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Implementation of Value Engineering in Iraq Opportunities and Obstacles (Case Study)

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Abstract
The performance of the construction sector in Iraq suffers both price fluctuations and inaccurate estimations. Thus, the need for the development of engineering management is of paramount importance. The main objective of this study is to investigate the possibilities for implementing value engineering technique as a tool of construction management in Iraq. Moreover, to develop an overarching framework for the decision-making in construction projects. Analysing an actual case study, the Islamic sciences college at the University of Fallujah, highlighted that the value engineering is an applicable strategy in Iraq since its clear, concise, and obtaining results rapidly. A better alternative was suggested increasing durability and decreasing time and cost consumption. A precast concrete system slightly better than the steel structure due to the factors and conditions of the market. As a result, enhancing rigidity, thermal and sound isolation and code compatibility were the most essential criteria to be considered in such cases.
Keywords: Management, Precast, Analysis, Development, Cost, Time, Evaluation, Construction, Quality, Al-Anbar Province, Fallujah.

1. Introduction
Construction projects in Iraq are beset by many issues and problems due to poor management and lack of appropriate performance metrics; it is uncommon to find construction projects in Iraq that are completed on time, in budget, and to the required quality. In today's dynamic working climate, traditional performance measures such as cost, time, and quality are no longer suitable (Awss Hatim Mahmoud, 2020) ،Furthermore, this situation is not a new one to contend with, as it was, and continues to be, the primary source of concern for Iraq's infrastructure and economy. Price fluctuations, imprecise calculations, inadequate planning and scheduling, unreliable preparation, missing resources, frequent change orders, non-payment of workers' wages, waste and unsuitable materials all contributed to the poor performance (Abidali & Ali, 2018). As can be seen from the factors listed previously, the primary cause is poor management, and better time, resources, and budget management may solve many conflicts. Indeed, without adequate experience of management techniques, and from an engineering perspective especially, this reform is impossible to achieve. For decades, one of the most widespread ideas in constructing buildings is that the quality always increases the cost, but recent theoretical development has revealed that it is possible to achieve a required quality with much less cost ،Since that time, there are growing appeals to apply these techniques but, for some countries, these types of phenomena still not widely known or used. The main objective of this research is to apply one of these techniques on a project in Iraq aiming to reach alternative solutions that enhance the once used, which will be more efficient, and less costly and time-consuming. Decision making strategy during the planning phase in Iraq is mainly based on the experience of the responsible engineers, stating by selecting a structural system for a project then analysing it using structural analysis techniques, which is the main issue to be considered.

1.1. Background
Most of the construction projects in Iraq are repetitive, the main repetitive projects due to their function are residential multiple typical units beside commercial or educational multi-story buildings ،Despite this, many engineering management principles are still not applied and there is a significant weakness in the ability to complete the project with the specified quality, time and cost; although project management implementation places a greater focus on short-term organizational and tactical planning (Alajeeli & Alsodani, 2017).
This fact makes the need for a technique to choose between different types of alternatives in the construction project very limited or uncomprehensive. That is explained by the limited implementation of engineering management in the decision-making phase since the same structural system and materials are used everywhere. Traditional activities in the Iraqi construction industry have been increasingly judged, resulting in project delays, construction waste, dissatisfied users, over-budget schemes, inadequate safety and health values, and excessive resource consumption (Hadi, 2020).

1.2. The Research Objective and Methodology

The main objective is to investigate the possibilities for implementing value engineering technique as a tool of construction management in Iraq. Furthermore, to develop an overarching framework for the strategy of evaluating, developing, and choosing between the alternatives in such projects as decision-making technique. The study mainly deals with the structural system of the selected case study and try to find alternative solutions that provide the conditions mentioned above from the designing perspective which is the best time to implement the value engineering approach. Since there was not enough experience in this field it was a good opportunity to find out what can be achieved and what is the possible obstacles due to the application of this technique.

2. Literature Review

It is vital to understand construction in Iraq to identify the opportunities of giving any suggestion. The scientific level with studies and journal articles is quite high. Researchers examine many strategies and show what can be done using them, but the problem is mainly the application; since most of the projects in Iraq done by the same methodology named as *repetitive projects*, problems like:

a) The shortage of raw materials and limited experience for the workers to deal with them, using some developed methods in construction will not be suggested.
b) A limited number of tests can be done for each element to be built within the construction so the suggested alternative must be examined locally too.
c) Cost is almost everything, unfollowed perspectives or unused resources due to cost limitations will not be covered in the creative phase using the value engineering approach.

