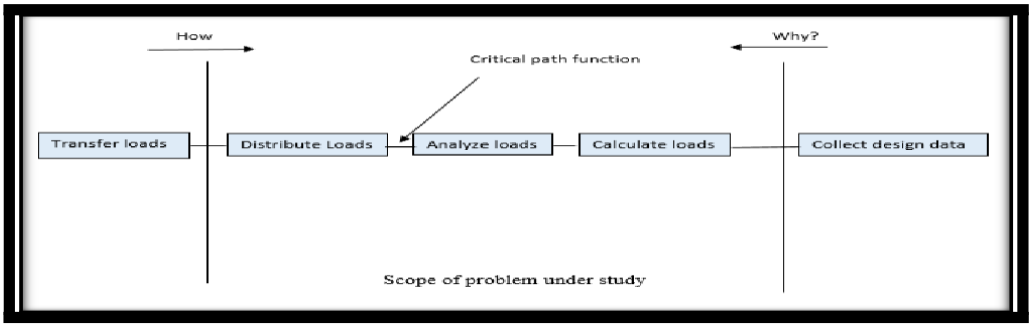

Figure-1: FAST diagram for slabs.

Table-2: Ranking criteria for slabs.

Rank	Criteria	(A)	(B)	(C)	(D)	(E)	Total
A	Resist loads		A/5	A/5	A/5	A/5	20
B	Construction cost			B/4	B/4	B/4	12
C	Faster Construction				D/3	C/4	4
D	Easier installation					E/3	3
E	Suitable for large spans						3

Table-3: Scores for the slab.

Criteria	Score
A	20
B	12
C	4
D	3
E	3

Table-4: Ranking scores for the slab.

Alternatives	A (20)	B (12)	C (4)	D (3)	E (3)	Total Score
Flat Slab	5	3	5	5	4	183
Hollow block Slab	4	4	4	4	3	165
Paneled Beams	4	4	3	3	4	161
Waffle slab	3	3	4	4	3	133

It could be concluded that the flat slab had the highest total score followed by the hollow block slab.

Best Alternative Direct Cost: Qf or floor slab = 156 m^3

Materials cost: 1m^3 Ready Mixed Concrete= 660 LE
1m^3 wood for Carpenter Work = 120 LE
1 ton of steel = 12000 LE
Quantity of steel in flat slab = 160 kg/$m3$
Total material cost = 1m3 ready mixed concrete x QRC) + 1m3 of wood x QRC) + (1- ton steel x quantity of steel

$$\frac{kg}{1000}\ x\ Q\ ) = (660\ x\ 156) + (120\ x\ 156) + \left(12000\ x \frac{160}{1000} * 156\right)$$

102,960+18,720+299,520 = 421,200 LE

Labour cost: Expected time of carpentry work = $\frac{Q\ for\ one\ floor\ slab}{production\ rate\ \ per\ day} = \frac{156}{30} = 6\ days$
Expected time of steel work = $\frac{Q\ for\ one\ floor\ slab}{production\ rate\ \ per\ day} = \frac{156}{30} =$ 6 days
Expected time of concrete pouring work = $\frac{Q\ for\ one\ floor\ slab}{production\ rate\ \ per\ day} = \frac{156}{250} = 1\ day$
Labour cost for carpentry work = [(6 carpenter x 160) + (4 carpenter helpers 90)] x 6 days = 7920 LE.
Labour cost for steel work = [(4 steel fixers x 160) + (4 steel fixer helper x 90)] x 6 days = 6000 LE.
Labour cost for concrete pouring work = [(1 pump worker x 160) + (2 worker x 160) +(2 unskilled x 60) + (2 vibrators worker x 160)] x 1 days = 920 LE.
Total Labour cost = 7920 + 6000 + 920 = 14,840 LE.

Equipment cost: Total equipment cost for pouring work = [(2 vibrator x 160) + (1 pump x 2000)] x 1 days = 2320 LE.
Final cost for slab = 421200 + 14840 + 2320 = 438,360 LE.

Table-5: Final cost for the slab.

Type of slab	Cost for 1 slab	Difference in cost
Solid slab	368480 LE	69880
Flat slab	438,360 LE	

From the previous table we can conclude that solid slab achieves best value in terms of cost.

Recommendation: Although cost of flat slab is higher than solid slab but, from factor of time and strength flat slab would be better.

Conclusion

The beginning of the concept of value engineering is tracked back to the start of the World War 2 due to the lack and shortage of materials in the construction sector as most of the consumption was related to war dedications. Then, the history of value kept on growing especially in the manufacturing industry were the owners tend to use those products that could accomplish the same function with lower costs. The value engineering is the idea of enhancing the function of the project through the use of lower costs that could provide cost savings. The procedure of value engineering contains multiple processes starting from the information stage, until reaching the presentation stage where the ideas are presented to the stakeholders.

The research then conducted a value engineering analysis on a real case study in Egypt in order to gather the procedure of value analysis on several structural elements in the building. The analysis showed that some elements can be better than others to be used in the building in terms of cost, but others can be more effective in terms of aesthetic value. The value engineering presented multiple changes to the case study that has to be taken into account in future projects.

Research Recommendations: The recommendations of this research are as the following: i. Value engineering can be the best approach used to enhance the function of construction projects and must be applied in the future. ii. The flat slab can be a better option in residential buildings in terms of aesthetic value, but the solid slab can be less in terms of cost. iii. The use of ready mix concrete from plans is much faster than the use of manual mixing and can provide higher qualities, but the use of manual mixing can be a huge cost savings. iv. The use of granite in the design of floors is quite effective especially within the design of floors that seek the aesthetic value and it is available in the market. v. The best type to design walls in buildings is the use of granite as it could offer the needed aesthetic value and quality needed. vi. The most suitable kind of insulation that could be used in buildings is the use of membrane and bitumen soil.

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