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"A Value Engineering Methodology for Low Income Housing Projects in Gaza Strip"

منهجية هندسة القيمة لمشروعات إسكان ذوي الدخل المنخفض في قطاع غزة

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Declaration

I certify that all materials presented in this thesis are my own work and has not been written to me, in whole or in part, by any other person(s), and that no portion of this thesis has been submitted as an application for another degree or qualification of any other university or institution.

Signed

Usama El Sadawi

Date: August 2008

﴿ ولا تجعل يدك مغلولةً إلى عنقك
ولا تبسطها كل البسط فتقعد ملوماً محسوراً﴾
(الإسراء 29)

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ABSTRACT

***T**he main aim of this research is to develop a Value Engineering methodology (VE) that leads to reduce cost and/or improve performance of housing projects for low income people in an applicable way that local professionals can understand and apply. The methodology is anticipated to help Palestinian Institutions in performing low cost housing for people of low income in Gaza Strip. International agencies engaged with emergency re-housing programs may benefit from the methodology as well. This in turn contributes in utilizing the limited financial resources allocated for housing to serve larger number of beneficiaries as well as improving the housing projects.*

***T**o achieve this aim, the researcher developed models to serve application of the methodology and applied the methodology on a case study for further clarification of the methodology. The publications of the famous experts and institutions as well as the experience of other countries in Value Engineering were reviewed. Local implementing institutions in construction sector and local professionals were approached to assess the state of the art of knowledge of Value Engineering and to benefit from local professionals expertise to enrich the research.*

***T**he methodology developed is composed of three main stages. The first stage is the Pre-Workshop of the Value Engineering aiming to collect as much information as possible and to clarify the project to the VE team in addition to the preparation of models to be used in the second stage. The second stage is the Workshop stage which is the core of Value Engineering study and it is composed of five phases, the Information, Functional Analysis, Creativity, Evaluation and the Presentation phase. Such sequence of the methodology is expected to assist in logical and systematic flow of the process to achieve the targets of the VE study. The third stage is the Post Workshop where recommendations of VE study are implemented and feedback regarding the results and the impact of implementation of VE recommendations is performed to the parties in concern for future benefit.*

A *real life case study was studied and the methodology was applied where improvement of the project and cost saving of 17% were achieved and the study results were sent to the owner of the project for benefit.*

T*he developed methodology forms a first step towards applying VE in Gaza Strip and it can easily be adapted to serve other sectors like infrastructure. The researcher recommended to apply VE in Gaza Strip for its benefits and recommended further researches in addition to qualification of professionals in VE.*

ملخص

إن الهدف الرئيس لهذا البحث هو تطوير منهجية لهندسة القيمة والتي تهدف لخفض الكلفة و/أو تحسين الأداء لمشاريع إسكان ذوي الدخل المنخفض وذلك بصورة قابلة للتطبيق بحيث يتمكن الخبراء المحليون من فهمها وتطبيقها. ويتوقع أن تساعد هذه المنهجية المؤسسات الفلسطينية في تنفيذ مشاريع إسكانية قليلة التكلفة لذوي الدخل المنخفض في قطاع غزة. ويتوقع أن تستفيد أيضاً من المنهجية المنظمات الدولية العاملة في برامج إعادة الإسكان الطارئة. وسوف يساهم ذلك في ترشيد الموارد المالية المحدودة التي تخصص للإسكان لخدمة أعداد أكبر من المستفيدين وتحسين مشروعات الإسكان.

ولتحقيق هذا الهدف، قام الباحث بتطوير نماذج تخدم تطبيق المنهجية الموضوعة وقام أيضاً بالتطبيق على حالة دراسية لمزيد من الإيضاح لهذه المنهجية. تم مراجعة الأدبيات المنشورة للخبراء المشهورين والمؤسسات المتخصصة وخبرات البلدان الأخرى في مجال هندسة القيمة. كما تم الاتصال بالمؤسسات التنفيذية في قطاع الإنشاءات والخبراء المحليين لتشخيص الحالة المعرفية لموضوع هندسة القيمة وللاستفادة من خبرات الخبراء المحليين لإثراء البحث.

وتتكون المنهجية التي تم تطويرها من ثلاث خطوات رئيسية. الأولى ما قبل ورشة العمل وتهدف إلى جمع ما يمكن جمعه من معلومات حول المشروع وتوضيح المشروع لفريق هندسة القيمة علاوة على تحضير النماذج التي ستستخدم لاحقا في ورشة العمل. والثانية خطوة ورشة العمل وهي لب دراسة هندسة القيمة وتتكون من خمس مراحل هي جمع المعلومات والتحليل والإبداع والتقويم والعرض وخلال هذه المراحل يتم تحليل الوظائف وطرح البدائل وتقويم هذه البدائل. ويتوقع لهذا التسلسل في مراحل ورشة العمل أن يساعد عملية الدراسة من خلال انسياب منطقي ونمطي للوصول إلى أهداف هندسة القيمة. والخطوة الثالثة هي مرحلة ما بعد ورشة العمل حيث يتم تنفيذ توصيات هندسة القيمة والتغذية الراجعة لأطراف المشروع ذات العلاقة حول نتائج وآثار تنفيذ التوصيات بغرض الاستفادة المستقبلية.

تم دراسة مشروع حقيقي كحالة دراسية وتطبيق للمنهجية حيث نتج عن الدراسة تحسين المشروع مع خفض التكلفة بنسبة 17% وأرسلت نتائج الدراسة لمالك المشروع للاستفادة منها.

تشكل المنهجية التي تم تطويرها البداية نحو تطبيق هندسة القيمة في قطاع غزة ويمكن أن يتم تعديلها لخدمة قطاعات أخرى مثل البنية التحتية. وأوصى الباحث بتطبيق هندسة القيمة في قطاع غزة لما لها من فوائد كما أوصى بـــإجراء المزيد من البحوث وتأهيل الخبراء في مجال هندسة القيمة.

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ABBREVIATIONS

PCBS: Palestinian Central Bureau of Statistics

VE: Value Engineering

VM: Value Management

VA: Value Analysis

LCC: Life Cycle Cost

FAST: Functional Analysis System Technique

SAVE Int.: Society of American Value Engineers International

CSVA: The Canadian Society of Value Analysis

ALE: Acquisition Logistics Engineering

QM: Quality Model

UNRWA: United Nations Relief and Work Agency

CVS: Certified Value Specialist

R.S: Required Secondary Function

B: Basic Function

S: Secondary function

VI: Value Index

P.W: present worth of future annuity

CHAPTER 1

INTRODUCTION

1.1 General

Gaza Strip is considered one of the most dense urbanized areas in the world where about 1.5 million inhabitants are living in 360 square kilometers (Palestinian Central Bureau of Statistics (PCBS), 2007 census). The growth rate is estimated at 3.8% annually and the average of the family size is 6.5 persons.

According to Shabana (2005) from PCBS, the economical and geographic siege on Gaza caused serious damage to the Palestinians' social and economical life. 65% of Palestinians are living under poverty line in Gaza Strip. Among the Palestinian families, 91.1% will be in need of housing units. 71.1% of the families are not expected to afford the cost of housing relying on their financial resources.

With an increase in the population of 3.8% annually, the need of 91.1% of the families for housing units and the family size, it can be concluded that around 8,300 new housing units in the next three years are needed annually. Historically, private sector used to be the leader in providing the local market with housing. Due to its nature, private sector form of intervention is investment wise. As a result, families of low income can neither benefit from private sector activities nor build their houses relying on their own resources. Social housing programs may be the only way to solve such problem.

Social housing programs were implemented in Gaza Strip by governmental and

nongovernmental institutions. Such programs did not succeed in providing housing units that repayment suited beneficiaries' economical capabilities. In other term, it is restricted by law that beneficiary does not pay more than 30% of the monthly income for mortgage or rent. As a result, the repayment process was restricted and the evolvement of such programs was not in place.

Such programs were almost postponed since 1998 due to the reluctance of donors to contribute to housing sector with minor exception to projects granted by the Islamic Development Bank through the Palestinian Housing Council and the re-housing activities donated mainly by funds from Islamic countries to mitigate the impact of the Israeli army machine destruction of thousands of houses.

One of the main challenges in Gaza Strip to the Palestinian institutions engaged with housing sector is providing low cost housing for people of limited income and those in need of housing. Such challenges came due to inability to balance between the needs of the targeted families in terms of spaces and the minimum quality standard in one hand, and the high construction prices and the shortage of financing in the other hand.

This research aims to look for the techniques that may be used to contribute in solving housing problem through utilization of available resources. It forms an initiative to facilitate application of Value Engineering (VE) as a cost control technique that is not used in Gaza Strip and being widely used around the world even within rich countries for its impact in cost reduction and performance improvement.

1.2 General objective

The main aim of the research is to develop a Value Engineering Methodology that local

professionals can understand and perform in order to be able to lower the cost of the low cost housing projects that contribute to solve the housing problem in Gaza Strip.

1.3 Specific objectives

In order to achieve the main goal, the following objectives are derived:

a. Investigation of the state of the art of VE as practiced in other countries.
b. Investigation of the local practice of VE.
c. Development of methodology for application of VE in Gaza Strip.
d. Evaluation of the developed VE methodology.
e. Application of the VE methodology.
f. Recommendations for further development of the VE methodology for future researches.

1.4 Problem statement

The increasing demand for affordable housing is forming a real challenge to the Palestinian Institutions. As part of construction industry, cost of housing dwelling in the social housing projects implemented by Palestinian Institutions was high compared to the financial capacity of people of limited and low income. As a result, the repayment of the cost of these projects by the beneficiaries was postponed and endangered the sustainability of the housing programs. The planned objectives of these projects were inconsistent with the results. Following the rush of construction of social housing projects in the years from 1993-1997, no further significant projects were initiated due to lack of new funds and non repayment.

Referring to the history of these projects, project cost overrun was found during or before

implementation. Engineers either reduced quality of finishing or omitted some items (painting, kitchens, boilers, etc.). Reduction of significant part of buildings also took place.

The high cost of apartment was mainly due to the high cost of building materials.

Other factors that contributed to the high cost of flats may be summarized as follows:

a. The high cost of land.
b. Lack of infrastructure, i.e. water, wastewater and power lines.
c. The instable conditions of the market due to the external factors (i.e. closures).
d. The lack of integrated planning of housing projects.
e. Costly design in terms of usage of layout, space and specifications.
f. Negligence of customer satisfaction in preparation and planning phases.
g. The completion time of the project.
h. Isolation of construction process from community participation.
i. Building codes requirements (especially for high rise buildings).

Further to the high cost of flats, operational and maintenance cost of buildings was high as a result of building type (especially for high rise buildings), specifications and bad construction.

This research aims to deal with the problem of achieving low cost houses in a new different approach that focuses on functions rather than elements. This comes through application of Vale Engineering (VE) that can be applied through teamwork that is not being practiced in Gaza.

1.5 Research methodology

This research starts with literature review to gather as much information of VE as possible.

As a result of the literature review and the own experience of the researcher, a questionnaire was developed and passed to local professionals to get their input to the research and to identify the state of the art of VE in Gaza Strip. A methodology is proposed by the researcher with the associated models to facilitate VE application. In addition; a case is taken to clarify the methodology application and validate benefits of application of value engineering.

The research focuses mainly on reducing cost of housing projects through studying building materials' specifications, spaces used in design and maintenance and operation costs of housing projects, or the life cycle cost (LCC) of the project.

1.6 Rationale and justification

The research area is completely new in Gaza Strip and it is highly needed due to the scarcity of funds for low-cost housing programs associated with high prices of building materials. The local market in Gaza Strip needs new cost control techniques that insure utilizing financial resources, insuring sustainability of housing programs, enhancing teamwork as a culture and enriching housing sector with new techniques of cost reduction. In addition, application of VE serves the construction industry in general.

The groups that are anticipated to benefit from the research are the researchers, the experienced engineers, the owners of social housing projects as well as the low income beneficiaries of social housing projects. In addition, international agencies engaged with emergency re-housing programs will benefit from the research.

1.7 Thesis structure

The thesis is composed of seven chapters. The first chapter is the introduction of the thesis describing the nature of the problem of the research, the main aim, the method used to achieve the aim and the dissertation contents. The second chapter, is the literature review summarizing what the researcher studied in the field of the research. Chapter 3 describes the research methodology. In Chapter 4, the questionnaire is discussed and the main findings regarding the state of the art of VE in addition to the quality model are summarized. Chapter 5 describes the initially developed Value Engineering Methodology, the structured interviews performed to improve the VE methodology and amended methodology as a result of the structured interviews. Chapter 6 presents the case study taken to apply and test the developed VE methodology. Chapter 7 summarizes the researcher conclusions and recommendations.

In addition, 7 appendices (from Appendix A to G) are attached to the thesis containing materials of questionnaire, structured interview, VE models, Sheets used in the VE study and the case study report.

CHAPTER 2

LITERATURE REVIEW

2.1 Historical background

During the World War II, General Electric Company (GE) faced the problem of scarcity of critical materials to fulfill the demand of the war equipment. To overcome that problem, GE had to use substitute materials for those in shortage. Many of the substitutes were less expensive and better in performance. In 1947, Lawrence D. Miles, a staff engineer for GE developed a number of ideas and techniques to select alternative materials that could be used internationally. His main attitude was to search for value in a product and he developed a function-based methodology that was successfully proven. The new methodology was so successful that it was possible to produce goods at greater production and operational efficiency and at lower costs. As a result of its success, GE formed a special group leaded by Larry Miles to refine the methodology. Due to its success, private industry in the United States used the new methodology as well.

In 1954, the U.S Navy Bureau of Ships used the Value Analysis process to cost improvement during design. They called it "Value Engineering". The Value Engineering was used formally in the U.S Department of Defense in 1961. (U.S ARMY PEO STRI)

In the 1960's, Mr. Charles Bytheway developed an additional component to the basic method. During his work for Sperry UNIVAC, he created a functional critical path analysis procedure that highlighted the logic of the activity under value study. A diagramming procedure called the "Functional Analysis System Technique" (FAST) was adopted as a

standard component of the Value Method.

In 1985, the Value Engineering process had gained world-wide acceptance. It spawned an international organization, Society of American Value Engineers International (SAVE Int.), dedicated to its practice, and the certification of competent practitioners. Further, it had saved billions of dollars, (SKY MARK). In 1997, SAVE approved a standard for Value Engineering Methodology.

2.2 Definition of Value Engineering

Despite its recent evolution; Value Engineering has a lot of definitions that are very closed. Shublaq (2003) defines the general term Value Engineering Methodology as a function oriented systematic team approach to eliminate or prevent unnecessary costs. He introduced the definition of the USA and Europe as follows:

1st: In USA: SAVE int. glossary of terms contained three terms:

a. Value Analysis (VA): is defined as a method for enhancing product value by improving the relationship of work to cost through the study of function.

b. Value Engineering: the same as Value Analysis except with emphasis on application during product development and/or design.

c. Value Management (VM): The same as Value Analysis with emphasis on application as a management technique.

2nd: In Europe: The Institute of Value Management defines Value Management as a style of management particularly dedicated to motivating people, developing skills and promoting synergies and innovation, with the aim of maximizing the overall performance of an organization.

Shublaq (2003) defines Value Engineering as " A specialized cost control technique, performed by a group of experienced professionals. The technique involves an intensive, systematic and creative study to reduce cost while enhancing reliability and performance. The technique is used to achieve the best functional balance between cost, quality and performance of a product, system or facility". Shublaq presents Figure No. 2.1 to clarify that VE is a functional balance between cost, quality and performance.

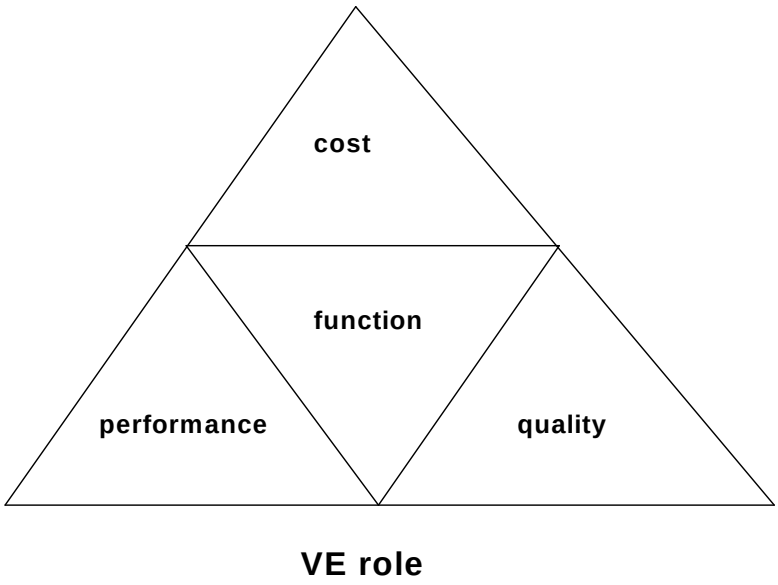

Figure 2.1, VE as a functional balance between cost, quality and performance

Al Asheesh (1997) defines it as " An analytical systematic study performed by a multi disciplinary team on a product, project or facility in order to identify the functions it performs to achieve such functions in a better way or a less cost or both through setting creative alternative without affecting the basic requirements".

Dell'Isola (1982) and Zimmerman et al. (1982) (cited by Elzarkah, Suckarieh and Dorsey, 1998) defined VE as "A creative systematized approach whose objective is to seek out the best functional balance between the cost, reliability, and performance of a project.

2.3 Terminologies and definitions:

The basic elements of VE are function, quality, worth and cost. They are defined as follows:

2.3.1 Function

Function has various definitions by experts and foundations of VE. Following are the most common definitions of function.

Function was defined by Shublaq (2003, S-3 Page 5) as the specific work that a design item must perform. Shublaq described types of functions as follows:

1. Basic Function: the function that is essential to the performance of a user function. It may also be defined as the function describing the primary utilitarian characteristics of a product or design to fulfill a user requirements (Shublaq 2003, S-3 Page 5). An example of basic function is "process data" for a computer.
2. Required Secondary Function: Shublaq (2003) agrees with the definition of Dell'isola (1997) that required secondary function is that must be achieved to meet codes, standards or mandatory owner requirements. An example for required secondary function is power to computer as computer does not work without power.
3. Secondary Function: Shublaq (2003, S-3 Page 5) defined it as that which can be removed from the design while realizing the basic and the required secondary functions. An example of secondary function is the color of the computer.

Al Asheesh (1997, page 112) used different classification as follows:

Basic Function: that there is no possibility to remove it. He added that sometimes basic function may not be the most important to the user and it may not form a major part of the cost.

1. Secondary Function: he defined it as supporting function to the basic and classified it into three types:

   - Required Secondary: is the function that enables the Basic Function to be achieved. For instance power to the computer.

   - Secondary Desired: is the function that is preferred to be included in a project or a product but it is not essential to the basic function to perform; like quiet to air condition.

   - Secondary Undesired Function: is that function that causes inconvenience; like noise or heat.

2. Beauty Function: that adds beauty or comfort. This function is directed to sight or taste or touch. It may be basic if it is a basic requirement to the client. In addition; it usually forms the most important factor to the user and forms the highest share of the cost.

Lawrence D. Miles Value Foundation classified function into two types:

1. Basic function: that which is essential to the performance of a work or sell functions. It is also defined as the function describing the primary utilitarian characteristics of a product or service.

2. Secondary function: the manner in which the basic function implements. It is also defined as a function indicating quality, dependability, performance, convenience, attractiveness and general satisfaction beyond that need to satisfy the end user.

The researcher considered the classification of functions into basic, secondary required and secondary function that suit low cost housing projects analysis. The classification reflects the reality of the low cost housing where:

- Basic functions: forms the functions that fulfill project basic requirements, in term of functions and spaces.
- Required secondary functions: forms conditions to enable fulfillment of project basic functions, like codes, regulations and durability requirements.
- Secondary functions: they always exist in designs. In such projects, they will be eliminated as unnecessary costs.

2.3.2 Value

Mandelbaum (2006) defines value as the relationship between the worth or utility of an item (expressed in monetary terms) and the actual monetary cost of the item. The highest value is represented by an item with the essential quality available at the lowest possible overall cost that will reliably perform the required function at the desired time and place.

The Canadian Society of Value Analysis (CSVA) defined value as the personal perspective of your willingness to pay for the performance delivered by a product, process or project. It also stated that good value is achieved when the necessary performance can be accurately

defined at the lowest life cycle cost.

Shublaq (2003, S-1 page 10) defines value as the most cost-effective way to reliably accomplish a function that meet the user's need, desires and expectations. He used Dell'Isola, (1998) expression for value as follows:

$$\text{Value} = \frac{\text{Function} + \text{Quality}}{\text{Cost}} \quad \text{..... (Eq. 2.1)}$$

Where:

Function: The specific work that a design/ item must perform.

Quality: The owners' / user's need, desire and expectation.

Cost: Life cycle cost (LCC).

Al Asheesh (1997, pages 28-30) defined value as the relationship between the function or the performance with the cost. He classified value into four types:

1. Use Value: that is the benefit resulted from owing or using a thing through the capabilities it provides or the functions it performs to the owner or the user. For example the calculator to an accountant.
2. Cost Value: is the total amount of money paid to have a product or a service including direct and indirect costs paid during the period of owing it.
3. Esteem Value: is the special characteristic of a thing, like scarcity or beauty that makes others willing to have it.
4. Replacement or trade-off value: is the value resulted from containment of the product of properties and functions that makes it benefiting others so that it can be traded-off with another product or money.

2.3.3 Cost

Cost is defined by the majority of the authors as previously defined by Al Asheesh 1997. To consolidate the definition it is the total amount of money paid to have a product or a service including direct and indirect costs paid during the period of owing it. Even when it is not defined; the same meaning can be implicitly understood. It is used among researchers to express the design value of projects.

In this research the term "cost" will be used to express the design value that means how much will be paid to achieve a function if the project is implemented according to the design. It will be used for both spaces and construction and maintenance cost.

2.3.4 Worth

Worth was defined by Lawrence D. Miles Value Foundation as the lowest cost to achieve a function. It is determined by comparison, historical data and personal experience. Mandelbaum (2006, page 4) defines the worth in approximately the same manner as Miles where he defines it as the lowest cost to reliably achieve the required function. Worth is established by comparing various alternatives to accomplish that function and selecting the lowest cost alternative. The same definition is very closed to the two definitions above was found by other authors.

Due to the nature of the low cost housing project, the researcher will use the definition of worth as the minimum cost that a function can be achieved with without affecting the function.

2.3.5 Value index

The concept of value index is defined by many authors. Kirk and Spreckelmeyer (1998) cited on Shublaq (2003, S-3 Page 2) use the expression:

$$\text{Value Index} = \frac{\text{Cost}}{\text{Worth}} \quad \text{..... (Eq. 2.2)}$$

AL-Khuwaiter (2002) cited on Shublaq (2003, S-3 Page 2) uses the expression:

$$\text{Value Index} = \frac{\text{Function Cost}}{\text{Function Worth}} \quad \text{..... (Eq. 2.3)}$$

The best value according to the above mentioned definitions is achieved when the cost of a building, system or component approaches the worth; i.e. the value index equals one. For value index is greater than 1, then the function is of poor value (Shublaq, 2003).

The researcher will consider the definition of Shublaq since it serves to compare the design cost to the minimum cost that function can be achieved with. Such comparison will serve to highlight areas of high cost or poor value and will be the target of VE study.

2.4 Objectives of VE

SAVE Int**.** describes the objectives of VE in construction sector in identifying cost-saving alternatives, using resources more effectively, decreasing project operation and maintenance costs, improving safety programs for major governmental installations. It also assists in reducing paperwork and simplifying procedures and improving project schedule. Furthermore, it has impact on streamlining an agency's organizational structure and cutting down on waste.

Shublaq (2003, S-1 Page 10) mentioned that VE techniques can be used to achieve saving in money, reducing time and improving quality. In addition, it can be used to improve maintainability and performance. Other achievements of VE are improve in human factors, attitude, creativity and team work as well as improving decision making.

Value Management Guideline published by Department of Housing and Works-Government of Western Australia, (pages 2-3, August 2005) defines the aims of VE as to produce results creatively and economically by identifying unnecessary expenditure, challenging assumptions, generating alternative ideas, promoting innovation and optimizing resources, time, money, energy and consideration of whole of life cycle costs. VE aims also to simplify methods and procedures, eliminating redundant features, updating standards, criteria and objectives and improve team performance and other synergies. Other benefits that showcase the evolving nature of Value Management as something more than a sophisticated cost reduction tool like improving communication, teamwork and cooperation as well as increasing awareness and ownership by stakeholders. It forms aid to the briefing and approvals process and increasing quality. Enhancing risk management measures, improving sustainability and promoting innovative service delivery processes are also achievements of VE.