It was also obvious that factors like; rigidity, ability to be modified and fast to build are the main criteria needed to be followed in the designing and constructing phases.

2.1. Previous Studies

In 2011, Juma'a A. Al-Somadaii published his article "***Study for using value engineering and application in projects of Al-Anbar government***". He discusses the value engineering strategy by conducting a field survey and distributing a questionnaire to various project stakeholders as in Al-Anbar state at various levels, from primary and final planning to building construction stage and final operational and maintenance period. With their real onsite expertise on some of the building sites, several site tours and personal interviews were conducted. (Al-Somadaii, 2011).

In their research "***The effect of applying value engineering on reducing costs in construction projects in Iraq***" in 2018, the authors discussed the challenges and barriers that value engineering faces in Iraqi construction projects. These challenges are significant due to the variety of technological, administrative, behavioural, and social factors(Arslan & Rasham, 2018). In this study Value engineering has been applied to a case study for choosing the type of building units for a wall to be built, but this application is incomplete as it neglects the disparity between Criteria in terms of importance from the experts' point of view, which is known as Criteria weighting or Evaluation.

Followed by Suaad Khaleel I. Al-Fadhli in 2020 and her article entitled "***Value Engineering and Constructability Assessment Relating Infrastructure Projects***" Infrastructure projects in Iraq were evaluated in this study, and it discovered that they struggled on many aspects when they were initiated using conventional approaches, which resulted in a substantial loss of money. A model is formulated and extended to project phases focused on constructability and value engineering principles. The results demonstrate that by using the expertise of all project participants involved in the project, the suggested model saves time, money, and improves the necessary quality of materials and work(Al-Fadhli, 2020).

2.2. Value Engineering

In 1947 the purchase engineer Lawrence Miles in General Electric Company-GEC established his vision in GE central purchasing department named "Value Analysis" after a request from the company to increase one of their production lines (Mukhopadhyaya, 2009). Then, this theory used by the Department of Defence -Bureau of Ships in 1954 and changed its name to Value Engineering (VE). It was taken as the same principles but applied on the design phase; in the opposite of the Value Analysis, which used for an existed project consecutively the National Association of Purchasing Agents and Purchasing publication start using it. The 1960-1970s period was an essential period for Value Engineering when it was used by the Postal Service institution in the year 1967. The US National Aeronautics and Space Administration (NASA) adopted it in 1969, the US Congress recommended the use of VE in federally funded highway programs in 1970, and the US General Services Administration (GSA) in 1971As a result of this spread, the following VE professional societies were formed and founded: The Society of American Value Engineers-SAVE was established in 1959 in the United States, followed by the Indian Value Engineering Society (INVEST) in 1977. (Mukhopadhyaya, 2009).

The main objective of applying the Value Engineering approach is to balance function, performance, quality, safety and cost, and these relations give us the maximum value where the best balance can be reached as shown in Figure

1. The value of a solution is numerically (weight) calculated as shown in equation (1). L. D. Miles defined Value as "a product is considered not to have good value if it lacks either appropriate performance or cost." According to this, the value can be increased either by increasing the performance or decreasing the cost (LAWRENCE D. MILES, 1989). Also, it's defined as "At the perfect time, location, and quality, the lowest cost can be obtained from the required target (Younker, 2003).

$$\boldsymbol{Value} = \frac{\boldsymbol{Funcation} \times \boldsymbol{Quality}}{\boldsymbol{Cost}} \qquad \textbf{(1)}$$

Miles defined the Value Analysis (VA) as "is a problem-solving system implemented by the use of a specific set of techniques, a body of knowledge, and a group of learned skills." Society of American Value Engineers-SAVE defined Value Engineering (VE) as "is a method for analysing and improving manufacturing systems and services, as well as design and construction projects, business and organizational processes". We can now distinguish between (VA) and (VE) based on the definitions above. The VA refers to the analysis of an existing product, service, or administrative process, whereas the VE refers to the same analysis applied to products, services, or administrative processes that are still in the planning stage and have not yet been completed. (Ahire, C. & Chaudhari, T. & Kanjoor, P. & Chavan, A. & Patel, 2019).

