T.C.
ISTANBUL GEDİK UNIVERSITY
INSTITUTE OF GRADUATE STUDIES

APPLICATION OF THE VALUE ENGINEERING METHODOLOGY DURING THE ELECTRICAL PROJECTS STAGES IN THE IRAQI MINISTRY OF ELECTRICITY

MASTER THESIS

Faissl G. Chremk. CHREMK

Engineering Management Department

Engineering Management Master in English Program

JANUARY 2021

T.C.
ISTANBUL GEDİK UNIVERSITY
INSTITUTE OF GRADUATE STUDIES

APPLICATION OF THE VALUE ENGINEERING METHODOLOGY DURING THE ELECTRICAL PROJECTS STAGES IN THE IRAQI MINISTRY OF ELECTRICITY

MASTER THESIS

Faissl G. Chremk. Chremk
(181281014)

Thesis Adviser: Prof. Dr. Gözde ULUTUGAY

Engineering Management Department

Engineering Management Master in English Program

JANUARY 2021

T.C.
İSTANBUL GEDİK ÜNİVERSİTESİ
LİSANSÜSTÜ EĞİTİM ENSTİTÜSÜ MÜDÜRLÜĞÜ

Yüksek Lisans Tez Onay Belgesi

Enstitümüz, Engineering Management Tezli Yüksek Lisans Programı 181281014 numaralı öğrencisi Faissl G. Chremk. Chremk'un " Application of the Value Engineering Methodology During the Electrical Projects Stages in the Iraqi Ministry of Electricity" adlı tez çalışması Enstitümüz Yönetim Kurulunun 23.12.2021 tarih ve 2020/03 sayılı kararıyla oluşturulan jüri tarafından OY BİRLİĞİ ile Yüksek Lisans tezi olarak KABUL edilmiştir.

Öğretim Üyesi Adı Soyadı	İmzası
Tez Savunma Tarihi :14/01/2021	
1)Tez Danışmanı: Prof. Dr. Gözde ULUTUGAY	....
2) Jüri Üyesi : Prof. Dr. Efendi NASİBOĞLU	....
3) Jüri Üyesi : Dr. Öğr. Üyesi Redvan GHASEMLOUNİA	....

Not: Öğrencinin Tez savunmasında **Başarılı** olması halinde bu form **imzalanacaktır**. Aksi halde geçersizdir.

To

My dear father's soul.

To

My dear mother, may God prolong her life for me.

To

My dear wife and children

To

My respected teachers

To

All colleagues

PREFACE

Thanks to God Almighty for his great blessings and generosity, and thanks to Honorable Professor Dr. Gözde ULUTAGAY, and for what she gave me of a great deal that she did not spare anyone, and perhaps her fingerprints have become clear in the institute of social sciences, in Gidek University.

I also do not miss to present my sincere thanks to all the professors of the Institute of Social Science at Gedik University, and I hope it will be the castle of science and technology.

Thanks to all the colleagues and everyone who helped me to come up with this research.

January 2021 Faissl G. Chremk. CHREMK

TABLE OF CONTENTS

Page

ABBRIVATIONS

GSA	**:** General service adds
GSM	**:** General service ministry
LAT	**:** Finite difference method
SPSS	**:** Statistical Package for the Social Sciences
US	**:** United States
VA	**:** Value analysis
VAT	**:** Value-added tax
VE	**:** Value engineering
VI	**:** Value improvement
VM	**:** Value management
VP	**:** Value planning
VR	**:** Value research

LIST OF TABLES

LIST OF FIGURS

Page

APPLICATION OF THE VALUE ENGINEERING METHODOLOGY DURING THE ELECTRICAL PROJECTS STAGES IN THE IRAQI MINISTRY OF ELECTRICITY

ABSTRACT

The purpose of applying value engineering (VE) to the phases of electric power projects in Iraq is to better understand the project scope and eliminate unnecessary costs without affecting the functional requirements of the components of these projects. Despite all the advantages of applying value engineering, it is not properly applied in electrical power projects in the Iraqi Ministry of Electricity. Therefore, this research aims to suggest a framework that facilitates the application of the value engineering methodology through the establishment of engineering departments or divisions to undertake the tasks of reviewing electric power projects. To achieve this goal, the value engineering methodology was reviewed and how it was applied during the electric power project stages, starting from the initial design stage to the recommendation stage.

The researcher relied on the deductive approach in formulating the theoretical framework of the study that serves its requirements and the inductive approach in developing hypotheses to arrive at the results and recommendations.

The researcher adopted the methods of quantitative and qualitative research, using the method of the questionnaire, and the target samples were identified Randomly, with 168 samples which the researcher believes are sufficiently large, as these answers achieved the objective of the questionnaire, which are all engineering specialties of different ages, experiences, and scientific qualifications, and finally the questionnaire was analyzed quantitatively using the SPSS program to obtain useful data that was used to determine the extent to which the value engineering methodology was adopted in stages the project. Some of the many data and indicators show the importance of applying this methodology as it will contribute to improving the basic functions of the elements and reducing the cost without compromising the functions of the electrical project.

Originality/value: The field of research is not widespread in Iraq and the Iraqi Ministry of Electricity, and it is urgently needed due to the need for projects that perform the planned functions in a focused and highly efficient manner to compensate for the shortage of electric power. Moreover, this study will add to the existing body of knowledge on the application of value engineering in Iraq. This study also recommends the adoption of value engineering divisions and departments to be added to the structure of the departments of the Iraqi Ministry of Electricity.

Results: The results of the study concluded that value engineering is still not commonly applied in the departments and headquarters of the Iraqi Ministry of Electricity. The research concluded with results and recommendations that urge in the first place to adopt the value engineering approach and to add it as a clause in the contracting conditions for electric power projects.

The study benefited from the results of the questionnaire to improve the performance of value engineering departments by focusing on adopting the methodology and standard models for value engineering.

Keywords: *Value engineering, Electric power projects, Iraqi Ministry of Electricity, SPSS.*

IRAK ELEKTRİK BAKANLIĞI ELEKTRİK PROJELERİ AŞAMALARI BOYUNCA DEĞER MÜHENDİSLİĞİ METODOLOJİSİNİN UYGULANMASI

ÖZET

Irak'taki elektrik gücü projelerinin aşamalarında "Değer Mühendisliği (DM)" uygulanmasının amacı, projenin faaliyet alanının daha iyi anlaşılması ve bu projelerin bileşenlerinin işlevsel gereksinimlerini etkilemeden gereksiz maliyetlerin elemine edilmesidir. Değer Mühendisliği'nin tüm avantajlarına rağmen, Irak Elektrik Bakanlığı'nın projelerinde bu düzgün bir şekilde uygulanmamaktadır. Bu yüzden, bu araştırma, elektrik gücü projelerinin incelenmesinde görev alacak mühendislik departmanlarının ve bölümlerinin kurulması sayesinde değer mühendisliği metodolojisinin uygulanmasını kolaylaştırmada bir çerçeve çizmeyi amaçlamaktadır. Bu amaca ulaşmak için, değer mühendisliği metodolojisinin ve ilk tasarım aşamasından öneri aşamasına kadar elektrik gücü projelerinin nasıl uygulanacağının incelenmesi söz konusudur, Araştırmacı, sonuçlara ve önerilere ulaşmada hipotezlerin geliştirilmesinde tümevarımcı yaklaşıma ve bu çalışmanın ihtiyaçlara hizmet eden teorik çerçevesini oluşturan tümdengelim yaklaşımına dayanmaktadır. Araştırmacı, anketin amacına ulaştığı için araştırmacının yeterince büyük olduğuna inandığı 168 örnekle rasgele anket yöntemini kullanarak nicel ve nitel yöntemleri benimsemiştir.Farklı yaşlardaki tüm mühendislik özellikleri, deneyimler ve bilimsel nitelikler belirlenmiştir. hedef örnekler olarak. Son olarak, anketin nicel olarak analiz edilmesinde SPSS programı kullanılmıştır ki, bu program, projenin aşamalarında benimsenen değer mühendisliğinin ne kapsamda kullanılacağının belirlenmesinde faydalı verilerin elde edilmesini sağlamıştır. Pek çok veri ve gösterge ortaya koymuştur ki, bu metodolojinin uygulanmasının, elementlerin temel fonksiyonlarının geliştirilmesinde ve elektrik projelerinin fonksiyonlarından taviz vermeden maliyetlerin düşürülmesine katkıda bulunmasında önemi büyüktür.

Özgünlük/Değer: Araştırma alanı Irak ve Irak Elektrik Bakanlığı'nda yaygın değildir, elektrik gücü açığını kapatmada oldukça etkili ve odaklanmış bir yol olan planlı fonksiyonlara gereksinim açısından aciliyet göstermektedir. Ayrıca, bu çalışma, Irak'ta değer mühendisliğinin uygulanmasıyla ilgili hali hazırdaki bilgi düzeyine katkıda bulunacaktır. Bu çalışma, Irak Elektrik Bakanlığı yapısına değer mühendisliği bölümlerinin ve departmanlarının eklenmesinin benimsenmesini tavsiye etmektedir.

Sonuçlar: Bu çalışmanın sonuçları göstermiştir ki, değer mühendisliği, Irak Elektrik Bakanlığı'nın merkezinde ve departmanlarında hâlâ yaygın olarak uygulanmamaktadır. Araştırmanın sonuçları, değer mühendisliği yaklaşımının acilen ilk sırada benimsenmesini ve inşaatların elektrik projelerine de eklenmesini tavsiye etmektedir. Çalışmadaki anket sonuçları, metodolojinin ve standart modellerin benimsenmesine odaklanılması açısından değer mühendisliği departmanlarının performanslarının gelişmesine fayda sağlayacak özelliktedir.

Anahtar sözcükler: *değer mühendisliği, elektrik gücü projeleri, Irak Elektrik Bakanlığı. SPSS.*

1. INTRODUCTION

In this chapter, the principle of the analysis is described. In addition to the issues, difficulties and barriers that affect the implementation of value engineering methodology, the issue statement was illustrated by the need to implement value engineering in electricity projects in Iraqi Ministry of Electricity, and the analysis was triggered by the lack of the acceptance of value engineering methodology in most engineering fields in Iraq. In addition, the subject of the studies, problem statement, meaning, importance and scope are included in this chapter.

1.1 Background

Much has been said on the international level on value engineering (VE), implementations and performance. Quality engineering is not specialized engineering, for example in computer engineering, mechanical or electrical engineering, or civil engineering. Both administrative, engineering or manufacturing issues are concerned (Dell'Isola, n.d.). VE is an ordered way to think or to perceive an object or mechanism using a practical approach in fundamental terms. It includes an analytical assessment of roles carried out by parts, goods, facilities, processes, services, etc. VE is achieved to eliminate or change any factor that adds substantially to total costs without adding a proportionate value to the overall feature (Mandelbaum, 2006).

Innovative alternatives are generated along with the evaluation of generated options based on the specified criteria for that purpose at a crucial stage of valuation engineering. So, it is based upon the innovative process of the VE job strategy that a VE analysis is successful or not successful. Installation of concepts and solutions instead of using the conventional brainstorming process. However, before contributing money to the acceptance of programs, facilities or architecture, VE should be done as soon as possible — to optimize performance. At the early stages of a project, the contribution of future savings from VE implementations is even higher. Two items increase as VE is introduced later: the expenditure needed for improvements and resistance to improvements (Atabay and Galipogullari, 2013).

A multidisciplinary team uses Value Engineering methodology to define and classify job opportunities for better or lower total costs, or both through creative alternatives without sacrificing fundamental requirements and efficiency, to achieve those jobs. The challenges and difficulties that can raise the average or total expense of projects, in particular projects for energy, often face unforeseen or pre-considered challenges and may impact the efficiency and can hinder project progress if a budget shortfall occurs, for example, in the implementation by high-cost materials. Lower prices and improved quality, or alternatives available to manufacture the same content at a cost near or below the original cost. Therefore, a particular approach and methodology to analyze projects and work on improving the work method and choosing the best and least costly way for the work tools were required, while ultimately retaining the project's shape, function or service. The need for value engineering applications has thus arisen as desperately needed, which leads to substantial reductions in costs – without prejudice to the key functions and efficiency of the project – and not delays or cancels the project due to expensive and sometimes exaggerated concerns. Figure 1.1 shows the value/cost relation.

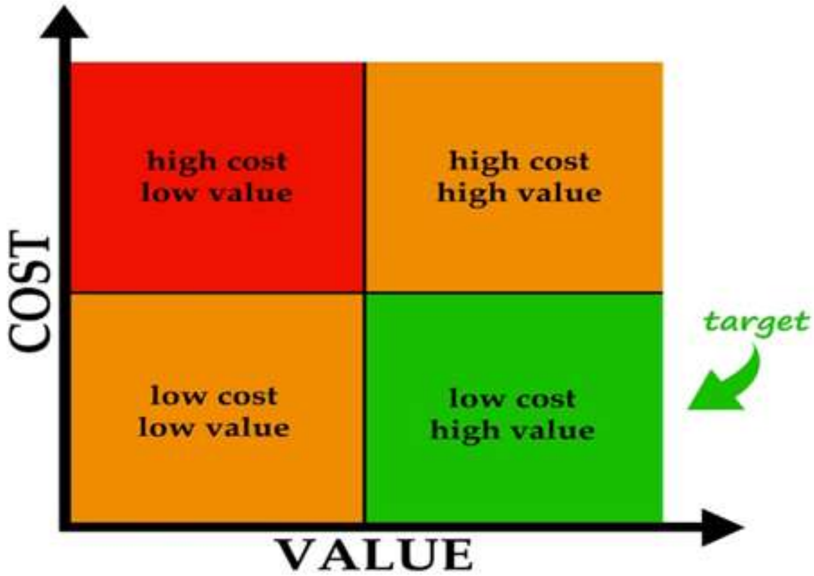


Figure 1.1: Relationship between cost and value

The beginning of the name-value engineering after it became known the method of value analysis in various fields was used in the (US Navy sector), which is a branch of the US Department of Defense, where they found that it is better to analyze engineering drawings before starting construction or manufacturing (the design phase), unlike What was prevalent in the method of value analysis, where the study is done after the completion of the construction or manufacturing phase, and thus the name was modified from value analysis to value engineering, and this method led to achieving excellent results, and thus it was applied to all projects of the US Department of Defense in 1963.

1.2 VE Concepts

The use of value engineering in a variety of project management has been limited by, for example, the proper implementation of organizational standards and regulations, and the degree and direction of the project. The complexity of the project can be significantly reduced through coping with resource deficiencies and potential expense by using modern approaches and procedures by management through the use of available resources and through managing the use of staff, coordination, power-sharing and accountability through order to achieve the desired plan. In reality, value engineering initiative organizes the project. In order to reduce the undue increments of costs or quality of work, project management has consistently tried to use less time spent in value engineering while using the finished product. Value engineering is also a coordinated initiative designed to evaluate and research all of the plans' activities as the first thought for the design, and implementation phases are established in order to achieve the lowest cost and the lowest possible time (Cooper, 2017).

1.3 Problem Statment

Many electrical energy projects in the Ministry of Electricity in Iraq suffer from multiple problems in all their stages, starting from the feasibility study and design to the implementation, use, and maintenance, which affected the level, efficiency, and feasibility of these projects. This led to the continuing shortage of electrical energy supplied to consumers and thus affected the Economic and commercial activities and public life. For this purpose, the study aims to propose a framework for engineering departments in the Iraqi Ministry of Electricity to apply the value engineering methodology to find mechanisms and engineering administrative methods to address these problems.

1.4 Purpose of the Thesis

The research aims to show the importance of this methodology in the integrated preparation of the priorities of electric power projects in the Iraqi Ministry of Electricity and all its stages to make the necessary improvements and evaluations in the quality, efficiency, and cost of these projects where the application of this methodology is one of the main stages of the project before the final approval for its implementation.

The research also aims to propose the approval of a new department for value engineering within the structure of engineering offices in the Ministry of Electricity in Iraq. Thus, the highest specifications and costs can be obtained as possible without compromising the quality and purpose of the projects. To achieve the above aim, the following objectives will be carried out:

First objective: Conduct analysis and study to prove the importance of applying the value engineering methodology in electric power projects in Iraq.

Second objective: To study the factors affecting value engineering studies and apply them to the proposed framework.

Third Objective: Conducting the questionnaire according to the standards of scientific questionnaires to know the reality of engineering departments in the electricity departments in Iraq and their knowledge of the value engineering methodology and the possibility of its application and what are the potential expectations for the development of these departments using this methodology by using the following statistical methods were used:

- Repeated distribution A of answers.
- Percentages of 102.
- The Alpha-Cronbach equation to calculate the stability coefficient.
- Pearson correlation coefficient.
- Simple linear regression analysis.
- A regression model quality test using.

To get as accurate results as possible, the SPSS statistical program was used, which indicates Acronym to the Social Statistical Package for Sciences.

The results will also be scheduled according to the (Pearson Chi-Square) parameter between the independent variable and the variable for the opinions of the individuals in the study sample (Zhu, 2017).

1.5 Thesis Hypotheses

There is a limitation in using the value engineering methodology in the engineering departments of the Ministry of Electricity, this is the main hypothesis, and also, they are sub-hypothesis:

1- There is a close relationship between applying the value engineering methodology and cost management to electric power projects.

2- There is a close relationship between the application of value engineering and the quality and specifications of the service provided by the electric power projects.

1.6 Significance, Scope and Definitions

The value of research is derived from the use of the value engineering approach for projects in electric energy. Through the inspection and calibration of all the phases of the electrical project, this approach has been successfully demonstrated, minimizing project costs and enhancing efficiency and services quality for customers. Therefore, this approach is important if all aspects of the project phases are considered previously.

With respect to the scope of the study, the historical value engineering can be defined, the implementation of that engineering and the desired objectives can be determined. And the app analysis of this technique in the field of project management of engineering with a focus on electric energy projects in Iraq and the importance of developing departments for value engineering in Iraqi ministry of electrical engineering.

Value Engineering includes a variety of principles and definitions indicating that (V.E) is an innovative, organized strategy aimed at enhancing the cost or efficiency of any facility or system by means of the investigation system (Dell'Isola, n.d.; 1982). The management strategy of VE is often illustrated by a systematic approach in order to strike the best balance between the loss, capacity and efficiency of a product or project aimed at enhancing programs' management capacity and facilitating incremental improvement through excessive costs (Zimmerman and Hart, 1982). When identifying project phases, it is a temporary task in which a product, service or special product is launched in a variety of ways. Herson (1992) described the project as "a set of tasks that must be completed within two specific criteria and have specific objectives. Cash, time, machinery and work (Ballard and Howell, 2003).

1.7 Thesis Outlines

This thesis contains five chapters. The first chapter is an introduction to value engineering and its applications in electrical projects. Chapter two is a literature review of value engineering and related studies. The third chapter covers the application stage of the value study. Field study and data analysis included in chapter four. While chapter five includes conclusions and recommendations.

2. LITERATURE REVIEW

This study aims to establish a theoretical understanding of the concept of engineering value in all projects. Areas of interest for the literature review are: Firstly, VE as a concept (definitions, VE features, phases, business plan, VE functions), Benefits of VE, barriers to implementing VE, and use of BIM techniques to evaluate the value. Engineering team. Secondly, the purpose of implementing VE in which it distinguishes different alternatives over multiple standards. Sources have been mainly passed on to judicial academic research journals, Refereed conferences, dissertations, reports / incidental papers, government publications and Books.

2.1 VE Concepts

The contemporary world experiences numerous drastic shifts and dynamic changes at all stages, which have had a positive effect on the creation and transformation of many ideas and theories in each area and in the sciences and aims at achieving the goal of this contest. The value engineering technique that suffered many obstacles and controversies in its application and methods of implementation in all areas of the LAT has proved to be impressively financial savings (Pakdil, Toktaş, and Leonard, 2018). In many Western countries, such as America, which ranks at the top of application for this technology, followed by Japan, which seconds in the world. There are many definitions and concepts of value engineering VE, and some of those definitions are discussed in this section.