Dell-Isola (2002) describes the quality limits forming the target for VE as in Figure 2.2. As indicated on the figure, the initial cost depends mainly on quality while operation and maintenance costs decrease as quality goes higher. The summation of the two curves in Figure 2.2 produces the total life cycle cost of a project. VE searches for the zone forming the lower cost in terms of initial costs and the future costs.

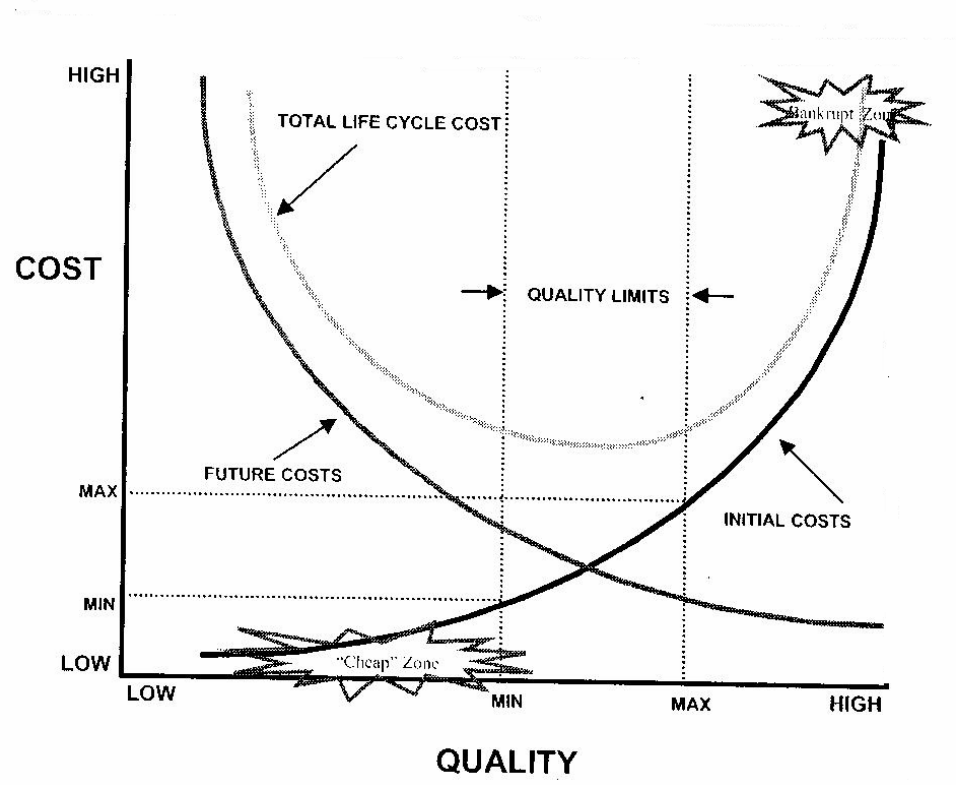

Figure 2.2, Quality limits forming the target for Value Engineering

2.5 VE fields of application

According to SAVE Int., value engineering is widely used in the following fields:

a. Transportation: where there is increasing demands for services and finite budgets. VE provides innovative and cost-effective solutions for the construction, operation and maintenance of improved transportation systems.

b. Health care: since health care spending is escalating at a rapid pace. Quality and effectiveness of health-care services are improved by VE application.

c. Construction: VE assists in overcoming many challenges like budget constraints, safety issues, and environmental impact.

d. Manufacturing: VE (or value methodology) is a powerful tool for solving problems

and improving value in terms of cost, quality and performance for any item or activity.

e. Environment: industrial and governmental organizations face increasing pressures due to strict environmental laws. They must deliver safe, effective solutions that are cost-effective as well.

f. Government: due to its potential for yielding a large return on investment, the value methodology has rapidly spread to all levels of government in the United States. The U.S. Federal Highway Administration, in particular, has used the value methodology to great effect and with ongoing success.

2.6 VE application in various countries

Among its history of application, VE has been proved high effectiveness in both cost reduction and performance improvement. In United States, VE is widely used at governmental and private levels. As an example, the Federal Highway Administration's (FHWA) on its web site summarized the results of application of VE in the period between 2002 and 2005 according to Table 2.1 where cost saving due to application of VE between 5% and 10% of the project cost.

Table 2.1, Summary of past VE savings, Federal-Aid Highway Program

Item	FY 2005	FY 2004	FY 2003	FY 2002
Number of VE Studies	300	324	309	377
Cost of VE Studies and admin. Costs, Million $	9.80	7.67	8.42	9.02
Estimated Construction Cost of Projects, Billion $	31.58	18.7	20.48	20.61
Total No. of Recommendations	2427	1794	1909	2344
Total Value of Recommendations, Billion $	6.76	3.04	1.97	3.050 .
No. of Approved Recommendations	1077	793	794	969
Value of Approved Recommendations, Billion $	3.187	1.115	1.110	1.043
Percentage of saving	10.1%	6.0%	5.4%	5.1%
Return on Investment	319:1	145:1	132:1	116:1

In Saudi Arabia, the Department of Defense internal rules uses VE in its projects. According to Al-Yousefi, Al-Khowaiter, Al-Oshaish and Shublaq (1999), 300 projects where value engineered in 1990s in Saudi Arabia and more than 1.5 Billions of US$ have been saved. Wixon stated that the Saudi government mandated VE applications on all governmental projects exceeding $5 million. According to McConachy (1997), in British Colombia, Canada, huge successful stories were achieved through application of VE. Such success was in variety of results as cost saving, schedule improvement, design improvement and spaces utilization. Province's Treasury Board requires that projects with capital cost exceeding $10 million to be reviewed by VE formal study.

2.7 When VE is used

VE application is of greatest benefits early in the development of a project with improvement in value gained. Department of Housing and Works in the Government of West Australia Value Management Guideline 2005, presented the potential influence of Value Management according to Figure 2.3.

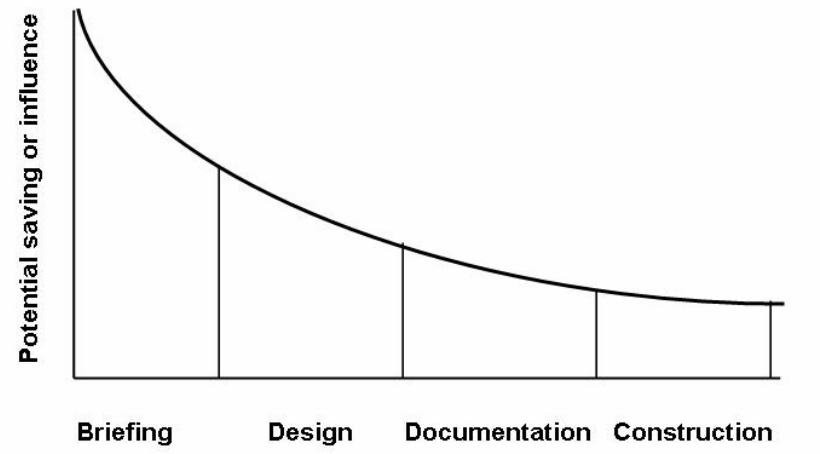

Figure 2.3, Potential influence of VE during project phases

Dell'Isola (cited on Shublaq, 2003) suggests that when VE is intended to be performed, it should be performed in the early stages of the design. When VE is applied later, the investment required to implement VE increase and the resistance to change increases as well. Figure 2.4 presents potential saving from VE application.

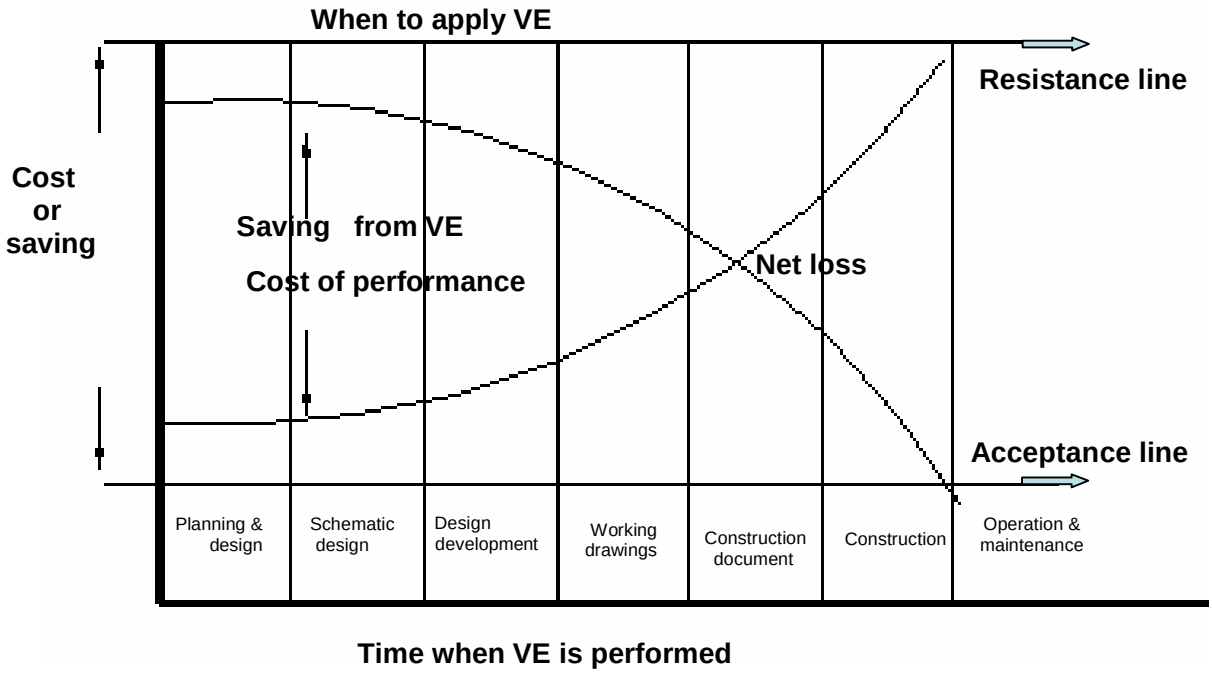

Figure 2.4, Potential saving from VE application

2.8 Determination of the best opportunities for improvement

Since Value Engineering is an extensive work of a group of professionals, then minimization of time is essential to the success of the workshop to enable VE team to focus during the workshop as well as to minimize the cost of VE study.

It is agreed among authors and the associations of VE to make use of Pareto Law to determine the best opportunities for improvement in a project. According to Shublaq (2003, S-2 Page 20), An Italian economist, Vilfredo Pareto, presented a formula showing that the

distribution of income is uneven. The largest share of world income (80%) was held by small number of people (20%). In VE, the same rule is applicable where the 80% of the systems costs are controlled by 20% of the project components. Therefore, the Pareto's chart focuses on the 20% factors / items contributing to the 80% cost. Figure 2.5 illustrates the Pareto's Engineering Law (80/20) rule concept.

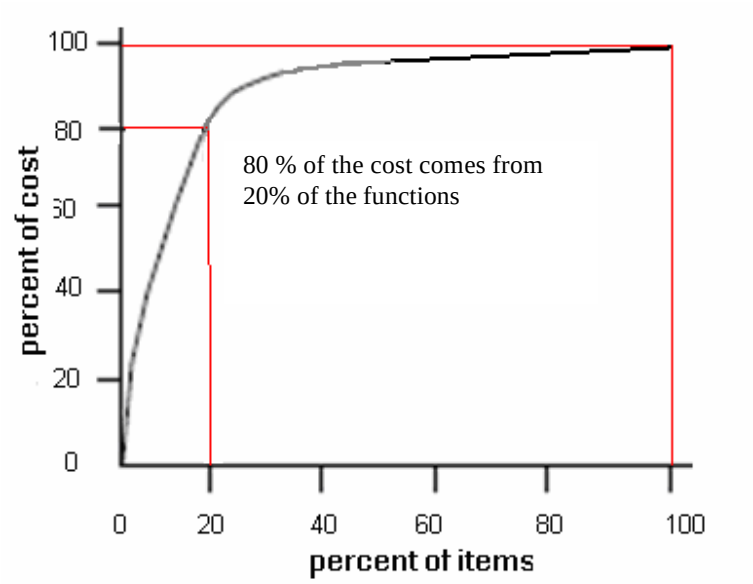

Figure 2.5, Pareto Law (80/20)

Mandelbaum and Reed (2006) state that function cost to function worth is being compared in VE workshops to determine whether the VE effort will be worthwhile and provides a reference point to compare alternatives. It is usually not necessary to determine the worth of every function. **C**ost data aid in determining the priority of effort. Because significant savings potential in low-cost areas may not be a worthwhile pursuit and high-cost areas may be indicative of poor value, the latter are prime candidates for initial function worth determination.

2.9 Determination of owner attributes for a certain project

Since VE depends on relative concepts, especially value and worth, it is important to find a tool that "*assists in defining, measuring and managing of owner quality expectations*" (Kirk and Smith, 1994). Kirk and Smith add that quality model is the entry point during the planning phase for establishing and developing the owners' project criteria. The quality model (QM)provides a thorough definition of project performance expectations required by the owner. The approach of QM according to Kirk and Smith is based on the total quality management and consists of managing quality expectations, measuring quality conformance, and managing project quality. The elements QM are described as follows:

1. Operations:

a. Operational effectiveness: the degree to which the building is able to respond to the work process and flow of people, equipment and materials.
b. Flexibility/expandability: the degree to which the building can be rearranged to conform to revised work processes and personnel changes. The ability of the building to grow and meet projected changes in the work process without disturbing existing building functions.
c. User comfort: how the building provides a physically and psychologically comfortable place for people to work and live.

2. Resources

a. capital cost effectiveness: the economic consequences of the building in terms of initial capital investment including construction cost, design fees, land cost, etc.

b. Operations and maintenance: the degree to which the building is able to conserve energy resources through construction, site orientation, and solar design. Other considerations include maintenance, operations and replacement costs.

c. Schedule: the amount of time required to complete the various tasks including programming, design, construction and start-up/move-in.

3. Technology

a. Environmental: the degree to which the facility is sensitive to environmental concerns such as hazardous waste, air and water pollution, use of sustainable materials, recycling, etc.

b. Security/safety: the degree to which the building can segregate sensitive functions from one another and prevent the entry of people to restricted area.

c. Engineering performance: how the building operates in terms of mechanical systems, electrical systems and industrial processes.

4. Image

a. Site planning/image : the degree to which the site responds to the needs of the project in terms of parking, vehicular and pedestrian traffic, outdoor amenities and the visual impact to the employees and visitors.

b. Architectural image: the visual concept of the building and the way in which the building attracts attention to itself. The form of the building and the degree to which it acts as a symbol for the company.

c. Community value: how the building and the site project "a good neighbor" identity in terms of safety, security and privacy.

These elements can be measured by team judgement.

Shublaq (2003) agrees with the 12 elements of quality model. He adds that quality model serves as a foundation for VE application. Attitudes and expectations regarding operational and technical performance having been clearly defined, understood and documented become the yardstick by which decisions are made. The concept of Figure 2.6 presenting elements of quality model for buildings was presented by both Kirk and Smith and Shublaq.

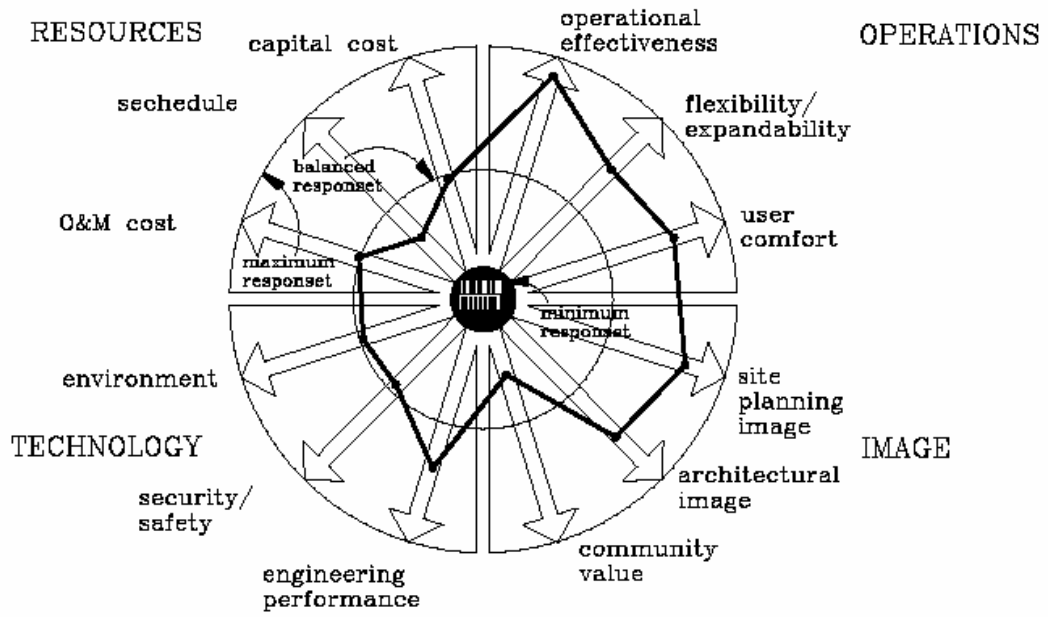

Figure 2.6, Quality model of building

The researcher will use the definitions above of the parameters of quality model subjected to questionnaire to test the validity of each element in the local practice of low cost housing.

2.10 Uniformat presentation of the masterformat

For buildings, the most common work breakdown structure for a construction cost model is based on the Uniformat system. According to Shublaq (2003) Uniformat has become a standard in the construction industry because it is based on the building systems level of detail rather than on a trade breakdown. Building systems can be directly related to one or two basic functions for each system. Figure 2.7 shows the relationship between the Uniformat and the masterformat that is usually used in the representation of the bills of quantities. In the figure, transformation is made between master format and unformat. For example, blockwork in masterformat is transformed into internal partitions and exterior closures as functions.

Design Uniformat			01 General requirements	02 Site works	03 Concrete	04 Masonry	05 Metals	06 Wood- plastic	07 Thermal & moisture protection	08 Doors and windows	09 Finishes	10 Specialties	11 Equipment	12 Furnishings	13 Special conditions	14 Conveying systems	15 Mechanical	16 Electrical	Total uniformat costs
01 Foundations	011	Standard foundations																	
	012	Spec. foundations																	
02 Substructure	021	Slab on grade																	
	022	Basement excavation																	
	023	Basement walls																	
03 Superstructure	031	Floor construction																	
	032	Roof construction																	
	033	Stair construction																	
04 Ext. Closures	041	Exterior walls																	
	042	Exterior doors and windows																	
05 Roofing																			
06 Int. Const.	061	partitions																	
	062	interior finishes																	
	063	specialties																	
07 Conveying System	07	elevator																	
08 Mechanical	081	plumbing																	
	082	H.V.A.C																	
	083	Fire protection																	
	084	Special mechanical system																	
09 Electrical	091	service & distribution																	
	092	lighting and power																	
	093	special electrical system																	
10 Gen. Cond. OH&P	101																		
11 Equipment	111	fixed & movable equipment																	
	112	furnishings																	
	113	special construction																	
12 Sitework	121	site preparation																	
	122	site improvement																	
	123	site utilities																	
	124	off site works																	
		Total Master format divisions																	

Figure 2.7, Relationship between uniformat and masterformat, Shublaq (2003)

2.11 Space Model

Both AL Asheesh (1997) and Shublaq (2003) conveyed the importance of preparation of space model at the early phase of the project (AL Asheesh page 98, Shublaq S-2 page2). In the early phase of a project, all one knows or can measure is the area of various types of functional space. Space model may take various shapes like in Figure 2.8.

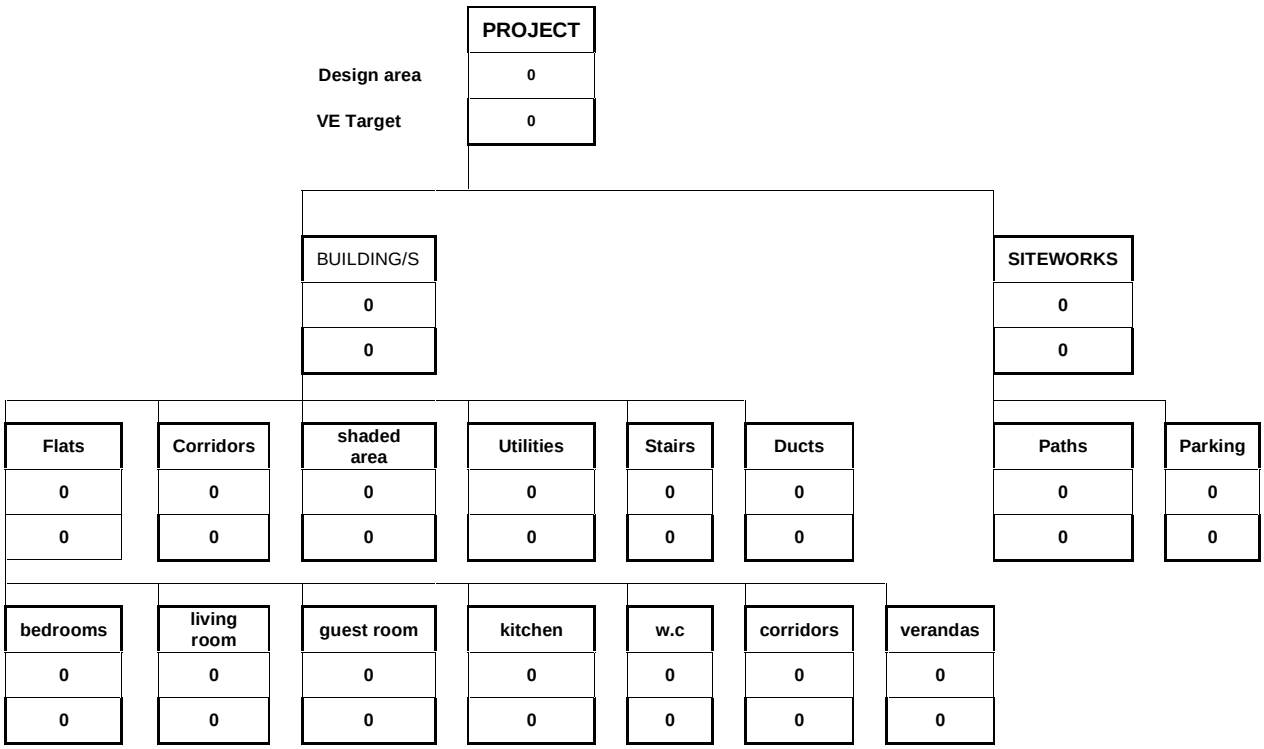

Figure 2.8, Typical Space Model

Space model may take a shape of pie chart or bar chart to represent space of various project elements. The pie chat represents overall picture of a project while bar chart is a detailed one.

2.12 Life Cycle Cost Model

The life cycle cost model (LCC) is the ultimate indicator of value to the client. It encompasses both initial costs and running costs. As indicated in Figure 2.2, the LCC

model considers optimum value because it takes into account all probable costs over the life of the facility. The LCC model can be based on either the annualized cost or the present worth approach (Shublaq, 2003). **A**ccording to West Virginia Division of Highways (2004), the total cost of a project is composed of design cost, construction cost and operation and maintenance cost. From its records in highways, the construction cost does not exceed 50% of the life cycle cost.

2.13 Present worth of future annuities

In order to evaluate life cycle cost of a project, it is necessary to present expenditures at various periods of time in a way that reflects the value of money in relation to time. For this reason, LCC model can be based on either the annualized cost or the present worth approach. The following formulas for calculations of money equivalence at different times are used by LaGrega , Buckingham and Evan (1994).

2.13.1 Present worth analysis

The following formulas are used as present worth evaluation of future value:

$$PV = \frac{F}{(1+i)^n}$$ present value or worth..... (Eq. 2.4)

$$F = PV \times (1+i)^n$$ future value or worth ..... (Eq. 2.5)

$$i = \left(\frac{F}{PV}\right)^{1/n} - 1$$ interest rate ..... (Eq. 2.6)

Where *n* is the number of payments.

And *i* is the interest rate in the payment period.

2.13.2 Present worth of annual payments

The following formulas are used as present worth evaluation of future value:

$$PV = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$ present value or worth ..... (Eq. 2.7)

$$A = \frac{PV}{\frac{(1+i)^n - 1}{i(1+i)^n}}$$ annual payment or cost ..... (Eq. 2.8)

2.13.3 Future value of annual payments

The following formulas are used to evaluate annual payments in future value:

$$A = \frac{F \times i}{(1+i)^n - 1}$$ annual payment or cost..... (Eq. 2.9)

$$F = \frac{A \times \left[(1+i)^n - 1\right]}{i}$$ future value or worth ..... (Eq. 2.10)

2.14 Function Analysis

Function analysis is the key issue in VE. For this purpose, Function Analysis System Technique (FAST) has been developed as a powerful tool of prioritization of functions.