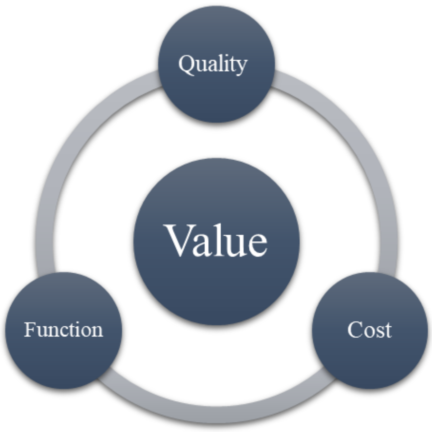

Figure 1. Value Engineering Principles

SAVE expounded the main approaches of value engineering as follow (see Figure 2):

- Information: Collect information to a deeper understanding of the project.
- Function Analysis: Analyse the project to recognize and specify the required criteria.
- Creative: Come up with ideas on all the feasible ways to achieve the required criteria.
- Evaluation: Combine theories and strategies and choose those that can be developed into real value enhancements.
- Development: Pick and organize the highest quality alternative(s) for improving value.
- Presentation: Decision-makers in the project should be informed of the value analysis suggestion.

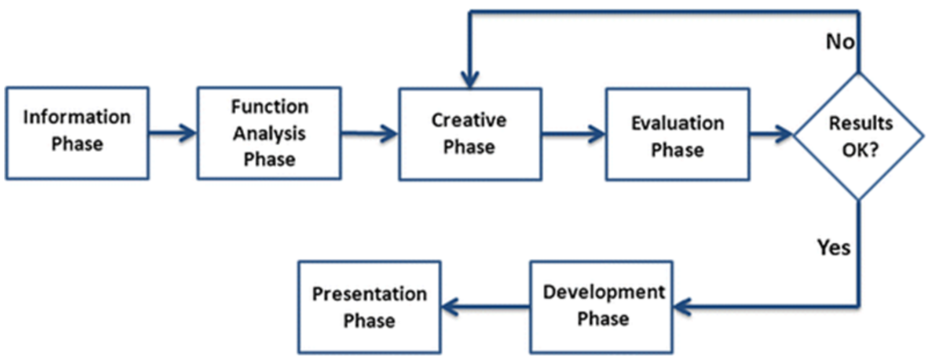

Figure 2. The main phases of value engineering – Source: (SAVE International, 2007)

2.3. Value Engineering in Iraq

The first experience for VE in Iraq was in 1990 and since that time many studies, theses and journal articles had been published, and many case studies took place until now. But, even with that much background available, these principles stayed as words on paper and has not been applied efficiently (Arslan & Rasham, 2018). This gap between this knowledge and application can be due to the challenges which faced and facing Iraq since 1991 until now and that is caused the following problems directly or indirectly:

- Design fundamentals and standards are exaggerated.
- Failure to use modern technologies to their full potential.
- Relationships and coordination between decision-making parties are lacking or missing.
- Failure to calculate and estimate the cost at the planning stage.
- Concentrating on the initial cost rather than the overall cost or life cycle cost (LCC).
- There is a limited amount of time available for analysis and innovation.

3. Research Methodology

The following is a summary of the research methodology used in this study:

- Starting with a literature review on concepts such as early-stage decision making, construction project contexts, and value engineering implementations in Iraq, the research framework and base material were built on this information.
- Providing the base information for the value analysis by asking the users and the experts about the situation of the existed design by identifying the advantages to keep it or develop it, and the disadvantages to avoid it or fix it.
- Collect the needed data to implement the value analysis including quantities, unit costs and criteria to take into consideration.
- Suggest alternatives for the existed structural system based on the collected data.
- Analyse the data using the value analysis approach for both the existing system and the suggested systems.
- Evaluate the results to come up with the best system for the selected case.
- Dictating the recommendations and the main obstacles and opportunities for implementing the value engineering approach.

4. The Case Study

The project selected for this study is in Al-Anbar province –Iraq constructed five years ago; it is a three-story educational building part of the University of Fallujah shown in figure 3. The study will focus on the structural system and will not go into other details such as the finishing works. Data were collected from the responsible engineers there, including architectural and structural drawings and feasibility studies. The purpose is to reach alternative solutions providing better quality with lower cost than the solution already used.

It should be noted that the structural system used in this project is the skeleton structural system. This study comes with a time limitation within 2 years for these results to be understood and followed for coming projects by having trained engineers and enough background of quality-cost principles.