2.1.1 Dell ' Isola concept

In essence, value engineering is an orchestrated method for getting more for every dollar invested. It is a matter of removal or amendment of anything that adds costs to a commodity but is not required to fulfil its fundamental purpose, that is, efficiency, protection, appearance or maintenance, as set out in the Armed Services procurement regulation. Value engineering seeks to reduce the cost of an object without impacting output negatively. Initially, during the ii World War, value engineering was created when materials were difficult to procure, and the resulting shortage caused many alternatives to be implemented. In order to find ways of reducing time and expense, the engineering facility control has a full-time staff assigned to review designs. Contractors operating with fixed-price prices are encouraged to propose improvements to economic strategies, and the contractors save half on any agreed proposals. Initial findings in the implementation of value engineering techniques for the building industry have shown that there is considerable potential. The degree of success of this idea within the building industry depends on both the engineers and the contractors' acceptance and active support (Dell'Isola, 1966).

2.1.2 Hart Zimmerman concept

Value Technology is a validated management methodology that uses a systemized approach to seek the best working balance between the missing, enhanced and efficient product or project results, which aims at enhancing people's management skills and facilitates progressive improvements through the detection and movement of unnecessary costs (Zimmerman and Hart,1982).

2.1.3 Miles concept

Value engineering is an organizational thought framework for finding and removing any unnecessary costs while preserving and improving the quality of all goods, buildings or services or for anywhere a dollar is spent (E. P. Miles, 1960).

2.1.4 VE Definition according to US Department of Defence

Value Engineering is a coordinated endeavour to examine device functions, products, specification, slander, practices and procedures for fulfilling the functions needed at the lowest ownership cost while not reducing the quality required (Cropley et al., 2010).

2.2 VE Origin

Warren Mills has been the author of the approach to analyze value engineering. In the late 1940s of the Second World War, he was involved in the idea of value analysis in general electricity, which was exposed to a shortage of strategic materials required for its goods in the war (Dell'Isola, n.d.). The second project was to find, negotiate and get the supplies and components the company needed, which prompted Myles to think about the possible solution. These challenging circumstances. The question he asked was, "If I am not able to take the product, how can I achieve the same purpose as the product with the same equipment, work or materials?

In 1954 the American Navy Fleet Office with Myles' assistance and staff introduced the idea of Operational Analysis which later became an analysis of the value. The result was that the study of value became very popular and finally, a group of practising professionals succeeded in forming a learning community that shared the conception and growth of creative capabilities in this area, known as the American Society for Value Engineering (Shillito and De Marle, 1992). The Miles software is widely distributed in other fields of the sector and is regarded as an important tool. He deserves the highest regard for his advancement of management. This software has continued to evolve until this day, so it is named "Father of Value Engineering" (Shillito and De Marle, 1992).

Several general measures followed the principle of value.

A. Moving the idea from value analysis to value technology.
B. Save the establishment of the VAT company.
C. Dissemination of value engineering in the field of construction.
D. Usage of the technology of value engineering (design).
E. Private sector growth.

From the above, we note that there have been several general stages in the definition of value to achieve the term. Table 2.1 contains the most influential production stages in the process.

Table 2.1: Historical development of the field of value engineering

No	Year	Evolution of event	Scope of application
1	1940	The beginning of the concept of cost reduction while retaining the value expected of the product by the electricity company after implementation of the product.	After implementing the product
2	1952	First Value Analysis Sessions	After implementing the product
3	1954	The idea developed through the Maritime Office, the Ministry of American Defense, into a value engineering program.	During the design stage
4	1958	Establishing a Value Engineering Committee. The first assessment conference was conducted with 300 participants in study and decision making. The alternative is to issue a permanent bond with saving jobs	The research and decision-making
5	1963	Adding American Armed Forces clauses to the law to facilitate value engineering to its funders	Contracts and commitments
6	1964	Conducting workshops to train Army engineers on the value program	Training
7	1965-1966	The U.S. Defense Department's Land Reclamation Office began training its workers in the program and authorized the participation of contractors.	Training
8	1967	NASA conducts workshops to educate its staff in their projects on the application of technology.	Training
9	1970	The Ministry of Transport and General Services (GSA) adds rewards to contractors for the use of this technology.	Activate and encourage
10	1970	The spread of value engineering in Japan	Activate and encourage

Table 2.1: Continued

11	1971	CM started to use value engineering technology in the construction industry during the design process	It is in the design stage
12	1972	Usage of the value program by the Minister of Transport and General Services GSM in the design process to manage building costs	It is in the design stage
13	1973	GSM is requesting save to set up an accredited curriculum for value practitioners to ensure full application of value engineering principles	Curriculum development
14	1975	The U.S. Environmental Protection Association Web Armj Construction Charity (USA / EPA) has an optional Engineering Value scheme that will be extended to projects by multiple construction firms following the progress and transition to a program.	It is in the design stage
15	1978	The Ministry of Transport's used the value engineering in Its projects	during design and implementation stages
16	1978	The spread of American value engineering in Italy from CHEMIST company	The design and implementation phases

2.3 Value Engineering Names

There are various names for value engineering, depending on the area of study, the stage of study and the following:

2.3.1 Value management (VM)

It is a modern approach to management and requires a collection of procedures and extensive means to find useful solutions to problems, pursuing a scientific, systematic approach that focuses on improving job output efficiency and quality while simultaneously reducing project elements cost by presenting ideas and solutions to this problem that has been posted to the study, figure 2.1 shows the relation between cost, time and scope (Stoker, 2006).

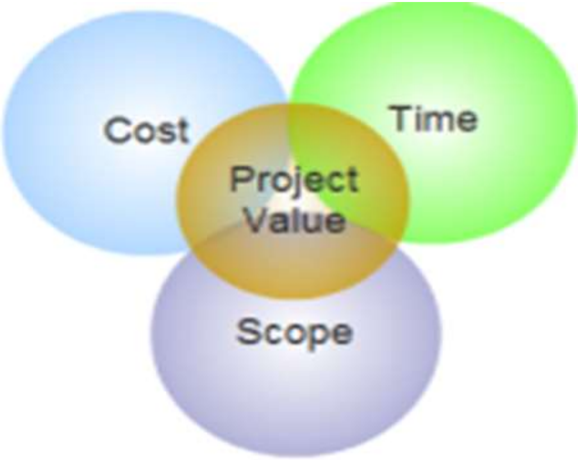


Figure 2.1: Relation among cost, scope and time

2.3.2 Value planning (VP)

It is an empirical analysis that takes place at the first phases of projects (the feasibility study or the initial design stage) and where a particular need arises, and there are many projects to satisfy this need, it helps to choose, in such situations, the highest possible use and some are often called a value control method. The following Table 2.2 illustrates the value planning level or stages (Eggli, Pisan, and Müller, 1998).

Table 2.2: Value planning stages

		Value determination	SBCE prioritization	Pull events determination	Value creation activities sequencing
Lean Principles	Specify value	x			
	Identify the value stream			x	x
	Guarantee the flow		x		x
	Pull the value			x	
	Seek perfection	x	x	x	x
Traps to value creation	Preconceived solution	x	x		
	Powerful advocate with vested interest	x			
	Develop a new product with new technology		x		
Issues on traditional	Early solution freeze		x		
	Planning to control and not execution	x		x	x
	The transformation wiew			x	x
	Systemic vision loss	x		x	x

2.3.3 Value Improvement (VI)

It is an analysis of current projects that expand them or enhance their performance at any point of this project by presenting several ideas and proposals to a group of experts and evaluating cost, performance and quality comparisons and selecting the best to achieve the lowest cost and best change and progress while retaining quality (Setijono et al., 2012).

2.3.4 Values analysis (VA)

Value Analysis implies the empirical research by evaluating the alternatives available to assess the nature and improvement of these projects and the appropriateness of their projected budgets without affecting the efficiency and quality of these projects (Reiss, Thomas and Reiss, 1997).

2.3.5 Value Research (VR)

A systematic review of the management work of companies and organizations and associations to increase operational efficiency, increasing human performance productivity or minimizing time wasted or simplifying working methods or rationing and activating communications lines to increase performance value in management at all company everyday levels at various administrative levels (Spratt, 1997).

Table 2.3: The nomenclature of value engineering according to the field of application

No	Business field name (in engineering Value	Field of application	Purpose
1	Value management	The method of administering the value engineering study is based on all components of project or product functionality	Maintain the job and try to reduce the cost

Table 2.3: Continued

2	Values control	In the early stages of projects (as Preliminary studies - or preliminary design	Assist in selecting the business field that achieves the highest investment through potential available.
3	Value development	Existing projects or products	To develop or improve its performance
4	Value buying	Procurement, especially with materials and raw materials	They are obtaining alternatives that perform the same job and quality level with an effort. To reduce their costs.
5	Value analysis	Projects that were designed from long ago. or remote or existing projects	Knowing the extent of the possibility of developing or expanding work Appropriateness of the estimated cost allocated
6	Value research	Administrative affairs in organizations, bodies, and associations	Improving institutional work performance through Raise the productivity of human performance

2.4 Value Elements

When consumers judge a good or service, their perceived value weighs against the price demanded. In general, advertisers have based much of their time and resources on handling the cost side of the equation because higher prices will raise profits instantly. But that's the easy part: pricing typically requires the management of a limited number, and pricing analytics and strategies have advanced greatly. However, what customers actually value can be hard to pin and psychologically complex. How do management teams actively handle or decide ways to deliver more, be it practical (save time to minimize costs) or emotional (reduce anxiousness, deliver entertainment)? Discrete analysis of product attributes, price and other components and related testing techniques simulating the market are effective and useful methods but intended to measure customer responses to pre-conceived value concepts, and the concepts managers use to evaluate. New ideas require anticipation of what others consider important (Almquist, Senior and Bloch, 2016).

The value depends on three main elements: cost, quality and feature, as well as the relation between them:

Value = (function (performance) + quality) / cost **(2.1)**

Equation 2.1 shows that the value study approach improves value by increasing functions and efficiency while reducing overall costs. The three main components are shown in figure 2.2.

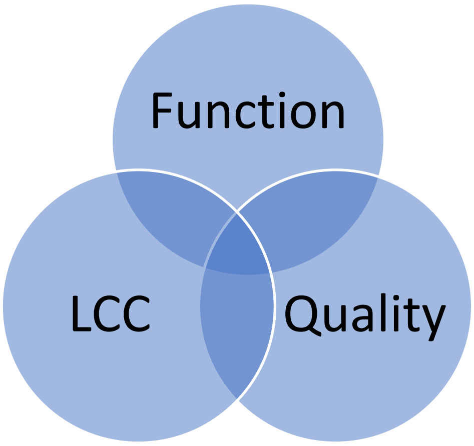


Figure 2.2: Value main components

Function: The purpose of the product or project for which it has been found and its capabilities, whether for use or for sale, it meets users and recipients' needs and wishes.

Quality: means the realization of the project, product or service to the appropriate output limit or work over its lifetime, so that it is used to achieve the purpose for which it was planned in compliance with the organizational and maintenance principles.

Life Cycle Costing (LCC): This is the total amount needed to operate and maintain a project or a part, products, facilities, or development or financing. The so-called substitution and depreciation (project life-cycle costs).

In learning about concepts or meanings of value engineering, the elements common to value engineering can be defined, including (L. D. Miles, 2015):

1. That the change is important:

When this approach poses philosophical problems that do not include just the tools used, but go beyond the company itself, and the underlying assumptions, for example, why do we do the job we do? Why do we use this method? Such fundamental questions challenge the underlying assumptions and cause staff to rethink these assumptions.

2. This is a significant change:

The requisite change in the values engineering must be drastic, meaning-value and not a superficial change to strengthen and to enhance what is present, i.e. to restore the current situation, but the change should be embedded in the root system. Products or procedures in compliance with existing criteria and the economic unit's objectives.

3. The findings should be important and enormous:

Substantial and enormous results are needed for this process, i.e. not just relatively formally and gradually improving and evolving products or performance.

4. Process Change:

This approach focuses on evaluating and restoring processes, not just organizational and functional frameworks and roles, which means that

the processes themselves, and not individuals and departments, are viewed as analysis and focussing.

5. The change is based on information technology:

The accepted system is focused on investments in IT and the productive use of this technology so that it is used to bring about drastic changes that establish a new working style and methods and not a time-consuming process.

6. That the change is based on inductive and not deductive thoughts:

This approach is focused on extrapolation and reflects the quest for growth and improvement opportunities before issues occur, which involve change and reflection.

7. Then work on analyzing them and searching for suitable solutions.

A- Measure value

The value can be assessed by the value index expressed by equation 2.2 (Churchman and Ackoff ,1954):

$$Value\ indicator\ =\ Estimated\ Cost\ /\ Accumulated\ Cost \quad \textbf{(2.2)}$$

Value Index

The relation that exists between the real or expected cost and the costs due to the feature, the closer the result of the indicator to the correct result, which means that the better the value-technique, which shows that the value is high. If the real and estimate value is equivalent to the project, service or product and thus the required task is carried out effectively, then according to the value engineering approach this means that the value is low, the value is low and the cost estimate is inflated and undesirable (Attarzadeh and Hock, 2009). Note that for contrast and comparison between many alternatives or systems, a measure or predictor of value is used in implementation of this equation:

$$Value\ Index\ =\ (Function\ (Performance)\ +\ Quality)\ /\ Total\ Cost \quad \textbf{(2.3)}$$

To illustrate how to calculate this equation on an electricity project, we choose three methods of delivering electrical energy to the consumer.

By a network of suspended copper wire and we symbolize it by the symbol A.

By the underground cables and we symbolize it by the symbol B.

By hanging cables, and we symbolize them by symbol C.

When choosing, we give each of the quality and performance of ten marks according to the preference of the method. As for the cost, ten is given to the most expensive method, and the other methods are attributed to it. As follows:

100$ per kilowatt electrical capacity, system cost B.

So, it gives 10 degrees

70$ per kilowatt of electrical capacity, system cost C.

So, given $100/80\ \times 10\ =\ 8$ degrees

$ 60 per kilowatt of electrical power is the cost of System A.

So, it is given $100/60 \times 10 = 6$ degrees

Table 2.4: Illustrates how to differentiate between the different methods using value engineering

method	performance	Quality	Total cost	degrees
A	8	5	6	(8+5)/6 = 2.17
B	7	10	10	(7+9)/10 = 1.7
C	9	7	7	(9+7)/7 = 2.29

From the table 2.4, the following appears:

• System C has the best performance (9 scores), but it is of average quality and cost.

• System B is of the highest quality (10 scores), but it is the most expensive.

• System B has the lowest cost (6 scores), but the lowest quality.

B-Worth Value

It is the lowest cost to achieve the desired project or product efficiency or functionality. The cost is estimated by the work and compared with the alternatives that fulfil the same function (Beidelman, 1987).

2.5 VE Objectives

There are several objectives that value engineering can achieve of which (Keeney and Raiffa, 1993):

1- Achieving a fundamental output or product change:

This approach aims at achieving significant performance improvements by modifying the processes, resources and job outcomes and also allowing employees to design goods in line with consumer expectations and economic unit objectives.

2- Customer Emphasis: This approach is intended to guide the economic unit to focus on consumers by defining their needs and working towards satisfying their wishes in order to restore goods or processes for this purpose.
3- Speed: This approach is intended to facilitate the Economic Unit will easily charge its money by supplying and encouraging its decision-making process.

4- Quality: This approach seeks to increase the quality of your goods or services that are tailored to the needs and wishes of our customers. Reducing costs: an engineering value strategy is designed to minimize cost by eliminating or eliminating unnecessary operations and concentrating on value-added operations.

2.6 VE Methodology about the Effectiveness of an Application

Value engineering is an efficient methodological approach to problem-solving. (Methodology) in most developed countries around the World has proved useful, and the explanation is that the workgroup of many disciplines has proposed and advocated the possibility of finding the areas of excessive expense and enhancing quality and efficiency together (Liu et al., 1998).

Four key points can be used to define the field of value engineering as a solution approach. The dilemma is based on the following methods of problem-solving

1- The way the distinguished workers are analyzed.
2- The work plan has been followed, consisting of a logical series of many stages.
3- The multiplicity of specializations in important research in the community work team.
4- Coordination efficiency among the study authorities.

2.6.1 Types of project cost

In the field of project engineering, the cost and the relationship of the project is classified, see figure 2.3:

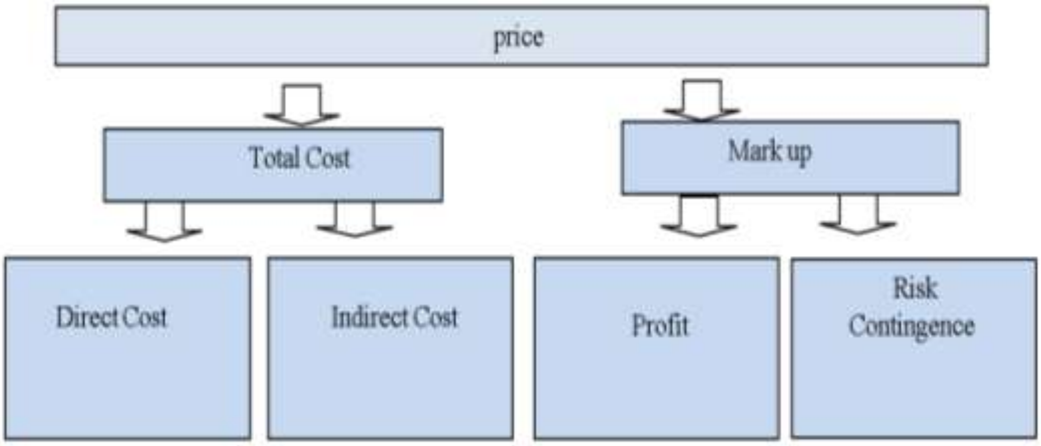


Figure 2.3: The division of the types of costs related to the project

Source: (American University Lectures on the Professional Program in Project Management 2009-2010)

Types of cost can be classified according to the field of value engineering on which it is based.

Basis of apportioning the cost into:

1- Necessary cost (Chi, 1994).

- Initial cost: There are several components of the base cost, such as Land costs: in addition to the licensing processes, the expense of buying a piece of land. For this point, the necessary legal preliminary steps are needed. Construction costs: covers labour crisis costs, products used costs and labour costs. The site coordination (Landscape) and the expense of the monitoring process, which is a change in values dynamically. Cost of final procedures: value associated with the final product and duty and taxation, permits and licenses (Chi,1994).
- Financing cost (Wei and Xuesong, 2005)
- It is the value of the interest accruing on the financial amounts that have been allocated for their investment in the project during the period before you turn it on.
- Alteration cost (Sager, 2006)
- It is the cost necessary for changing the fundamental function of a project, such as changing the overall function between workers.
- Replacement cost (Cabeza and Moilanen, 2006)
- The cost ensures that the building development is rehabilitated to its basic purpose with the standard demanded of it.

- Taxes cost (Russo, 2004)

  It is the costs of taxation and administrations levied upon the project by regulatory bodies and officials, and this expense changes as the legislation on taxes and the returns imposed on companies change.

2- Unnecessary cost.

It clearly indicates from the name that it is the expense inside the project. Without disruption to the fundamental function. One or more types of critical costs which the former listed can include high costs if these costs increase the value of the feature, the product or the project. An appearance and may be formulated in a different way where these unnecessary costs are defined as the cost that cannot be borne by increasing the value of the element in terms of its position or extending its esthetic existence of the element(Russo 2004). The cost unnecessary can be measured by comparing a group of cost alternative approaches, thereby making a cost difference between the two alternatives an unnecessary cost, given that the two alternatives perform and carry out the same task without affecting the appearance and the esthetic and sensory aspects of the project of the final product.