According to Kasi and Benesch (1994), technical FAST diagram is a picture of all the functions of a component's subsystem (process, etc.) showing their specific relationships to each other and clearly showing what the subsystem does. It yields a different and useful perspective of the problem. FAST diagrams basic uses are to test the validity of the functions and insure that all the functions are included in the analysis and to be used to define, simplify, and clarify the problem. It is also used to aid communication and enable

VE team to examine where the costs are located. Finally, it is an aid to the creative process and define the scope of the project. Such FAST diagram is a SAVE Int. diagram that is widely used in VE applications.

A completed FAST diagram is the general representation of a result achieved by the Functional Analysis System Technique. Figure 2.9 was used by Kasi and Benesch for a retaining wall to clarify the FAST diagram.

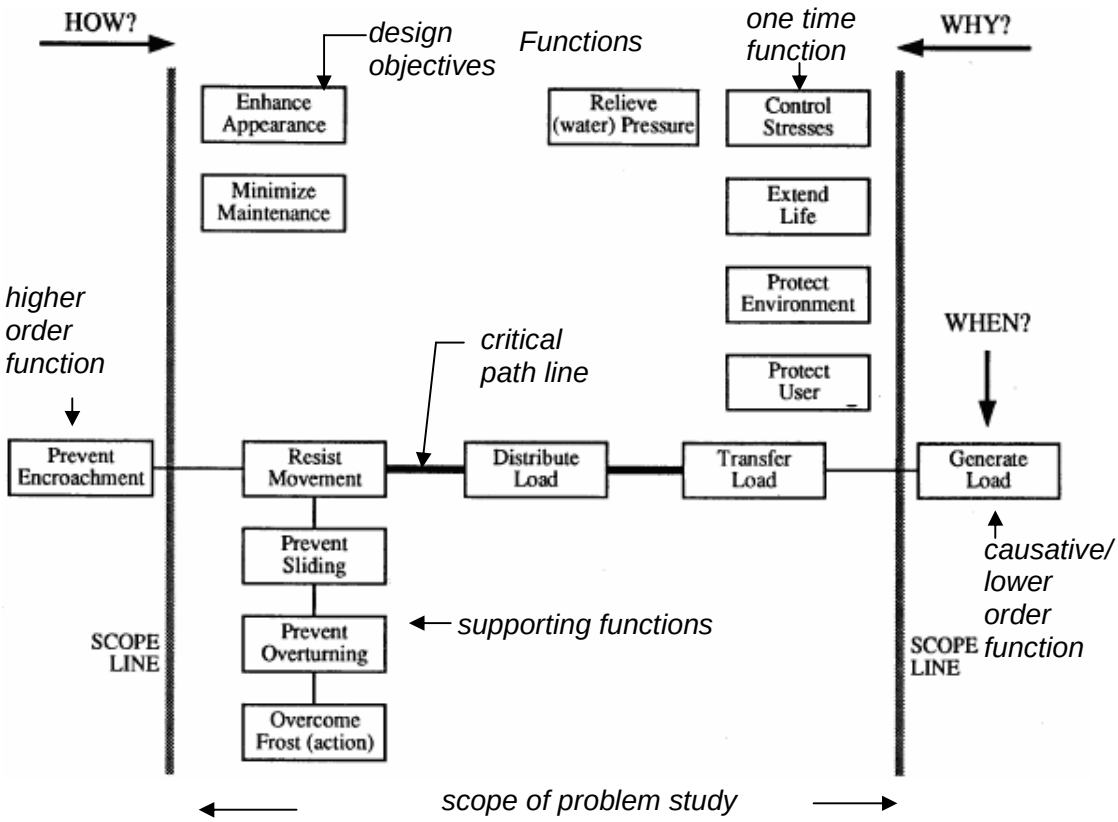

Figure 2.9, FAST diagram, Kasi and Benesch, 1994

Figure 2.9 is used to point out the features of a completed FAST diagram and introduce its terminology. The retaining wall example will be explained to help illustrate how a Technical FAST diagram is developed. Each block in the diagram represents a two-word

(verb-noun) function. The functions, or blocks, between the two vertical shaded lines are functions of the project or problem, such as the retaining wall. The region between these lines thus represents the scope of the problem under study. It includes all the functions which the subsystem itself performs. Each function appears only once. There is a left (or HOW) scope line and right (or WHY) scope line. There is a critical path of functions which runs between the two scope lines. Ideally it is a single, unique path on a Technical FAST diagram which never branches into multiple paths. (On Task FAST diagrams, multiple paths are common.) The critical path functions are those functions of the problem which are absolutely necessary in order to achieve specifically what the user (customer) wants done. All other functions are called supporting functions.

Once the critical path is determined, the functions within the scope of the project fall into two major categories: critical path functions and supporting functions. In addition, there are two external functions, the higher order function and the causative function. The functions on the critical path must occur in a particular order-from the highest level to the lowest level or, as shown in Figure 2.10, from left to right. The highest level function within the scope of the problem or project is called the basic function. All other critical path functions within the scope of the problem are called secondary functions.

Kasi and Benesch (1994) presented the HOW-WHY questions as a key to a correct and useful FAST diagram. One asks both a HOW question and a WHY question. The arrows beneath the HOW and WHY labels in Figure 2.10 indicates the direction to look for the respective answers. **I**n determining correct higher order and basic functions, the two way question HOW-WHY must have the same path. In the example of the retaining wall FAST diagram,

Question: WHY is it necessary to resist movement?

Answer: prevent encroachment.

And conversely

Question: HOW do we prevent encroachment?

Answer: resist movement.

The functions were used in their exact two-word form as they are listed for the retaining wall. Shublaq (2003) and Al Asheesh (1997) agreed with the concept of FAST diagram described above.

Other types of FAST diagram is the customer type that is used in Latin America. According to BArch (2002), once the objectives are prioritized it is possible to evaluate the options that would return the most value based on predetermined value criteria, i.e.:

a. Targeting true customer needs and wants
b. Delivering requirements but still enabling cost reduction by focusing on "what the function accomplishes" versus "what the product is".
c. Elimination of unimportant requirements
d. Adding incremental costs to achieve larger performance benefit
e. Improving performance and reducing cost simultaneously

BArch presents Figure 2.10 showing the logic of the FAST diagram that is used widely in Latin America.

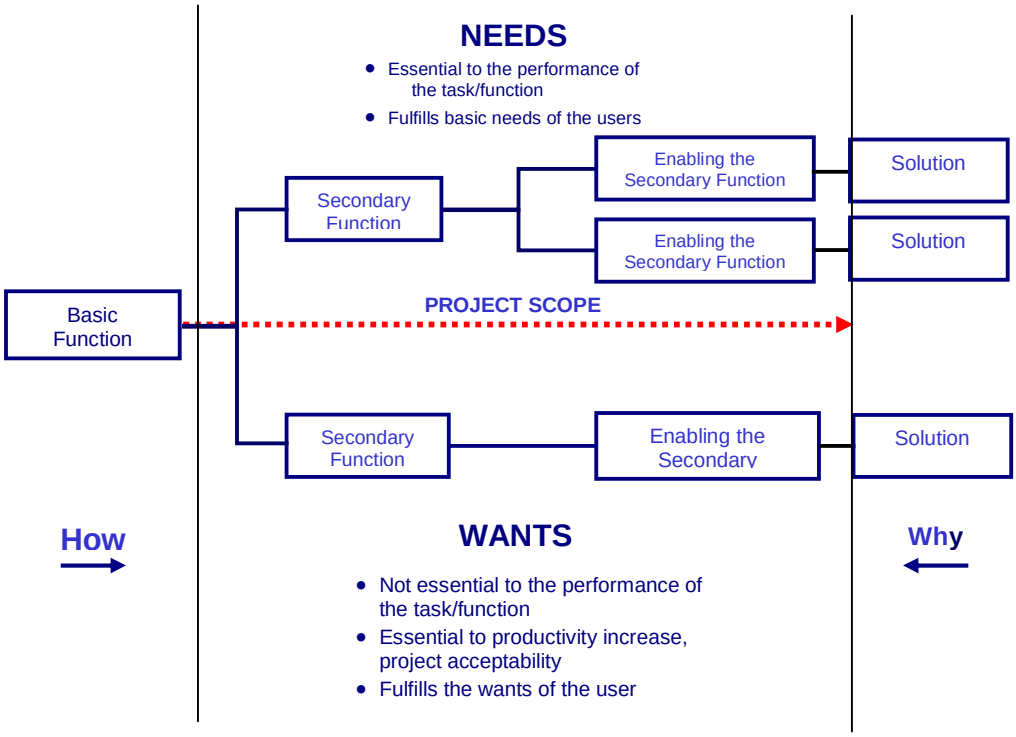

Figure 2.10, Customer FAST diagram, Project Managers Company

In defining function description, Al Asheesh stressed to use two-word form and explained that the verb is to express action that gives indicator for performance and the noun to be a measurable noun to give quantitative indicator for function. He advised to avoid verbs that does not indicate action, like save, enhance, promote, and un- measurable nouns, like services or environment.

2.15 How to apply Value Engineering

To apply VE effectively, various institutions, authors and specialists developed VE methodologies for application of VE.

2.15.1 SAVE Int.

SAVE Int. is the most famous association involved with value engineering. It has its own standard VE methodology that was intended to assure maximum benefits while offering greater flexibility once it had been adhered to. SAVE Int., Value Methodology Standard was published in 1997 and it may be summarized as follows:

A: Pre- study

1. Collect user/customer attitudes: like the prime buying influence of the product or project, the features, perceived complains and the competition to other projects.
2. Complete data file: this comes through primary sources of information, like people and documentation, and secondary sources, like engineering standards, regulations, test results, failure reports or similar project quantitative data.
3. Determine evaluation factors: the VE determines the criteria for evaluation of ideas and relative importance of each idea.
4. Scope the study: the VE team develops the scope statement of the study.
5. Build models: the team may develop models for further understanding of a project. Such models include cost, time, energy and flow charts.

B: Value study

1. Information phase: in this phase, data package is completed and the scope statement is reviewed.
2. Function analysis phase: this phase aims to identify functions, classify functions, develop function models, function hierarchy or FAST model, cost functions, establishment of function worth and value index. Functions for study are selected at

this phase.

3. Creative phase: in this phase, plenty of ideas by function are created.
4. Evaluation phase: alternative ideas are ranked and rated and ideas for development are selected.
5. Development phase: this phase includes conducing benefit analysis, completing technical data package, creating implementation plan and preparing final proposals.
6. Presentation phase: oral repot is presented as well as written report.

C: Post study

Following the study, changes are completed, implemented and monitored.

2.15.2 Australian Department of Housing and Works

The Department of Housing and Works in Western Australia developed value management guidelines. It almost has the same steps for VE methodology as SAVE Int. methodology. The steps of Value Management process are:

1. Information Phase: essentially preparatory work for the study, including items such as the development of objectives, key issues and concerns, background information, key assumptions, cost overview and study scope.
2. Analysis Phase: includes functional analysis, establishing system links, testing parameters and rationalizing data.
3. Creative Phase: is predominantly concerned with encouraging divergent ideas, lateral thinking and brainstorming, and generating alternatives for better value alternatives.
4. Evaluation Phase: ideas are assessed, culled and prioritized to identify viable

alternatives.

5. Development and Reporting Phase: options and rationale are refined and documented into action plans for recommendation to the project decision maker.

2.15.3 Acquisition Logistics Engineering.

Acquisition Logistics Engineering (ALE) presented the Value Engineering six phases job plan as The Department of Housing and Works in Western Australia did with addition of Implementation Phase and with some differences. **A**LE methodology steps are:

1. Information Phase: in addition to gathering information, ALE added that VE team establishes the areas that will allow for the most improvement and isolates the major cost items.
2. Function Analysis Phase: sometimes it is performed within information phase. FAST model is developed as well as cost and cost worth models. An initial assessment is done to find mismatch between cost and value. This can be shown graphically by plotting each item's worth versus cost percentage as shown in Figure 2.11 below where the numbers in the circles represents the value index of functions.

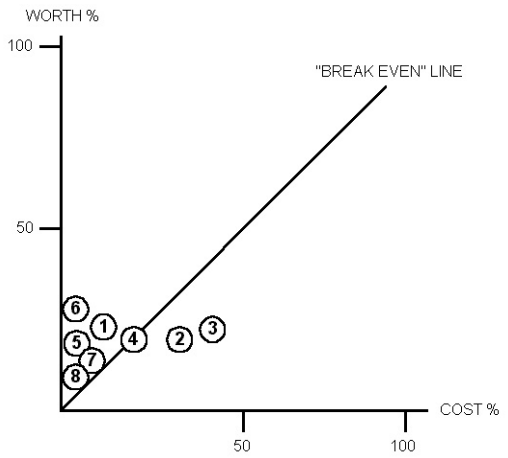

Figure 2.11, Worth Versus Cost Graph

3. Creative Phase: in this phase, team brainstorming identifies many alternative ways of performing the functions of the candidate items having the greatest worth/cost mismatch.
4. Evaluation Phase: a first cut through alternatives should eliminate impractical or unfeasible alternatives. Advantages and disadvantages of each alternative in addition to cost is concluded. If every alternative is eliminated during this phase, the team must return to the creative phase.
5. Development Phase: the remaining alternatives are refined and developed into a value engineering proposals including detailed description of the alternatives including benefits in terms of cost and performance.
6. Implementation Phase: it is sometimes broken into two parts, one for presentation, and approval and the other for formal implementation.

2.15.4 Caldwell

Caldwell (2006) methodology is composed of the following phases:

1. Information Phase: presentation is made to the VE team to explain the main concepts of the design. This includes project objectives, design constrains, drawings, specifications, the special conditions and the estimated cost. Caldwell prefers that those who present the information should not be part of the VE team.

2. Function Analysis: in this phase major project components are identified as well as their functions and estimated cost.

3. Speculation: during the speculation phase, the VE team considers each design

component and suggests alternative means of accomplishing the function of the component. Brainstorming is the most suitable technique.

4. Alternative Comparison: this phase is done to define comparison criteria so that alternatives can be compared. This phase is preferred to be performed using brainstorming initially and then through a detailed definitions of each criteria. Weights of criteria are developed by VE Team.

5. Analysis: analyzing alternatives involves comparing them to the criteria. Each team participant numerically evaluate each alternative against a specific criterion. Scores may vary from 1 to 5 with 1 identified as poor and 5 is very good.

6. Concept Development: during the concept development phase, the concept selected by the VE team is organized and refined before presentation to the owner. Sketches may be prepared or a narrative report compiled. Cost estimates may be refined.

7. Presentation and Implementation: in the presentation/implementation phase, VE recommendations are presented to the client, owner, or project manager who is sponsoring the project. The project manager decides whether the VE recommendations should be incorporated into remedial action.

8. Report: depending on the budget, topic, and significance of the VE workshop, a formal report may be prepared. Generally the most cost-effective method is to have the flipcharts photo-reproduced, copied, collated, and distributed. This provides a full record of deliberations, scores, recommendations, etc.

Caldwell elaborates the criteria for both the facilitator of the job plan and the participants as follows:

a. The Facilitator

The facilitator should be chosen with care. He is not required to have specific knowledge of the project or even of the technologies involved. His role is simply to act as a neutral presence and to make certain that the workshop is conducted in accordance with standard VE procedures.

b. Participants

The number of participants is between five and twelve. Never let the number of participants rise above twelve. There should be a balance of senior and mid-level experience. The majority should be well versed in the technology being examined.

Caldwell presents the following Figure 2.12 for VE methodology,

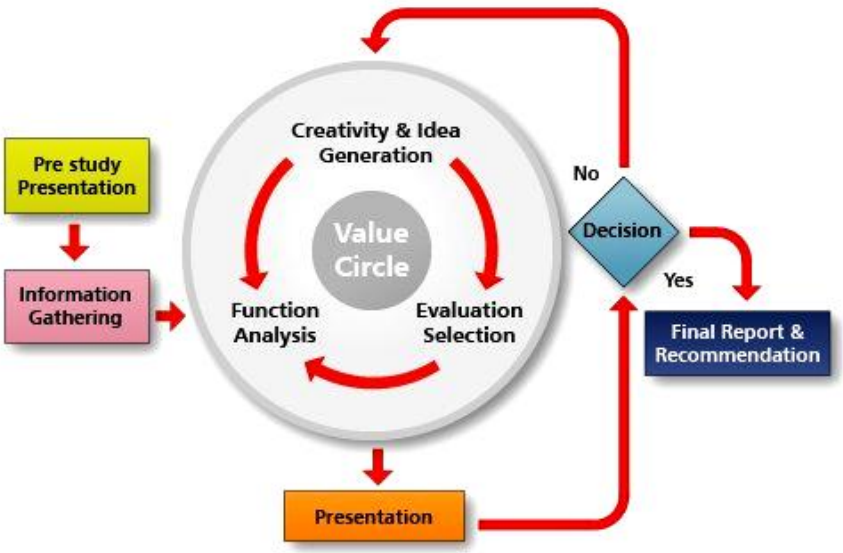

Figure 2.12, Value Engineering Methodology, Caldwell

Other examples of VE methodology are presented in the following figures

2.15.5 Shublaq

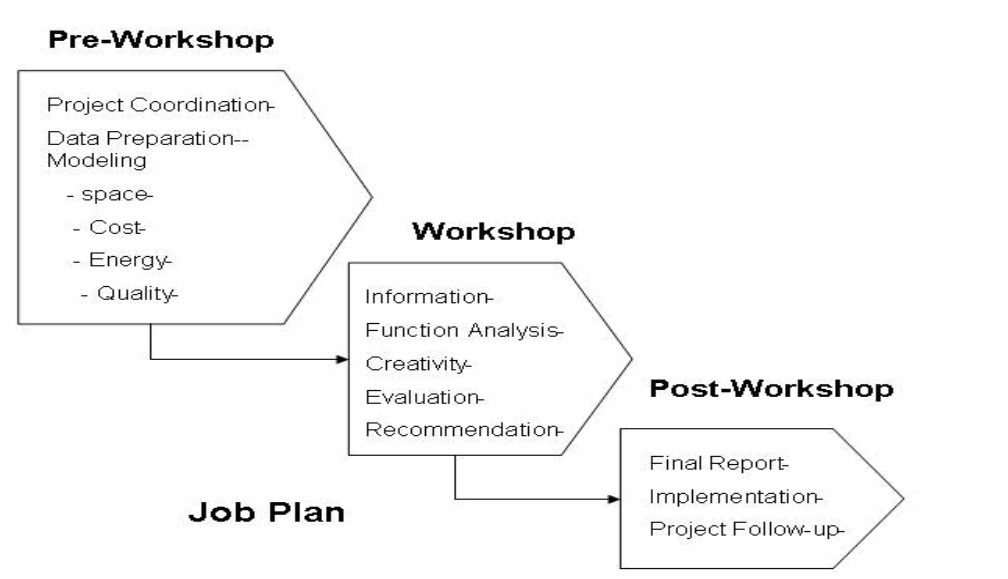

Figure 2.13, Value Engineering Methodology, Shublaq 2003

2.15.6 Dell'Isola

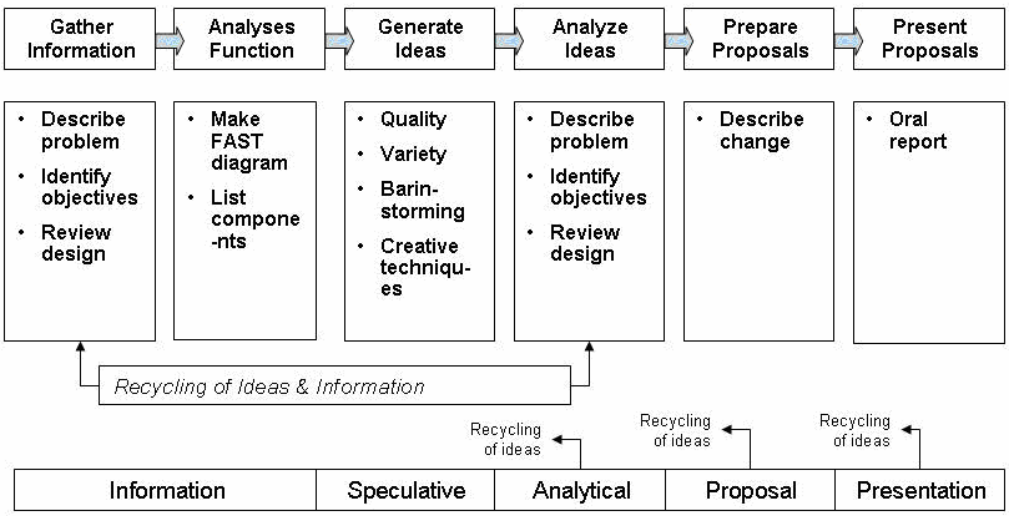

Figure 2.14, VE Methodology, Dell'Isola 1998, (cited by Shublaq 2003)

2.15.7 Al Asheesh

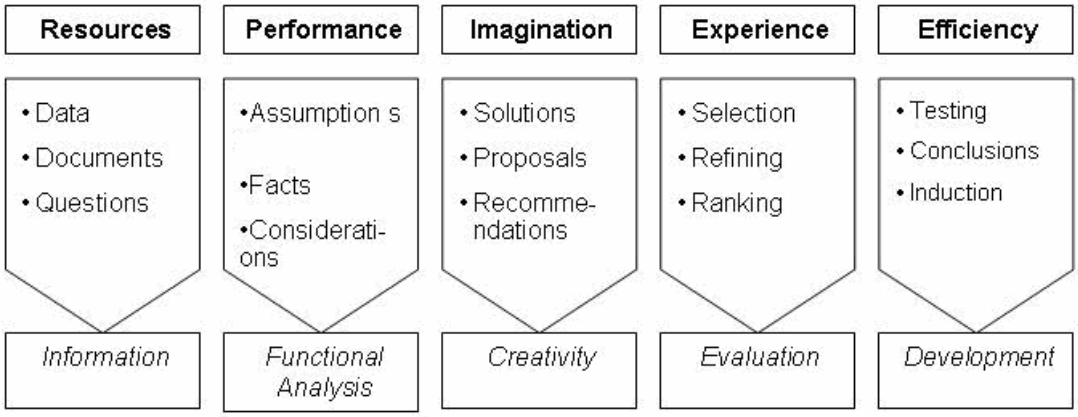

Figure 2.15 , VE Methodology, Asheesh 1997

2.16 Selection among alternatives

During evaluation phase, there may be more than one alternative for the same function to select among. Since project have multiple criteria, no single factor can be relied on for evaluation. For such kind of multi criteria evaluation, some common techniques are used for assessment and selection.

A: Al Asheesh and Shublaq

Asheesh (1997) and Shublaq (2003) present two common techniques as follows:

1. Evaluation by comparison. In this type of evaluation advantages and disadvantages are listed for each alternative that was refined in the evaluation phase of the job plan. Selection is a team judgment.
2. Evaluation using evaluation matrix. The matrix contains upper part for weights and lower part containing alternatives and the score.

B: Shublaq

Shublaq (2003) added other evaluation techniques like feasibility ranking, ranking by vote, cost reference usage, expert consultation and use of own judgment.

C: AASHTO

American Association of State Highway and Transportation Officials (AASHTO) has a standard evaluation matrix that is simple and easy to apply. The matrix is shown in Figure 2.16 below.

	List the best ideas from the suitability evaluation. Determine which one ranks best against desired criteria. Work down, not across.	5=Superior 4=Very Good 3=Average 2=Fair 1=Poor	Objectives or Criteria							Total	Ranking
	Alternatives	**Weight**									
1											
2											
..											
n											

Figure 2.16, Standard Evaluation Matrix, AASHTO

The matrix includes weights of evaluation criteria. The VE decides upon the criteria and the relative weight of each element of the criteria through discussion and following the understanding of the project concept and the owner requirements. Then for each alternatives, scores are assigned for each element out (of 5 for example). By multiplying the weight with the score and summation of the multiplication results, a relative mark is concluded that the higher score alternative represents higher fulfillment of project objectives.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

As VE is a new subject in Gaza Strip, the research followed a methodology trying to utilize all sources of knowledge regarding VE and the low-cost housing sector. The researcher followed a technique based on building knowledge gradually to conclude VE methodology suiting local professional engaged with low-cost housing utilization. The research methodology is presented as indicated in Figure 3.1.