Figure 3. Al-Anbar province Map and the Building Location

4.1. Data Collection

To give the best solutions, we must understand the situation of the existed design according to the users of the building and the engineers who are dealing with it by knowing the advantages to keep it or develop it, and disadvantages to avoid and fix it. In the first round of data collection, the following plans and information were sent to the group of experts and asked them to define the advantages and disadvantages of the design from their point of view. Besides, asking the users about their perceptions as well.

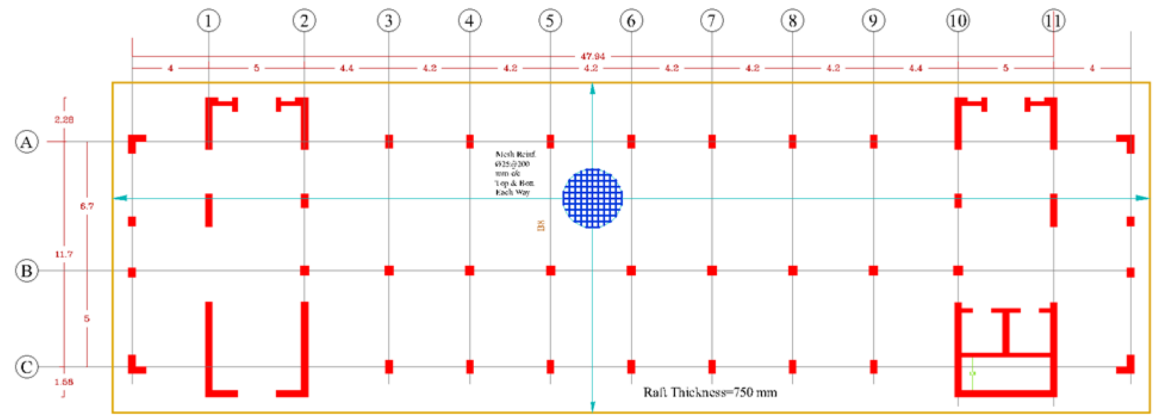

Figure 4. Foundation of the building

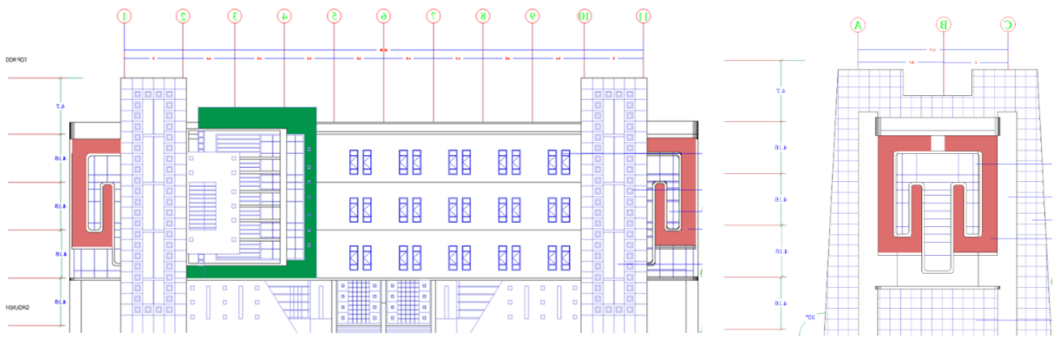

Figure 5. Side View and Front View Elevations

Table 1 - Civil Work BOQ

Main structure work		Unit	Quantity	Price (million dinar)
Foundation	Site preparation and Excavation work	m^3	1150	8.75
	Refilling + spaying Insecticides	m^3	550	7.10
	Blinding Concrete	m^2	920	11.04
	Raft Foundation	m^3	720	230.40
Masonry below D.P.C		m^3	44	8.36
Filling		m^3	460	5.52
Dump Proofing Course		m^3	7.74	2.303
Masonry Work		m^3	680	136
RC casting for beams, columns, and slabs		m^3	1220	390.40
Floor filling and grading		m^2	550	3.85
Floor concrete casting		m^2	550	6.6
TOTAL = 1.658 Billion Iraqi Dinars				

The feedback was analysed, and the following points were noted:

a) Advantages
- The architectural design meets the purpose it is designed for.
- The structural system used is the skeleton system which gives the ability to modify in some areas.
- The materials used are widely available.

b) Disadvantages
- Bad thermal and sound isolation.
- Materials and method of construction need a lot of time to deal with or to be done.
- Bad implementation during the construction phase of the building.