- Reasons and factors for the emergence of unnecessary cost (Schwanen, n.d.)

  The constraints on the quality and the causes of increasing costs, and many are often forced both the designer and the owner for example, to estimate the cost of air conditioning, and here the importance of value engineering appears to avoid these barriers and thus improve the quality and reduce the cost and the most cost barriers to the emergence of unnecessary lack of a tool.

  Classification of unnecessary costs:

- Cost of unnecessary component: This is due to the use of an element which can be supplied or replaced by an element of the same feature but at a lower cost.
- Unnecessary material cost: Any use of materials that are incompatible with and increase the functional requirements of the content should be deleted or replaced as long as this does not interfere with organizational and maintenance considerations.
- Unnecessary cost due to poor implementation capacity: When using poorly implementable ideas that require specialized labour and high techniques.,

which clearly shows its effect on the cost without a noticeable effect on the function or performance of the element. Consequently, the value decreases.

- Unnecessary life cycle cost: Resulting from the use of materials that need frequent maintenance, which reflects a rise in costs that can be avoided by making a good decision, which can lead to a re-cost of the original cost, but can have an effect on the life cycle of the building.
- Unnecessary Opportunity Cost: The use of the available expenditure is seen without a substantial rise in costs relative to the sum of interest.

2.7 Value Engineering Studies

It is required to complete four basic points before carrying out the value engineering studies, and these points are the cornerstone of the value studies (Dell'Isola, 1982).

2.7.1 Selecting the project

The selection of the project or projects on which the value studies will be applied is an important step that must be taken care of due to a large number of reasons and motives that differ according to the entity that requested the study or who proposes it, the site it occupies, the stage of application of the study to the projects and the expected results of the study. Among the most important of these reasons and motives that must be taken into consideration are:

1. High financial estimates for the implementation of the project compared to the estimated budget for its implementation (prior to the bidding process or the lowest offers were higher than the estimated budget for implementation) after the bidding process.
2. The procedures followed by the administration or the entity that owns the project within the higher management strategy.
3. They provided the designs for the project, as the design was made in a previous period and was not implemented. It is required to update the design to keep pace with the development in the current technologies and technology and the difference in the size of the project.
4. Modification in the size of the project or the time required for implementation, such as completion at a certain time, to benefit from the project in a specific

season, such as Hajj and Umrah, tourism, or .... etc. as in the case of hotel projects.

5. Some projects have a repetitive character such as (housing projects and education projects) and value studies are required to be applied to them in order to avoid errors that have already occurred during implementation in previous projects, whether technical or administrative, which resulted in a lack of efficiency or quality and an increase in the cost to be used in future projects and models.
6. The project, during the implementation phase, due to the lack or absence of Change Orders, must make change orders, materials, or any other obstacles that impede the implementation of those items or delay their implementation dates beyond the approved time program for the project by a period of time longer than necessary, and only those items are studied .Regardless of the motives or reasons for choosing projects to implement value studies, it is imperative that we make a preliminary study of value engineering on the project under study and focus on the elements affecting the cost of the project and is the stage on which the study will be conducted is feasible and useful and will lead to results It is better for the study student, the owner, or it is better not to conduct the study.

2.7.2 The formation of a study team

The most important characteristic of value engineering studies is that it is a group work carried out by a team of experts and different specialties that have a direct relationship with the project to be studied and they have the ability to think, creativity and flexibility in accepting the ideas of others and the size of the team varies from one project to another according to the size of the project, but usually, the number of team members varies from (five to seven) individuals including the team leader. The composition of the team members varies according to the specializations needed by the project under study. We find that forming a team to conduct value engineering studies on building and construction projects differs from forming another team to conduct value studies on industrial projects and production projects. This is in addition to the help of some of the owners of different experiences and specialties and related parties (such as (the ultimate beneficiary of the project as a school director or teacher in studying school projects - a hospital director or a doctor in the case of studying hospital projects, operation and maintenance engineers or implementing contractors) in some stages of study as consultants Depending on the nature of the project, the owner may also be a participant in the study or his representative to convey his point of view and benefit from it. Making use of the project designer in the value study and discussing the opinions on the basis of which the initial design of the project was made and which may or may not meet the needs of the owner (Khosrow-Pour, 2001).

2.7.3 Specify the field of work

It is imperative to determine the scope of work of the value study for any project chosen for the application of the value study and set specific goals before starting the procedures for implementing the study through the leader of the study team in a meeting attended by all the parties involved in the study as well as the owner and designer. The study team leader explains the value study approach and the benefits it will achieve by achieving a balance between cost and performance without compromising the project requirements or its quality or even affecting the time program prepared for the completion of the design work. Or deficiencies in the design. And that the value study team is complementary to the design team, and together they form part of the project's work system (Castillo, 2012). The following points are also having to identified in this meeting:

1- Define and clearly describe the objectives and scope of the study work based on the requirements of the owner or the student of study
2- Define the criteria and principles upon which the study is based.
3- Determine the information and documents required for the study and the source responsible for it.
4- Knowing the basic needs and functions to be performed by the project**.**
5- Estimate the study costs and the savings or benefits expected from them.
6- Setting a timetable for the value study and its stages.
7- Nominate the members of the study team and their qualifications and capabilities that are commensurate with the work they are required to perform.

2.7.4 Value engineering study team

The Value Engineering Research Team consists of:

1-The leader of the project team.

2-Members of the project team.

3-Administrative coordinator who is the agent of the owner.

4 – Representatives of the consultant or project designer himself (Dell'Isola, 1982).

The below is a general overview of the project team for value engineering:

1- Leader of the project team: The team is considered to be the primary supervisor of the study and must therefore be a specialist in value engineering studies holding a CVS certificate of specialization awarded by the American International Association of Value Engineers-an expert in economic, financial, technical and administrative studies-who holds a master's degree or diploma. The team leader should have high leadership and leadership qualities that allow him to lead and lead the study team and to be well-coordinated and coordinated between them (Keller, 2006).
2- Members of the Value Engineering Study Team: They are people with specialties that are commensurate with the different tasks of the project and should be on the efficiency of the science and practical expertise and fit the essence of the project that will be examined. Team members typically ranged from five to seven members with the specializations required for the project under study (Tohidi, 2011).
3- Administrative Coordinator shall be a representative of the owner: The expected administrative coordinator representing the project owner is a person who specializes in investments and trends in technology and marketing works for the owner and is familiar with full directions of owner material and future expenditure allocated to the project under review, including telling him to direct a valuable study of the owner's requirements to a working group.
4- Representatives of the consultant or project designer himself: The key task for the main project consultant or project planner is to participate in the special study sessions, explain and demonstrate the reasons why a design decision has

been made that works or does not work to satisfy the needs of the owner as well as decisions. The Executive Committee to focus on the completion of the project within the expected timeline without barriers to execution and the necessary quality and the development of additional costs.

2.7.5 Preparing for VE study

It is one of the actions taken by the Value Research Team Leader to train anyone who has a connection with the project.

The following shall be decided by a meeting held in the presence of all the parties:

1- Clarify the method by which the value analysis is to be performed.

2- Respond to all questions and objections by identifying the planner and all project parties who will be subject to the Importance of Engineering Principles and when they have come to the assistance.

3- What would be accomplished by the outcome of the evaluation and by what is defined by the point at which the analysis will begin, and whether or not they are in proportion to what the owner envisages in terms of financial savings or expansion? And technology, by making use of all the variables that influence the cost of the project (Beaman, Guy and Sexton, 2008).

2.7.6 Value engineering approach

The choice of a value study approach is one of the most critical steps that the study team must recognize from the researcher or the owner and, on the basis of the expectations of the owner or the project client, work will be done to decide the appropriate input. Many entries are applied through the value engineering approach:

1-Assessment of cost reduction while retaining efficiency.

2-An approach to enhancing efficiency and at the same time preserving costs.

3-Assessment of changing jobs while retaining prices.

4-Introduction to shift employment while retaining results.

2.7.7 Workshop phase

The Value Engineering Workshop, with its six phases as described by the American International Society of Value Engineers (SAVE), is the correct method of analysis. These phases are shown in figure 2.4.

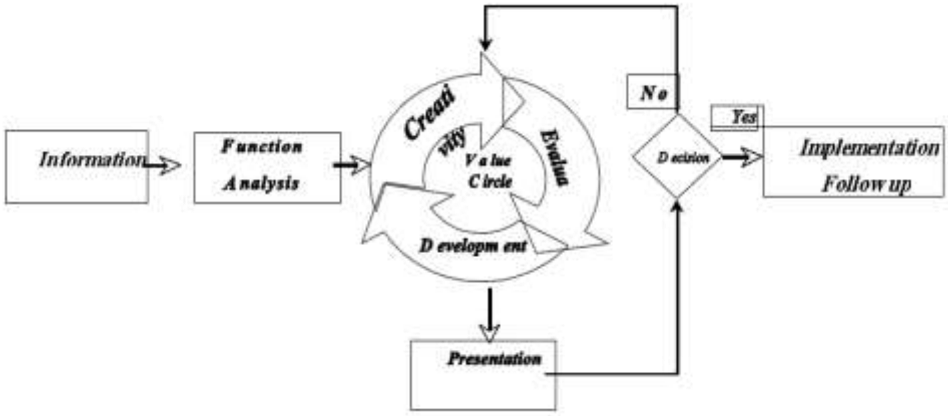


Figure 2.4: Steps of the workshop phase

2.7.7.1 Information phase

The knowledge stage is considered to be one of the basic stages on which useful engineering studies are focused. It is therefore advisable, at this point, not to speed it up, since the more knowledge and verification is achieved, the more successful the activities of the Value Engineering Studies and their access to the objectives. The project deals with the measurements, histories, and details that function and aid in the analysis (Elliott, 2004). The research team agrees with the most acceptable progress goals, such as importance, expense, performance and timing factors. These are checked with appropriate management, such as the project manager, the Value Study Facilitator, and the designer, for competition. Ultimately, the scope statement is reviewed for any changes due to new information obtained during the Information Process. Figure 2.5 shows the information phase steps.

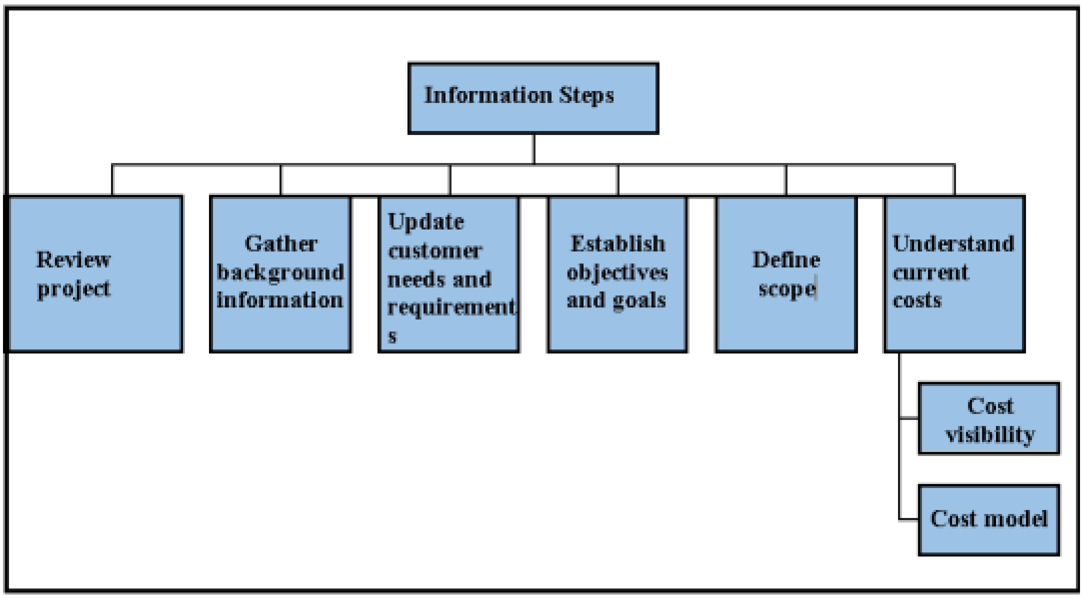


Figure 2.5: Information phase steps

1- Review project: Project analysis begins with the detailed identification of the proposals for change that the client is searching for. First, a clear definition of whether the project is to be changed should be understood. The following information sets out the details needed in the preparation of the VE construction project report. This knowledge should be collected, checked and understood in advance of the VE workshop (Assaf and Al-Hejji, 2006).

2- Gather Background Information: Once the project is clearly understood, pertinent data needs to be gathered to assure the team has sufficient information to properly conduct the study. A checklist of data required is listed below:

   - Description of project - Outline Specifications.
   - Analysis of Design.
   - The site and building drawings.
   - Cost Model (preliminary cost estimates design level)
   - Listing of all material and quantity requirements.
   - Quality model (Client requirements and features).

3- Quality model (Update Client Needs and Requirements)

   Client information is a vital part of the project history information. It is necessary to consider the project from the client's point of view. Therefore, it is important to explain the quality model in the early stages of the VE work plan; Figure 2.6 shows the key elements of the quality model.

Figure 2.6: Main elements of the quality model

4- Establish Objectives and Goals: The basic goals and objectives of the project are typically presented to the team by the client or Value Engineering Specialist VES. After evaluating the context of the project and drawing on the experience of the individual team members of the project, priorities relating to the cost of the life cycle, efficiency, design, construction time, environmental concerns and future expansions are also essential considerations. The team must consider not only what they are researching, but also why, if they want to make suggestions that will best improve the project (Alattyih, Haider and Boussabaine, 2019).
5- Define the scope: The parameters of the analysis must be specified in order to solve the problem. It is necessary to know what was included in the analysis as well as the interface points. Usually, the scope includes not only the structure (main criteria) but also certain elements (sub-criteria) such as site planning, demolition, landscaping, provisions for potential expansion, and parking(Alattyih, Haider and Boussabaine, 2019).
6- Cost Model (Understanding Current Costs): One of the key goals of most Value Engineering studies is to minimize costs in addition to improving

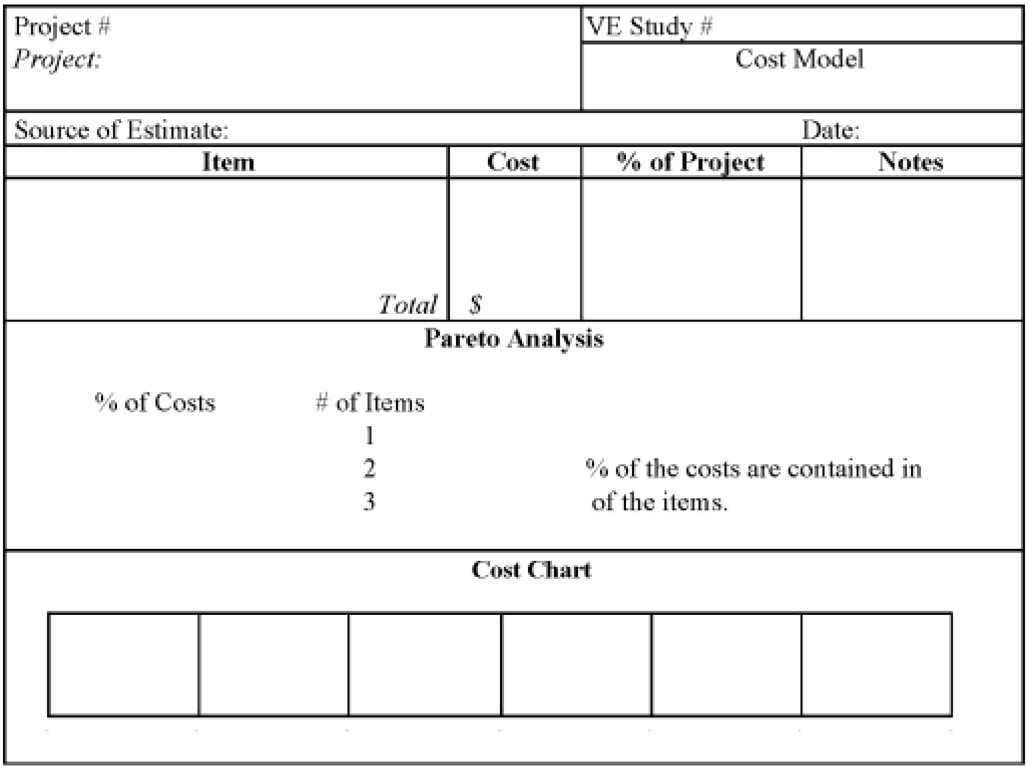
efficiency. Although cost estimates for new construction projects are given at a very comprehensive level, these cost data need to be structured in a format that is useful for rapid analysis (Anderson and Lanen, 2007). Several important things to be viewed as cost data are evaluated as described below:

- Determine total cost
- Determine cost elements
- Determine cost within the scope of the project

It is also important to consider the reasons for unnecessary costs, though there are many reasons why there are unnecessary costs in goods, processes or systems, the most common reasons will usually be one or more of the following:

- Lack of idea
- Lack of information
- Temporary circumstances
- Honest wrong beliefs
- Habits and attitudes

The cost model is shown in figure 2.7


Project #
Project:
VE Study #
Cost Model
Source of Estimate:
Date:

Item	Cost	% of Project	Notes
Total	*$*		

Pareto Analysis

% of Costs
# of Items
1
2
3
% of the costs are contained in
of the items.

Cost Chart

Figure 2.7: Cost Model

2.7.7.2 Function analysis phase

This is the second stage of the Value Engineering Study, and this stage is considered to be the cornerstone from which value engineering begins with the actual work on the project. The stage is related to the research study presented. By knowing and analyzing the project functions, the project team can turn them into ideas and proposals that will verify these functions and reduce costs (Jay and Bowen, 2015). Function Analysis techniques, figure (2.8), are used in defining, analyzing, and understanding the functions of a project, how the functions relate to one another, and which functions required attention if the value of a project is to be improved There is a difference between reducing costs in value engineering technology than with traditional methods is that costs in value engineering are not a goal in itself but as a result of the goal. Where the goal is to find alternatives to perform the same function key (what to play and what is required to play) for the project or extends and ultimately lead to lower costs. At the same time, it is reducing costs by other methods to reduce costs that are directed to the project components directly, either by reducing its components, lowering its quality, or eliminating some of its jobs. Therefore, value engineering works on the project functions while other methods of reducing costs work on the project components.

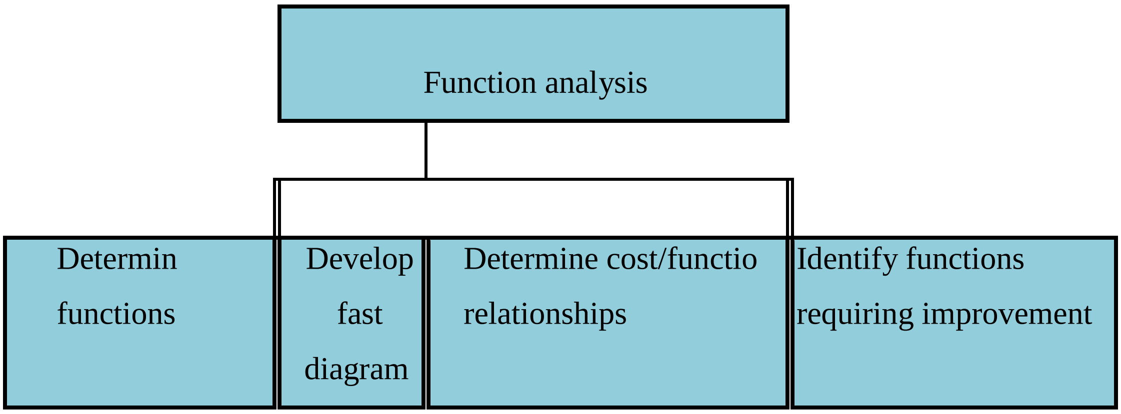


Figure 2.8: Function Analysis Steps

Therefore, value engineering works on the project functions while other methods of reducing costs work on the project components. As we show:

- Value engineering ⇨(working on) ⇨ project function ⇨ Alternatives cost ⇨ reduction.