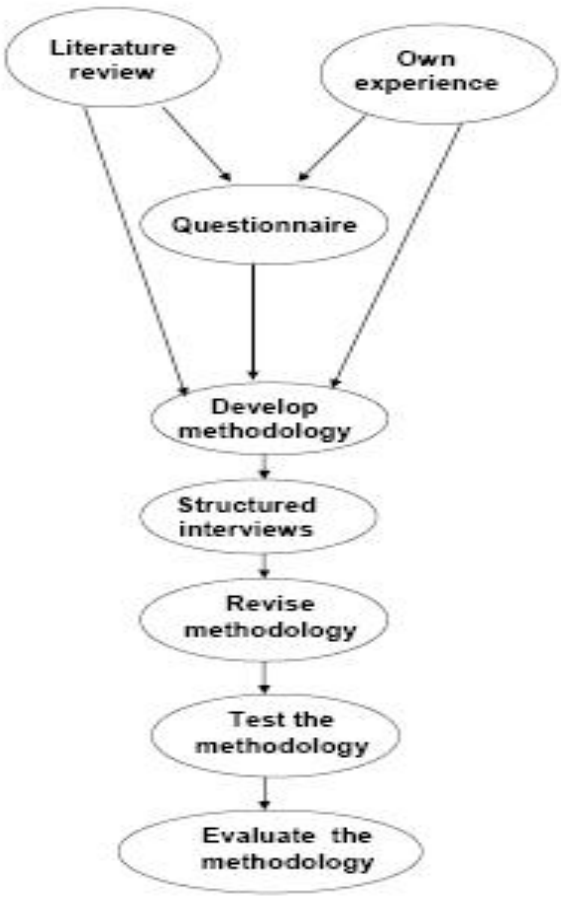

Figure 3.1, Research methodology presentation

The approach of the research is a qualitative one that includes the steps:-

3.2 Literature review

This step is considered as the research first step that includes retrospective data, reports, researches, documents, papers, text books and standards. The purpose of such references was to define VE, check feasibility and benefits gained from application of VE, present how VE is being handled among different countries and present sample of value engineering methodologies used in practice.

3.3 Questionnaire

Since the issue of VE is believed to be almost completely new, it is essential to identify the state of the art of VE to assist in developing methodology based on such facts. A questionnaire was performed with the following main objectives:

a. Determine the state of the common knowledge of VE related applications in the implementing institutions to benefit of any existing background.
b. Determine whether VE related applications are being applied or not since any methodology to be developed has to take into consideration whether the subject is completely new or it is being applied.
c. Determine reasons behind the non application of VE methodology.
d. Determine reasons of possible resistance of engineers to VE application.
e. Assess the needs of the local market for cost reduction techniques.
f. Determine the techniques used within institutions in the reduction of cost of housing.

Other objectives were added to benefit from the experience of the local professionals approached like:

1. The assessment of the parameters composing quality model that will be a major

judgment tool within evaluation of ideas during application of value engineering methodology.

2. The composition of the team engaged with the preparation of the quality model.

Accordingly, the questionnaire was divided into three sections. The first section was related to the background of the professional and his institution. The second one focused on the state of the art of the VE among professionals and institutions in terms of knowledge, experience, applicability, need for VE and acceptance of application of VE. In the last section, the researcher added questions to benefit from the personal experience of the professionals to identify the important parameters composing the attributes of housing projects and their directions towards the needed expertise during the identification of the attributes of the project.

3.4 Data Analysis

In this stage, a VE methodology that may be applied in Gaza Strip was proposed. This includes the common phases of VE:

a. Information Phase (problem description, objectives identification and design review): at this phase, space and cost models was presented to identify areas of possible improvement.

b. Function Phase: techniques for function analyses was presented in order to classify functions into basic or secondary and get cost-worth analysis in order to identify areas for improvement.

c. Creativity Phase (quality, variety, brainstorming, creative techniques): this phase is the core of VE in which alternatives are produced and documented to be analyzed in the

next phase.

d. Evaluation Phase: analysis of alternatives is being performed in this phase to evaluate alternatives. Life cycle costing was developed as well in order to evaluate the whole cost of the project including construction and life cycle cost The analysis might be repeated for further exploration of alternatives.

e. Reporting and Presentation Phase: in this stage, all information, analysis and recommendation would be combined in a final report including executive summary and the rest of the report.

f. Implementation, Feedback and Follow-up Phase: such phase, the impact of application of VE study is being assessed for future benefits..

3.5 Evaluation of the methodology

Following preparation of the VE methodology, structured interviews were conducted with senior professionals who are aware of VE methodology for evaluation and critique of the proposed methodology. Before an interview, a summary of the proposed methodology was submitted to each professional to be prepared to the interview. The expected outcome of this phase was improvement of the methodology and any needed amendment.

3.6 Application of VE Methodology (case study)

As a final step of the research, VE methodology was applied to a real project. The researcher chose a housing project at the early design stage and facilitated application of VE job plan to the project through a team of experienced engineers. Such step intended to clarify the proposed VE and the steps followed in application as well as to clarify the

associated models proposed by the researcher. Furthermore, the impact of VE application will be compared with results gained in other countries. At the end, the product of the job plan was submitted to the owner to benefit from it.

CHAPTER 4

QUESTIONNAIRE ANALYSIS

4.1 Introduction

The questionnaire in Appendix A was developed as a tool of assessment of the state of the art of VE in Gaza Strip and as a means of assessment of quality model elements and the engaged parties in the team in the development of the quality model.

4.2 Questionnaire components

The questionnaire was divided into three sections as follows:

4.2.1 Background

This part contained eight questions related to the background and experience of the professional and his institution.

4.2.2 VE state of the art

This section of eighteen questions was developed to explore the state of the art of VE in Gaza Strip. The questionnaire contained questions in relation to the personal knowledge and experience of the professional of the VE and the source of the knowledge as well as the institution of the professional. The impact of application of VE in the questionnaire and the obstacles facing application of VE are investigated as well. The previous experience of the institution of the professional in cost reduction of construction project was also investigated.

4.2.3 Quality model

This section began with definition of the 12 proposed elements of the quality model to assist the professional to understand the meaning of the terms used to describe quality. In order to benefit from questioned professionals, section three contained two parts as follows:

4.2.3.1 Quality model elements

Part 1 was related to the elements of the quality model in the field of low cost housing in Gaza Strip. The professional was asked to dedicate the importance of the proposed 12 elements of the quality model with the chance to add other elements that are not included in the questionnaire. The professional was given the chance to add any other element to the 12 proposed.

4.2.3.2 Quality model team composition

Part 2 was related to the team of professional to participate in the preparation of the quality model. The professional was asked to dedicate the importance of the proposed 5 specialties and to add other elements that are not included in the questionnaire.

4.3 Characteristics of the selected professionals

The approached professionals for questionnaire were selected taking into consideration the following criteria:

a. Having relatively long and rich experience in the field of construction. Experience of professionals ranged between 10 years and 34 years with two exceptions where juniors fill the questionnaire.
b. Working with institutions directly in relation to construction.

c. Covering variety of institutions and firms as follows:

    1. Class "A" contractors. The technical manager was approached who is an engineer of usually a long experience.
    2. Representatives of owners belonging to governmental, nongovernmental and international institutions.
    3. Professional construction managers.
    4. Other professionals for their own expertise.

A list of 40 professionals was assigned. Such list was expected to represent the crème of professional engineers in a variety of institutions.

4.4 Technique used

The professionals approached were first contacted either directly or by phone call. The scope of the questionnaire was explained and the questions as well. Then a hardcopy of the questionnaire was handed to the professional to fill the questionnaire.

4.5 Professionals response to the questionnaire

Out of 40 professionals short listed**,** 36 were approached. Four could not be contacted due to their engagements. 30 professionals out of 36 replied and were classified as follows:

- Contracting firms' engineers: 14
- Professional Construction Managers: 4
- Owners: 6
- Others: 6

4.6 Analysis of the response of the professionals

4.6.1 First: the personal experience in VE

The answers of the professional indicated the following:

1. The answers were as follows on the question of the state of knowledge of VE:

State of knowledge	Number of professionals
Very good	1
Good	15
Fair	8
Poor	3
Very poor	2
N.V	1
Total	30

2. In relation to the source of knowledge of VE, professionals' answers were as follows:

Source of knowledge	Number of professionals
Hearing only	7
Reading only	7
Training only	1
Application only	3
Hearing and reading	2
Hearing and application	1
Reading and application	3
Hearing, reading and application	1
Training, reading and application	1
Hearing and benefit from the experience of the institution	1
Reading and contact with experts	1
N.V	2
Total	30

3. In relation to the ability to apply VE, eight answers range were between good and very good while the rest 22 range was between fair and very poor. The details of the answers were as follows:

Ability to apply VE	Number of professionals
Very good	1
Good	7
Fair	15
Poor	5
Very poor	2
Total	30

4. The personal experience in participation in VE professional workshops was very limited. The answers were as follows:

Participation in VE workshops	Number of professionals
Those who participated as experts	4
Those who did not participate	26
Total	30

5. In relation to benefits of application of VE, 14 professional answered positively of the existence of benefits. The distribution of the answers is as follows:

Benefit of application of VE	Number of professionals
Improvement of performance only	2
Cost reduction only	6
Both improvement in performance and cost reduction	5
Improvement in performance, cost reduction and improvement of schedule	1
Redesign of some elements	1

4.6.2 Second : the experience of the institution

The main findings of the second part of the questionnaire (related to the experience of the institution) were the following:

1. Answering the question in relation to the application of VE by the institution of the responses were as follows:

Application of VE by the institution	Number of professionals
The institution applies VE	14
The institution does not apply VE	16
Total	30

2. Answering the question with regard to the impact of application of VE by the institution, the answers were as follows:

Benefit of application of VE	Number of institutions
Cost reduction	5
Cost reduction and improvement of performance	7
Nothing gained	2
total	14

The answers regarding cost reduction as a result of the application are summarized as follows:

Percentage of saving in the cost of the project	Number of institutions
3%	1
6%	1
17%	2
20%	3
40%	1
60%	1
No response	5

3. In response to the question regarding reasons behind non application of the institution of VE, answers indicated variety of reasons as follows:

Cause of non application	Number of institutions
Lack of knowledge	6
Lack of experience	6
Lack of knowledge and experience	3
The higher management does not believe in the benefit of VE	1
Lack of knowledge and experience in addition to the higher management opposition.	1
Other factors, like the nature of works and the owner of the project	3
total	20

4. Responses to the question about the tendency of the institution to apply VE in case it is being provided with a simplified manual and methodology for VE application were as follows:

If the institution is provided with simplified manual for VE	Number of answers
The institution will apply VE	27
The institution will not apply VE	3
total	30

The reasons behind non application were indicated in the responses as follows:

Reasons of non application of VE when provided with manual	Number of answers
The difficulty to work as a team	2
The issue is new	1

Among the 27 institutions that are expected to apply VE when provided with simplified manual for VE application, the following difficulties were highlighted in the answers:

Difficulties in VE application when provided with manual	Number of answers
The issue is new	1
The issue is new and the management opposition	1
The opposition of the engineers and the difficulty of team work	1

Other professionals did not expect difficulties in VE application.

5. When asked about whether VE is considered as interference in the design, 21 professionals answered "No" and 7 considered VE as interference.

6. When asked about whether the institution was forced to reduce cost of projects, 28 professionals answered yes.

7. The reduction in cost came through the following:

Technique used in cost reduction	No. of institutions
Reduction of quality	4
Elimination of items	5
Replacement of some elements of the project	5
Reduction in quality and elimination of items	3
Elimination of some items and replacement of others	6
Reduction in quality, elimination of some items of the project and replacement of some parts	2
Cancellation of the project	1

The researcher believes that none of the institutions used really VE methodology since most of the above mentioned techniques are cost reduction techniques while VE study follows specified systematic methodology.

8. The decisions of cost reduction were taken by:

Decision maker in cost reduction	Number of institutions
Higher management only	11
Team decision only	9
Higher management and team	3
Project manager only	3
Project manager and team	1
Higher management and project manager	1

This question showed variety of decision making power in cost reduction. Any how, the most apparent were the higher management and the team followed.

9. Decisions of cost reduction had negative impact on:

Impact of cost reduction	Number of institutions
User satisfaction only	17
Quality only	6
Performance and user satisfaction	1
Quality, performance and user satisfaction	1

It was concluded that cost reduction tackled user satisfaction at most and then quality.

4.6.3 Section 3, Quality Model (QM)

Section three was divided into two parts,

4.6.3.1 Part 1

Results of the questionnaire in relation to the effectiveness of the proposed elements of the quality model were as follows:

a. The highest relative weight was given to the "capital cost effectiveness". The researcher agrees with the result since financing is the biggest challenge to the housing projects in

general and the cost of the housing unit plays an important role in the repayment capabilities of beneficiaries.

b. The second item of relative weight was operational effectiveness. The responses reflected the importance of the design of the project to serve the main objective. The items " user comfort" and " engineering performance" came very closed in the relative weight to the "operational effectiveness".

c. Other items came with medium relative weight except environment and flexibility/expandability. Since the available building materials in Gaza Strip have the same effect on the environment, the researcher agrees to consider the environment of lowest relative score.

Table 4.1 below summarizes the results of the responses :

Table 4.1, Summary of the answers regarding quality model elements

		Answers						
	Quality model factors	v. high	high	fair	poor	v. poor	relative weight	Rank
1	Operational effectiveness	9	15	5	1	0	0.81	2
2	Flexibility/expandability	2	8	12	6	2	0.61	11
3	User comfort	4	21	5	0	0	0.79	3
4	Capital cost effectiveness	18	9	3	0	0	0.90	1
5	Operation and maintenance	8	9	11	2	0	0.75	5
6	Schedule	2	16	10	2	0	0.72	7
7	Environment	1	9	9	11	0	0.60	12
8	Security/ safety	5	14	10	1	0	0.75	6
9	Engineering performance	6	17	7	0	0	0.79	4
10	Site planning/ image	1	10	16	3	0	0.66	9
11	Architectural image	0	9	20	1	0	0.65	10
12	Community value	3	12	11	3	0	0.70	8

Figure 4.1 presents the ranking of the relative weight of the quality model elements.

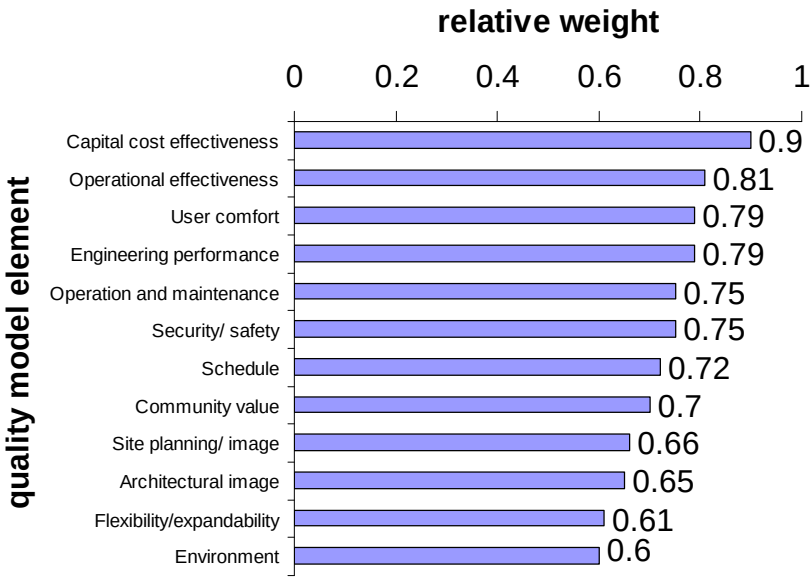

Figure 4.1, The ranking of the relative weight of the quality model elements

4.6.3.2 Part 2

This part was related to the importance of parties involved in the preparation of the Quality Model for low cost housing project subjected to VE methodology application. The responses indicated that professionals agreed with the proposed parties, but with variable importance. This might be elaborated as follows:

a. The highest relative weight was assigned to the owner. The researcher agrees with the importance of the owner as the party who is aware of all constrains.
b. Next highest elative weight was assigned to the architect followed by the civil engineer. The researcher agrees with the ranking since around 80% of the cost normally comes from the skelton and the finishes.
c. The other two parties, the beneficiary and the maintenance engineer came at the end but still having fair importance.

Table 4.2 below summarizes the answers of the professionals with regard to the parties to be involved in the preparation of the quality model for low cost housing projects.

Table 4.2, Summary of the answers regarding parties involved in QM preparation

		Answers						
	Parties engaged with quality model	v. high	high	fair	poor	v. poor	relative weight	Rank
1	The owner	14	10	2	0	0	0.82	1
2	The beneficiary	4	9	12	1	0	0.72	4
3	Architect	7	13	5	1	0	0.80	2
4	Maintenance engineer	6	7	9	4	0	0.68	5
5	Civil engineer	8	7	11	0	0	0.78	3

Figure 4.2 below presents the ranking of the relative weight of the parties to be involved in the preparation of the quality model for low cost housing project.

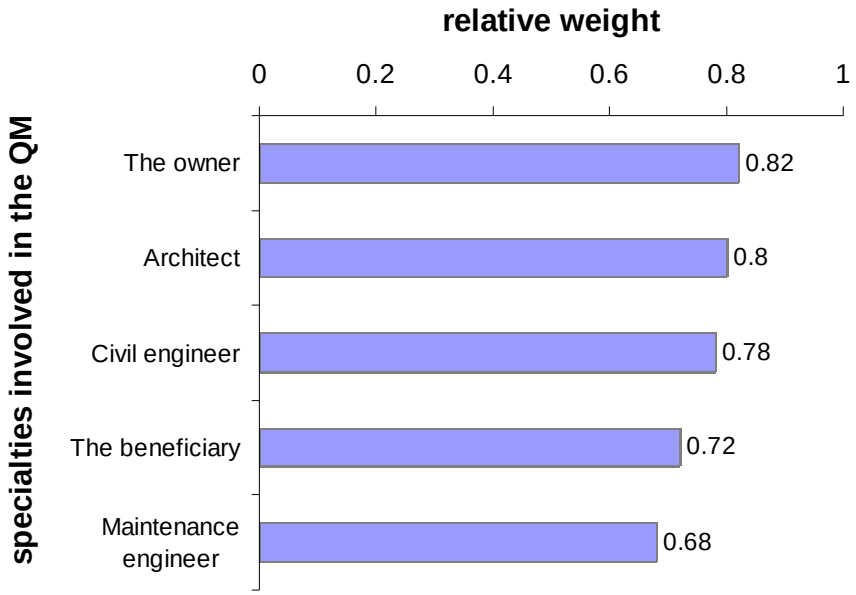

Figure 4.2, The ranking of the relative weight of the parties involved in the QM

4.7 General findings and conclusions of questionnaire analysis

4.7.1 The state of the art of value engineering in Gaza Strip

Even though good culture of value engineering was found in general, Gaza Strip lacks real experience of value engineering application. The researcher approached the elite of the professionals, the results of the questionnaire assured that real value engineering is not applied in Gaza Strip.

It was also found that there was a discrepancy between the value engineering as a specified cost control analytical methodology based on team work and other practice in cost reduction of construction projects.

With regard to the need for VE, there is a high potential for value engineering application due to the limitation of financing. Cost reduction during construction was found a common phenomenon. Institutions engaged with implementation of construction projects are anticipated to apply value engineering in case they are provided with a simplified manual and methodology for value engineering.

In relation to the team work culture, the questionnaire indicated lack of team work culture that may form an obstacle in value engineering application.

4.7.2 The elements of quality model

Since responses indicated that the factor of environment has low relative weight, and since all alternatives that may be used in building have almost the same environmental effect, the element of environment was considered as a neutral element. So it was eliminated from the quality model. The remaining eleven elements of the quality model are:

- Operational effectiveness
- Flexibility/expandability

- User comfort
- Capital cost effectiveness
- Operations and maintenance
- Schedule
- Security/safety
- Engineering performance
- Site planning/image
- Architectural image
- Community value

4.7.3 The team engaged with quality model preparation

As a conclusion of the responses in addition to the personal experience, the researcher will maintain the five proposed parties in the preparation of quality model. These parties are the owner, the architect, the civil engineer, the beneficiary (if determined) and the maintenance engineer.

The owner is very important at this stage and it is highly needed to determine the project objectives and concerns at the early stage of the project. The end beneficiary input is crucial as the success of the project in terms of spaces and characteristics from one hand and the operation and maintenance from other one. The other parties proposed are key players of clarifying the general characteristics and raising the issues of concern of the project in its early stages.

CHAPTER 5

VALUE ENGINEERING METHODOLOGY DEVELOPMENT

5.1 Methodology developed

As a result of literature review and the state of the art of Value Engineering in Gaza Strip, a methodology was developed that can be simply used by local professionals. The methodology may be applied for all kinds of building construction with emphasis on low cost housing construction.

Value Engineering application is recommended to be preformed during concept phase as plans and rough cost estimation is prepared. The methodology has been developed for VE application in reducing cost of low cost housing in Gaza Strip according to Figure 5.1

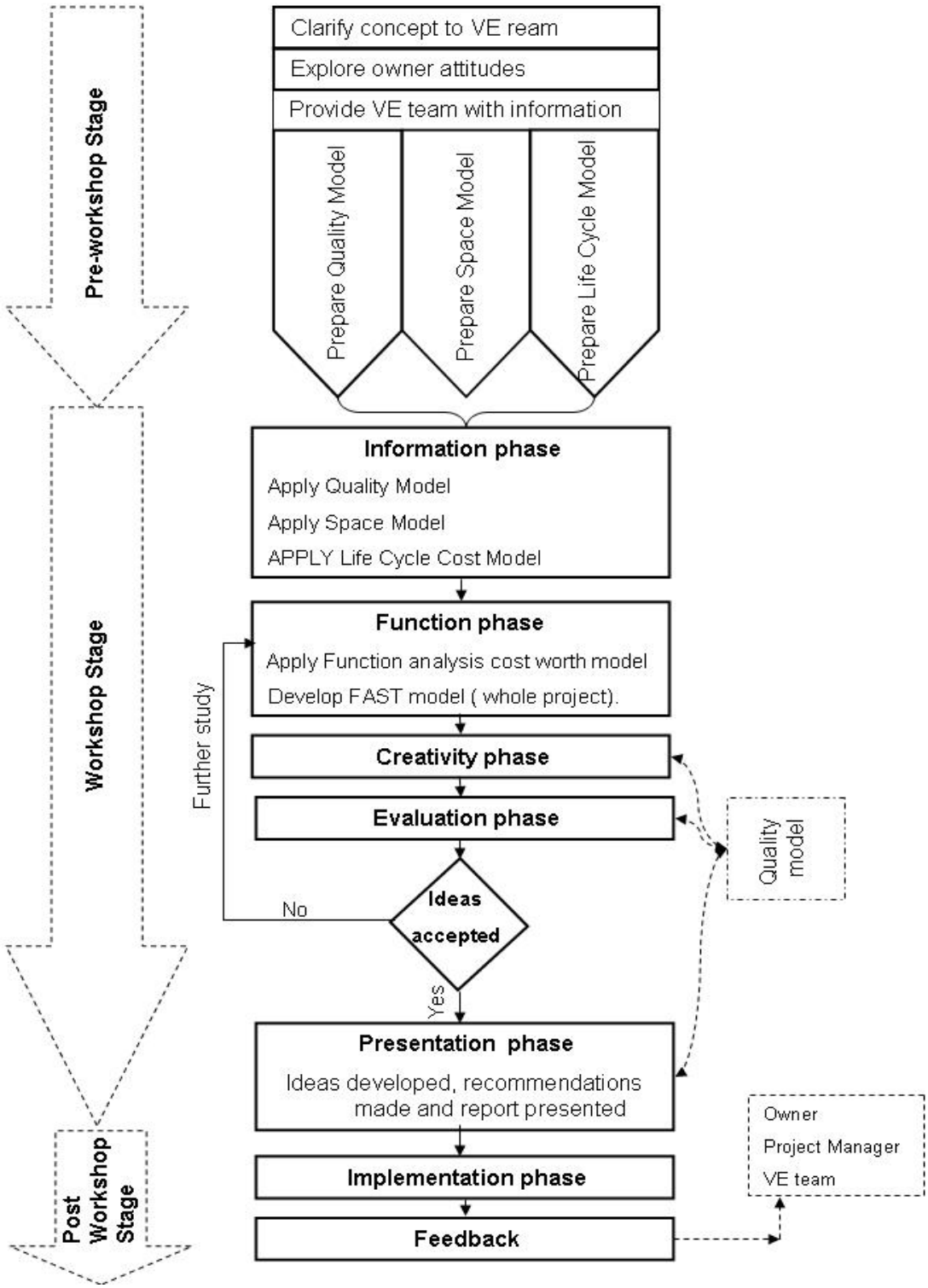

Figure 5.1, Value Engineering Methodology

5.1.1 Pre-Workshop stage

5.1.1.1 Objectives

The objective of this stage is to clarify the concept of the project in concern to VE team and explore owner attitudes as well as providing VE team with design information like:

a. Codes used,
b. Local authorities building regulations,
c. Specifications,
d. Drawings,
e. Soil test results,
f. Site information (like topography, availability of infrastructure, neighboring environment),
g. Site planning of the project (location of buildings, number of dwellings, green areas, streets, parking, services, etc.).