4.2. Criteria of the Value Engineering

After getting the full picture of the situation in Iraq generally and this project especially; the criteria which lead us to the suggested solution for the value analysis were assigned. As can be seen above, there is a need for development in durability and rigidity, environment compatibility and time-consuming aspects. On the other hand, problems like thermal and sound isolation, and the ease of repair must be considered for suggesting any solutions. As a result, using the value engineering rules by using an active verb and measurable noun, the following criteria were chosen to be evaluated.

Functions of the value analysis:
- Enhancing Rigidity
- Environment Compatibility
- Repairing Easily
- Modifying Ability
- Thermal and Sound Isolation
- Code Compatibility
- Fast Build

4.3. Analysis and Assessment

To apply the cost estimation for the alternatives, it was vital to recalculate the quantities as a modelling process then the cost analysis was made to be able to apply the value analysis approach.

4.3.1. Modelling and Quantities Calculation

To apply the value engineering concept first, accurate quantities should be defined. Regarding the AutoCAD's plans given by the responsible engineers, a modelling process is followed using the Student Version of Autodesk Revit 2020 (Available using the credentials of Ankara Yıldırım Beyazıt University). Figure 6 shows the building modelled using Revit.

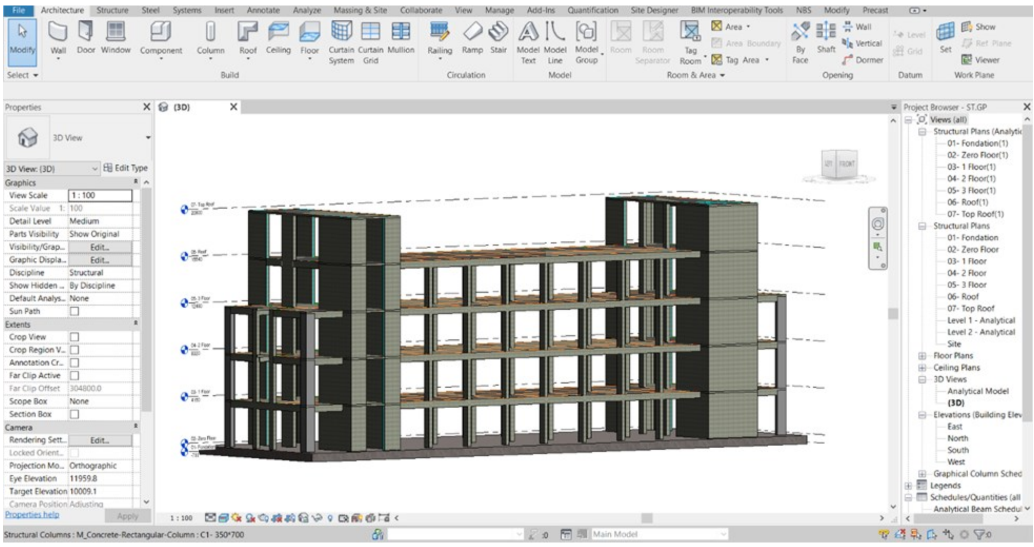

Figure 6. 3D View for the building in REVIT

Revit program gives the ability to have the quantity for any part of the building to use it in the cost estimation, it was a good opportunity to check the building quantities and cost calculation done by the designer and save a lot of time calculating it manually. so, a table of quantities has been created for the slabs to be used in the value analysis. See Table 2.

Table 2. Slab Schedule from REVIT

A	B	C	D	E	F
Absorptance	Area	Level	Structural Material	Type	Volume
0.7	686 m²	03- 1 Floor	Concrete, Cast-in-Place	Generic 160mm	109.80 m³
0.7	676 m²	04- 2 Floor	Concrete, Cast-in-Place	Generic 160mm	108.21 m³
0.7	586 m²	06- Roof	Concrete, Cast-in-Place	Generic 160mm	93.84 m³
0.7	83 m²	07- Top Roof	Concrete, Cast-in-Place	Generic 160mm	13.34 m³
0.7	676 m²	05- 3 Floor	Concrete, Cast-in-Place	Generic 160mm	108.21 m³
0.7	83 m²	07- Top Roof	Concrete, Cast-in-Place	Generic 160mm	13.35 m³