- Methods to reduce costs ⇨ (work on) ⇨ project elements ⇨ (delete - merge - reduce) ⇨ reduce costs.

A- Determine Functions

In Value Management, the roles are decided by asking the question, "What is it doing?" All designs, processes and procedures have many roles. And then, the team decides the project functions (Alkheribi, 2017).

B- Defining Functions

All functions can be described in two terms, the Verb and the Noun. It is often difficult to state what is done in two terms, but it helps to clarify language and increase comprehension. When choosing terms that describe a function, make them as broad and generic as possible. Do not pick terms that predetermine how the operation should be done(Waldron, Vsanthakumar and Arulraj, 1997).

C- Categorizing Functions

There are only two types of functions within the scope of a study item - Basic and Secondary:

- **Basic function (b)** is the specific work that a product, process, construction project, or procedure is designed to accomplish.
- **Secondary functions**: The secondary functions (rs) are the other functions that the system performs and are subordinate to the basic function. They support the basic purpose and enable the product, method or process to operate and sell. Secondary functions can be necessary, aesthetic or undesirable. Requisite secondary functions are needed to make it possible for the basic function to happen or to happen better. Esthetical secondary roles enhance the appearance of the substance and make it more attractive for the consumer. Unwanted secondary functions are generally undesirable by-products of either basic or other secondary functions and often require costs to minimize their impact.

D- Function Analysis System Technique (FAST Diagram): FAST is an acronym for Function Analysis System Technology. The FAST diagram is a powerful value management technique. (i) shows the specific relationship of all functions with respect to each other; (ii) tests the validity of the functions under study;

(iii) Helps to recognize missing roles and (iv) broadens the awareness of all team members on the project. At first glance, the FAST appears to be identical to the PERT chart in the flow chart. However, the basic difference between FAST diagramming and these other techniques is that FAST is functional and not time-oriented (Nayebvali, Zarabadipour and Zargarpour, 2014). Figure 2.9 shows the basic ground rules for developing a FAST diagram, while FAST drawing disarm is shown in figure 2.10.

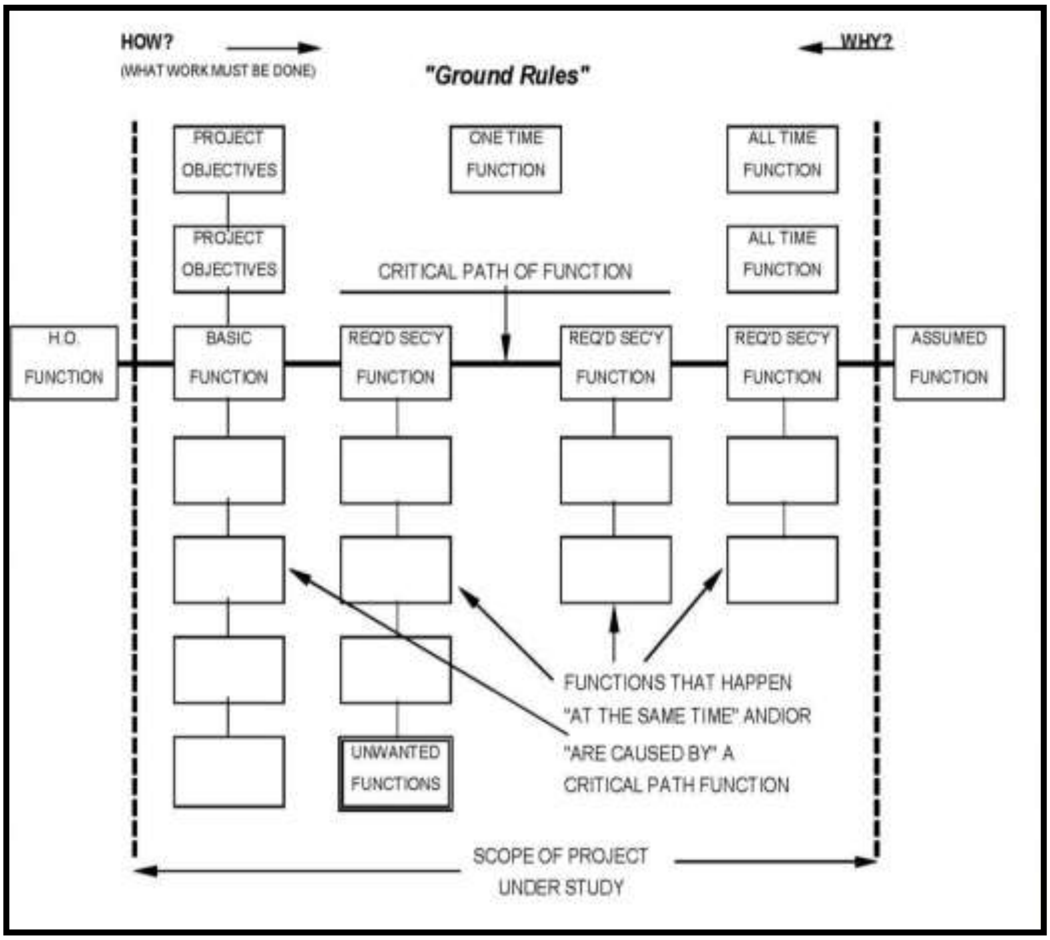


Figure 2.9: Basic ground rules for developing a FAST diagram

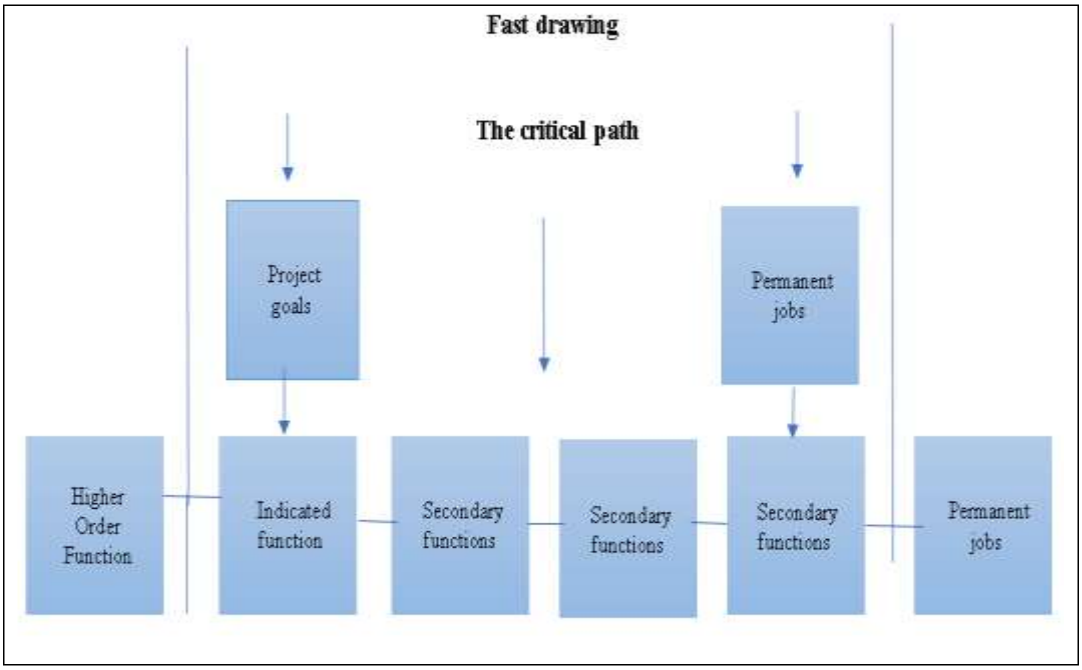


Figure 2.10: FAST drawing diagram

E- Cost-Function Relationships

The technique of establishing a Cost-Function Relationship:

- Is a marriage of the cost to function.
- Identifies the amount of cost doing Basic Function work vs. Secondary Function work.
- Identifies functions which represent "poor value."
- Points direction as to where to get to work first, second, etc.

2.7.7.3 Creative and innovative thinking phase

The stage of inventive and creative thought is one of the most critical stages of engineering studies. Ad valorem is more than any other form. The goal of this stage is to generate creative ideas that shape proposals and alternatives that lead us to retain the functionality of the project components and parts at a lower cost and to remove unfair functions. Innovation and imagination are not a talent, but rather an effort and a desire for reflection inherent in the life cycle. Scientist Addison, the inventor of the electric lamp, claims that invention and innovation are 99 per cent. Effort and perseverance, 1% motivation and intuition. Some people know of the creativity and innovation of mental activity that is produced in the right part of the brain as a result of stimulus needs such as desire or need or challenge resulting in a new idea or a useful solution, but it cannot be generated by vacuum, but depends on expertise and knowledge and is related to paradoxes (Evans, 1986).

Creative Session Ground Rules

Generating 100 ideas on any function or activity is made easier if you follow these four basic ground rules:

- Express the problem-free from all specifications.
- Assume that every idea will work.
- Search for ideas with a competitive spirit.
- Capitalize on an environment of praise and support for one another. In addition to these basic rules, the speculation session would be much more effective if the VES keeps the speculation session going quickly. It shouldn't take more than 20 to 30 minutes to produce 100 ideas.

2.7.7.4 Evaluation & judgment phase

It is the stage at which the ideas generated in the previous stage are judged by discussing the provisions discussed by the study team. And the stage of the assessment is to minimize the enormous amount of ideas circulating at the stage of innovation and creativity and to test the best of these ideas on the basis of the parameters that have been developed and used as a criterion to delete or pick ideas and the appropriateness of those ideas for implementation (Too and Weaver, 2014).

The aim of the evaluation phase is to systematically reduce the large number of ideas produced during the Speculation phase to a number of concepts that appear promising in achieving the objectives of the project. During the evaluation phase, the obvious nonsensical ideas developed during the speculation sessions will be eliminated, the ideas will be organized into logical groupings, analyzed on project criteria, and the best combination of ideas will be identified. The evaluation process consists of four steps, as shown in figure (2.11). The first three steps satisfy the needs of most teams.

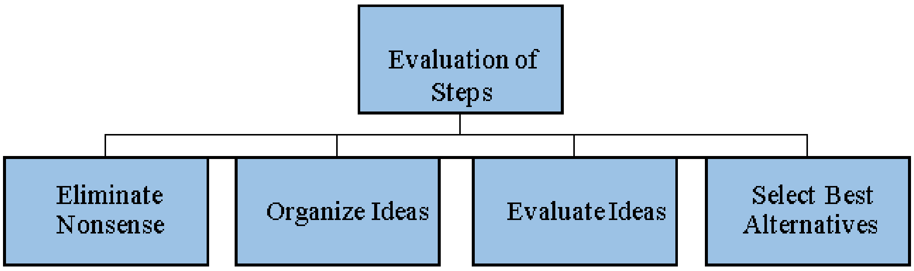


Figure 2.11: Evaluation Steps

2.7.7.5. Criteria development for evaluation

The cost of alternatives is a problem that must be dealt with correctly and objectively; nevertheless, it is worth mentioning if the cost is taken as a single criterion in value engineering; it is only rational in the right context. The findings of the community investigation using qualified, multi-disciplinary teams show that the value and economy of the project can be enhanced by creating alternatives with various design principles, materials and methods without compromising the client's purpose and value objectives (Young, Clive and Miles, 1972).

2.7.7.6 Development phase

This step was considered to be an integral part of the previous stage, and in certain cases, the final stage is called, as it was codified and chosen in the previous phase. These ideas are entrusted to the research team members, each in their own fields, where they prepare the idea for a submission. Explanation and anchor assist the beginning of the application process. Management costs have been calculated as recognized and accepted by the employer or by the project (Monghasemi et al., 2015). The goal of the development process is to pick and prepare the best value-added alternative(s). The data package prepared by the team of each alternative should contain as much technical detail, costs and timetable as possible so that the designer and owner can determine their implementation viability for the first time.

2.7.7.7 Reporting phase

This phase is seen as a demonstration of the project value engineering work, as is reported during the final report by writing in an organized manner and providing proposals and suggestions, suggested improvements and their justifications, and their feasibility in the form of a report. In addition, all efforts at the various stages of the analysis are documented. This report is submitted to the owners of the amendment or to review it (Dell'Isola, n.d.). The written report documents the alternatives with the supporting data and supports the management's agreed implementation strategy. The basic structure of the report is unique to the specifications of each study and organization.

2.7.7.8 Life cycle costing

The cost of the life cycle (LCC) is the ultimate measure of value for the consumer. It covers all initial and maintenance costs. The LCC model takes a maximum value as it takes all likely cost over the lifespan of the facility into consideration. The LCC model may be based on the annualized cost or the current value (Kirk and Dell'Isola, 1995). The West Virginia Highways Division (2004) reports that the cumulative cost of the project covers design costs, construction costs and maintenance and service costs. Construction costs do not exceed 50 per cent of the life cycle cost.

- The present worth of future annuities: In order to determine the life cycle cost of a project, investment should be viewed at different times, in a way that represents the value of money for time. The LCC model may, therefore, be based on either the annualized cost or the current value approach (El Sadawi, 2008). The formulas in table 2.5 for calculations of money equivalence at different times are used by La Grega, Buckingham and Evan (Kuo, 2004).
- Present worth analysis: The following formulas are used as present worth evaluation of future value, table

Table 2.5: Present Worth Calculations

Year	Amountat Beginning of Year	Interest Earned During Year	Compound Amount at the End of year	
1.	P	Pi	P + Pi	= P(1+i)
2.	P (1+I)	P(1+i)1	P(1+i) +P(1+i) i	= $P(1+i)^2$
3.	$P(1+I)^2$	$P(1+i)^2I$	$P(1+i)^2+P(1+i)^2i$	= $P(1+i)^3$
N.	$P(1+I)^{n-1}$	$P(1+i)^{n-1}I$	$(P1+i)^{n-1}+P(1+i)^{n-1}i$	= $P(1+i)^n$ = F

Figure 2.12: shows the LCC for a typical project (Langdon, 2006)

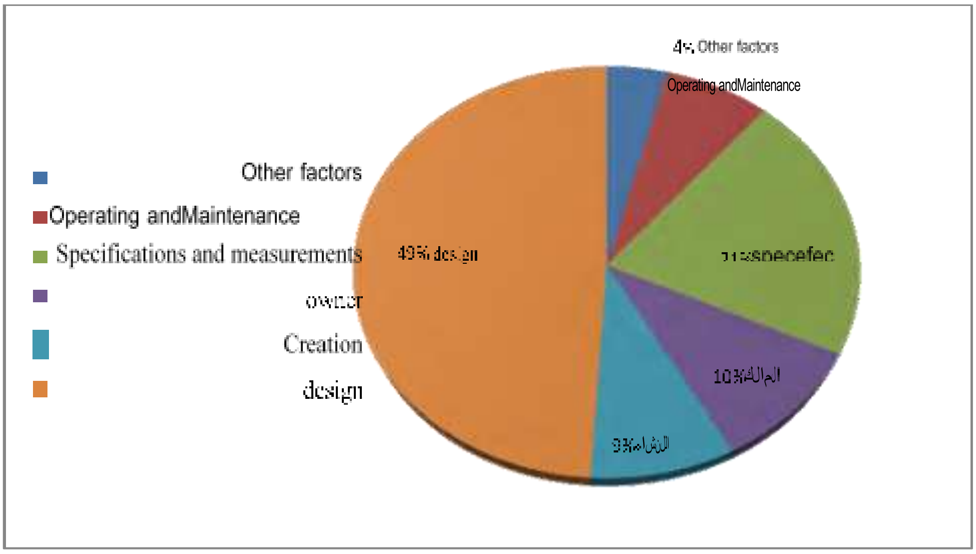


Figure 2.12: LCC for typical project

2.7.7.9 The results of applying value engineering

From the previous presentation of stages of the value study, it can be said that in any phase of the project's life, a value engineering study can be carried out, aiming to:

- Expand resource use (financial-workplace-administration) by eliminating unnecessary or additional costs without sacrificing quality or performance.

- Rapid application of changes with economic benefits or in other words, the establishment of a good quality change for the project owner, which adds value to the project and therefore for the project owner.
- Employers' growth and work satisfaction have evolved through effective economic skills, leading to an increased awareness of cost and the impact on employers of costs.

3. THE APPLICATION STAGE OF THE VALUE STUDY

There is a need, in addition to the necessary facilitation and access to resources for and support from all the stakeholders, to better understand the distinction between value management and value engineering. The preparation and approval of official reports will ensure that the full gain both from the value management and value engineering exercises is given, and then the implementation of the design recommendations will be monitored. This approach will be applying the recommendations of the electrical project research group during the project phases (Jay and Bowen, 2015).

The stage of applying the value study to the project is called a plan or workshop in which the work team applies the value engineering approach to the project chosen for the study. It is an organized plan, as we mentioned, consisting of several stages in a logical sequence according to the following (Figure 3.1).

Before making investment decisions, it is important to analyze the most crucial aspects of the project. Therefore, a small sum of money is worth investing in an experiment called reinvestment research/formulation. Depending on the project size, this cost can vary. However, the project sponsoring organization/department allows the project sponsoring organization/department to stop further expenditure at any point of the investigation during this phase, depending on the empirical analysis of the data and other collected information, when the data shows unfavourable patterns. Today's programs, particularly in the urban development field, concentrate on achieving clear goals for social and economic development. While problems abound in all types of projects, it is now increasingly evident that development projects produced by local governments, public agencies, and government departments have faced uncertain performance in terms of quality and quantity. Why is Formulation of Project Important?

For example: As a result of an insufficient demand survey, a major housing project initiated by a Development Authority in one of the states in India faced weak public demand after implementation. It was later discovered that the public, who had paid the registration fees at the time of the application, had refused to pay the entire cost of the house and that most of them had not responded. Until the authority had to renovate the houses by joining another private builder in an arrangement to improve the plan, efficiency, and longevity of the houses at an enormous expense, the housing units remained unsold. Upon alteration, after a gap of three years, the houses were sold to the public.

3.1 Initial Design

This is the stage in which most VE participants get interested when at least the concept has made it to the schematic stage. Most government agencies, on projects above a certain monetary value, need at least one VE session at the design level. The workshop, usually a 40-hour course, Proposal of the thesis, is the key method available to the VE team.

Table 3.1: The general method of working with value engineering

General process	Basic steps	Detailed steps	Problems to be tackled
analysis	The process of define and sort out the function	1. choose an object 2.gather and sort out materials	(1) what the research object of value engineering?
		3.define the function 4.sort out the function	(2) The function?
	Evaluation of the function	5.analyze the cost of function	(3) The cost?
		6.evaluation of the function 7.determine the scope of object	(4) The value?
generalize	Stipulate improvement solution	8.create a scheme	(5) Are there any other methods to achieve the same function?

Table 3.1: Continued

evaluation	9.examine and approve 10.implement and inspect 11.identify the results 12.make proposals	(6) The cost of the new plan? (7) Does the new plan meet the requirements?

3.2 Information Phase

It is the first stage in the value study and it takes lengths of time and forms the cornerstone on which the study is built and its goal is to get acquainted with all the information related to the project and to familiarize the members of the study team with all the details of the project by examining the project documents and documents and understanding them completely technically, financially and economically by dividing it into parts It is easy to study and listen to a brief about the project, write down the required information and notes, analyze and estimate the costs for each element of the project, and the elements can be prioritized for the study Italian economics, which states that (80 %) by following what is derived from the Pareto Law) of the project cost (20%) of its elements fall into what helps focus on the most costly elements first, prepare the required forms, fill in the data in them, determine the sources of information gathering, make visits to the owner, the user and the beneficiary, discuss the requirements of each of these agencies, and identify places of impairment through the value indicator. Determine the potentials of savings through the forms designated for this, and thus facilitate defining the objective of the study and its field of action.