5.1.1.2 Models prepared

5.1.1.2.1 Quality Model (QM)

QM is prepared by team containing the owner, the end user (if determined), the architect, civil engineer and maintenance engineer. The elements of the quality model are:

1. **Operations**
    a. Operational effectiveness: it is defined as the degree to which the building is able to respond to its basic function as a residential building for people of limited income in terms of flow of residents taking into consideration their culture.

b. Flexibility/expandability: it is the ability of the building to be expanded horizontally and/ or vertically.
c. User comfort: it is the extent to which the building provides a physically and psychologically comfortable place for people to live.

2. Resources

a. Capital cost effectiveness: it is defined as overall initial investment of the building in terms of construction cost, design fees, land cost, municipality fees, administration cost, etc.
b. Operations and maintenance: this includes maintenance, operation and replacement costs.
c. Schedule: it is meant by the schedule the amount of time required to complete the various tasks including programming, design and construction.

3. Technology

a. Safety/ Security: it is here defined as how the building is restricted from other people than residents against entry and to what extent the building is considered safe in terms of construction techniques and operation.
b. Engineering performance: it is defined as the extent to which the building operates soundly in terms of mechanical and electrical systems.

4. Image

a. Site planning/image: the degree to which the site responds to the needs of the project in terms of parking, green areas, lighting, accessibility to the traffic system and the visual impact to the visitors.

b. Architectural image: it is limited to the external appearance of the building and the degree to which it acts as a symbol for the community.
c. Community value: how the building and the site reflect a "good neighbor" to the surrounding community.

Quality model is described as a quantitative description of the owner requirements. The above elements are assigned scores according to the owner requirements. The ranking of such scores is as follows:

Importance	Poor	fair	good	very good	excellent
Score	2	4	6	8	10

Figure 5.2 shows a graphical representation of the owner attributes as determined by quality model where the solid line shows the boundary of the owner requirements. The dotted line represents the design characteristics. The parameter of the cost will take the value of the ratio between the cost of the project due to the existing design to the owner ceiling for the cost multiplied by the importance of the factor to the owner.

The dotted line of an element to the outside means higher than owner requirements and to the inside means less than owner requirements.

As the issue of low cost housing projects are sensitive in terms of high restrictions to cost, the VE team mission is to study the project and propose alternatives that make the two lines very closed.

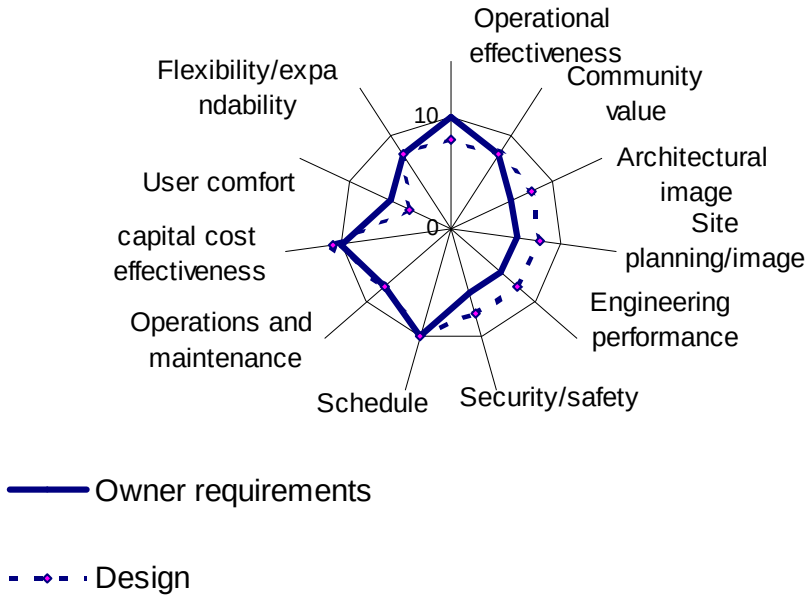

Figure 5.2, Quality Model

5.1.1.2.2 Other models prepared

Pre-Workshop Stage includes preparation of other models to be used in the workshop. This step is the responsibility of the facilitator or the Value Specialist. The models to be prepared at this stage, without application, are the following:

1. Cost model.
2. Cost-worth model
3. Space model
4. Function analysis model

5. Life cycle cost model

These models will be explained in the next part of the methodology.

5.1.1.3 Output of Pre-Workshop Stage

The output of this stage is collection of the maximum possible information with regard to the project in concern, good exploration of quality model and owner attitudes in terms of desires and needs and preparation of models to serve the next phase.

5.1.1.4 Resources

Resources engaged with this stage are the value specialist (CVS) or the facilitator, the owner, the end user (if determined), the architect, the civil engineer and the maintenance engineer.

5.1.2 Workshop Stage

5.1.2.1 Objectives

This stage is the core of the VE study. The main objective of this stage is to analyze the project in terms of functions rather than elements, to identify areas of high cost that has saving potential as well as to generate ideas to overcome high cost and/or improve performance

5.1.2.2 Phases of the Workshop Stage

The phases in the workshop are the following:

5.1.2.2.1 Information phase

In this phase, information collected in the pre-workshop phase is presented to the VE team. As a complementary step, the VE team starts the workshop with applying space model with

functional analysis to analyze the existing deign in terms of spaces. To enable revision of each element of the project in terms of space, a four levels work breakdown structure model was developed. The space model may be applied as shown in Figure 5.3. **I**n the figure, the word cost means the value of the design. Worth means the minimum space that fulfils the function to be performed. The worth is depending mainly on standards. The table includes functional analysis of space. For example the function of the bed room is "accommodate people" and its classification is basic. By calculating cost/worth or the value index (VI), areas of high cost, or poor value, are determined as well as secondary function spaces. This leads to team judgment of needed re-design of some space to get the design VI close to one.

Project:
VE study
space model with functional analysis

area cost= design value (m2)
worth= VE target (m2)

system	*subsystem*	*component*	*part*	Function		area			
Level 1	**Level 2**	**Level 3**	**Level 4**	Verb-noun	type	cost	worth	cost/worth	***remarks***
Project									
	BUILDING/S								
		Flats							
			bedrooms						
			living room						
			guest room						
			kitchen						
			w.c						
			corridors						
			verandas						
		Corridors							
		shaded area							
		Utilities							
		Stairs							
		Ducts							
	SITEWORKS								
		Paths							
		Parking							
		Green areas							

Figure 5.3, Space model with functional analysis

Then, VE team applies Uniformat cost model to determine the cost of each function. The cost of the items may be assigned based on local experience of the cost of square meter or previous similar project costs or own judgment. The Uniformat cost model is presented in a functional way that helps in assessment during later stages of VE workshop. Figure 5.4 shows the proposed Uniformat cost model and its relationship with the traditional masterformat. Each item in the Uniformat is estimated and may include many elements of the master format; i.e. exterior closures is composed of masonry, concrete, finishes, marble, metal..etc. For each project there is a cost model depending on its component.

Uniformat \ Master format			General requirements	Site works	Concrete	Masonry	Metals	Wood- plastic	protection	Doors and windows	Finishes	Specialties	Equipment	Furnishings	Special conditions	Conveying systems	Mechanical	Electrical	Total unioformat costs
01- Foundations	011	Standard foundations																	
	012	Spec. foundations																	
02- Substructure	021	Slab on grade																	
	022	Basement excavation																	
	023	Basement walls																	
03- Superstructure	031	Floor construction																	
	032	Roof construction																	
	033	Stair construction																	
04- Exterior closures	041	Exterior walls																	
	042	Exterior doors and windows																	
05- Roofing	05																		
06- Int. Const.	061	partitions																	
	062	interior finishes																	
	063	specialties																	
07- Conveying Sys.	07	elevator																	
08- Mechanical	081	plumbing																	
	082	H.V.A.C																	
	083	Fire protection																	
	084	Special mechanical system																	
09- Electrical	091	service & distribution																	
	092	lighting and power																	
	093	special electrical system																	
10- Gen. Cond.	101	general conditions & OH																	
OH&P	102	Profit																	
11- Equipment	111	fixed & movable equipment																	
	112	furnishings																	
	113	special construction																	
12- Site work	121	site preparation																	
	122	site improvement																	
	123	site utilities																	
	124	off site works																	
		Total Masterformat																	

Figure 5.4, Uniformat relationship with masterformat.

The next step is to apply Pareto Law 20/80. This comes through ranking of the function according to their costs in descending order. Normally, around 20% of the functions constitute around 80% of the cost. These functions (20%) are the subject of value engineering. Also the VE determines the evaluation criteria. Such criteria will be used to assess ideas generated during evaluation phase. Weight for each criterion is assigned to reflect relative importance based on the project attributes that has been clearly verified and defined.

5.1.2.2.2 Function analysis

A FAST diagram is developed to whole project to help the VE team in deep understanding of project objectives and constrains. As a result, basic functions are consolidated clearly.

Then function analysis cost-worth model is applied to find functions of high cost/worth value. Secondary functions and functions of poor value are determined through such model and they will be the target for development. The model can be applied as shown on Figure 5.5. Each function identified as high cost to be evaluated by the model below.

PROJECT:

ITEM:

cost= design value, worth= VE target

B = Basic Function S = Secondary Function

RS = Required Secondary Function

COMPONENT DESCRIPTION	FUNCTION VERB-NOUN	KIND	COST	WORTH	COST/ WORTH	COMMENTS
1-						
..						
..						
TOTAL						

Figure 5.5, Function Analysis Cost- Worth Model

5.1.2.2.3 Creativity

At this phase, functions of high cost are under focus. The team is to be motivated to generate ideas of possible alternatives to reduce cost or improve performance. At the end of the session, ideas are revised and assessed in terms of reasonability and validity. Ideas that are found practical will be evaluated. To promote creativity, no discussion to be made for ideas mentioned. They are just listed. No opposition of ideas to be allowed. Brainstorming is a suitable technique for idea generation.

5.1.2.2.4 Evaluation phase

At this phase, ideas are first refined. Some ideas might be repeated. Ideas are refined and good ideas are short listed. VE team agrees upon the list. Then ideas generated and refined are evaluated in detail against evaluation criteria assigned by the VE team. Such evaluation is to handle at least the following:

- General discussion
- Advantages
- Disadvantages
- Rank

Figure 5.6 presents the evaluation sheet used,

No.	Idea	Advantage	Disadvantage	Rank
A-01	(general description)	(generally list)	(generally list)	(out of 10)
A-02				
S-01				
...				

Figure 5.6, Value Engineering evaluation sheet

Rank is assigned by the VE team. Ideas with scores greater than 7 are proposed to be maintained for further discussion and ideas of rank less than or equal to 7 to be dropped. Any how, the VE team may use its own judgment to decide upon the limit of the rank to be assigned for idea development or elimination.

When having more than one alternative to the same function, the team may use the evaluation matrix presented in Figure 5.7. The total score of each alternative is calculated by summating the multiples of the weight of each criterion times the score. At the end columns, alternatives are ranked from the highest score to the lowest. The alternative with the highest score is supposed to be the best one.

			Objectives or Criteria							**Total**	**Ranking**
		5=Superior 4=Very Good 3=Average 2=Fair 1=Poor									
	Alternatives	**Weight**									
1											
2			score ranges between 1-5								
3											
4											
5											

Figure 5.7, Evaluation matrix

If ideas generated were found of low score, the VE team will repeat the effort starting from the creativity phase until it succeeds in gaining improvement.

For more details of the models used during VE application, refer to Appendix B.

5.1.2.2.5 Presentation phase

At the end of the session, the output of the VE study is a report prepared for discussion with the owner. If the owner disagrees with some ideas, the VE team does repeated cycles of study starting from creativity phase. The end product of the VE is a final report including two parts. The first one is a summary of the VE study including final recommendations and expected improvements and cost savings. The second one is the written report including introduction, project description, analysis procedure and summary of the results. QM is to be applied to show the impact of ideas on the project attributes. In case that the VE team finds more than one alternative for a certain issue, either evaluation by comparison or the evaluation matrix can be used depending on the team judgment. In case of usage of evaluation matrix, VE team determines the alternative of the highest score using the previously determined criteria.

This phase includes application of cost model and life cycle cost analysis to evaluate ideas. Life cycle cost is calculated using present worth of future payments using Eq. 2.7. The operation and maintenance costs are determined by the team experience and the common practice. From the personal experience of the researcher, the yearly maintenance cost of a housing project is around 2% of the capital cost. Income generated from ideas is evaluated as well. The interest rate (i) used is the desirable interest rate. It can be assigned using the following question:

If money are invested by the owner, what rate will he earn annually? The answer is the interest rate. According to the approached economist in the questionnaire of this research, it is advised to be 10% at least.

Value engineering recommendation sheets are presented in figure 5.8.

VE recommendation sheet						
Item: Mechanical						
No. of proposals			1			
current proposal Code:			M-01			
evaluation						
Item:						
Original Design						
Proposed Design						
Discussion						
Advantages:						
Disadvantages:						
Cost evaluation:						
1st: capital cost						
		item	unit	quantity	unit rate	total
	1	**original design**				
		Shower tray Ariston 70x70cm with fittings	No.	174	130	22,620
						22,620
		item	unit	quantity	unit rate	total
	1	**Proposed changes**				
		reduced level shower place with fittings	No.	174	50	8,700
						8,700
2nd: Life cycle cost summary						
		interest rate:	**10%**			
		Life cycle duration -year:	**40**			
				capital cost	annual operation & maintenance	other annual income
	Original			22,620	452	0
	Proposed			8,700	174	0
	present worth			13,920	2,722.5	0.0
	Savings			13,920	2,722	0
		total saving in present worth =			**16,642**	

Figure 5.8, Value Engineering recommendation sheet

5.1.2.3 Resources

The resources needed in this phase are determined according to the project nature and its components. Usually, for housing projects the VE team is to contain architect, civil engineer, structural engineer, mechanical engineer, electrical engineer and a cost estimation expert.

5.1.3 Post-Workshop Stage

Since the experience is completely new in Gaza Strip; it is very important to assess the impact of VE application precisely. Such assessment will serve all parties engaged with activities of low cost housing in particular, and parties engaged with building construction in general. For this reason, two modes of evaluation are recommended to be used. The first one is a short term evaluation during construction including the impact of application of VE recommendations in terms of assigned criteria for evaluation and it can be led by the project manager. The second evaluation is a long term and it can be done through follow-up of the project operation and the end user feedback. Tools used are site visits, documentation of annual operation cost, maintenance and replacement cost, interviews with end users, interviews with neighbors of the project and questionnaires. Feedback will assess post occupancy stage of the project and the long term impact for VE application and to consolidate lessons learned. Feedback is essential to parties concerned with the project, like the owner, the project manager, the VE team and the facilitator.

5.2 Structured interviews

The structured interview was performed following development of the methodology to get feedback from a group of professionals regarding the proposed methodology for improvement and enrichment. The interview is described as follows:

5.2.1 Introduction

Following preparation of VE methodology and the associated models, structured interviews were conducted with eight professionals for the purpose of evaluation and critique of the methodology in general as well as applicability and suitability for local practice in Gaza.

5.2.2 Characteristics of the selected professionals

The interviewed professionals were selected taking into consideration the following criteria

a. Having relatively long and rich experience in the field of construction (over 15 years).
b. Working with institutions in relation to construction.
c. Having relatively good background in low cost housing or building construction.
d. Having relatively good background in value engineering.
e. Working with variety of institutions that has some experience or knowledge of value engineering (i.e. consultants, contractors, universities, international agencies.).

Since the methodology contained some economical calculations related to annual payments presentation in present worth, one of the interviewed was of purely economical background. He was only interviewed for economical enrichment of the research. The other seven interviewed were engineers. Table 5.1 summarized the characteristics of the professionals and their background.

Table 5.1, Characteristics of the professional interviewed

Professional Position	Institution	Qualification	Years of experience
Instructor	Islamic University of Gaza	Professor Civil engineering	27
Instructor	Islamic University of Gaza	Associated Professor, Civil engineering	27
Technical manager	Contracting firm	Bsc. Civil engineering	32
General manager	BIG contracting firm	Msc. Civil engineering	33
Manager	EFFCO Consulting firm	Bsc. Architectural eng.	25
Consultant	Consulting firm	Bsc. Civil engineering	19
Facilitator	UN Habitat	Phd. Civil engineering	20
Principal	Deloitte & Touche auditors	Msc. Business Admin.	26

5.2.3 Technique used

To enable the interviewed to take his time to understand the proposed methodology, the interviewed were either provided with a summary of the proposed methodology prior to the interview or the interview contained an hour before questions during which the researcher explained in detail the methodology.

The interview structure was based on the following:

1. Making the professional prepared for the interview. This came through briefing of the value engineering methodology proposed by the researcher with examples of successful stories of VE applications
2. Conduction of the interview through asking closed and open ended questions to have specific answers and encourage the professional to express his comments.
3. The professional was asked to add general comments at the end of the interview.
4. The researcher added his own remarks immediately after the interview.

5.2.4 The structured interview components

The structured interview was divided into two parts

5.2.4.1 Part 1

This part contained questions related to the personal background and experience of the professional and his institution.

5.2.4.2 Part 2

Part 2 contained questions related to the evaluation of the proposed VE methodology. It contained questions about the evaluation of the proposed VE methodology three stages.

5.2.4.2.1 Pre-workshop stage

This part contained three questions that are related to the objectives of the pre-workshop stage, the team engaged with the quality model preparation and the models to be prepared in this stage. Finally, the professional was asked to add his comments upon other arrangements to be prepared in this phase.

5.2.4.2.2 Workshop stage

This part contained eight questions that are related to the objectives of the stage, thee focus area of the study, the evaluation basis of the space model, the goals of the low cost housing project, the quality model application, the work breakdown structure of the project for the purpose of space model application, the elements of evaluation in terms of capital cost and operation and maintenance cost, the calculation of present worth of future annuities (for economist).

5.2.4.2.3 Post workshop stage

This part contained two questions that are related to the parties engaged with feedback of application of VE recommendations and future evaluation during the operation of the project.

5.2.4.2.4 General comments and suggestions by the professional

The professional was asked to add his comments and suggestions in relation to the proposed methodology prepared by the researcher.

5.2.4.2.5 General comments and suggestions by the researcher related to the structured interview

This part was assigned such that the researcher can consolidate the interview immediately after the interview and put his remarks on the interview. For more details of the structured interview, refer to Appendix D.

5.2.5 Comments and Remarks of the Professionals

The comments and remarks of the interviewed professionals are summarized as follows:

a. The professionals agreed with the overall structure of the VE methodology.
b. With regard to the Pre-Workshop Stage:
   b.1 Most of the professionals agreed with the objectives of the stage.
   b.2 Contractor participation was proposed by one professional.
   b.3 The professionals agreed upon the proposed team to prepare the QM. Other parties were proposed to be added to the team, like professional in housing,

quality engineer, contractor and local authority representative.

b.3 The professionals agreed upon the proposed models to be prepared at this stage. A professional proposed to analyze as much information as possible in this stage. Other professional proposed a site visit by the VE team.

c. With regard to the Workshop Stage:

c.1 Most of the professionals agreed that this stage to be implemented after developing the concept of the project and a fair cost estimation.

c.2 They agreed upon the proposed objectives of this stage.

c.3 The professionals agreed upon focus on 20% of the functions having 80% of the cost of the project.

c.4 The professionals proposed that space model to be applied evaluating design spaces considering, standards and VE team judgment.

c.5 The majority of the professionals agreed to prepare FAST model based on multiple goals of the housing project. Two of them considered one goal only.

c.6 Quality model was proposed to be used during evaluation. One proposal was to be used as needed.

c.7 The professionals agreed upon division of the project into the proposed 4 levels for evaluation.

c.8 Capital cost and annual operation cost were both considered by the professionals for evaluation.

c.9 The economist agreed upon the used formula for comparing future payments to present. He also assured to use an interest rate of 10-12% and a life of 30 years of the buildings based on financial regulations.

d. With regard to the Post Workshop Stage:

d.1 Feedback was considered important to the proposed parties. Feedback to the relevant institutions and the consultant were also proposed by two professionals.

d.2 The evaluation by the beneficiaries of a housing project, the maintenance engineer and the architect was agreed upon.

The results of the interviews are listed in Tables E.1 to E.6 included in Appendix E.

5.2.6 Concluded Remarks of Structured Interviews

As a conclusion, the researcher was assured that the proposed methodology is workable and covered almost the whole issues of the VE. However, researcher will consider the following points as an outcome of the structured interview:

a. QM will be used as needed. This will be decided upon by the VE team.
b. Move as much preparation as possible to VE team during the pre-workshop phase.
c. Apply Pareto law prior to the workshop. (VE effort).
d. Each member will have the chance to study the project and prepare his own proposals prior to the workshop.
e. The VE team to contain a skilled contractor on a part- time basis as needed.
f. The VE team to conduct a site visit before the workshop to get familiar with topography, soil conditions, location, access roads, infrastructure and the sight view.

CHAPTER 6

CASE STUDY

6.1 Introduction:

As a clarification part in the research, this part intends to represent VE methodology application technique. Due to the scope of the research, the project selected to be considered for VE is a project in its initial phases being implemented by the United Nations Relief and Work Agency (UNRWA). The project is intended to be built in Khan Younis to re-house 437 refugees' families of demolished houses by the Israeli Army between the years 2001-2005. The first phase of the project was studied.

6.2 Project Information:

a. Exact name: The project name is "The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis".
b. Implementing agency or the owner: UNRWA is the implementing agency through three departments:
    1. Construction of buildings: by Engineering and Construction Service Department.
    2. Infrastructure: by the Environmental Department.
    3. Social role: through Social Department.
c. Project phases: The project will be divided into three phases, the first phase is composed of 171 housing units.

d. Location: The project is located in the western part of Khan Younis on a governmental land.

e. Area of land occupied by the project: The project will be built on an overall area of 130,000 square meters. 52,000 square meters were dedicated to phase 1 (in concern).

f. Topography: the project was originally part of the sand dunes closed to the sea cost generally with slope from east to west with concavity in a small zone in the middle. The difference in level originally reached up to 25 meters. UNRWA graded the site with smooth slope from east to west and from south to north. The final levels maximum difference is not exceeding 12 meters.

g. Soil exploration: soil test was prepared to the whole site. Laboratory recommended cleaning the site from rubbish and trees and to compact soil with 8.0 ton roller up to -2.0 meters below foundations level and then compacting the remaining at 25 cm thick layers and to reach minimum degree of compaction of 98%. Then foundations may be designed as strip foundations with allowable bearing pressure of 1.5 kg/cm2

h. Water table: water table was not encountered up to the explored 15 meters. It is not anticipated to be encountered for any distance less than 40 meters deep.

i. Estimated cost: the estimated cost of the project is 3.2 million US dollars.

j. Schedule: 26 weeks are given to contractors as the period of implementation. UNRWA facilitates extra working hours if the contractor is in need of. The week contains 6 working days.

k. Project components: UNRWA has its own standard for re-housing project. Table 6.1 summarizes the specifications in terms of spaces:

Table 6.1, Types of housing units and their components

Code	beneficiaries	Area m2	bedrooms	bathroom	kitchen	Water closet
A1	1-2 persons	44.2	1	1	1	
A2	3-4 persons	62.2	2	1	1	
A3	5-7 persons	79.8	3	1	1	1
A4	8 and greater	97.3	4	1	1	1
A5	Two wife family	121.5	5	1	1	1

A stair case with an area of 10.5 square meters is added for the cases of extended families to facilitate building two to three storey buildings. Extended families benefit from units with codes A2,A3,A4 and A5 while separated families benefit from units with codes A1 and A2 with no stairs. The dedicated units for phase 1 are as indicated in Table 6.2.

Table 6.2 Classification of buildings and number of each type of units

	No of building	No. of units	Stair yes/no
Single storey			
A1	3	3	no
A2	18	18	no
A3	24	24	no
A4	30	30	no
A5	9	9	no
Two storey			
A1/A1	2	4	yes
A1/A2	1	2	yes
A1/A3	1	2	yes
A1/A4	1	2	yes
A2/A1	2	4	yes
A2/A2	1	2	yes
A2/A3	2	4	yes
A2/A4	1	2	yes
A3/A2	2	4	yes
A3/A3	4	8	yes
A4/A2	1	2	yes
A4/A3	6	12	yes
Three storey			
A2/A2/A2	1	3	yes
A3/A2/A2	1	3	yes
A3/A3/A2	2	6	yes
A4/A3/A3	1	3	yes
A4/A3/A1	2	6	yes
A3/A3/A1	1	3	yes
A2/A3/A1	1	3	yes
A1/A2/A1	1	3	yes
A3/A4/A1	1	3	yes
A5/A2/A4	1	3	yes
A3/A2/A3	1	3	yes

(note: A4/A3/A1 : The ranking of the types of units from bottom to top).

Table 6.3 shows a summary of the number of each type of units.