4.3.2. Weighted Evaluation in Value Engineering

Value Engineering is methodology deals at the first with the value of a solution, this value shows how much this solution is satisfying our perspectives and needs regarding the cost of applying this solution. To evaluate the factors that we select according to how much it intersects our needs we must know the importance of each factor by comparing it to the other factors, which can be called *Weighted Evaluation*. The evaluation procedure is done with the help of 11 experienced engineers and value engineering experts and it is as follow:

- Function Evaluation: The evaluation for the functions (factors) by comparing their importance to each other according to the experts. This procedure gives us a clear idea of the functions needed the most in Iraq and prevent any mistake in the value analysis by putting rigidity and modifying ability at the same level of importance. Table 4 shows the experts feedback regarding this evaluation. By calculating the average of the responses, and transforming the results out of 10, a weight for each criterion was obtained, and the importance of each factor for suggested alternative solutions is defined.

Table 3. Criteria Evaluation Results

	A	B	C	D	E	F	G
Expert 1	6	4	4	6	7	4	3
Expert 2	10	9	2	0	8	7	2
Expert 3	9	4	2	1	9	8	2
Expert 4	11	5	1	1	5	5	2
Expert 5	9	7	4	1	6	10	3
Expert 6	11	1	5	5	1	4	3
Expert 7	16	7	2	3	13	12	0
Expert 8	10	7	1	1	6	11	7
Expert 9	9	6	2	0	9	7	1
Expert 10	11	5	3	3	9	9	3
Expert 11	14	6	2	2	6	7	0
Average	**11**	**6**	**3**	**2**	**7**	**8**	**2**
out of 10	**10**	**5**	**2**	**2**	**7**	**7**	**2**

Code	A	B	C	D	E	F	G
Function (F)	Enhancing Rigidity	Environment Compatibility	Repairing Easily	Modifying Ability	Thermal and Sound Isolation	Code Compatibility	Fast Build

- Quality Evaluation: After setting each factor to it is weight, now we can evaluate the structural systems according to how much they can meet the functions we need to represent the quality of the structural system. notice that the evaluated systems were:
  a) Used structural system: Skeleton structural system.
  b) Suggested alternative structural systems:
     - Steel Structure
     - Load Bearing Walls
     - Precast concrete

Asking the experts again in the second round of evaluation to give each structural system a note, between 1-5 for each criteria previously defined, as following:1= poor, 2= fair, 3= good, 4= very good, 5= excellent. Again, with the average calculation of the responses, the quality weight of each criteria is calculated, shown in Table 4.

Table 4. Alternatives Evaluation Results

Structural System	A	B	C	D	E	F	G
Skeleton structure system	5	4	3	4	3	5	4
Steel Structure	4	3	4	4	3	4	4
Load Bearing Walls	3	4	3	3	4	4	3
Precast concrete	4	4	4	4	4	5	4

Code	A	B	C	D	E	F	G
Function (F)	Enhancing Rigidity	Environment Compatibility	Repairing Easily	Modifying Ability	Thermal and Sound Isolation	Code Compatibility	Fast Build

- Function-Quality Evaluation: this can be obtained from both previous evaluations by multiplying them with each other, then an average for each structural system can be found. The result is shown in Table 5:

Table 5. Function-Quality Evaluation

Structural System		A	B	C	D	E	F	G	Function - Quality
Steel Structure	Quality	4	4	3	4	3	5	4	129
	Function	10	5	2	2	7	7	2	
Load Bearing Walls	Quality	4	3	4	4	3	4	4	126
	Function	10	5	2	2	7	7	2	
Precast concrete	Quality	3	4	3	3	4	4	3	131
	Function	10	5	2	2	7	7	2	
Skeleton structure system	Quality	4	3	3	3	3	4	4	141
	Function	10	5	2	2	7	7	2	

4.3.3. Cost Analysis in Value Engineering

For the cost analysis process, a Life-Cycle-Cost (LCC) is used, this cost contains the initial cost of constructing plus the maintenance cost for each year summed up for the whole service life of the building and salvage value if any (Equation 3). For the initial cost of constructing, it is calculated in this project as Sum-Lum because for some structural systems there was not enough information so to have a unified procedure for the estimation process this method was applied. This method deals with the area of construction for each story which represents the unit for cost estimation.

$$\boldsymbol{Maintenance\ cost} = \sum_{\boldsymbol{Life\ Service}} (\boldsymbol{Initial\ cost} * \mathbf{5}\%) \quad \textbf{(2)}$$

$$\textbf{Toltal cost} = \textbf{Initial cost} + \textbf{Maintenance cost} \quad \textbf{(3)}$$

On the other hand, for the maintenance cost the service life fixed as 50 years (EN 1992-1-1, 2004), and for the maintenance estimation and due to the repeating process in constructing in Iraq with a small opportunity of a change to occur, a fixed percentage is defined for different cities and it was as 5% of the initial cost of the construction in Al-Anbar province (Equation 2). The results are shown in the table presenting the cost of the structural system and its alternatives to our studied project.