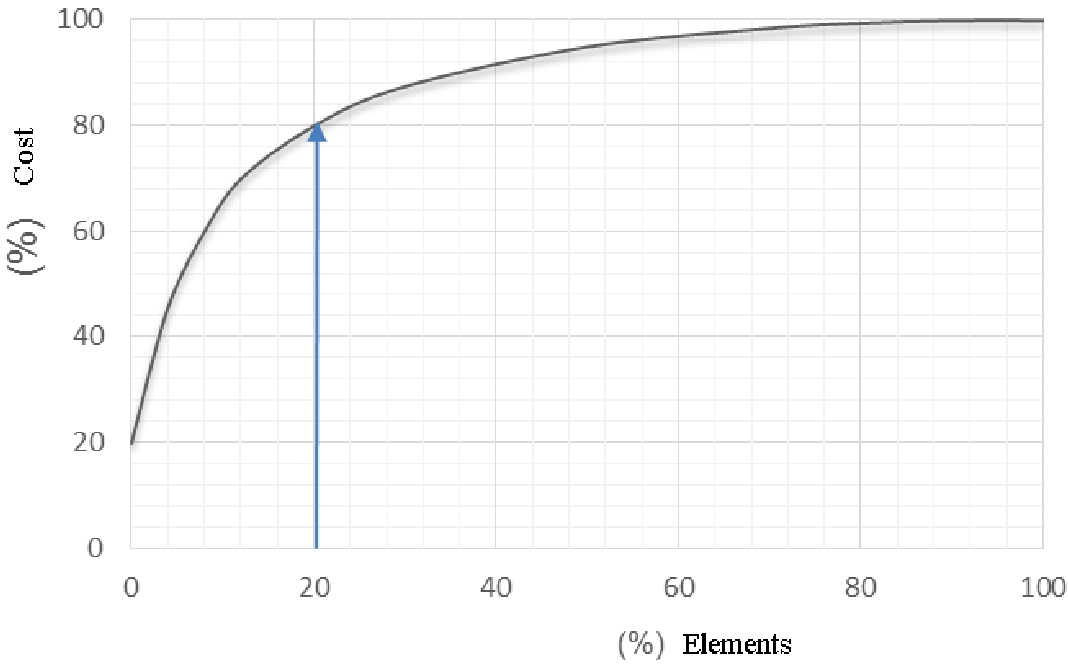


Figure 3.1: Barrett's Law

3.2.1 Sources of information

There are several sources from which the information necessary for the value study can be obtained from which we must specify the required information only so that the huge amount of information is not an obstacle for the study team. The most important sources of information can be limited to the following points:

First: Project documents and documents the most important source, including but not limited to:

1-Approved plans and specifications.

2- Design guidelines, standards and calculations.

3- Cost estimates and bill of quantities.

Second: Field visits to the relevant parties, including:

1- The signer, owner, designer, and ultimate beneficiary of the project

2-Similar projects.

3-Factories and research centres.

Third: the members of the study team. Members of the study team may be a source of information because the team has individuals with experience, competence and various specializations.

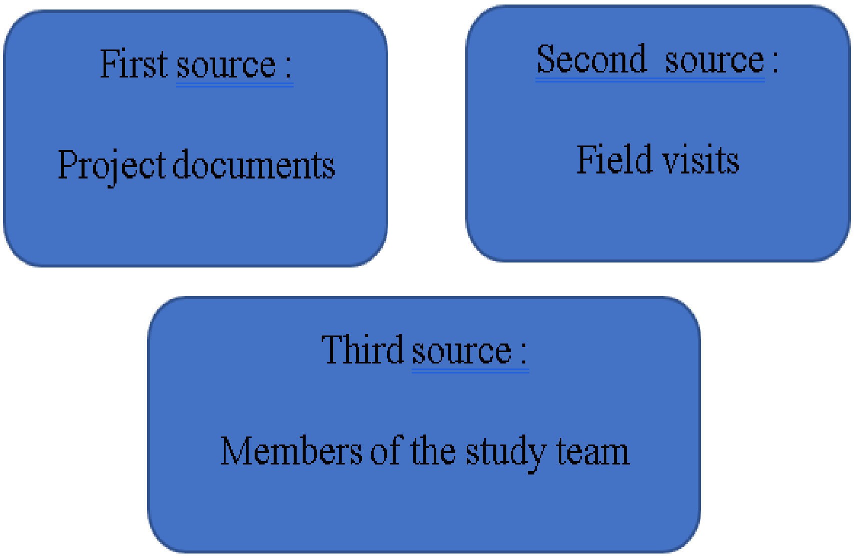


Figure 3.2: The sources of information

Many of the concepts were expanded into workable solutions during the creation process of the VE research. The production consists of a description of the suggested design change; a descriptive assessment of the proposed recommendation's advantages and disadvantages; cost comparison; and estimates of lifecycle costs. A brief narrative is presented with each suggestion to equate the original design approach to the proposed improvement. Where appropriate, sketches and design calculations are also included in this part of the study, as shown in the diagram below.

3.2.2 Information forms

There are a number of models used in the value study to empty the information about the study, and they differ from one project to another and help the work team in providing the necessary information in an organized way, including those forms.

Information Form		Consultation &Document Record
Study Title		
Information Source Name ,Title ,Organization Or Reference Document.	Phone No. If Applicable	Major Points of Data

Figure 3.3: Form for information sources

Economic information: can be listed as below,

- Desired return on investment.
- Percentage of equity by the owner.
- Financing period.
- Interest rate.
- The inflation rate on product market value.
- Inflation rates to be used for.
- Escalation rates to be used for.
- Life span to be used for analysis purposes.
- Cost estimates or all process equipment and facilities expected to be procured.

3.2.3 Other information

- Goals and objectives of the Project.
- Special requirements or criteria (i.e. flexibility, operations and maintenance, cost-effectiveness, safety, security, environment, etc.)

3.3 Function Phase

The Value Engineering Research has used the knowledge gathered to generate many new ideas and recommendations specific to this type of study.

3.3.1 Functon logic diagram

A "Function Logic Diagram" was prepared to present the importance engineering team for an understanding of the project's overall functions. From left to right, it is used to inform the designer how he chose to solve the tasks. The "Logic Diagram" feature also contributes to understanding the value of these functions for the owner. The diagram usually transforms the aims, priorities and tasks of production into a hierarchical diagram of functions to better understand the needs of the owner. A basic concept for this analysis was the Quick diagram prepared by the Value Engineering group leader just prior to the workshop.

3.3.1.1 Function-cost-worth

This approach involves activities performed to fulfil customer requirements. Costs for carrying out the functions are listed. The value to perform the necessary tasks is the least costly.

Preparing the functional review leads to generating several ideas that ultimately give rise to recommendations. The Value Engineering team, therefore, needs to speculate on alternatives to the proposed design. A cost-of-function analysis has generally not been conducted as a primary design or a primary innovative idea generator. During the field analysis and brainstorming activities, a large number of ideas were produced. In an effort to produce more ideas, a list has been made of the roles of the most important or dubious building systems.

3.4 Creative Phase

The list of innovative ideas is part of this phase in value engineering research. During this time, the Value Engineering team is considering as many ways as possible to provide the owner with the required functions inside the project at a lower cost. Judgments of the ideas are not allowed during this imaginative session. Ideas are then created to develop the best features and ideas on the weakest function. This chapter includes the strongest and worst features. In the creative process, the Value Engineering team looks for the quantity and association of ideas produced by the functional analysis. This list may contain ideas for further evaluation and use in functional testing. In the chapter on Value Engineering, the innovative ideas produced during the workshop are included in the workshop report.

3.5 Evaluation Phase

The Value Engineering team judges the ideas resulting from the innovative session in this process of the project. There is a study of the benefits and drawbacks of any proposal. Ideas are rated based on possible savings, time redesign and acceptability for the owner. Ideas worthy of further research are granted a higher ranking for the production of proposals. In certain cases, a weighted assessment is applied to take results other than costs into account. The Value Engineering team would like to develop all their concepts, but time limits typically limit the amount to be produced. For further analysis with design team members, the ideas that have been rated highly by the Importance Engineering team are selected.

This idea development consists of the preparation of estimated initial and life cycle costs, a descriptive assessment of the advantages and disadvantages of engineering calculations, and suggested recommendations as appropriate. It was considered important for the Value Engineering team to convey to the owner/design team the concept of their recommendation. To compare the original design method to the proposed reform, each recommendation is therefore prepared along with a brief narrative. In this part of the study, sketches and related materials, where appropriate, are also prepared.

3.6 Recommendation Phase

The presentation of recommendations is the final stage of the Value Engineering report. Until formal presentation, the value engineering recommendations are further screened by the Value Engineering team. Oral presentation of findings to the owner/design team on the last day of the workshop. The recommendations rationalize the implementation of each proposal and a review of cost savings is provided at this time to allow the owner/design team to begin an assessment of the recommendations for value engineering, as an example for recommendations in VE application in electrical works in a study of VE application in United Arab Emirates UAE to be applied on The Ruwais Housing Complex Expansion. The Ruwais Housing Complex Expansion scheme, Phase III, Married Accommodation and associated services, including utilities, is located in the Western Region of Abu Dhabi, United Arab Emirates, 242 kilometres from the capital. The project consists of seventeen (17) buildings comprising six (6) store buildings consisting of seven (7) Type F4 buildings and ten (10) Type F5 buildings comprising a sub-station, a chiller yard, sidewalks, walkways, playgrounds and car parking facilities. A total of two hundred and four (204) with two (2) bedroom flats and one hundred and twenty (120) with three (3) bedroom flats are given in Type F5 buildings. The estimated built-up area is 80,700 m2 or so(Engineer, n.d.). The ideas that listed in table 3.2:

Table 3.2: Proposed ideas for The Ruwais Housing Complex

No	Idea code	Description	Rank
1	E1	Delete five (5) amp flexible outlet in kitchen	10
2	E2	Decrease one compact fluorescent 4x18 win the master bedroom	10
3	E3	Reduce lift outlet in the shaft	5
4	E4	Reduce the size of rooftop telephone rooms	9
5	E5	Delete lighting for the top roof (floodlights)	6
6	E6	Reduce the lighting of corridors to seven on each floor	8
7	E7	Reduce main entrance building light	8
8	E8	Reduce the number of earth pits for the lighting system	7
9	E9	Introduce the central system for solar water heating	7

Table 3.2: Continued

10	E10	Revisit external light of the building	7
11	E11	Delete lighting for planter (halogen)	9
12	E12	In bathrooms, delete shaving sockets (to be studied with mirror light)	7
13	E13	Replace in the kitchen, 45-amp cooker sockets with 15 amp	9
14	E14	Using the PLC integrated energy meter (to match RHD existing system)	10
15	E15	Use PLC controlled water system	1
16	E16	Adjust and decrease the amount of landscape lighting to 3 m decorative pollard lighting	5
17	E17	Increase the transformer capacity to fit linked loads from 1500 KVA to 2000 KVA	9
18	E18	Delete associated sockets of deleted FCU	9
19	E19	Delete double pole switches connected to inactive water heaters	8
20	E20	Remove electrical installation connected with the disconnected chillers	10
21	E21	Delete one transformer	9

4. FIELD STUDY AND THE DATA ANALYSIS

Because of the low efficiency of the implementation and operation of many electrical energy projects in the Iraqi Ministry of Electricity and the complexity of maintenance problems for these projects due to the lack of scheduling and planning the stages of these projects and the difficulty in applying the value engineering methodology in the field of these projects because of this correlation with multiple variables represented in the absence of this methodology in the laws that govern the number and design And the referral of these projects for implementation, likewise, the lack of a mechanism for applying quality and measuring the value that is compatible with modern methodologies in value engineering, especially what is compatible with the approach proposed by the American International Society for Value Engineering. This study suggests taking into consideration all of the above to apply it in the mechanisms of work of the Iraqi Ministry of Electricity.

4.1 Field Study

The field study focused on the projects implemented by the ministry of electricity in Iraq because all-electric projects are implemented by that ministry. There are many projects in the electricity field such as power generation, transmission and distribution. All those operations controlled and implemented by the ministry of electricity and the affiliated companies.

4.1.1 Description of the study sample "Iraqi Ministry of Electricity"

It is one of the federal ministries in the Iraqi state, and it is one of the vital and important ministries in Iraq. The Ministry of Electricity in the Republic of Iraq is the body responsible for both policies and electricity supply throughout the country. In addition to overseeing operational functions (power generation, transmission, and distribution). The Ministry of Electricity was established in Iraq in 2003 after the Electricity Authority had been since 1999 and before that, the electricity sector was within the formations of the Ministry of Industry and Minerals (Iraqi Ministry of Electricity, n.d.).

4.1.2 The capabilities of the Iraqi Ministry of Electricity

The ministry is responsible for all-electric power sectors, as it is the only one in providing electricity in Iraq due to the absence of other means such as the private sector or specialized companies.

4.1.3 Ministry headquarters departments

A- General directorates for all regions of Iraq concerned with the generation and transportation of electric power.

B- Directorates of electricity distribution in all Iraqi provinces.

C- Major electric power plants.

4.1.4 The most important companies in the ministry

Production of electric energy companies:

The structure of the Iraqi Ministry of Electricity in the affairs of production of electric energy includes the following main companies: -

A. The General Company for Electric Power Production / Northern Region.
B. The State Company for Electric Power Production / Central Region.
C. The State Company for Electric Power Production / Middle Euphrates.
D. The State Company for Electric Power Production / Southern Region.
E. The State Company for Inspection and Rehabilitation of Electrical Systems.

Transmission and distribution companies:

The Iraqi Ministry of Electricity also includes the following companies:

A. The General Electric Power Transmission Company / Northern Region.
B. The General Electric Power Transmission Company / Central Region.
C. The General Electric Power Transmission Company / Southern Region.
D. The General Company for Electric Power Transmission / Middle and Upper Euphrates.

E. The General Company for North Electricity Distribution.
F. The General Company for Baghdad Electricity Distribution.
G. General Company for Southern Electricity Distribution.

4.1.5 Duties of the Iraqi Ministry of Electricity

A- Providing electric power to meet the needs of the Iraqi state

B - Transmission of electric power through the national and local electricity transmission networks for all governorates of Iraq

D- Carry out maintenance and maintenance of the generating stations and the national and local transmission and distribution networks for the governorates Contracting with foreign companies and countries to import electrical energy to Iraq.

4.2 Data Analysis and Hypothesis Testing

In this topic, a description of the method and procedures followed in carrying out this study are provided. This includes a description of the research community and its sample, the method for its preparation, and the actions taken to ensure its validity and reliability; the method used to apply it, and the statistical treatment according to which the data were analyzed and conclusions are drawn.

4.2.1 Description of the study population and sample

Study population means the total set of elements that the researcher seeks to generalize to the results related to the studied problem. The original study population consists of engineers and economists working in the field of implementing engineering projects, especially projects of the Iraqi Ministry of Electricity.

As for selecting the samples that were studied, the questionnaires were distributed through several outlets such as Internet pages and social media sites, especially those related to electricity, in addition to the Iraqi Engineers Association. The number of those who answered the questionnaire reached 168 people, their ages ranging from 20 to 60 years. While their specializations were divided into (electrical engineering, electronic engineering, mechanical engineering, civil engineering and a paragraph for other specialties), the selection of samples was random and according to the response of the people who looked at the questionnaire. The questionnaire included a range of specializations and years of experience, and this information was documented for later analysis. As for academic achievement, it was distributed on the basis of the certificate obtained by people and included (baccalaureate, university degree, master's, and doctorate). Individuals from different years of work experience (less than five years, 5-10, 11-15,16-20 and more than 20 years).

4.2.2 The study tools

The study tool is the method used by the researcher to collect the necessary information about the phenomenon the subject of the study, and there are many tools used in the field of scientific research to obtain the data and information needed for the research, and the researcher relied on the questionnaire as the main tool for data collection from the sample of the study.

To verify the apparent validity of the questionnaire and the validity of its statements in terms of wording and clarity, the researcher undertook by presenting the statements of the questionnaire to the supervisor, who in turn directed the questionnaire to be sent to some after giving an opinion Specialists for the purpose of the arbitration. Where the arbitrators arbitrated the questionnaire, and after retrieving the questionnaire from Arbitrators Some amendments that were proposed by the arbitrators were made after reviewing the supervisor.

4.2.3 Reliability and reliability of the statistical search scale

The consistency of the test is intended to give the meter the same results if used more than once under Similar conditions, and consistency also means that if a test is applied to a group of individuals and is monitored Then the same test was applied to the same group, and the scores were obtained the test is completely consistent. Reliability is also defined as the accuracy and consistency of the measurements made. It is obtained from what the test measures, and one of the most used methods for estimating the reliability of the scale are:

- Cronbach's Alpha Formula.
- Pearson correlation coefficient.
- Spearman-Brown prediction formula.
- Method of re-application of the test.

- The method of stoichiometric.

As for honesty, it is a measure used to know the degree of truthfulness of the respondents through their answers on a scale the truth is calculated in many ways, the easiest of which is that it represents the square root of the reliability coefficient (0-1). The self-validity of the questionnaire was the measure of the tool when it was developed, and the measurement of validity is the knowledge of the validity of the tool to measure what you have put to it. Table 4.1 contains Reliability Statistics

Table 4.1: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.853	.857	20

4.2.4 The used statistical methods

To achieve the study objectives and verify its hypotheses. The following statistical methods were used:

- Frequency distribution of answers.
- Percentages.
- Cronbach Alpha Coefficient for stability.
- Pearson correlation coefficient.
- Simple Linear Regression Analysis.
- Testing the quality of a regression model using F.

In order to obtain the results as accurate as possible, the statistical program SPSS was used, which refers to the statistical package for the social sciences.

4.2.5 Analysis of personal data

4.2.5.1 Age

Table 4.2 contains Repetitive distribution of the study sample according to the age variable. While figure 4.1 shows the charts for the same distribution.

Table 4.2: Repetitive distribution of the study sample according to the age variable.

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	<30 years	8	4.8	4.8	4.8
	31-40 years	40	23.8	23.8	28.6
	41-50 years	96	57.1	57.1	85.7
	51-60 years	24	14.3	14.3	100.0
	Total	168	100.0	100.0	

From table 4.2, it is clear that the age group for the study samples contains five ranges with the following percentages: for the range of fewer than 30 years, the percentages are 4.8% with eight samples. The range (31-40) years the samples are 40 samples with the percentage of 23.8%, (41-50) years was 96 samples represents 57.1%, while (51-60) was 24 samples with 14.3%.