Table 6.3 Summary of the number of each type of units

Type	Number	Remark
A1	19	
A2	40	
A3	58	
A4	44	
A5	10	
Stairs (single floor stair)	87	

l. Estimated cost: According to UNRWA quantity surveyor, no cost estimation was made to this phase in terms of cost of each type in particular. He could estimate the average of each unit at 19,000 US Dollars with an overall cost of phase 1 of 3.2 millions. This cost includes cost of building including site works.

m. Infrastructure: Infrastructure is not included in the three phases, of the project. Due to the structure of UNRWA, it is being handled completely by the sanitary department.

n. Case study focus: the case study will consider phase 1 of the project. The recommendations of the study can easily be applied to the later phases of the project. Infrastructure will not be considered due to the limitation of time and unavailability of information.

6.3 Team of VE study

A voluntary team of professionals formed the team of VE study. The characteristics of the team are as follows:

a. Covering the skills to be engaged with the study.
b. Long and rich experience. (15 years and more).
c. Working as consultants and skilled in implementation.
d. Can act efficiently through team work.

The team structure and characteristics is indicated in Table 6.4

Table 6.4, VE team structure and characteristics

specialty	experience	notes
Civil/ structural engineer	19 years of experience in building construction, structural design of buildings and design of infrastructure projects.	Full attendance
Architect	14 years of experience in building design with emphasis on low cost housing. He has research in low cost housing.	Full attendance
Contractor	25 years of experience in various fileds of civil engineering. Class A contractor in buildings. He implemented massive housing projects for UNRWA.	Part time attendance
Civil engineer	20 years of experience in building design with emphasis on low cost housing.	Acted as a VE and worked on cost estimation of the project.

6.4 Value Engineering study

A value engineering study was executed through applying the methodology and the associated models proposed by the researcher.

The steps and the conclusions of the study are presented as follows:

6.4.1 Pre workshop stage

6.4.1.1 Introduction

To collect information, the researcher contacted the technical team of the owner engaged with the different activities of the project. Five meetings in addition to phone calls were conducted with the team. The contacted technical staff of the owner were:

a. Head Engineering & Construction Service Department.

b. Re-housing and Maintenance Engineer.

c. Head of the Design Unit.

d. Architect.

e. Structural engineer.

f. Urban planning engineer.

g. Quantity Surveyor.

Through these meetings, the objectives were explored. The researcher explained the methodology to the team in order to enable them to express the objectives of the project in compliance with good understanding of the meaning of every item. The following information was provided to the researcher by the team:

1. Concept of the project and the owner needs.
2. Drawings.
3. Bills of quantities.
4. Schedule of the project implementation.
5. Budget considerations
6. Site information and topography.
7. Soil test report.
8. Specifications.
9. UNRWA guidelines for such project in terms of spaces per family size.

6.4.1.2 Quality Model

The quality model was developed during meetings with the owner departments in concern. It might be summarized according to Table 6.5.

Table 6.5, Quality model- Owner input

No	Item	Level of importance to the owner	Notes
	1. Operations		
1	Operational effectiveness	V. high	The project forms the minimum requirements to function as a housing project.
2	Flexibility/expandability	high	Each unit suits present needs and it is designed to be expanded by the end user in future.
3	User comfort	fair	The project is of emergency nature.
	2. Resources		
1	Capital cost effectiveness	V. high	There is a limited budget of 12.6 millions to build 438 units.
2	Operations and maintenance	high	It is important to avoid high maintenance since many of the end users are very poor families who can not afford cost of maintenance.
3	Schedule	V. high	It is extremely important due to consideration of the donor and since UNRWA pays to the beneficiaries for rental since their houses were demolished.
	3. Technology		
1	Security/safety	fair	It is fair since building are not exceeding three stories in height.
2	Engineering performance	fair	There is no elevators or power generators.
	4. Image		
1	Site planning/image	fair	Focus is directed to the buildings rather than site. Site to contain the minimum to be functioning.
2	Architectural image	fair	UNRWA does not has high considerations due to the nature of the project and the limitation of financing.
3	Community value	high	UNRWA considers this item of high importance in order to avoid social problems among beneficiaries and between the project and the neighbors.

6.4.1.3 Other models:

The following models were prepared by the researcher to be used during the workshop:

a. Cost model

b. Cost worth model

c. Space model

d. Function analysis model

e. Life cycle model

6.4.1.4 Uniformat presentation of the bills of quantities

The masterformat bill of quantities of the project was prepared and the quantities and cost estimation are presented in Table 6.6.

Table 6.6, Estimated cost (masterformat form)

	Item	Estimated cost in $
1	General requirements including over head and profit (OH&P)	**240,131**
2	Site works	**51,048**
3	Concrete	**1,462,225**
4	Masonry	**292,746**
5	Metals	**51,399**
6	Wood- plastic	**1,346**
7	Thermal & moisture protection	**30,148**
8	Doors and windows	**242,844**
9	Finishes	**632,212**
10	Specialties	**0**
11	Equipment	**0**
12	Furnishings	**0**
13	Special conditions	**0**
14	Conveying systems	**0**
15	Mechanical	**231,937**
16	Electrical	**194,402**
	Total	**3,430,438**

The next step was to present the project bills of quantities in the form of uniformat instead of the masterformat. The transformation of the bills of quantities into a uniformat form is presented in Appendix F (page F3). The summary is presented in Table 6.7

Table 6.7, Unifromat presentation

Code	Uniformat			Cost
01	Foundations	011	Standard foundations	618,063
		012	Spec. foundations	0
02	Substructure	021	Slab on grade	0
		022	Basement excavation	0
		023	Basement walls	0
03	Superstructure	031	Floor construction	664,093
		032	Roof construction	5,409
		033	Stair construction	82,794
04	Exterior closures	041	Exterior walls	433,103
		042	Exterior doors and windows	121,622
05	Roofing	05	roofing	22,989
06	Int. Const.	061	partitions	72,932
		062	interior finishes	442,627
		063	specialties	0
07	Conveying System	07	elevator	0
08	Mechanical	081	plumbing	243,358
		082	H.V.A.C	0
		083	Fire protection	0
		084	Special mechanical system	0
09	Electrical	091	service & distribution	116,526
		092	lighting and power	77,876
		093	special electrical system	0
10	Gen. Cond. OH&P	101	Gen. Cond. & over head	156,085
		102	Profit	84,046
11	Equipment	111	fixed & movable equipment	0
		112	furnishings	0
		113	special construction	0
12	Site work	121	site preparation	5,384
		122	site improvement	283,532
		123	site utilities	0
		124	off site works	0
Total				**3,430,438**

6.4.1.5 Application of Pareto law

The uniformat bill of quantities was sorted in a descending order. By accumulating the cost of the uniformat items, the result was as indicated in Table 6.8

Table 6.8, Functions of Uniformat ranked in descending order

code	uniformat	cost	% of the total cost	accumulative cost	% accumulative
31	Floor construction	664,093	19%	664,093	19%
11	Standard foundations	618,063	18%	1,282,156	37%
62	interior finishes	442,627	13%	1,724,783	50%
41	Exterior walls	433,103	13%	2,157,886	63%
122	site improvement	283,532	8%	2,441,418	71%
81	plumbing	243,358	7%	2,684,776	78%
101	Gen. Cond. & over head	156,085	5%	2,840,861	83%
42	Exterior doors and windows	121,622	4%	2,962,483	86%
91	service & distribution	116,526	3%	3,079,009	90%
102	Profit	84,046	2%	3,163,055	92%
33	Stair construction	82,794	2%	3,245,849	95%
92	lighting and power	77,876	2%	3,323,725	97%
61	partitions	72,932	2%	3,396,657	99%
5	Roofing	22,989	1%	3,419,646	100%
32	Roof construction	5,409	0%	3,425,055	100%
121	site preparation	5,384	0%	3,430,439	100%
12	Spec. foundations	0	0%	3,430,439	100%
21	Slab on grade	0	0%	3,430,439	100%
22	Basement excavation	0	0%	3,430,439	100%
23	Basement walls	0	0%	3,430,439	100%
63	specialties	0	0%	3,430,439	100%
7	Elevator	0	0%	3,430,439	100%
82	H.V.A.C	0	0%	3,430,439	100%
83	Fire protection	0	0%	3,430,439	100%
84	Special mechanical system	0	0%	3,430,439	100%
93	special electrical system	0	0%	3,430,439	100%
111	fixed & movable equipment	0	0%	3,430,439	100%
112	furnishings	0	0%	3,430,439	100%
113	special construction	0	0%	3,430,439	100%
123	site utilities	0	0%	3,430,439	100%
124	off site works	0	0%	3,430,439	100%
	Total	**3,430,439**			

It was noticed that the first 6 items (out of 31) forms 78% of the total cost. This means 19% of the functions form 78% of the cost which is very closed to Pareto Law. Functions of zero values were presented and counted since the Uniformat is generalized to buildings. In addition, the VE team may add to these zero functions as necessary.

As a conclusion, the area of value engineering analysis and study will be controlled by the first six functions that are listed in Table 6.9

Table 6.9, Functions of 78% of the cost and forming 20% of the whole functions

code	Uniformat	cost
031	Floor construction	664,093
011	Standard foundations	618,063
062	Interior finishes	442,627
041	Exterior walls	433,103
122	Site improvement	283,532
081	Plumbing	243,358
Total cost		**2,684,776**

6.4.1.6 Site visit

Due to limitation of time, the researcher conducted a site visit to the project location so that the team gets full information about the project in terms of location, soil nature, topography, neighboring environment and sight views. The team members know the area well and they were satisfied by the presentation of the researcher.

6.4.2 Workshop stage

This phase is the core of the VE methodology. During this phase, team work plays the main role of the study. Steps followed in this phase were according to the proposed VE methodology.

6.4.2.1 Information phase

In this phase, the facilitator of the VE study consolidated all information gathered in the pre-workshop phase to the VE team. This included:

a. Project objectives.

b. Budget.

c. Owner attitudes (quality model).

d. Soil test report.

e. Drawings.

f. Cost estimation (both master format and uniformat).

g. Models prepared for usage of VE team.

6.4.2.2 Quality model of existing design versus owner requirements

The VE team looked at the design information available and compared quality elements of the design with the owner requirements. From the available information and the team expertise, the result was as follows:

- The estimated cost of the existing design exceeded the allocated budget by 7%.
- Operational effectiveness of the design was lower than owner requirement.
- User comfort requirements are lower than that provided by the design especially with the absence of living room in each unit.
- Security/safety, engineering performance, site planning/image and architectural image are higher than the owner requirements.

Figure 6.1 expresses the design values of the quality model versus the owner requirements prior to the VE study.

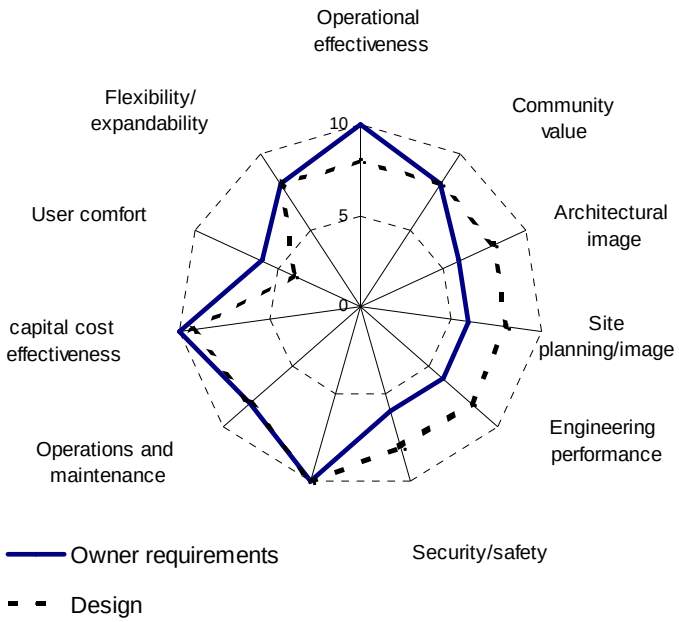

Figure 6.1, Quality model showing design versus owner requirements

6.4.2.3 FAST diagram

Following getting familiar with the project, VE has extended meeting to conclude F.A.S.T diagram of the project. The concluded FAST diagram is presented in Figure 6.2.

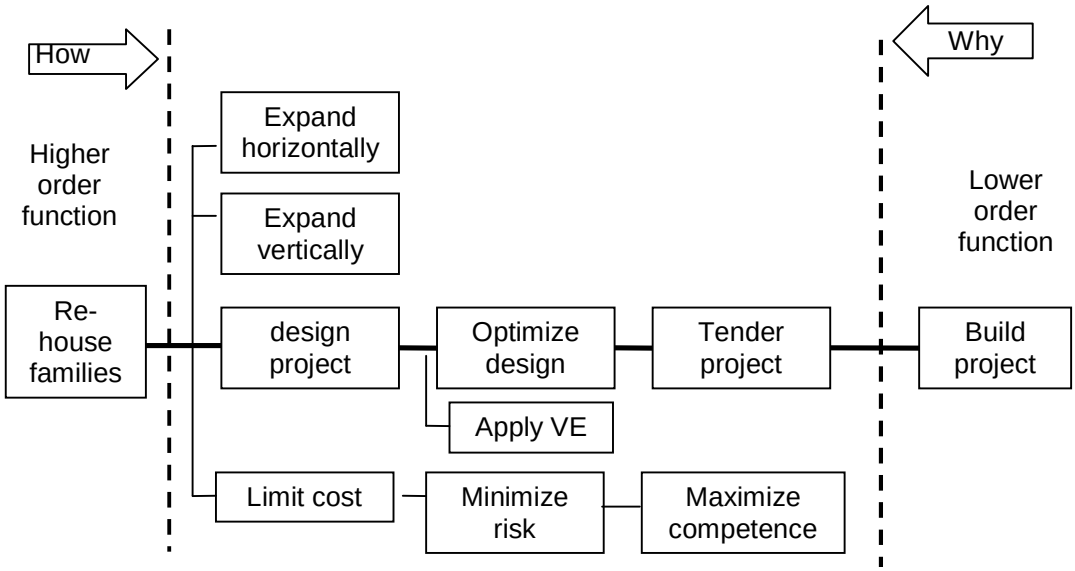

Figure 6.2, FAST diagram of the re-housing project

6.4.2.4 Space Model application

The space model was prepared in the pre-workshop phase. The team reviewed the spaces of the project using space model. The worth is the least required area to fulfill the function while the cost means the design space. Tables 6.10 to 6.16 present space model of different project components. The "worth" was based on standards taking into consideration local factors and social life of beneficiaries. The comparison showed the following:

6.4.2.4.1 Building type A1 (19 units)

Table 6.10, Space model- Type A1

		Area m2							
		Cost m2	Worth m2	cost/worth	***remarks***	Δ = worth-cost	(Δ^2)	(Δ^2)/n	relative deviation
	Total	**44.2**	**44.3**	**1**	amend design		**86.01**		
1	Bedroom1	13.1	14.5	0.9	increase space	1.4	1.96		
2	Bathroom	3.9	3.9	1		0	0	**86.01/ 6 = 14.34**	**square root of (14.34)/ 44.3 = 8.5%**
3	kitchen	11.2	6.5	1.72	poor value	-4.7	22.09		
4	corridors	8.1	4.5	1.8	poor value	-3.6	12.96		
5	Living room	0	7	0	add space	7	49		
6	Partitions	7.9	7.9	1		0	0		

6.4.2.4.2 Building type A2 (40 units)

Table 6.11, Space model- Type A2

		Area m2							
		Cost m2	Cost m2	Cost m2	***remarks***	Δ	(Δ^2)	(Δ^2)/n	deviation
	Total	**62.2**	**59.2**	**1.05**	amend design		**108.18**		
1	Bedroom1	14.8	14.5	1.02		-0.3	0.09		
2	Bedroom2	18.5	12.5	1.48	poor value	-6	36		
3	Bathroom	3.9	3.9	1		0	0	**15.45**	**6.6%**
4	kitchen	11.2	6.5	1.72	poor value	-4.7	22.09		
5	corridors	5	6	0.83	increase space	1	1		
6	living room	0	7	0	add space	7	49		
7	Partitions	8.8	8.8	1		0	0		

6.4.2.4.3 Building type A3 (58 units)

Table 6.12, Space model- Type A3

		Area m2							
		Cost m2	Cost m2	Cost m2	***remarks***	Δ	(Δ^2)	(Δ^2)/n	deviation
	Total	**79.8**	**71.2**	**1.12**	amend design		**137.34**		
1	Bedroom1	13.3	14.5	0.92	increase space	1.2	1.44		
2	Bedroom2	18.5	12.5	1.48	poor value	-6	36		
3	Bedroom3	16.2	12.5	1.3	poor value	-3.7	13.69		
4	Bathroom	4.1	4.1	1		0	0	**15.26**	**5.5%**
5	kitchen	8.6	8.6	1		0	0		
6	w.c	0	2	0	add space	2	4		
7	corridors	9.1	8	1.14	poor value	-1.1	1.21		
8	living room	0	9	0		9	81		
9	Partitions	10	10	1		0	0		

6.4.2.4.4 Building type A4 (44 units)

Table 6.13, Space model- Type A4

		Area m2							
		Cost m2	Cost m2	Cost m2	***remarks***	Δ	(Δ^2)	(Δ^2)/n	deviation
	Total	**97.3**	**99.9**	**0.97**	amend design		**128.08**		
1	Bedroom1	11.8	14.5	0.81	increase space	2.7	7.29		
2	Bedroom2	12.4	12.4	1		0	0		
3	Bedroom3	16.2	12.5	1.3	poor value	-3.7	13.69		
4	Bedroom4	17.3	12.5	1.38	poor value	-4.8	23.04		
5	Bathroom	4.1	4.1	1		0	0	**12.81**	**3.6%**
6	kitchen	8.6	9.5	0.91	increase space	0.9	0.81		
7	w.c	2.5	2.5	1		0	0		
8	corridors	12.5	11	1.14	poor value	-1.5	2.25		
9	living room	0	9	0	add space	9	81		
10	Partitions	11.9	11.9	1		0	0		

6.4.2.4.5 Building type A5 (10 units)

Table 6.14, Space model- Type A5

		Area m2							
		Cost m2	Cost m2	Cost m2	***remarks***	Δ	(Δ^2)	(Δ^2)/n	deviation
no.	**Total**	**122**	**123.1**	**0.99**	amend design		**157.08**		
1	Bedroom1	11.8	14.5	0.81	increase space	2.7	7.29		
2	Bedroom2	12.4	12.4	1		0	0		
3	Bedroom3	16.2	12.5	1.3	poor value	-3.7	13.69		
4	Bedroom4	17.3	12.5	1.38	poor value	-4.8	23.04		
5	Bedroom5	18	14.5	1.24	poor value	-3.5	12.25		
6	Bathroom	4.1	4.1	1		0	0	**14.28**	**3.1%**
7	kitchen	8.6	9.5	0.91		0.9	0.81		
8	w.c	2.5	2.5	1		0	0		
9	corridors	13	12.5	1		0	0		
10	living room	0	10	0	add space	10	100		
11	Partitions	18	18.1	1		0	0		

6.4.2.4.6 Stair (87 floor stairs)

Table 6.15, Space model- stairs

	Area m2			
	Cost m2	Cost m2	Cost/worth	***remarks***
Stairs	**10.6**	**10.6**	**1.00**	Maintain design

6.4.2.4.7 Site works

Table 6.16, Space model- site works

	Area m2			
	Cost m2	Worth m2	cost/worth	***remarks***
Paths	**1700**	**1700**	**1.00**	Maintain design

6.4.2.4.8 Conclusions

Taking into consideration the number of units of the project, Table 6.17 summarizes the result of space model application in terms of excessive area used:

Table 6.17, Summary space model- cost worth

	Area m2			
	Cost m2	**Worth m2**	**cost/worth**	***remarks***
total	**16085.2**	**15598.7**	**1.03**	
Buildings	14374.6	13888.1	1.035	3.5 % saving opportunity in the area of buildings
stairs	922.2	922.2	1.00	
Paths	1700	1700	1.00	

In terms of deviation, Table 6.18 summarizes the deviation in areas where the squares of the deviation were initially taken to avoid minus signs.

Table 6.18, Summary space model in terms of deviation

					Overall level deviations	
	area worth (m2)	No.	worth (m2)	unit deviation	deviation (m2)	Deviation %
Building A1	44.3	19	841.7	8.50%	72	
Building A2	59.2	40	2368	6.60%	157	
Building A3	71.2	58	4129.6	5.50%	227	
Building A4	99.9	44	4395.6	3.60%	157	
Building A5	123.1	10	1231	3.10%	38	
total buildings			**12966**		**651**	**5.00%**
Stairs	922.2	1	922.2	0	0	
Paths	1700	1	1700	0	0	
total stairs and paths			**2622**		**0**	**0.00%**
G-total			**15588**		**651**	**4.20%**

Looking at the tables above, it was concluded that:

a. There is a saving potential in the areas of the building of around 3.5%. Despite the VE team decided to maintain the area of the dwellings but with changes to improve the internal design.

b. Improvement of the design was found possible through addition of basic functions as follows:

b.1 Addition of living room to each type of units depending on the family size as follows:

b.1.1 Building types A1, A2: living room with area 7.0 m2 was added.

b.1.2 Building types A3, A4: living room with area 9.0 m2 was added.

b.1.3 Building types A5: living room with area 10.0 m2 was added.

b.2 Addition of a toilet unit to type A3 building that serves 5-7 persons.

b.3 Increase the area of the kitchen in types A4, A5 from 8.6 m2 to 9.5 m2.

The proposed changes in the design were presented in Appendix G.

6.4.2.5 Cost-worth model application:

The next step in the VE workshop was cost-worth model application in order to identify areas of high cost in the items selected for value study.

The VE team relied in cost estimation on their own experience as professionals engaged with the sector of building construction. Table 6.19 summarizes the result of the cost-worth analysis.

Table 6.19, Cost -Worth model

No.	Item	Cost $	estimated worth	worth	VI	Remark
1	Floor construction	814,050	14,374 m2 @ 50$/m2	720,000	1.13	**poor value**
2	Standard foundations	757,625	10,614 m2 @ 45$/m2	480,000	1.58	**Very poor value**
3	Exterior walls	530,300	14,376 m2 @ 35$/m2	500,000	1.06	**poor value**
4	Interior finishes	427,860	14,377 m2 @ 27$/m2	390,000	1.10	**poor value**
5	Plumbing	298,310	171 units @ 1500$/unit	260,000	1.15	**poor value**
6	Site improvement	347,555	171 units @ 1600$/unit	275,000	1.26	**poor value**
	total evaluated items	**3,175,700**		**2,625,000**	**1.21**	**poor value**

From the above table, the VE team concluded an existence of a saving potential in the project. The item "standard foundations" has the highest value index " cost / worth " i.e. the poorest value. The result of this table was carried to the next step of the workshop.

6.4.2.6 Creativity

Referring to the available information, the VE team looked at the components of the items identified as areas of high cost or elements having improvement potential and those components that had alternatives were discussed. A group of ideas were generated to overcome high cost functions. Ideas were evaluated and accepted for further development. Table 6.20 summarizes the evaluated ideas.

Table 6.20, ideas generated and VE evaluation

Alt. No.	Idea	Advanta-ges	Disadvan-tages	rank
	Architecture			
A-01	cancel external emulsion paint for Tyrolean finished external walls	economy	appearanc e	8
A-02	cancel external emulsion paint for Tyrolean finished and lime free plastered external walls	economy	appearanc e	8
A-03	replace marble sills for windows with mortar sills	economy	appearanc e	8
A-04	replace joint fill material for joints from sikaflix to mastic bitumen	economy	none	8
A-05	replace internal walls paint from emulsion to policed	economy	durability	8
A-06	change chips of terrazzo tiles from marble to local limestone	economy	appearanc e	9
A-07	change thresholds from terrazzo with marble chips to terrazzo with local limestone	economy	appearanc e	9
A-08	change top of kitchen worktop from local marble to granite	durability	economy	9
	Structure			
ST-01	change raft foundation to single footings	economy, schedule	none	9
ST-02	redesign columns and slabs	economy, serviceability		9
	Site general			
S-01	delete opening in boundary wall	economy, security	none	10
S-02	change 20 cm thick boundary wall parts to 15 cm thick	economy	appearanc e	9
S-03	change concrete of boundary wall and steps from B300 to cast in situ B200	economy, schedule	durability	8
S-04	replace plaques at each unit by 4 signboards	economy	none	10
	Mechanical			
M-01	replace shower tray with reduced level ceramic floor tiles	economy, safety	none	10

6.4.2.7 Presentation

The VE team had extensive discussion for the purpose of recommendation for each idea generated and accepted by the team. Discussion taken into consideration the following:

a) Description of the idea,

b) Advantages,

c) Disadvantages,

d) Impact on cost in terms of capital cost and present worth of future maintenance cost.