4.4. Value Analysis

As mentioned in the equation of value engineering (Eq.(1) and from the two previous stages, a value for each structural system was estimated to find the best system for this project. this evaluation will represent the best alternative from an engineering management point of view and that mainly include function, quality, and time aspects. According to the value analysis stage, the best solution revealed by the previous analysis must be examined to prove it. Comparison between the new system and the used system will take a place in the following section as a Comparative approach.

5. Results and Discussion

By following the mentioned steps above a value analysis process has been done and results were obtained as listed below:

- Criteria to evaluate and priorities to consider when structural system choosing were defined with the help of 11 experts and functions like enhancing rigidity, thermal and sound isolation and code compatibility were the most essential criteria.
- Life cycle cost estimation for each structural system shown that the load-bearing system is the highest cost.
- The value analysis showed that the system used by the designers was not the best solution since two structural systems were more valuable than the used one as shown in Table 5.
- The precast concrete system is the best structural system for this building which meets our suggested criteria, slightly better than the steel structure, this is mainly for the lack of raw material and technology of these systems in Iraq.

To examine the results of evaluations, and check if the available technology of precast concrete structures will enhance the overall quality, and decrease the cost, a brief comparison for it against the onsite-cast concrete will help to prove the reliability of our choice by returning to the codes and structural studies.

Table 6. Value Analysis Results

Structural System	Function - Quality	Unit Cost (million Dinar/m^2)	Total LCC Cost (Billion)	Value
Steel Structure	129	0.14	1.4014	92.35
Load Bearing Walls	126	0.22	2.2022	57.23
Precast concrete	131	0.14	1.4014	93.51
Skeleton structure system	141	0.2	2.002	70.52

5.1. Advantages of Precast Concrete Over Onsite- Cast Concrete

a) Enhancing Rigidity:

Nowak and Szerszen collect concrete control data from many sources around the United States in 2001 and these data are summarized in Table 7 below. This data shows that precast concrete gave higher strength values than the ordinary ready mixed concrete and that due to the controlled conditions of casting in the precast concrete (Wight & MacGregor, 2009). Weather in Iraq is a very critical factor in the casting process due to the high-temperature level. Indeed, especially in the Al-Anbar province, another concern is given for the sandstorms on most days of the year. So, a controlled casting in a factory will reduce the effect of these factors and neglect those many precautions done on the site.

Table 7. Nowak and Szerszen Data – Source: (Wight & MacGregor, 2009)

Type of Concrete	Number of Tests	Specified Strengths	Mean Strengths
Ordinary ready mix concrete	317	3000 to 6000 psi	4060 to 6700 psi
Ordinary plant-precast concrete	1174	5000 to 6500 psi	6910 to 7420 psi
Lightweight concrete	769	3000 to 5000 psi	4310 to 5500 psi
High-strength concrete—28 days	2052	7000 to 12,000 psi	8340 to 12,400 psi
High-strength concrete—56 days	914	7000 to 12,000 psi	10,430 to 14,000 psi

b) Time Consuming:

FIB – International Federation for Structural Concrete consist that the most important reason for the prefabricated concrete is the time consuming and by a percentage of 51% from the other reasons (FIB, 1982). Reducing time can be reached in many ways, in his book Barry Donaldson showed some of them by saying "Use of precast concrete allows earlier access by finishing trades and minimizes delays caused by bad weather, permitting year-round construction" (Barry Donaldson, 1991). The percentage of this saving Varies from a place to another according to the way of applying it and the project conditions for example in research done in Sydney University on four different projects, the precast saved 35% of the construction time (Karahasanoglu et al., 2013). In another hand, another study in IJISET calculates the saving percentage as 49%. (Dineshkumar & Kathirvel, 2015).