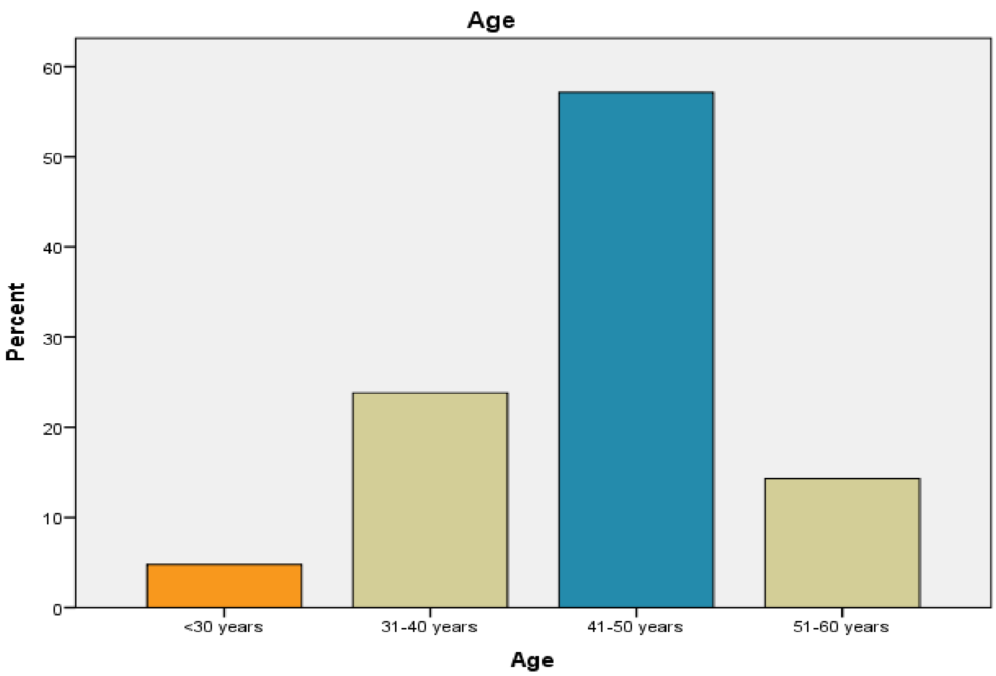


Figure 4.1: Repetitive distribution of the study sample according to the age variable

4.2.5.1 Scientific specialization

The frequency distribution of the study sample according to the scientific specialization variable included in Table 4.3.

Table 4.3: Frequency distribution according to the scientific specialization

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Electrical Engineering	40	23.8	23.8	23.8
	Electronics Engineering	8	4.8	4.8	28.6
	Mechanical Engineering	24	14.3	14.3	42.9
	Civil Engineering	48	28.6	28.6	71.4
	Other	48	28.6	28.6	100.0
	Total	168	100.0	100.0	

Table 4.3 contains the frequency distribution for the study samples according to the specialization, as is explained in the table, electrical engineers number was 40 sample with percentage of 23.8%, electronics engineering samples number was eight samples that represent 4.8% of the total samples, mechanical engineers were 24 samples with 14.3%, civil engineers number was 48 samples that represent 28.6%, while the other specializations number was about 48 sample with 28.6% from the total samples number. Figure 4.2 shows the frequency distribution for the samples depending on the specialist in chart form.

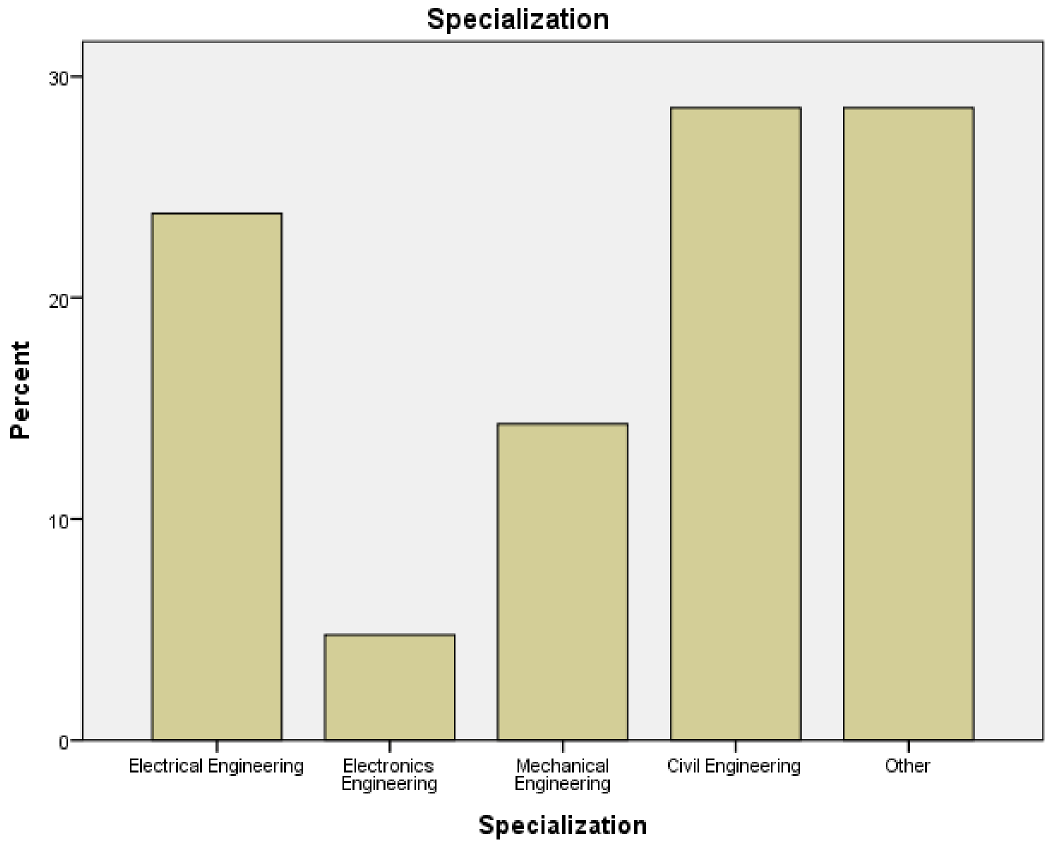


Figure 4.2: Frequently distribution for the samples depending on the specialist in chart form.

Experience

Table 4.4: Repetitive distribution of study sample individuals according to the work experience variable

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	< 5 years	8	4.8	4.8	4.8
	6 - 10 years	16	9.5	9.5	14.3
	11 - 15 years	64	38.1	38.1	52.4
	16 - 20 years	40	23.8	23.8	76.2
	> 20 years	40	23.8	23.8	100.0
	Total	168	100.0	100.0	

As shown in table 4.4 the samples how to have an experience less than five years are eight persons (4.8%), (6-10) years' experience samples are 16 people (9.5%), (11-15) years' experience is 64 sample (38.1%), the persons who have experience in the range

(16-20) years are 40 persons (23.8%), while the samples number for persons who have experienced more than 20 years are 40 people (23.8%). Figure 4.3 shows the repetitive distribution of study sample individuals according to the work experience variable.

Figure 4.3: The repetitive distribution of study sample individuals according to the work experience variable

4.3 Presentation and Discussion of the Results of the Hypotheses

4.3.1 Analysis of phrases for the first axis

The answers of the study sample can be summarized on the expressions for the first axis in Table 4.5. the question was: Do you have information about the value engineering methodology previously?

The persons who have previous information about VE is 71.4%, while whose have no information about VE percentage is 28.6%. Figure 4.4 shows the repetitive distribution.

Table 4.5: The repetitive distribution of study sample individuals according to first question

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	yes	120	71.4	71.4	71.4
	N0	48	28.6	28.6	100.0
	Total	168	100.0	100.0	

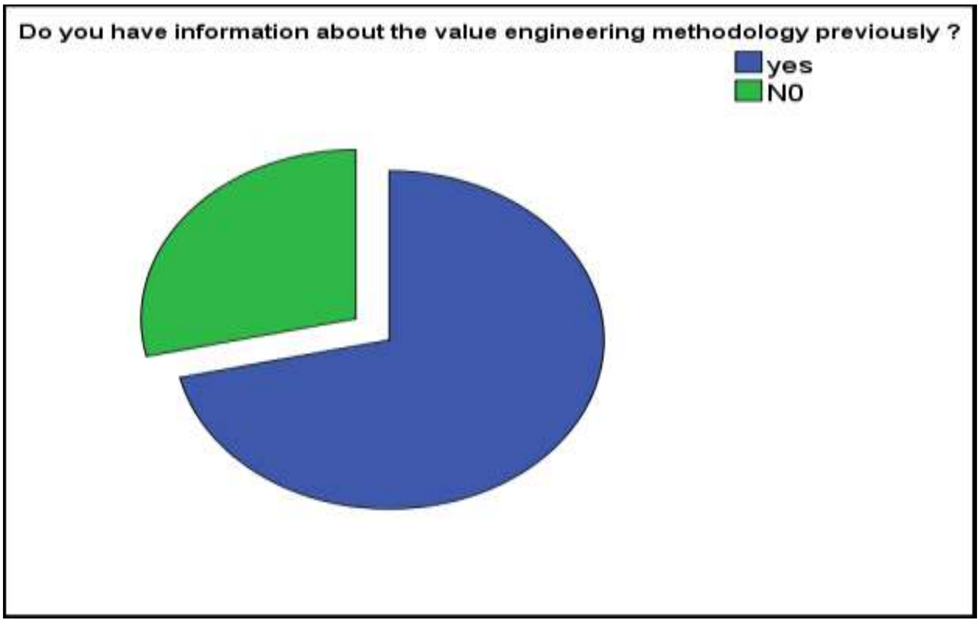


Figure 4.4: The repetitive distribution of study sample individuals according to first question

4.3.2 Analysis of answers for the second axis questions

This part related to a questionnaire on the application of the value engineering methodology during the stages of electrical projects in the Iraqi Ministry of Electricity.

Q1: Adopting value engineering methodology will reduce unnecessary costs?

Q2: Applying the value engineering methodology will determine the costs necessary for each project?

Q3: Accurately applying the phases of value engineering in project accounts will reduce project taxes?

Q4: Applying the methodology will reduce the amount of interest accruing on the financial amounts that have been allocated for investment in the project during the period preceding its operation?

Q5: Carefully studying the value of the projects will lead to the provision of sums used as a reserve for the project and used for emergency cases?

Q6: There is a relationship between not reviewing and auditing project costs before announcing the mand not implementing these projects or delaying the implementation? (The answers to the previous questions were approved to obtain the full information required in this axis).

Table 4.6: Statistics for the first axis questions

		Q1	Q2	Q3	Q4	Q5	Q6
N	Valid	168	168	168	168	168	168
	Missing	0	0	0	0	0	0
Mean		3.86	3.90	3.48	3.33	3.86	3.52
Median		4.00	4.00	3.00	3.00	4.00	3.00
Mode		4	3	3	3	3[a]	3
Percentiles	25	3.00	3.00	3.00	3.00	3.00	3.00
	50	4.00	4.00	3.00	3.00	4.00	3.00
	75	4.00	5.00	4.00	5.00	5.00	4.00

a. Multiple modes exist. The smallest value is shown

4.3.2.1 First question

Adopting value engineering methodology will reduce unnecessary costs? The answers for this question are listed in table 4.7, the results for the question divided to 56 samples (33%) don't know,80 samples (48%) answered with an agreement, while the other 32 samples (19%) answered with "strongly agree". Figure 4.5 shows the repetitive distribution of study sample individuals according to the first question.

Table 4.7: Adopting value engineering methodology will reduce unnecessary costs

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Don't know	56	33	33	33.3
	Agree	80	48	48	81.0
	Strongly Agree	32	19.0	19.0	100.0
	Total	168	100.0	100.0	

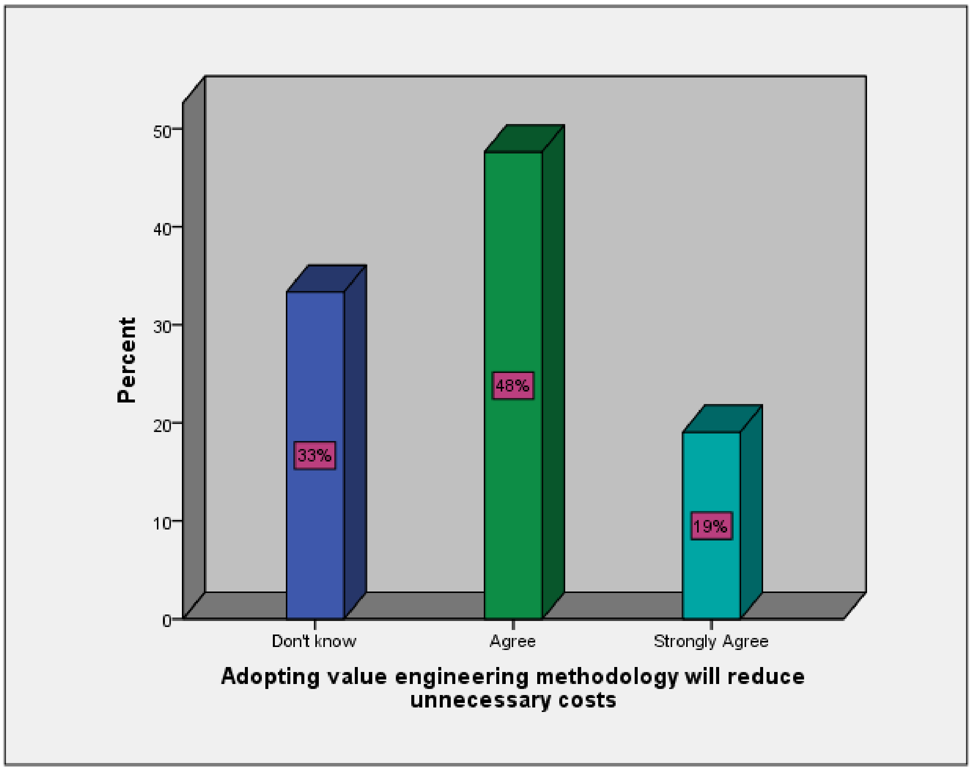


Figure 4.5: Repetitive distribution of study sample individuals according to first question

4.3.2.2 Second question

Applying the value engineering methodology will determine the necessary costs for each project?

The answers for this question are listed in table 4.8, the results for the question divided to 72 samples (43%) don’t know,40 samples (24%) answered with an agreement, while the other 56 samples (33%) answered with "strongly agree". Figure

4.6 shows the repetitive distribution of study sample individuals according to the second question.

Table 4.8: Repetitive distribution of study sample individuals according to the second question.

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Don't know	72	43	43	43
	Agree	40	24	24	67
	Strongly Agree	56	33	33	100
	Total	168	100	100	

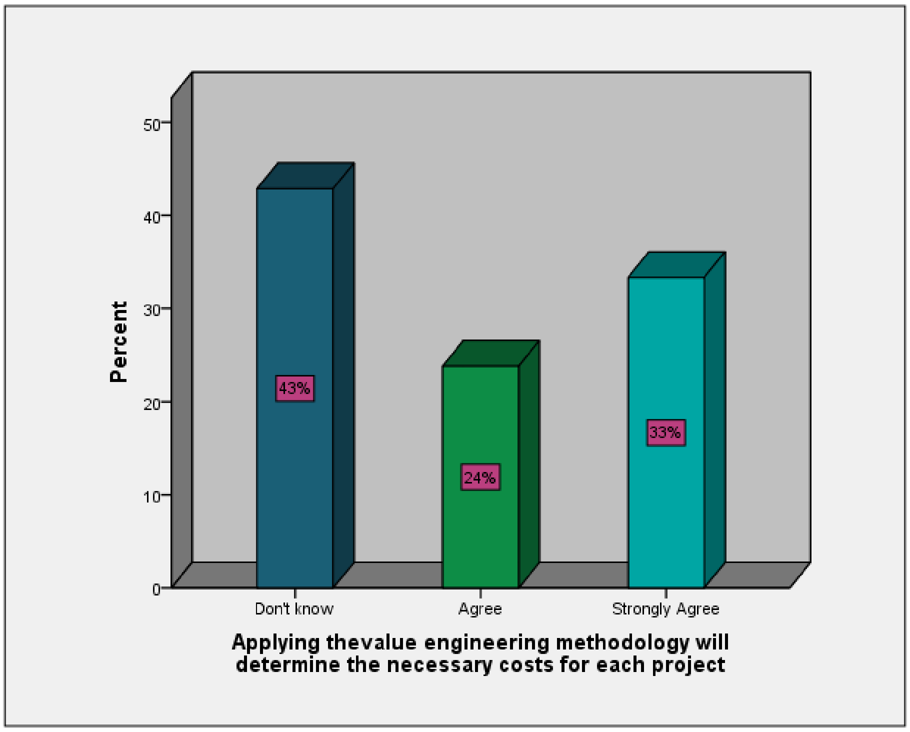


Figure 4.6: Repetitive distribution of study sample individuals according to the second question

4.3.2.3 Third question

Accurately applying the phases of value engineering in project accounts will reduce project taxes?

The samples answered the question in five different answers, eight persons (5%) answered with strongly disagree, 16 (10%) answered with disagreeing, 72 persons (43%) don't know if the application of VE will reduce the project taxes or not, 32 (19%) samples agreed with reduction idea, while the other 40 persons (24%) strongly agreed that the application of VE would reduce the project taxes. Table 4.9 contains the Repetitive distribution of study sample individuals according to the third question, while figure 4.7 shows the percentage of the answers for the same question.

Table 4.9: Repetitive distribution of study sample individuals according to the third question

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	8	5	5	5
	Disagree	16	10	10	14
	Don't know	72	43	43	57
	Agree	32	19	19	76
	Strongly Agree	40	24	24	100
	Total	168	100	100	

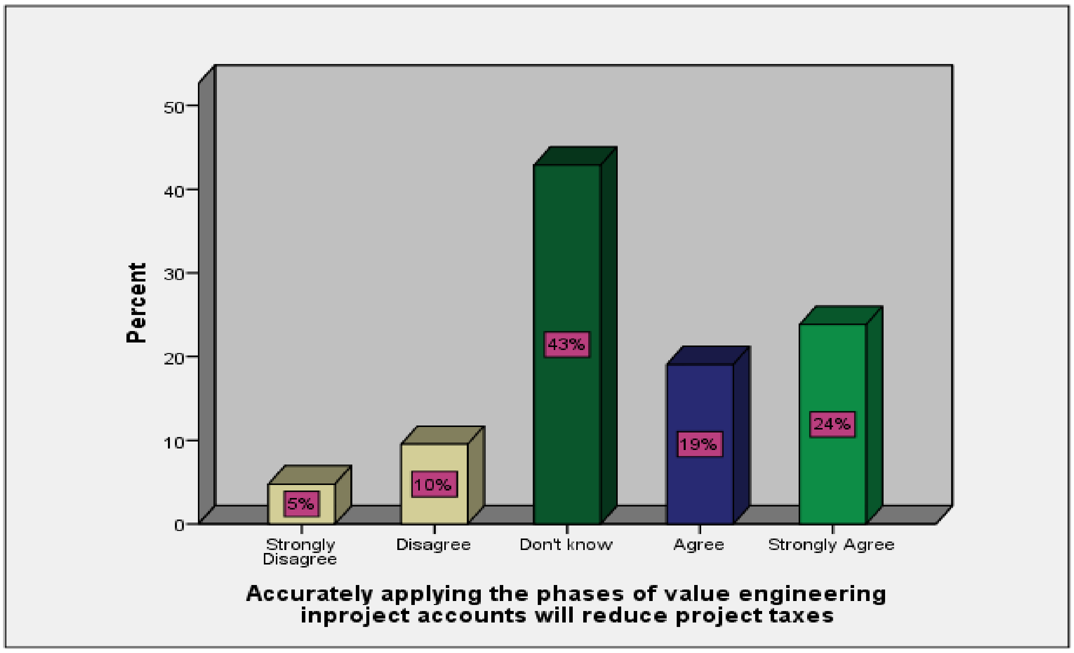


Figure 4.7: Repetitive distribution of study sample individuals according to the third question

4.3.2.4 Fourth question

Applying the methodology will reduce the amount of interest accruing on the financial amounts that have been allocated for investment in the project during the period preceding its operation? The persons answered the question in five different answers, 16 persons (10%) answered with strongly disagree, 24 (14%) answered with disagreeing, 64 persons (38%) don't know if the application of VE will reduce the project taxes or not, 16 (10%) samples agreed with reduction idea, while the other 48 persons (29%) strongly agreed that the application of VE would reduce the project taxes. Table 4.10 contains the Repetitive distribution of study sample individuals according to the third question, while figure 4.8 shows the percentage of the answers for the same question.