The outcome of such discussion was as follows:

6.4.2.7.1 Architecture

Eight proposals were developed. The result of recommendation was as indicated in Table 6.21.

Table 6.21, Summary of recommendations of Architecture

	item evaluated	capital cost saving	Present worth of annual operation& maintenance	other annual income
A-01	cancel external emulsion paint for Tyrolean finished external walls	47,495	9,289	0
A-02	cancel external emulsion paint for Tyrolean finished and lime free plastered external walls	6,316	1,235	0
A-03	replace marble sills for windows with mortar sills	6,557	1,282	0
A-04	replace joint fill material for joints from sikaflix to mastic bitumen	1,974	386	0
A-05	replace internal walls paint from emulsion to policed	18,268	3,573	0
A-06	change chips of terrazzo tiles from marble to local limestone	27,000	5,281	0
A-07	change thresholds from terrazzo with marble chips to terrazzo with local limestone	1,053	206	0
A-08	change top of kitchen worktop from local marble to granite	-9,541	-1,866	0
	sub-total architecture	99,121	19,386	0
	grand total architecture	**118,507**		

6.4.2.7.2 Structure

Two proposals were developed. The result of recommendation was as indicated in Table 6.22.

Table 6.22, Summary of recommendations of Structure

code	item evaluated	capital cost saving	Present worth of annual operation& maintenance	other annual income
ST-01	change raft foundation to single footings	258,180	0	0
ST-02	redesign columns and slabs	133,465	0	0
	sub- total structure	391,645	0	0
	grand total structure	**391,645**		

6.4.2.7.3 Site general

Four proposals were developed. The result of recommendation was as indicated in Table 6.23

Table 6.23, Summary of recommendations of Site general

code	item evaluated	capital cost saving	Present worth of annual operation& maintenance	other annual income
S-01	delete opening in boundary wall	36,184	7,077	0
S-02	change 20 cm thick boundary wall parts to 15 cm thick	614	120	0
S-03	change concrete of boundary wall and steps from B300 to cast in situ B200	22,982	0	0
S-04	replace plaques at each unit by 4 signboards	1,776	0	0
	sub- total site general	61,557	7,197	0
	grand total site general	**68,754**		

6.4.2.7.4 Mechanical works

One proposal was developed. The result of ecomendation was as indicated in Table 6.24

Table 6.24, Summary of recommendations of Mechanical

code	item evaluated	capital cost saving	Present worth of annual operation& maintenance	other annual income
M-01	replace shower tray with reduced level ceramic floor tiles	12,211	2,388	0
	grand total mechanical	**14,599**		

6.4.2.7.5 Summary recommendations

The result of the recommendations can be summarized as in Table 6.25

Table 6.25, Summary of recommendations

Item	capital cost saving	Present worth of annual operation& maintenance	other annual income
Architecture	99,121	19,386	0
Structure	391,645	0	0
Site general	61,557	7,197	0
Mechanical works	12,211	2,388	0
Total saving	**564,534**	**28,971**	0
Grand total saving in present worth	**593,505 dollars**		
The overall design cost	**3,430,439 dollars**		
Saving	**17.4%**		

6.4.2.8 Quality model after application of VE

The VE team looked at the project taking into consideration value engineering evaluation. In the VE team opinion, the quality model indicated harmony between the owner requirements and the project with VE suggestions. The following was noticed:

a) Cost became lower than the allocated budget where cost was reduced by 0.56 million dollars to become 2,606,496 US Dollars instead of 3.4 millions estimated with the existing design. The allocated budget is 3.2 millions.

b) Operational effectiveness was improved as well as the user comfort through utilization of areas and creation of living room with no increase in the total space.

c) Site image and architecture image were lowered to contribute in cost reduction, but still according to the owner requirements and no effect on functions was indicated by the virtue of proposals.

Figure 6.3 expresses the amended values of the quality model values versus the owner requirements.

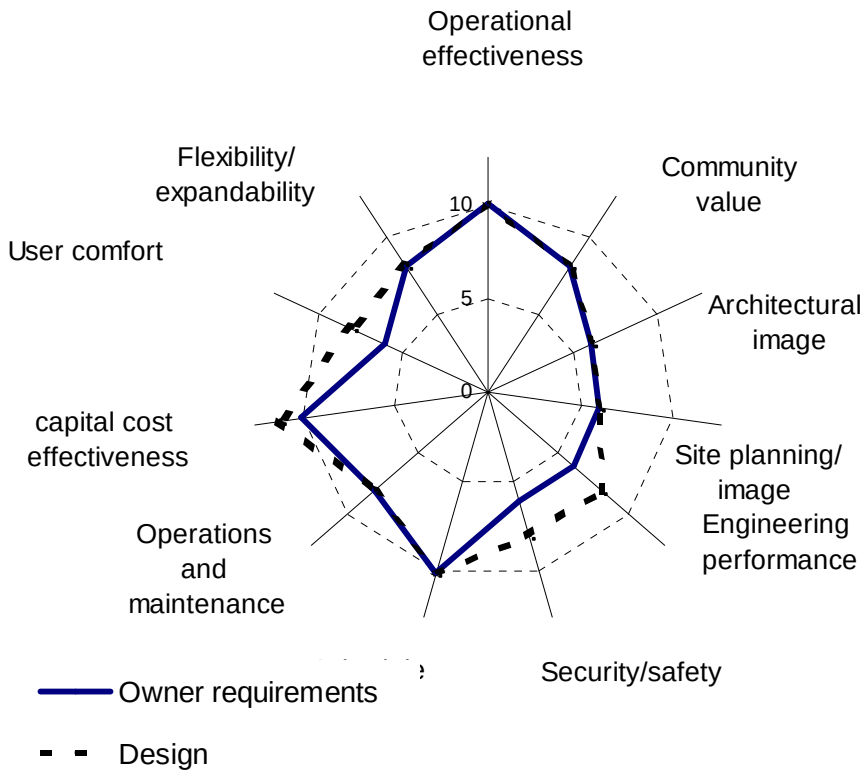

Figure 6.3, Value engineered project versus Quality model

6.5 Conclusions

VE methodology application was possible to the project in concern. Despite the project was planned to be at low cost; it was found very costly but VE application proved possibility of cost saving in addition to improvement in performance. The main findings of the VE methodology application were:

a) Possible saving in the cost of the project of about 593,504 dollars out of 3,430,438 ,i.e. 17.3% saving in cost.
b) Improvement in the project in terms of operational effectiveness and user comfort. Such improvement came through utilization of space that lead to modification of areas of bedrooms, corridors and addition of living room at no extra space.

In addition, VE team discussed schedule and the volume of the project. Due to oscillation of prices and the market attitude in cash payment of building materials, VE team recommended to divide the project into three lots and to hire three different contractors of category A in buildings. Such division into three lots is expected to:

c) Minimize risk of contractor through reducing the size of the project.
d) Improve schedule since 60 units are highly controllable compared to 171.

For more details refer to:

1. Appendix F: Sheets used in Value Engineering Workshop
2. Appendix G: Value Engineering report.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

Value Engineering is widely used in other countries, but it is not used in Gaza Strip. This refers mainly to the lack of knowledge and non-availability of simplified manuals for application of VE. In addition, there is other minor obstacles like the difficulty to work as a team, the internal rules of the implementing institutions, the higher administration of the institution and the financing procedures. However, application of VE is possible in Gaza Strip and the proposed methodology is relatively simple and can be easily applied.

7.2 Conclusions

a) Application of VE methodology reduces cost of housing projects significantly.

b) VE application improves performance as well in terms of operation and maintenance cost.

c) VE methodology application brings the project very closed to the owner requirements.

d) Most implementing Palestinian institutions faces cost overrun and financial constrains during implementation of projects. They are lacking VE experience and follow traditional cost reduction techniques to overcome lack of financing like reduction in quality and cancellation of parts of the project that cause user dissatisfaction.

e) Team work culture is not common in Gaza Strip in the field of housing construction. Decisions are most likely taken following managerial procedures.

f) Despite some difficulties that may face application of Value Engineering, it is anticipated that VE will find the way to go inside the Palestinian Institutions due to the

increasing demand for optimization of financial resources. Being easily introduced and proven to be of good impact, Value Engineering application will be accelerated.

7.2 Recommendations

a) It is recommended that Palestinian Institutions start applying Value Engineering Methodology. This may come through:

   a.1 Encouraging Value Engineering certification for a group of successful engineers who have leadership abilities in order to transfer the knowledge to the local market.

   a.2 Encouraging application of Value Engineering inside the institution. For this purpose, building team-work culture is very essential to the success of VE application

   a.3 Providing contractors with incentives to submit Value Engineering proposals during implementation of relatively large projects.

b) It is also recommended that Palestinian private sector as the leader of the progress of construction industry is encouraged to play an essential role in VE application and development.

c) Further researches are needed in the field of Value Engineering. This study was limited with the tight schedule of the research, tight schedule of other professional approached, very limited fruitful comprehensive publications, financial constrains as well as the extended topics that no single researcher can deeply cover. For instance, in high rise buildings, the energy model will be very effective that deserve researches in this topic.

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Appendix A

Questionnaire
(in Arabic)

بسم الله الرحمن الرحيم
الجامعة الإسلامية- غزة
كلية الهندسة- قسم الهندسة المدنية
برنامج الماجستير في إدارة التشييد

عزيزي معبئ الاستبيان
السلام عليكم ورحمة الله وبركاته،،

أرجو العلم أنني طالب دراسات عليا في الجامعة الإسلامية بغزة أقوم حالياً بإعداد رسالة الماجستير في إدارة التشييد حول تطبيق هندسة القيمة لخفض كلفة مشاريع الإسكان الموجهة لذوي الدخل المنخفض في قطاع غزة. ولكي استطيع البدء بعملي هذا فإنه يلزمني رصد حالة هندسة القيمة في قطاع غزة من حيث المعرفة والتطبيق- مع التقدير المسبق بندرة تطبيق هذا النوع من الدراسات في قطاع غزة. والإفادة من خبراتكم في هذا الموضوع ، وخبراتكم العامة كممارس خبير في مجالات الهندسة.
ولهذا الغرض أود أن أقدم مختصراً حول هندسة القيمة.

تعريفها:

" تعرف هندسة القيمة بأنها دراسة تحليلية ذات منهج محدد تجرى بواسطة فريق عمل متعدد التخصصات على منتج أو مشروع أو خدمة لتحديد وتصنيف الوظائف التي يؤديها، لغرض تحقيق تلك الوظائف المطلوبة بطريقة أفضل أو كلفة إجمالية أقل أو بهما معاً من خلال اقتراح بدائل ابتكاريه دون المساس بالمتطلبات الأساسية" .

وتهدف هندسة القيمة إلى رفع القيمة لما يتم دراسته من خلال إيجاد التوازن الدقيق بين الوظيفة والكلفة والجودة. وهي ليست مراجعة فنية أو بديلة عنها فالمراجعة الفنية تجرى عادة على التصميم للتأكد من جودته وسلامته والتأكد من عدم إغفال أو حذف أي من الأعمال. أما هندسة القيمة فهي أسلوب للدراسة والتحليل الوظيفي لرفع قيمة ما يتم دراسته.

وتجرى الدراسة عادة بواسطة فريق دراسة يتراوح عدده بين خمسة إلى سبعة أشخاص موزعين حسب التخصصات التي يحتاجها المشروع، ففي مشاريع البناء على سبيل المثال يتكون أعضاء فريق الدراسة من:

1. *مهندس معماري*
2. *مهندس مدني*
3. *مهندس ميكانيكي*
4. *مهندس كهربائي*
5. *خبير في حساب التكاليف*

فضلاً عن مشاركة المالك وأحياناً المستخدم. كما قد يشترك في بعض مراحل الدراسة تخصصات دقيقة تتعلق بطبيعة المشروع.

ويعتبر تطبيق هندسة القيمة في مرحلة التصميم الأولي أفضل ما يكون حيث يحقق جدوى عالية أما مع تقدم المشروع فتقل الجدوى حيث تكون كلفة التغيير مرتفعة فضلاً عن ازدياد المقاومة للمنهج.

آمل مشاركتكم الفاعلة في إثراء هذا الاستبيان وثقتي كبيرة أنه سيكون لمشاركتكم أثر كبير في إنجاح هذا البحث ، على أمل أن تقدم ثمرة هذا البحث للممارسين لاستخدامه في ترشيد استخدام الموارد في مشروعات إسكان ذوي الدخل المنخفض.
وفقني الله وإياكم لما فيه الخير والرشاد،

أسامة السعداوي ، المجلس الفلسطيني للإسكان- غزة
هاتف 2823280، جوال 0599411182 usamasadawi@yahoo.com

الجزء الأول: معلومات أساسية

1.1 الاسم الشخصي (اختياري): .....
1.2 اسم المؤسسة: .....
1.3 موقعكم في المؤسسة .....
1.4 عدد سنوات الخبرة .....
1.5 عدد سنوات العمل بالمؤسسة .....
1.6 اختصاص المؤسسة .....
1.7 تصنيف المؤسسة:

- ☐ مقاول
- ☐ مدير إنشاءات (Professional Construction Manager)
- ☐ مالك
- ☐ مورد
- ☐ غير ذلك (حدد رجاءً): .....

1.8 عدد الموظفين في المؤسسة: .....

الجزء الثاني: الحالة المعرفية بهندسة القيمة

2.1 مستوى إلمامكم بهندسة القيمة

☐ جيد جدا ☐ جيد ☐ متوسط ☐ ضعيف ☐ ضعيف جدا

2.2 مصدر المعرفة بهندسة القيمة

- ☐ السماع
- ☐ القراءة
- ☐ التدريب
- ☐ التطبيق
- ☐ غير ذلك (حدد رجاءً): .....

.....

2.3 القدرة على تطبيق هندسة القيمة

☐ كبيرة جدا ☐ كبيرة ☐ متوسطة ☐ ضعيفة ☐ ضعيفة جداً

2.4 هل سبق لكم المشاركة في حلقات هندسة القيمة في غير مؤسستكم الحالية ؟

☐ لا ☐ نعم

2.4.1 ماذا كان دوركم في هذه الحلقات ؟

- ☐ عضو في الفريق كمهندس خبير
- ☐ ممثل المالك
- ☐ ممثل مشغل المشروع
- ☐ غير ذلك(حدد رجاءً): .....

.....

2.4.2هل كان تطبيق هندسة القيمة مفيداً ؟

☐ لا ☐ نعم

2.4.2.1 الفوائد التي نتجت عن تطبيق هندسة القيمة:

- ☐ تحسين الأداء للمشروع
- ☐ خفض التكاليف
- ☐ ما سبق معاً
- ☐ غير ذلك(حدد رجاءً): .....

.....

2.5 هل تقوم مؤسستكم بتطبيق هندسة القيمة ؟

☐ لا ☐ نعم

2.5.1 هل نتج عن تطبيق هندسة القيمة في مؤسستكم :

2.5.1.1 وفر في التكاليف ؟ ☐ لا ☐ نعم (النسبة:.....%)

2.5.1.2 تحسين أداء المشروع؟ ☐ لا ☐ نعم

2. 6 إن كانت مؤسستكم لا تطبق هندسة القيمة، فالسبب يرجع إلى:

☐ نقص المعرفة بفوائد هندسة القيمة
☐ نقص الخبرة بهندسة القيمة
☐ عدم سماح أنظمة ولوائح المؤسسة بذلك
☐ عدم إيمان الإدارة العليا بجدوى ذلك
☐ غير ذلك(حدد رجاءً): .....

.....

2. 7 في حال تزويد مؤسستكم بدليل مبسط ومنهجية لتطبيق هندسة القيمة، هل تتوقع أن تقوم المؤسسة بتطبيق هندسة القيمة؟

☐ نعم ☐ لا

2.7.1 ما هي الأسباب التي باعتقادك وراء عدم التطبيق في هذه الحالة ؟

☐ الموضوع جديد ويوجد لدى المؤسسة منهجية للدراسات الفنية
☐ الإدارة العليا لا تقبل تطبيق هندسة القيمة
☐ معارضة المهندسين، خاصة المعماري، لاعتبار الدراسة كنوع من النقد لعملهم.
☐ من الصعب العمل كفريق ضمن المؤسسة.
☐ غير ذلك(حدد رجاءً): .....

.....

2. 8 هل تعتبر هندسة القيمة انتقاداً لتصميم المهندسين ؟ ☐ لا ☐ نعم

2. 9 هل سبق أن أجبرت مؤسستكم على خفض تكاليف مشروع ما ؟

☐ لا ☐ نعم

2.9.1 تم خفض الكلفة من خلال:

☐ خفض مستوى الجودة
☐ تقليص بعض عناصر المشروع
☐ استبدال بعض أجزاء المشروع
☐ إلغاء المشروع
☐ غير ذلك(حدد رجاءً): .....

.....

2.9.2 القرار بطريقة خفض الكلفة تم اتخاذه من خلال:

☐ الإدارة العليا
☐ فريق عمل
☐ مدير المشروع
☐ غير ذلك(حدد رجاءً): .....

.....

2.9.3 كان للقرار تأثير سلبي على:

☐ الجودة
☐ الأداء
☐ رضا مستخدم المشروع
☐ غير ذلك(حدد رجاءً) .....

.....

الجزء الثالث: أسئلة تتعلق بنموذج الجودة (QUALITY MODEL)

- **تعريف**:

يعرف نموذج الجودة بأنه أحد طرق الإدارة بالجودة الكلية (Total Quality Management) والذي يمكن تطبيقه خلال مراحل التخطيط والتصميم لمشروع ما. ويساعد النموذج في قياس وإدارة توقعات الجودة لمالك المشروع.

- **عناصره الأساسية في مشاريع الأبنية**:

1. **التشغيل:**
   - **التأثير التشغيلي**

وهو المدى الذي يكون فيه المبنى مستجيباً للعمليات المفترضة داخله وانسياب حركة الناس والمعدات والمواد فيه.

   - **المرونة والقدرة على التوسع:**

وهو المدى الذي يكون فيه المبنى قابلاً لإعادة الترتيب لملائمة تغير في العمليات والقدرة على التمدد أفقياً و/أو رأسياً لمواءمة توقعات محتملة في العمل دون الإخلال بوظائف المبنى.

   - **راحة المستخدم:**

وهي المدى الذي يكون فيه المبنى مكاناً مريحاً بدنياً ونفسياً للعمل والعيش.

2. **الموارد:**
   - **كلفة رأس المال اللازم لإقامة المشروع**

وهي التبعات الاقتصادية للمبنى من حيث رأس المال اللازم لإقامة المشروع بما فيه كلفة الإنشاء والتصميم وقيمة الأرض وأية مصاريف أخرى.

   - **التشغيل والصيانة:**

وهي المدى الذي يكون فيه المبنى محافظاً على الطاقة من خلال الإنشاء وتنسيق الموقع العام للمشروع والتصميم للطاقة الشمسية علاوة على اعتبارات تتعلق بالصيانة والتشغيل وكلفة تغيير القطع المستهلكة.

   - **جدولة المشروع:**

وهي الوقت المطلوب لإنهاء المهام المختلفة بما فيه المواعيد والتصميم والتنفيذ والبدء وتشغيل المشروع.

3. **التكنولوجيا:**
   - **البيئة**

الدرجة التي يكون معها المشروع حساساً للاعتبارات البيئية مثل النفايات الخطرة وتلوث الهواء والماء واستعمال مواد تعمر طويلاً وإعادة التصنيع ونحوه.

   - **الأمن والأمان**

الدرجة التي يمكن معها للمشروع فصل الوظائف الحساسة عن غيرها ويمنع عموم الناس من دخول مناطق محددة الدخول.

   - **الأداء الهندسي**

كيفية عمل المبنى من حيث النظم الميكانيكية والكهربية والعمليات الصناعية.

4. **المظهر:**
   - **الموقع العام (Site planning/ image)**

الدرجة التي يستجيب معها الموقع لاحتياجات المشروع من حيث أماكن الوقوف وحركة المشاة والمظهر الخارجي العام والأثر البصري على الزائرين.

   - **المظهر المعماري**

وهو المفهوم البصري للمبنى ومدى جذبه للانتباه.

   - **القيمة المجتمعية**

مدى ظهور المشروع بمظهر الجار الحسن من حيث الأمان والأمن والخصوصية.

الأسئلة:

3.1 بين درجة تأثير العناصر التالية فيما يتعلق بنموذج الجودة لمشاريع إسكان ذوي الدخل المنخفض (يمكن إضافة عناصر أخرى):

م	العنصر	درجة التأثير				
		كبيرة جدا	كبيرة	متوسطة	ضعيفة	ضعيفة جداً
3.1.1	التأثير التشغيلي					
3.1.2	المرونة والقدرة على التوسع					
3.1.3	راحة المستخدم					
3.1.4	رأس المال لإقامة المشروع					
3.1.5	التشغيل والصيانة					
3.1.6	جدولة المشروع					
3.1.7	البيئة					
3.1.8	الأمن والأمان					
3.1.9	الأداء الهندسي					
3.1.10	نسق الموقع					
3.1.11	المظهر المعماري					
3.1.12	القيمة المجتمعية					
3.1.13	.....					
3.1.14	.....					
3.1.15	.....					
3.1.16	.....					

بين أهمية مشاركة الإطراف التالية في تحديد الدرجات لعناصر نموذج الجودة لمشروع إسكان ذوي الدخل المنخفض (يمكن إضافة أطراف أخرى):

م	الطرف	درجة الأهمية				
		كبيرة جدا	كبيرة	متوسطة	ضعيفة	ضعيفة جداً
3.2.1	المالك					
3.2.2	المستفيد من المشروع					
3.2.3	المهندس المعماري					
3.2.4	مهندس الصيانة					
3.2.5	المهندس المدني					
3.2.6	.....					
3.2.7	.....					
3.2.8	.....					
3.2.9	.....					

Appendix B

Questionnaire

(English translation)

بسم الله الرحمن الرحيم

Islamic University of Gaza
Civil Eng. Dept. Faculty of Engineering

Dear Sir,

I am a post graduate student in the Islamic University of Gaza. For the time being, I am preparing the Msc research on the application of Value Engineering (VE) for low cost housing projects for people of low income. To be able to start this research, I need to determine the status of VE in Gaza Strip in terms of knowledge and application- with the pre consideration of the scarcity of application of such studies in Gaza Strip- and I also need to benefit of your personal experience in VE and from your professional experience in general in the fields of engineering

For this purpose, I would like to give a brief on VE,

Definition: " VE is defined as analytical systematic study executed by multidiscipline team of professionals on a certain project or a product or a service to identify the functions it performs in order to improve these functions in a better way or in a lower cost or with both without reduction in the basic functions ".

This kind of study aims to improve the value through establishing functional balance between function, cost and quality. It is not considered as design revision or a substitute to it since design revision is normally executed to make sure of quality and safety and make sure that none of the works were omitted while VE is a methodology for functional analysis of a project to improve the value of elements in focus.

VE study is normally executed by a team of 5-7 persons of multidiscipline. In building construction project the team is composed of:

1. Architect
2. Civil engineer
3. Structural engineer
4. Mechanical engineer
5. Electrical engineer
6. Cost estimation expert.

in addition to the owner participation and the user in some cases. People of specific specialty may join the team in certain cases depending on the nature of the project.

VE application is most effective in the preliminary stages of the design where it achieves high feasibility. With the progress of the project, VE becomes of lower feasibility since cost of changes increases and the resistance to change increases as well.

I m looking to your effective participation in the enrichment of this research, with my confidence of the great impact of your participation in enabling the success of this research hoping that the outcome of the research will be provided to professionals to utilize usage of resources in housing projects for people of low income.

Best regards

Usama El-Sadawi
Palestinian Housing Council- Gaza
Tel 2823280, 0599 411182 Email: usamasadawi@yahoo.com

SECTION 1 (basic information):

This section collects basic information of the professional and his organization

1.1 Your name(optional):

1.2 Your organization:

1.3 Position in the organization: …

1.4 Years of experience: …

1.5 Years being working with the organization :..

1.6 Your organization specialty:

1.7 Classification of your organization

- ☐ Contractor
- ☐ Construction manager
- ☐ Client
- ☐ Supplier
- ☐ Others (please specify):…….

1.8 Number of employees in your organization

SECTION2: (STATE OF ART OF VALUE ENGINEERING " VE"):

2.1 The state of your knowledge of VE:

☐ very good ☐ good ☐ fair ☐ poor ☐ very poor

2.2 Source of knowledge of VE:

- ☐ Hearing
- ☐ Reading
- ☐ Training
- ☐ Application
- ☐ Other (please specify):……..
  …….

2.3 : Ability to apply value engineering:

☐ very big ☐ big ☐ fair ☐ weak ☐ very weak

2.4 : Have you ever been engaged with VE workshop:

☐ no ☐ yes

2.4.1 : What was you role in the VE workshop team:

- ☐ Team member as a professional engineer
- ☐ Client representative
- ☐ User representative
- ☐ Other (please specify) …….
  ……

2.4.2 : Was it useful to implement VE workshop?