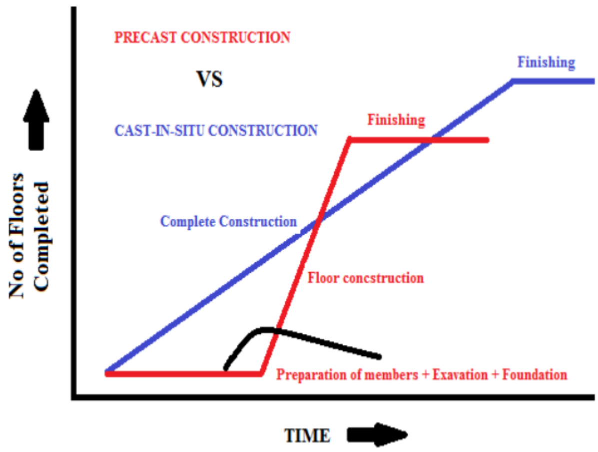

Figure 7. Precast Construction VS cast-in-situ Construction - Source:(Vyas, 2015)

c) Cost Decreasing:

Indeed, all previous reasons affect the cost and help to minimize it. Here more reasons for that decrease in the cost:

- Quantities: Since the precast gives high strength level we can reduce the Dimensions of our structural system.
- Reinforcement ratio: ACI Standards state that for walls cast-in-place concrete the minimum ratio is 0.0015 for longitudinal and 0.0025 for transverse. However, for precast concrete the minimum ratio for both reinforcement 0.001(ACI Committee 318, 2019).

- Precision: inaccuracy in casting leads to waste in the overall cost. Iraqi Standard gives the cast-in-place concrete a percentage of wasting that might happened as 5-10% while giving the precast concrete 1-5% only.
- Equipment and transportation since a series of transportation procedures must be done by casting in place. The percentage for this cost-saving also varies from a project to another, it was found as 23.22% in slabs and 21.4% in columns (Asamoah et al., 2016). on other hand, it was found as 20% (S.Senthamilkumar, 2007).
- Pay Back Period: When compared to the Precast Concrete System, the Cast-In-Place Concrete system takes longer to pay back the invested. According to Vaishali Turai and Ashish Waghmare, Cast-In-Place Concrete took 3.8 years and Precast Concrete took 2.5 years to pay back the project's investment (Turai & Waghmare, 2016).

5.2. Study Limitations

Regarding the limitations of information in the engineering economy field, it could be argued that cost analysis can be done in a better way if attention is given to this matter and a clear value is documented by the competent authorities. There are several limitations to this approach and the major source is the un-updated specifications. For example, the maintenance cost although widely accepted but is not a precise procedure to be followed because a specific value should be obtained for each different material and condition. An apparent limitation in this analysis is the unit price table since there is an urgent need for detailed prices which gives an accurate estimation.

6. Conclusion and Future Work

Due to the results and discussion of the work conducted in this project, the present findings confirm that precast concrete is more efficient by durability, cost, and time, where the superiority of precast concrete in the comparisons is illustrated above. Ideally, these findings should be replicated in a study where more accurate cost estimation can be reached and with a simulation for structural analysis approval. Besides, these findings provide additional information about the situation due to Iraq’s specifications and codes. The analysis leads to the following conclusions, construction in Iraq still need more development in the fields of engineering management and that appears in the level of dealing with the alternatives available around. Poor attention in the design phase is given to environment and isolation aspects.

On this basis, we conclude that value engineering is an applicable strategy in Iraq since its clear enough, has a limited need for information and fast result obtaining despite the limitations mentioned previously. This may be considered a promising aspect for more works in this field. This study adds to a growing corpus of research trying to increase the knowledge level about construction management in Iraq and it provides a basis for future research.

6.1. Recommendations

- Starting to deal with the precast technology widely and spread its culture in the Iraqi construction society.
- Provide more factories for casting concrete so at least in each city one of them is available.
- Conducting seminars and workshops for engineering experts, including designers, implementers, contractors, and everyone involved in decision-making to clarify the importance of using the principle of value engineering.
- Including value engineering in Iraqi contracting process with incentives to do it.
- Updating Iraq’s standards and Specifications for civil work to meet the new Knowledge and techniques.
- Updating the standards for cost estimation including the unit price and maintenance perspectives to get more wide understanding.
- Establishing a branch from any international society of value engineering or having an Iraqi independent society.
- Implementing similar studies to other modern Structural systems such as steel, wood, and composite structural systems.

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Conflict of Interests

There are no conflicts of interest declared by the authers.

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