Table 4.10: Repetitive distribution of study sample individuals according to the fourth question

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	16	10	10	10
	Disagree	24	14	14	24
	Don't know	64	38	38	62
	Agree	16	10	10	71
	Strongly Agree	48	29	29	100
	Total	168	100	100	

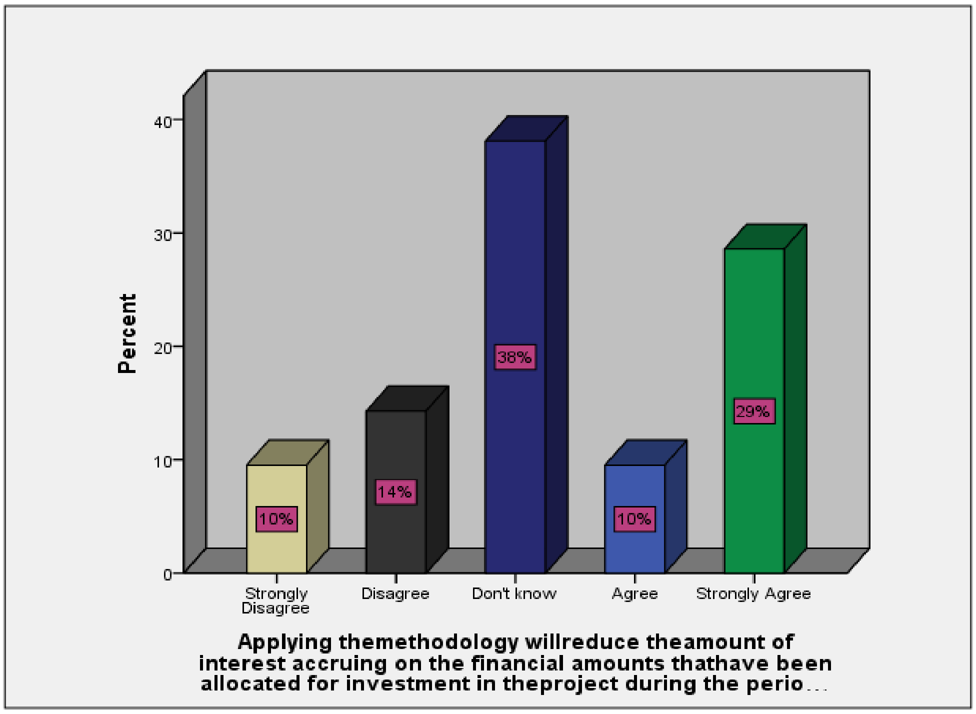


Figure 4.8: Repetitive distribution of study sample individuals according to the fourth question

4.3.2.5 Fifth question

Carefully studying the value of the projects will lead to the provision of sums used as a reserve for the project and used for emergency cases?

The persons answered the question in five different answers, eight persons (5%) answered with strongly disagree, 16 (10%) answered with disagreeing, 64 persons (38%) don't know if the application of VE will reduce the project taxes or not, 16 (10%) samples agreed with reduction idea, while the other 64 persons (38%) strongly agreed that the application of VE would reduce the project taxes. Table 4.11 contains the Repetitive distribution of study sample individuals according to the fifth question, while figure 4.9 shows the percentage of the answers for the same question

Table 4.11: Repetitive distribution of study sample individuals according to the fifth question

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	8	5	5	5
	Disagree	16	10	10	14
	Don't know	64	38	38	52
	Agree	16	10	10	62
	Strongly Agree	64	38	38	100
	Total	168	100	100	

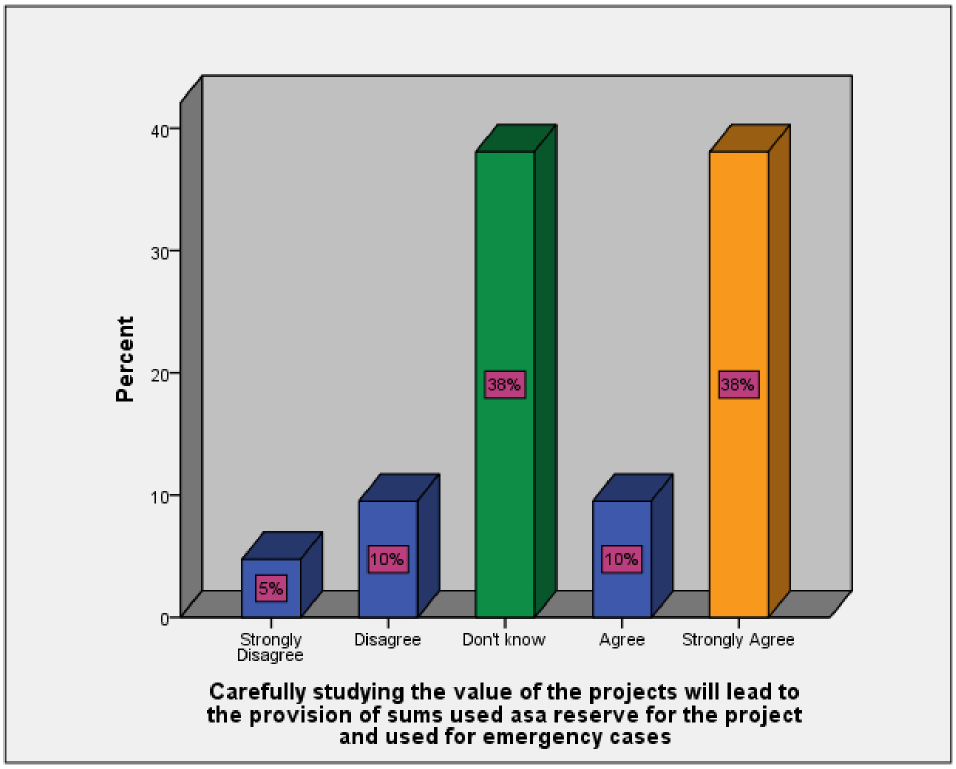


Figure 4.9: Repetitive distribution of study sample individuals according to the fifth question

4.3.3 Analysis of answers for the third axis questions

In this section, the answers for the questions about the relationship among value engineering, quality and specifications. The statics for this axis are listed in table 4.12.

Q1: Raise the quality of work for electricity projects by choosing the fine origins when writing the schedule of quantities?

Q2: Analyzing jobs in the project and allocating responsibilities accurately will increase the quality and efficiency of project implementation?

Q3: One of the mechanisms in value engineering is innovation, and this will contribute to finding solutions to problems in a fast and sophisticated way?

Q4: Value management and value control will make work be carried out according to specific mechanisms that are weighed and far from extravagance and waste of materials and money?

Q5: Raising the efficiency of the project's job performance will?

Q6: The value engineering team formed in the structure of the engineering departments enters the stages of preparing the project documents? (The answers to the previous questions were approved to obtain the full information required in this axis).

Table 4.12: Statics for third axis

Statistics							
		Q1	Q2	Q3	Q4	Q5	Q6
N	Valid	168	168	168	168	168	168
	Missing	0	0	0	0	0	0
Mean		1.62	2.10	2.24	2.10	1.90	2.00
Median		1.00	2.00	3.00	2.00	2.00	2.00
Mode		1	3	3	3	1	1[a]
Percentiles	25	1.00	1.00	1.00	1.00	1.00	1.00
	50	1.00	2.00	3.00	2.00	2.00	2.00
	75	2.00	3.00	3.00	3.00	3.00	3.00

a. Multiple modes exist. The smallest value is shown

4.3.3.1 First question

Raise the quality of work for electricity projects by choosing the fine origins when writing the schedule of quantities?

The answers in this section divided into three answers (yes, know, and I don't know), for the first question the answers came as 96 samples (57%) don't know, 40 samples (24%) answered with "no", while the other 32 samples answered with " yes". The Repetitive distribution of study sample individuals, according to the first question, are listed in table 4.13. And the graphical representation for repetitive distribution of study sample individuals according to the first question is shown in figure .10.

Table 4.13: The Repetitive distribution of study sample individuals according to first question

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	I don't know	96	57	57	57
	No	40	24	24	81
	yes	32	19	19	100
	Total	168	100	100	

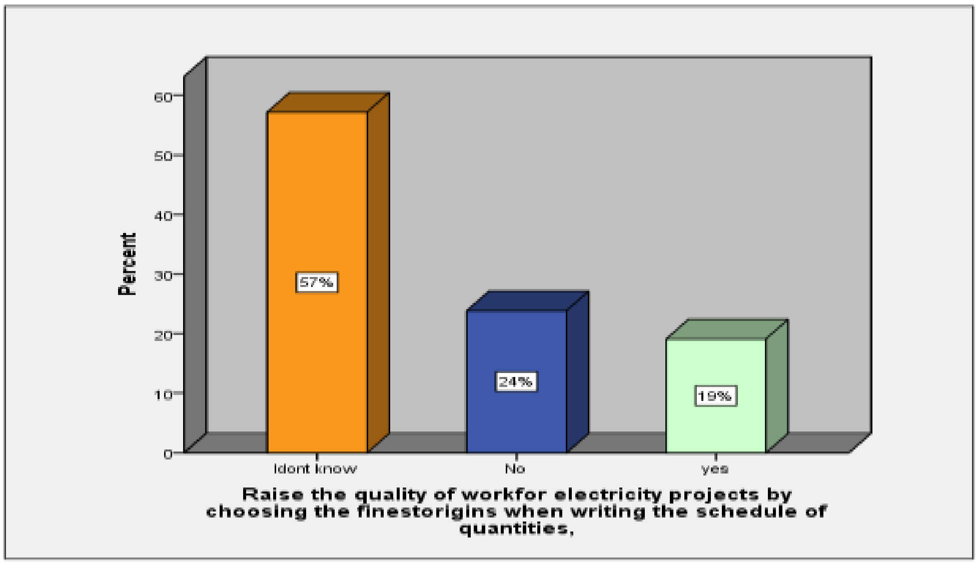


Figure 4.10: The Repetitive distribution of study sample individuals according to first question

4.3.3.2 Second question

Analyzing jobs in the project and allocating responsibilities accurately will increase the quality and efficiency of project implementation?

For the second question, the answers came as 56 samples (33%) don’t know, 40 samples (24%) answered with "no", while the other 72 samples (43%) answered with "yes". The Repetitive distribution of study sample individuals, according to the second question, are listed in table 4.14. figure 4.11 shows the graphical representation for the same answers.

Table 4.14: The Repetitive distribution of study sample individuals according to the second question

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	I don't know	56	33	33	33
	No	40	24	24	57
	yes	72	43	43	100
	Total	168	100	100	

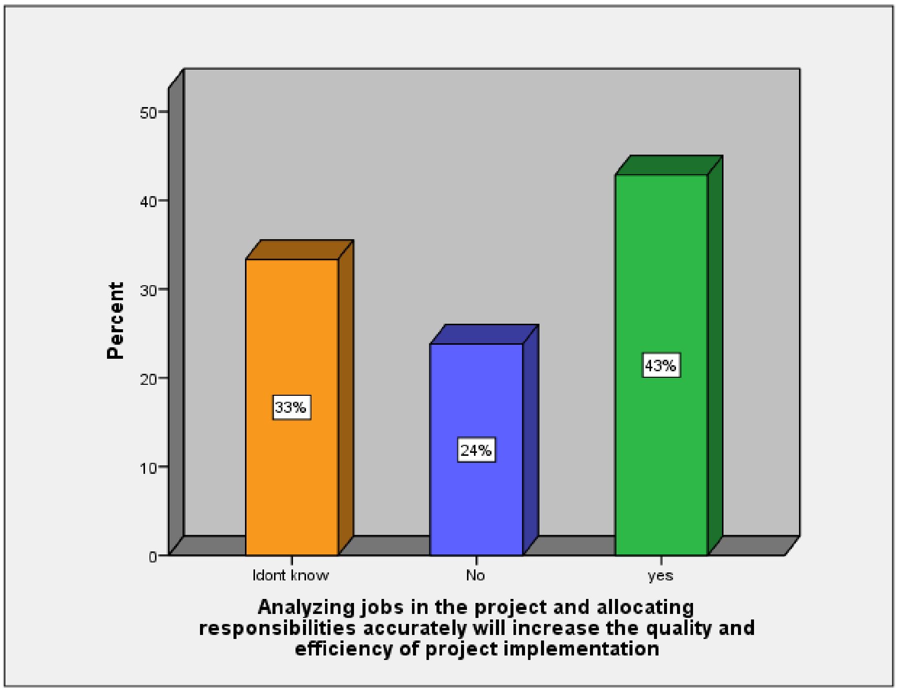


Figure 4.11: The Repetitive distribution of study sample individuals according to the second question

4.3.3.3 Third question

One of the mechanisms in value engineering is innovation, and this will contribute to finding solutions to problems in a fast and sophisticated way?

For the third question, the answers divided into 48 samples (29%) don’t know, 32 samples (19%) answered with "no", while the other 88 samples (52%) answered with "yes". The Repetitive distribution of study sample individuals, according to the second question, are listed in table 4.15. figure 4.12 shows the graphical representation for the same answers.

Table 4.15: The Repetitive distribution of study sample individuals according to the third question

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	I don't know	48	29	29	29
	No	32	19	19	48
	yes	88	52	52	100
	Total	168	100	100	

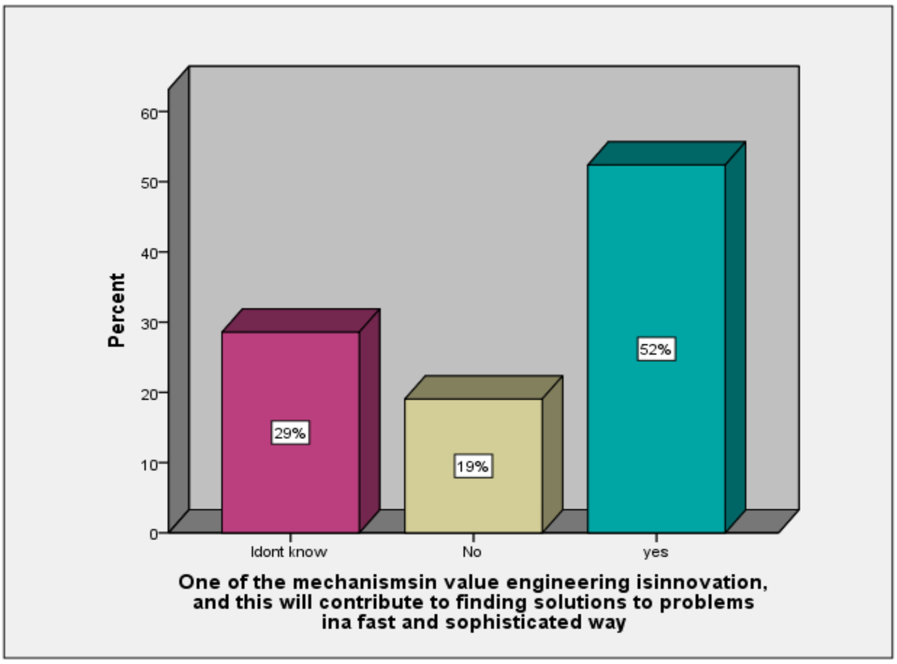


Figure 4.12: The Repetitive distribution of study sample individuals according to the third question

4.3.3.4 Fourth question

Value management and value control will make work be carried out according to specific mechanisms that are weighed and far from extravagance and waste of materials and money?

For this question the answers divided into 64 samples (38%) don’t know, 56 samples (33%) answered with "no", while the other 48 samples (29%) answered with " yes". The Repetitive distribution of study sample individuals, according to the fourth question, is listed in table 4.16. figure 4.13 shows the graphical representation for the same answers.

Table 4.16: The Repetitive distribution of study sample individuals according to fourth question

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	I don't know	64	38	38	38
	No	56	33	33	71
	yes	48	29	29	100
	Total	168	100	100	

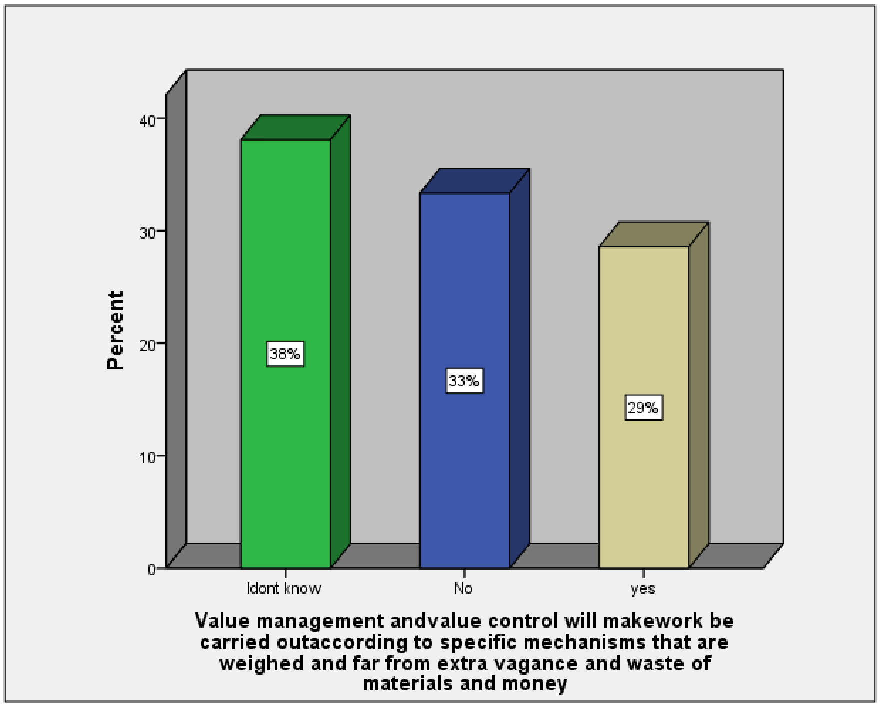


Figure 4.13: The Repetitive distribution of study sample individuals according to the fourth question

4.3.3.5 Fifth question

Raising the efficiency of the project's job performance will increase the project's life and sobriety?

The received answers for this question divided into 64 people (38%) don't know if there is a relation between efficiency raising and project life or sobriety, 40 people (24%) see that the efficiency raising will not affect the project life and sobriety, while the other 64 people (38%) think that the raising of efficiency will increase the project life and sobriety. The Repetitive distribution of study sample individuals according to the fifth question listed in table 4.17, while the graphical representation is shown in figure 4.14.

Table 4.17: The Repetitive distribution of study sample individuals according to the fifth question

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	I don't know	64	38	38	38
	No	40	24	24	62
	yes	64	38	38	100
	Total	168	100	100	

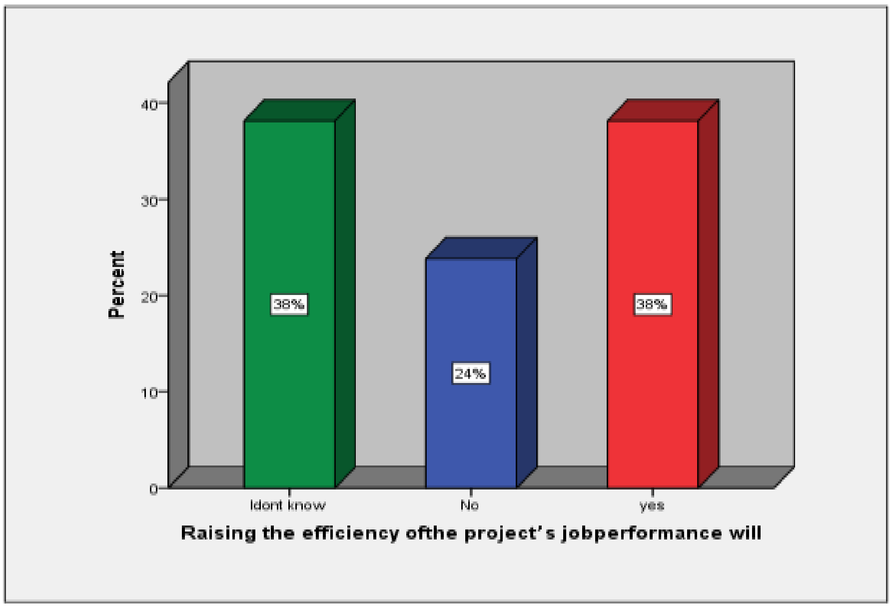


Figure 4.14: The Repetitive distribution of study sample individuals according to the fifth question

4.3.4 Analysis of answers for the fourth axis questions

This section contains one question only: Does value engineering increase quality?

The answers for this question came in three groups: about 80 sample (52%) don't know if the VE increase the quality or not, 40 samples (24%) agreed with the idea that the VE increase the quality, while the other 40 samples (24%) strongly agreed that the VE increase the quality. The percentage for the answers is listed in table 4.18, and the graphical representation is shown in (Figure 4.15).

Table 4.18: The Repetitive distribution of study sample individuals according to fourth axis question

		Frequency	Per cent	Valid Percent	Cumulative Percent
Valid	Don't know	88	52	52	52
	Agree	40	24	24	76
	Strongly Agree	40	24	24	100
	Total	168	100	100	

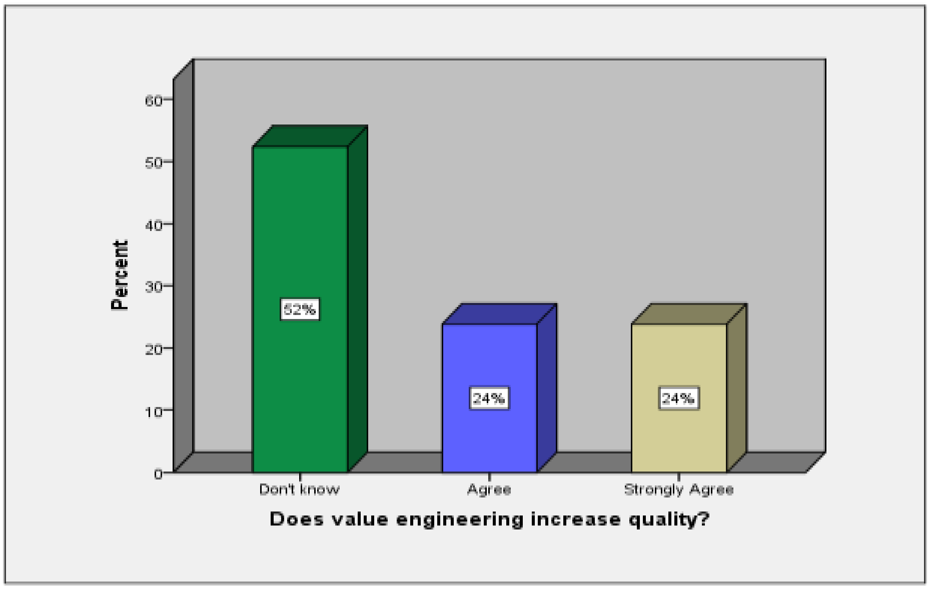


Figure 4.15: The Repetitive distribution of study sample individuals according to fourth axis question

4.4 Test Hypotheses of the Study

To study the hypothesis of the study Correlation by coefficient of Pearson Chi-Square used for three independent variables (Specialization, education level, and experiences) and the dependent variable in this case "effect of VE on quality”:

4.4.1 Specialization

Specialization * Does value engineering increase quality? Crosstabulation statics are listed in table 4.19. And Chi-Square Tests is listed in table 4.20.

Table 4.19: Specialization * Does value engineering increase quality? Crosstabulation

			Does value engineering increase quality?			
			Don't know	Agree	Strongly Agree	Total
Specialization	Electrical Engineering	Count	16	16	8	40
		Expected Count	21.0	9.5	9.5	40.0
	Electronics Engineering	Count	8	0	0	8
		Expected Count	4.2	1.9	1.9	8.0
	Mechanical Engineering	Count	0	16	8	24
		Expected Count	12.6	5.7	5.7	24.0
	Civil Engineering	Count	32	0	16	48
		Expected Count	25.1	11.4	11.4	48.0
	Other	Count	32	8	8	48
		Expected Count	25.1	11.4	11.4	48.0
Total		Count	88	40	40	168
		Expected Count	88.0	40.0	40.0	168.0

Table 4.20: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	64.145[a]	8	.000
Likelihood Ratio	84.082	8	.000
Linear-by-Linear Association	2.943	1	.086
N of Valid Cases	168		

a. three cells (20.0%) have expected count less than 5. The minimum expected count is 1.90.

4.4.2 Education level

Educational attainment * Does value engineering increase quality? Crosstabulation is listed in table 4.21, and Chi-Square Tests is listed in table 4.22.

Table 4.21: Educational attainment * Does value engineering increase quality? Crosstabulation

			Does value engineering increase quality?			
			Don't know	Agree	Strongly Agree	Total
Educational attainment	Diploma	Count	8	0	0	8
		Expected Count	4.2	1.9	1.9	8.0
	Bachelor	Count	40	16	16	72
		Expected Count	37.7	17.1	17.1	72.0
	Master	Count	32	24	16	72
		Expected Count	37.7	17.1	17.1	72.0
	Doctorate PhD	Count	8	0	8	16
		Expected Count	8.4	3.8	3.8	16.0
Total		Count	88	40	40	168
		Expected Count	88.0	40.0	40.0	168.0

Table 4.22: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.685[a]	6	.003
Likelihood Ratio	25.192	6	.000
Linear-by-Linear Association	6.188	1	.013
N of Valid Cases	168		

a. five cells (41.7%) have expected count less than 5. The minimum expected count is 1.90.

4.4.3 Experiences

Experience * Does value engineering increase quality? Crosstabulation is listed in table 4.23, and Chi-Square Tests is listed in table 4.24.

Table 4.23: Experience * Does value engineering increase quality? Crosstabulation

			Does value engineering increase quality?			
			Don't know	Agree	Strongly Agree	Total
Experience	< 5 years	Count	8	0	0	8
		Expected Count	4.2	1.9	1.9	8.0
	6 - 10 years	Count	8	8	0	16
		Expected Count	8.4	3.8	3.8	16.0
	11 - 15 years	Count	32	8	24	64
		Expected Count	33.5	15.2	15.2	64.0
	16 - 20 years	Count	16	16	8	40
		Expected Count	21.0	9.5	9.5	40.0
	> 20 years	Count	24	8	8	40
		Expected Count	21.0	9.5	9.5	40.0
Total		Count	88	40	40	168
		Expected Count	88.0	40.0	40.0	168.0

Table 4.24: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	31.004[a]	8	.000
Likelihood Ratio	36.112	8	.000
Linear-by-Linear Association	.605	1	.437
N of Valid Cases	168		

five cells (33.3%) have expected count less than 5. The minimum expected count is 1.90.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Depending on the analysis of the results, the VE not popular among the engineers and economists in the Iraqi ministry of electric and the companies in that ministry. This conclusion can be concluded from the high percentage ratio for persons who don't know anything about VE, and also from the variance of the answers for the overall questions. Educational attainment relation with the question about the effect of VE on quality improvement gives a clear indication that 50% of all samples have no information about VE independent on the education level. Also, the experience years not affected on the knowledge about VE effect on quality improvement, the percentage of the samples who think that the VE improve the quality was about 50%. Thus, the study results proved that the accuracy of the reasearch hypothsis which that:

There is a limitation in using the value engineering methodology in the engineering departments of the Ministry of Electricity. Also, the study results showed that: there is a close relationship between applying the value engineering methodology and cost management to electric power projects. And there is a close relationship between the application of value engineering and the quality and specifications of the service provided by the electric power projects.

In addition to what was presented above in proving the hypotheses of this study that there are many problems and obstacles facing engineering projects, they were identified through the performance calibration of the electrical project phases with the standard methodology for value engineering where the following was proven:

1. Not enough time is given to study and design, as the urgency leads to less ideas and alternatives, which leads to a lower level of study, and thus lower value.

2. Rushing to approve electric power projects in Iraq and not collecting sufficient information about the project from its correct sources and seeking the help of experts in the case of projects of a special nature.
3. There is a deficiency in taking advantage of the change in technology to develop and improve the performance of projects. New technology is often better in performance and quality and less in time, cost and restricting methods and products that the technology has overlooked.
4. Some engineering offices that adopt modularity in designs are relied upon, where creative ideas and alternatives are not used, and through constant stimulation of a group of designers to obtain from them a set of creative solutions and alternatives to choose the best ones in terms of performance, quality and cost.
5. Failure to adopt an effective mechanism for coordination between the parties concerned with decision-making by communicating with each other through communications and holding periodic meetings during work periods in a way that leads to overcoming deficiencies and reaching results that contribute to the success of the electrical project.

5.2 Recommendations

1. Introducing the concept of applying value engineering studies technology in government contracts, so that this concept becomes official procedures for government projects.
2. The value engineering studies technique leads to some financial savings from the base cost. Therefore, the study recommends the necessity of providing administrative mechanisms to transfer these savings to other projects in the ministry in addition to supporting and expanding jobs in the project.
3. The study recommends setting up qualifying courses and programs for engineers with specialization in value engineering technology, as it is one of the requirements for the correct application of this engineering management method.
4. It is very important to establish a local Iraqi organization, similar to the American and Japanese societies of value engineers, to be responsible for organizing work in the field of value engineering technology.

5. The necessity of holding periodic scientific conferences and organizing them and inviting all specialists and experts in the field of value engineering to demonstrate the importance of this methodology and the extent of its role in improving the quality of government projects, improving their functions and achieving financial savings through controlling costs.

REFERENCES

Alattyih, Wael, Husnain Haider, and Halim Boussabaine. (2019). “Development of Value Creation Drivers for Sustainable Design of Green Buildings in Saudi Arabia.” *Sustainability* 11 (20): 5867.

Alkheribi, Aya Hasan. (2017). “A Framework for Value Engineering Methodology Application Using Building Information Modeling (BIM).” *A Framework for Value Engineering Methodology Application Using Building Information Modeling (BIM).*

Almquist, Eric, John Senior, and Nicolas Bloch. (2016). “The Elements of Value.” *Harvard Business Review* 94 (9): 47–53.

Anderson, Shannon W, and William N Lanen. (2007). “Understanding Cost Management: What Can We Learn from the Evidence on sticky Costs’?” *Available at SSRN 975135*.

Assaf, Sadi A, and Sadiq Al-Hejji. (2006). “Causes of Delay in Large Construction Projects.” *International Journal of Project Management* 24 (4): 349–57.

Atabay, Senay, and Niyazi Galipogullari. (2013). “Application of Value Engineering in Construction Projects.” *Journal of Traffic and Transportation Engineering* 1 (1): 39–48.

Attarzadeh, Iman, and Ow Siew Hock. (2009). “Implementation and Evaluation of Earned Value Index to Achieve an Accurate Project Time and Cost Estimation and Improve" Earned Value Management System".” In *2009 International Conference on Information Management and Engineering*, 312–16. IEEE.

Ballard, Glenn, and Gregory Howell. (2003). “Lean Project Management.” *Building Research & Information* 31 (2): 119–33.

Beaman, Karen V, Gregory R Guy, and Donald E Sexton. (2008). “Managing and Measuring Return on Marketing Investment.” In. Conference Board.

Beidelman, Kevin. (1987). “Purchasing and Profit: Contributions Worth Measuring.” *Journal of Purchasing and Materials Management* 23 (3): 2–9.

Cabeza, Mar, and Atte Moilanen. (2006). “Replacement Cost: A Practical Measure of Site Value for Cost-Effective Reserve Planning.” *Biological Conservation* 132 (3): 336–42.

Castillo, Enrique. (2012). *Extreme Value Theory in Engineering*. Elsevier.

Chi, Taiwan. (1994). “Trading in Strategic Resources: Necessary Conditions, Transaction Cost Problems, and Choice of Exchange Structure.” *Strategic Management Journal* 15 (4): 271–90.

Churchman, C West, and Russell L Ackoff. (1954). “An Approximate Measure of Value.” *Journal of the Operations Research Society of America* 2 (2): 172–87.

Cooper, Robin. (2017). *Target Costing and Value Engineering*. Routledge.

Cropley, David H, Arthur J Cropley, James C Kaufman, and Mark A Runco. (2010). *The Dark Side of Creativity*. Cambridge university press.

Dell’Isola, Alphonse. n.d. “J., (1988).” *Value Engineering In the Construction Industry. Smith, Hinchman & Grylls, USA.*

Dell’Isola, Alphonse, J., (1966). “Value Engineering in Construction.” *Civil Engineering*.

———. 1982. *Value Engineering in the Construction Industry*.

Eggli, S, M Pisan, and M E Müller. (1998). “The Value of Preoperative Planning for Total Hip Arthroplasty.” *The Journal of Bone and Joint Surgery. British Volume* 80 (3): 382–90.

Elliott, Monica. (2004). “The Lean Offensive: The US Army Materiel Command Is Winning the Battle against Waste with Continuous Improvement.” *Industrial Engineer* 36 (9): 26–31.

Engineer, Senior Electrical. (n.d). “Employment History.”

Evans, James R., (1986). “Education Creative Thinking and Innovative Education in the Decision Sciences.” *Decision Sciences* 17 (2): 250–62.

Jay, C I, and P A Bowen. (2015). “Value Management and Innovation.” *J. Eng. Des. Technol* 13 (1): 123–43.

Keeney, Ralph L, and Howard Raiffa. (1993). *Decisions with Multiple Objectives: Preferences and Value Trade-Offs*. Cambridge university press.

Keller, Robert T., (2006). “Transformational Leadership, Initiating Structure, and Substitutes for Leadership: A Longitudinal Study of Research and Development Project Team Performance.” *Journal of Applied Psychology* 91 (1): 202.

Khosrow-Pour, Mehdi. (2001). *Advanced Topics in Information Resources Management, Volume 1*. Vol. 1. Igi Global.

Kirk, Stephen J, and Alphonse J Dell’Isola. (1995). *Life Cycle Costing for Design Professionals*.

Kuo, Jeff. (2004). “Of Odor and Volatile Organic Compound Treatment by Biotrickling Filters: Pilot- Scale Studies at Hyperion Treatment Plant, HHJ Cox, MA Deshusses, BM Converse, ED Schroeder, R. Iranpour 74, 557 (2002).” *Water Environment Research* 76 (3): 280–83.

Liu, Shaoying, A Jefferson Offutt, Chris Ho-Stuart, Yong Sun, and Mitsuru Ohba. (1998). “SOFL: A Formal Engineering Methodology for Industrial Applications.” *IEEE Transactions on Software Engineering* 24 (1): 24–45.

Mandelbaum, Jay. (2006). “Value Engineering Handbook.” Institute For Defense Analyses Alexandria VA.

Miles, E P. (1960). "Generalized Fibonacci Numbers and Associated Matrices." *The American Mathematical Monthly* 67 (8): 745–52.

Miles, Lawrence D. (2015). *Techniques of Value Analysis and Engineering*. Miles Value Foundation.

Monghasemi, Shahryar, Mohammad Reza Nikoo, Mohammad Ali Khaksar Fasaee, and Jan Adamowski. (2015). "A Novel Multi Criteria Decision Making Model for Optimizing Time–Cost–Quality Trade-off Problems in Construction Projects." *Expert Systems with Applications* 42 (6): 3089–3104.

Nayebvali, Ramtin, Saeed Zarabadipour, and Hamid Zargarpour. (2014). "Detecting Main Functions in the Implementation of Organization's Strategy by Making Use of Fast Diagram." *Kuwait Chapter of Arabian Journal of Business and Management Review* 33 (2536): 1–15.

Pakdil, Fatma, Pelin Toktaş, and Karen Moustafa Leonard. (2018). "Validation of Qualitative Aspects of the Lean Assessment Tool (LAT)." *Journal of Manufacturing Technology Management*.

Reiss, Rolf-Dieter, Michael Thomas, and R D Reiss. (1997). *Statistical Analysis of Extreme Values*. Vol. 2. Springer.

Russo, Benjamin. (2004). "A Cost- benefit Analysis of R&D Tax Incentives." *Canadian Journal of Economics/Revue Canadienne d'économique* 37 (2): 313–35.

Sadawi, Usama El. (2008). "A Value Engineering Methodology for Low Income Housing Projects in Gaza Strip." *A Value Engineering Methodology for Low Income Housing Projects in Gaza Strip*.

Sager, Tore. (2006). "The Logic of Critical Communicative Planning: Transaction Cost Alteration." *Planning Theory* 5 (3): 223–54.

Schwanen, Daniel. (n.d.) "Policy on Climate Change Should Aim to Reduce Risks, Avoid Unnecessary Costs, Says CD Howe Institute."

Setijono, Djoko, Paul Martin Gibbons, Colin Kennedy, Stuart Burgess, and Patrick Godfrey. (2012). "The Development of a Value Improvement Model for Repetitive Processes (VIM)." *International Journal of Lean Six Sigma*.

Shillito, M Larry, and David J De Marle. (1992). *Value: Its Measurement, Design, and Management*. John Wiley & Sons.

Spratt, Michael F., (1997). "HP AS A Source (Of Shareholder Value: Research And RecommendationS." *Human Resource Management* 36 (1): 39–47.

Stoker, Gerry. (2006). "Public Value Management: A New Narrative for Networked Governance?" *The American Review of Public Administration* 36 (1): 41–57.

Tohidi, Hamid. (2011). "Review the Benefits of Using Value Engineering in Information Technology Project Management." *Procedia Computer Science* 3: 917–24.

Too, Eric G, and Patrick Weaver. (2014). "The Management of Project

Management: A Conceptual Framework for Project Governance." *International Journal of Project Management* 32 (8): 1382–94.

Waldron, Mark W, Jeyarajan Vsanthakumar, and S Arulraj. (1997). "Improving the Organization and Management of Extension."

Wei, Zou, and Qian Xuesong. (2005). "Financing Cost, Rent-Seeking and Capital Allocation inside Firms [J]." *Economic Research Journal* 5.

Young, Robert Charles, William V Clive, and Benton E Miles. (1972). *Cational Education PlaVonning: Manpower, Priorities, and Dollars*. Center for Vocational and Technical Education, Ohio State University.

Zhu, Junfei. (2017). *A Power Study of Gffit Statistics as Components of Pearson Chi-Square*. Arizona State University.

Zimmerman, Larry W, and Glen D Hart. (1982). *Value Engineering: A Practical Approach for Owners, Designers, and Contractors*. Van Nostrand Reinhold Company.

Internet

Iraqi Ministry of Electricity." (n.d.). Accessed 10.12. 2020. https://www.moelc.gov.iq/home/page/about_us?lang=ar&&static=true.

Langdon, Davis. (2006). "Literature Review of Life Cycle Costing (LCC) and Life Cycle Assessment (LCA)." *Resource Document. Davis Langdon Management Consulting,* Accessed 11.12. 2020. *Http://Www. Tmb. Org. Tr/Arastirma_yayinlar/LCC_Literature_Review_Report. Pdf.*

RESUME

Name Surname : Faissl G. Chremk Chremk

Place and Date of Birth : Iraq - 1962

E-Mail : faisalgjir@gmail.com

EDUCATION:

Bachelor: 1983-1984, University of Technology, Electro-Mechanic Engineering, Electrical

Master: 2020 - 2021, Istanbul Gedik University Institute of Science and Art, Engineering Department, Engıneering Management Program

PROFESSIONAL EXPERIENCE AND REWARDS
PUBLICATIONS/PRESENTATIONS ON THE THESIS:

- Faissl. G. Chremk, International Journal of Computer Science and Mobile Computing, Vol.9 Issue.9 September- 2020, pg. 103-117 Application of Value Methodology in Engineering Management Using Wind Turbines Certification for Electricity Generation.