☐ no ☐ yes

2.4.2.1 : Benefits resulted from the application of VE are :

- ☐ Improvement of performance
- ☐ Reduction of cost
- ☐ Both
- ☐ Other (please specify):……
  ……

2.5: Does your organization implement VE workshops?

☐ no ☐ yes

2.5.1: Was the following achieved due to application of VE by your institution

2.5.1.1 ☐ saving in cost? ☐ no ☐ yes (%: ……..)

2.5.1.2 ☐ improvement of performance? ☐ no ☐ yes

2.6: If your organization did not implement VE workshops, the reason for non application is:

- ☐ Lack of knowledge of VE benefits

☐ Lack of experience of VE
☐ Internal roles do not allow
☐ Higher management do not believe in its feasibility
☐ Other (please specify):……..
……..

2.7: If your organization is provided with a simplified manual and methodology for application of VE, do you expect the organization to apply VE?
☐ Yes ☐ No
2.7.1What are the reasons behind non-application of VE in your opinion:
☐ It is a new subject and there is already a methodology for technical studies.
☐ Higher management may not accept VE
☐ Engineers, especially architects, may oppose application of VE as a criticism of their work.
☐ Teamwork is difficult to be implemented in your organization.
☐ Other (please specify):

2.8: Do you consider VE application interference and criticism of the design? ☐ Yes ☐ No

2.9: Had your organization ever been forced to reduce cost of project/projects?
☐ no ☐ yes
2.9.1 : If you organization was forced to reduce cost of a project, that was through:
☐ Reduction of quality.
☐ Elimination of items
☐ Replacement of some elements of the project.
☐ Cancellation of the project.
☐ Other (please specify):…….
…….
2.9.2: The above decision was taken through:
☐ Higher management.
☐ Team decision
☐ Project manager.
☐ Other (please specify): …….
…….
2.9.3: Such decision had impact on:
☐ Quality.
☐ Performance
☐ User satisfaction.
☐ Other (please specify):…….
…….

SECTION 3: QUESTIONS RELATED TO QUALITY MODEL

Briefing

- **Definition:**

  Quality model is a total quality management-based approach that can be applied during planning and design stages of a project. It assists in defining, measuring and managing the owner quality expectations.

- **Elements of Quality Model:**

1. **OPERAIONS:**
   1. Operational effectiveness:

      The degree to which the building is able to respond to the work process and flow of people, equipment and materials.
   2. Flexibility/expandability:

      The degree to which the building can be rearranged to conform to revised work processes and personnel changes and the ability of the building to grow and meet projected changes in the work process without disturbing existing building functions.
   3. User comfort:

      How the building provides a physically and psychologically comfortable place for people to work and live.
2. **RESOURCES:**
   1. Capital cost effectiveness:

      The economic consequences of the building in terms of initial capital investment including construction cost, design fees, land cost, etc.
   2. Operations and maintenance:

      The degree to which the building is able to conserve energy resources through construction, site orientation, and solar design. Other considerations include maintenance, operations and replacement costs.
   3. Schedule:

      The amount of time required for completion of various tasks including programming, design, construction and start-up/move-in.
3. **TECHNOLOGY**
   1. Environmental:

      The degree to which the facility is sensitive to environmental concerns such as hazardous waste, air and water pollution, use of sustainable materials, recycling, etc.
   2. Security/safety:

      The degree to which the building can segregate sensitive functions from on another and prevent the entry of people to restricted area.
   3. Engineering performance:

      How the building operates in terms of mechanical systems, electrical systems and industrial processes.
4. **IMAGE:**
   1. Site planning/image

      The degree to which the site responds to the needs of the project in terms of parking, vehicular and pedestrian traffic, outdoor amenities and the visual impact to the employees and visitors.
   2. Architectural image

      The visual concept of the building and the way in which the building attracts attention to itself. The form of the building and the degree to which it acts as a symbol for the company.
   3. Community value

      How the building and the site project a : good neighbor" identity in terms of safety, security and privacy.

Questions:

3.1 The following elements are effective in relation to Quality Model for low cost housing (additional elements might be added)

		The effectiveness				
	The item	v. high	high	fair	poor	v.poor
3.1.1	Operational effectiveness					
3.1.2	Flexibility/expandability					
3.1.3	User comfort					
3.1.4	Capital cost effectiveness					
3.1.5	Operations and maintenance					
3.1.6	Schedule					
3.1.7	Environment					
3.1.8	Security/safety					
3.1.9	Engineering performance					
3.1.10	Site planning/image					
3.1.11	Architectural image					
3.1.12	Community value					
3.1.13	…….					
3.1.14	…….					
3.1.15	…….					
3.1.16	…….					

3.2 Parties that should be involved in assigning the scores of the Quality Model for low cost housing. (additional parties might be added)

		The importance				
	The item	v. high	high	I don't know	poor	v.poor
3.2.1	The Owner					
3.2.2	The end user					
3.2.3	The Architect					
3.2.4	The Maintenance engineer					
3.2.5	The Civil engineer					
3.2.6	…….					
3.2.7	…….					
3.2.8	…….					
3.2.9	…….					

Appendix C

Sheets used in

VE workshop

Project:
VE study

space model

area		
	cost=	design value
	worth=	VE target

Note:
1 **red = entry**
2 Remarks are related to elements of either high or low cost/worth ratio
3 Parts suggested to be changed are carried to creativity phase and to be evaluated
4 parts not included in this sheet are to be added

system **Level 1**	*subsystem* **Level 2**	*component* **Level 3**	*part* **Level 4**	Function verb	Function noun	area cost	area worth	cost/worth	***remarks***
Project						**1**	**0**	#DIV/0!	
	BUILDING/S					**1**	**0**	#DIV/0!	
		Flats				**1**	**0**	#DIV/0!	
			bedrooms			0	0	#DIV/0!	#DIV/0!
			living room			1	0	#DIV/0!	
			guest room			0	0	#DIV/0!	
			kitchen			0	0	#DIV/0!	
			w.c			0	0	#DIV/0!	
			corridores			0	0	#DIV/0!	
			virandas			0	0	#DIV/0!	
		Corridores				**0**	**0**	#DIV/0!	
		shaded area				**0**	**0**	#DIV/0!	
		Utilities				**0**	**0**	#DIV/0!	
		Stairs				**0**	**0**	#DIV/0!	
		Ducts				**0**	**0**	#DIV/0!	
	SITEWORKS					**0**	**0**	#DIV/0!	
		Paths				0	0	#DIV/0!	
		Parking				0	0	#DIV/0!	
		Green areas				0	0	#DIV/0!	

Note:

Resources are assumed as a supreme priority not to be exceeded

importance factor	poor	fair	good	very good	excellent
score	2	4	6	8	10

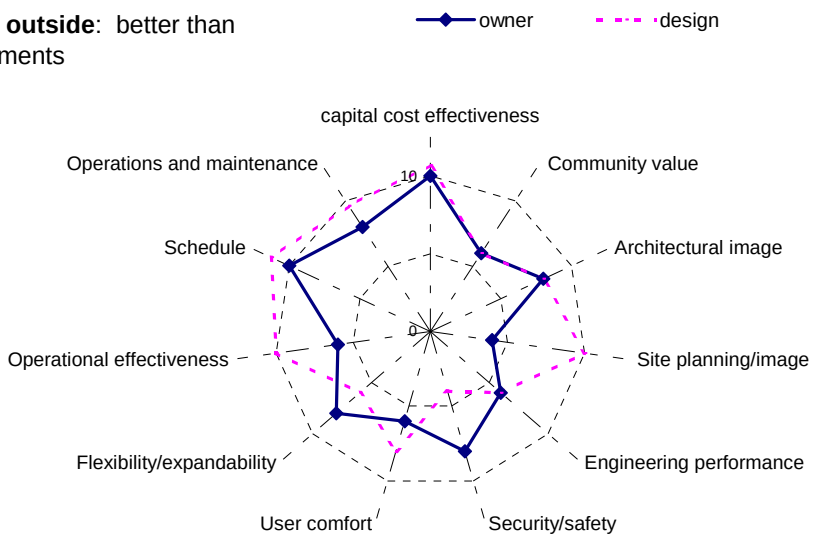
red=input

Project:
VE study

quality model

		LIMITATIONS					
Element	**Factor**		cost(owner input)	time (month)	owner value (owner input)	from design	design value
Resources	capital cost effectiveness	not exceeding	16000		10	15000	10.7
	Operations and maintenance	not exceeding	12000		8	10000	9.6
	Schedule	not exceeding		9	10	8	11.3
operations	Operational effectiveness				6		10
	Flexibility/expandability				8		6
	User comfort				6		8
Technology	Security/safety				8		4
	Engineering performance				6		6
Image	Site planning/image				4		10
	Architectural image				8		8
	Community value				6		6

design score outside: better than owner requirements



Project:
VE study
Uniformat BOQ

TRANSFORMATION OF MASTERFORMAT TO UNIFORMAT

	Uniformat			01 General requiremenrts	02 Siteworks	03 Concrete	04 Masonary	05 Metals	06 Wood- plastic	07 Thermal & moisture protection	08 Doors and windows	09 Finishes	10 Specialties	11 Equipment	12 Furnishings	13 Special conditions	14 Conveying systems	15 Mechanical	16 Electrical	Total unioformat costs
01	Foundations	011	Standard foundations																	0
		012	Spec. foundations																	0
02	Substructure	021	Slab on grade																	0
		022	Basement excavation																	0
		023	Basement walls																	0
03	Suprtructure	031	Floor construction																	0
		032	Roof construction																	0
		033	Stair construction																	0
04	Ext. Closures	041	Exterior walls																	0
		042	Exterior doors and windows																	0
05	Roofing	05																		0
06	Int. Const.	061	partitions																	0
		062	interior finishes																	0
		063	specialties																	0
07	Conveying System	07	elevator																	0
08	Mechanical	081	plumbing																	0
		082	H.V.A.C																	0
		083	Fire protection																	0
		084	Special mechanical system																	0
09	Electrical	091	service & distribution																	0
		092	lighting and power																	0
		093	special electrical system																	0
10	Gen. Cond. OH&P	101	general conditions & OH																	0
		102	Profit																	
11	Equipment	111	fixed & movable equipment																	0
		112	furnishings																	0
		113	special construction																	0
12	Sitework	121	site preparation																	0
		122	site improvement																	0
		123	site utilities																	0
		124	off site works																	0
			Total Masterform at divisions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Project:
VE study
cost- worth model of the 20% functions forming 80% of the cost

VI : value index =cost / worth

Function	**Cost**	**estimated worth**	**worth**	**VI**	**Remark**
Floor construction	10,000	area @ rate/m2	**12,000**	0.83	**high value**
Standard foundations	12,000	area @ rate/m2	**8,000**	1.50	**poor value**
	--	--	--	--	--
	--	--	--	--	--
	--	--	--	--	--
	--	--	--	--	--
total evaluated functions	**22,000**		**20,000**	**1.10**	**poor value**

Project: const. Of
VE STUDY
Presentation phase

recommendations of architecture

	item evaluated	capital cost saving	capital cost saving	annual operation & maintenance	present worth of annual operation& maintenance	other annual income	other annual income
A-01	(delete or change… to..)	0	0	547	547.1	-27	-27.4
A-02	(delete or change… to..)	0	0	547	547.1	-27	-27.4
A-03	(delete or change… to..)	0	0	547	547.1	-27	-27.4
A-04	(delete or change… to..)	0	0	547	547.1	-27	-27.4
A-05	(delete or change… to..)	0	0	547	547.1	-27	-27.4
A-06	(delete or change… to..)	0	0	547	547.1	-27	-27.4
A-07	(delete or change… to..)	0	0	547	547.1	-27	-27.4
A-08	(delete or change… to..)	0	0	547	547.1	-27	-27.4
A-09	(delete or change… to..)	0	0	547	547.1	-27	-27.4
A-10	0	0	0	520	519.8	-27	-27.4
	total		0		5443.7		-273.6
	grand total				**5170.2**		

Project: const. Of
VE STUDY
Presentation phase

Item: Architecture

A-01	A: Architecture 01: proposal No.

No. of proposals 10
current rpoposal Code: A-01

evaluation

Item: (delete or change… to..)
Original Design
--

Proposed Design

Discussion
--

Advantages:
--

Disadvantages:
--

Cost evaluation:
1st: capital cost

	item	unit	quantity	unit rate	total
1	**original design**				
	(item/s to be changed)	--	0	0	0
		--	0	0	0
					0
	item	unit	quantity	unit rate	total
1	**Proposed changes**				
	(alternative/s)	--	0	0	0
		--	0	0	0
					0

2nd: Life cycle cost summary

interest rate: **2%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income	
Original	0	110	11	
Proposed	0	90	10	
prsent worth of saving	0	547.1	27.4	
Savings	0	547	-27	
total saving in present worth =		**574**		(carried to summary)

Project: const. Of
VE STUDY
Presentation phase

recommendations of structure

Proposal code	item evaluated	capital cost saving	capital cost saving	annual operation & maintenance	other annual income
ST-01	(delete or change… to..)	0	0	547.1096	-27.35548
ST-02	(delete or change… to..)	0	0	547.1096	-27.35548
ST-03	(delete or change… to..)	0	0	547.1096	-27.35548
ST-04	(delete or change… to..)	0	0	547.1096	-27.35548
ST-05	(delete or change… to..)	0	0	547.1096	-27.35548
ST-06	(delete or change… to..)	0	0	547.1096	-27.35548
ST-07	(delete or change… to..)	0	0	547.1096	-27.35548
ST-08	(delete or change… to..)	0	0	547.1096	-27.35548
ST-09	(delete or change… to..)	0	0	547.1096	-27.35548
ST-10	(delete or change… to..)	0	0	519.7541	-27.35548
	total		0	5443.74	-273.5548
	grand total			**5170.186**	

Project: const. Of
VE STUDY
Presentation phase

Item:Structure

ST-01	ST: Structural
	01: proposal No.

No. of proposals 10
current proposal Code: ST-01

evaluation

Item: (delete or change… to..)
Original Design
--

Proposed Design

Discussion
--

Advantages:
--

Disadvantages:
--

Cost evaluation:
1st: capital cost

	item	unit	quantity	unit rate	total
1	**original design**				
	(item/s to be changed)	--	0	0	0
		--	0	0	0
					0
	item	unit	quantity	unit rate	total
1	**Proposed changes**				
	(alternative/s)	--	0	0	0
		--	0	0	0
					0

2nd: Life cycle cost summary

interest rate: **2%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	0	110	11
Proposed	0	90	10
prsent worth	0	547.1	27.4
Savings	0	547	-27
total saving in present worth =		**520**	(carried to summary)

Project: const. Of
VE STUDY
Presentation phase

recommendations of electrical

	item evaluated	capital cost saving	capital cost saving	annual operation & maintenance	annual operation & maintenance	other annual income	other annual income
E-01	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
E-02	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
E-03	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
E-04	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
E-05	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
E-06	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
E-07	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
E-08	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
E-09	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
E-10	(delete or change… to..)	0	0	520	519.7541	-27	-27.3555
	total		0		5443.74		-273.555
	grand total				**5170.186**		

….

Project: const. Of
VE STUDY
Presentation phase

Item: Electrical

E-01	E: Electriical
	01: proposal No.

No. of proposals 10
current rpoposal Code: E-01

evaluation

Item: (delete or change… to..)
Original Design
--

Proposed Design

Discussion
--

Advantages:
--

Disadvantages:
--

Cost evaluation:
1st: capital cost

	item	unit	quantity	unit rate	total
1	**original design**				
	(item/s to be changed)	--	0	0	0
		--	0	0	0
					0

	item	unit	quantity	unit rate	total
1	**Proposed changes**				
	(alternative/s)	--	0	0	0
		--	0	0	0
					0

2nd: Life cycle cost summary

interest rate: **2%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	0	110	11
Proposed	0	90	10
prsent worth	0	547.1	27.4
Savings	0	547	-27
total saving in present worth =		**520**	(carried to summary)

Project: const. Of
VE STUDY
Presentation phase

recommendations of mechanical

	item evaluated	capital cost saving	capital cost saving	annual operation & maintenance	annual operation & maintenance	other annual income	other annual income
M-01	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
M-02	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
M-03	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
M-04	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
M-05	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
M-06	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
M-07	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
M-08	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
M-09	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
M-10	(delete or change… to..)	0	0	520	519.7541	-27	-27.3555
	total		0		5443.74		-273.555
	grand total				**5170.186**		

….

Project: const. Of
VE STUDY
Presentation phase

Item: Mechanical

M-01	M: Mechanical
	01: proposal No.

No. of proposals 10
current rpoposal Code: M-01

evaluation

Item: (delete or change… to..)
Original Design
--

Proposed Design

Discussion
--

Advantages:
--

Disadvantages:
--

Cost evaluation:
1st: capital cost

	item	unit	quantity	unit rate	total
1	**original design**				
	(item/s to be changed)	--	0	0	0
		--	0	0	0
					0
	item	unit	quantity	unit rate	total
1	**Proposed changes**				
	(alternative/s)	--	0	0	0
		--	0	0	0
					0

2nd: Life cycle cost summary

interest rate: **2%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	0	110	11
Proposed	0	90	10
prsent worth	0	547.1	27.4
Savings	0	547	-27
total saving in present worth =		**520**	(carried to summary)

Project: const. Of
VE STUDY
Presentation phase

recommendations of equipment

	CATEGORY	capital cost saving	capital cost saving	annual operation & maintenance	annual operation & maintenance	other annual income	other annual income
EQ-01	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
EQ-02	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
EQ-03	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
EQ-04	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
EQ-05	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
EQ-06	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
EQ-07	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
EQ-08	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
EQ-09	(delete or change… to..)	0	0	547	547.1096	-27	-27.3555
EQ-10	(delete or change… to..)	0	0	520	519.7541	-27	-27.3555
	total		0		5443.74		-273.555
	grand total				**5170.186**		

….

Project: const. Of
VE STUDY
Presentation phase

Item: Equipment

No. of proposals	10
current rpoposal Code:	EQ-01

EQ-01	EQ: equipment 01: proposal No.

evaluation

Item: (delete or change… to..)
Original Design
--

Proposed Design

Discussion
--

Advantages:
--

Disadvantages:
--

Cost evaluation:
1st: capital cost

	item	unit	quantity	unit rate	total
1	**original design**				
	(item/s to be changed)	--	0	0	0
		--	0	0	0
					0

	item	unit	quantity	unit rate	total
1	**Proposed changes**				
	(alternative/s)	--	0	0	0
		--	0	0	0
					0

2nd: Life cycle cost summary

interest rate: **2%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	0	110	11
Proposed	0	90	10
prsent worth	0	547.1	27.4
Savings	0	547	-27.4
total saving in present worth =		**520**	(carried to summary)

Project: const. Of
VE STUDY
Presentation phase

Recommendations of site general

Proposal code	item evaluated	capital cost saving	capital cost saving	annual operation & maintenance	other annual income
S-01	(delete or change… to..)	0	0	547.1096	-27.35548
S-02	(delete or change… to..)	0	0	547.1096	-27.35548
S-03	(delete or change… to..)	0	0	547.1096	-27.35548
S-04	(delete or change… to..)	0	0	547.1096	-27.35548
S-05	(delete or change… to..)	0	0	547.1096	-27.35548
S-06	(delete or change… to..)	0	0	547.1096	-27.35548
S-07	(delete or change… to..)	0	0	547.1096	-27.35548
S-08	(delete or change… to..)	0	0	547.1096	-27.35548
S-09	(delete or change… to..)	0	0	547.1096	-27.35548
S-10	(delete or change… to..)	0	0	519.7541	-27.35548
	total		0	5443.74	-273.5548
	grand total			**5170.186**	

Project: const. Of
VE STUDY
Presentation phase

Item: Site General

S-01	S; Site general 01: proposal No.

No. of proposals 10
current proposal Code: S-01

evaluation

Item: (delete or change… to..)
Original Design
--

Proposed Design

Discussion
--

Advantages:
--

Disadvantages:
--

Cost evaluation:
1st: capital cost

	item	unit	quantity	unit rate	total
1	**original design**				
	(item/s to be changed)	--	0	0	0
		--	0	0	0
					0
	item	unit	quantity	unit rate	total
1	**Proposed changes**				
	(alternative/s)	--	0	0	0
		--	0	0	0
					0

2nd: Life cycle cost summary

interest rate: **2%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	0	110	11
Proposed	0	90	10
prsent worth	0	547.1	27.4
Savings	0	547	-27
total saving in present worth =		**520**	(carried to summary)

Appendix D

Structured interview

بسم الله الرحمن الرحيم

Islamic University of Gaza
Civil Eng. Dept. Faculty of Engineering
Structured interview

Dear Sir,

I am a post graduate student in the Islamic University of Gaza. For the time being, I am preparing the M sc research on the application of Value Engineering (VE) for low cost housing projects for people of low income.
The main objective of the research is to develop an applicable value engineering methodology that local professional can perform to achieve affordable housing. Operational Objectives to achieve the main goal of the research are:

- Investigation of the state of the art of VE as practiced in other countries.
- Investigation of the local practice of VE.
- Development of proposed methodology of application of VE in Gaza Strip.
- Evaluation of the produced methodology.
- Application of VE methodology.
- Recommendations for further development of the VE methodology for future researches.

At this stage of the research, I have proposed the attached methodology.
It is highly needed to evaluate the proposed methodology by senior professionals who are aware of VE methodology for evaluation and critique of the proposed methodology.
The attached structured interviews is divided into 2 parts:
Part 1: Questions related to the professional background.
Part 2: Questions related to the evaluation of the proposed VE methodology three phases:

- Pre-workshop phase.
- workshop phase.
- Post- workshop phase.

I am looking forward to your effective participation in evaluating the proposed methodology to enrich my research.

Best regards

Usama El-Sadawi
Palestinian Housing Council- Gaza
Tel 2823280, 0599 411182 Email: usamasadawi@yahoo.com

Part 1 (basic information of the professional):

This section collects basic information of the professional and his organization

1.1 Your name (optional): …….

1.2 Your organization:……

1.3 Classification of the organization:

- ☐ Governmental
- ☐ Non-governmental
- ☐ Local authority
- ☐ University
- ☐ Private
- ☐ Others (please specify):……..…….

1.4 Classification of your organization in relation to construction sector

- ☐ Contractor
- ☐ Construction manager
- ☐ Client
- ☐ Supplier
- ☐ Others (please specify):……..…….

1.5 Number of employees in your organization: ……

1.6 Recent position in the organization: …….

1.7 Years of experience: .....….....

1.8 Years being working with the organization :……..

1.9 Your organization specialty: ……

1.10 What is the scope of your work and the your main tasks at your organization:

……

……

……

……

……

……

……

……

……

Part 2: (Questions related to the evaluation of the proposed VE methodology):

2.1 Pre-Workshop Phase:

(For questions from 2.1.1 to 2.1.3 more than one selection is possible)

2.1.1 The objective of the pre-workshop phase should be to:

- ☐ Clarify the concept of the project in concern to VE team.
- ☐ Explore owner attitudes
- ☐ Provide VE team with design information
- ☐ Prepare quality model as model prepared by team not necessarily the VE team.
- ☐ Preparation of other modeling to be used in the workshop (by CVS):
- ☐ Others (define):

……
……
……..

2.1.2 The quality model of the low cost housing project is to be prepared by:

- ☐ The owner.
- ☐ The beneficiaries
- ☐ Architect
- ☐ Civil engineer
- ☐ Maintenance engineer
- ☐ Others (specify):

……
……
……..

2.1.3 Which of the following models you think has to be prepared at this stage by the Certified Value Specialist (CVS):

- ☐ Cost model
- ☐ Cost worth model
- ☐ Space model
- ☐ Function analysis model
- ☐ Life cycle model
- ☐ Others (specify):

……
……
……

2.1.4 Other arrangements to be prepared at this stage:

- ☐ (specify):

……
……
……
……

2.2 Workshop Phase:

2.2.1 The workshop phase to be implemented after:

- ☐ Completion of detailed design drawings
- ☐ Developing the concept design
- ☐ Developing fair cost estimation
- ☐ Developing bills of quantities
- ☐ Others (define):

……
……
……..…….

2.2.2 The main objective of the workshop phase should be to(more than one selection is possible):

☐ Analyze the project in terms of functions rather than elements
☐ Identify areas of high cost that has saving potential
☐ Generate ideas to overcome high cost and/or improve performance
☐ Others (define):

……
……
……..

2.2.3 During workshop, it is preferred to focus on:

☐ Each element in the project
☐ 20% of functions forming 80% of the overall cost.
☐ Others (specify):

……
……
……..

2.2.4 At the start of the workshop phase, space model is applied by comparing design value of spaces to (more than one selection is possible):

☐ Standards.
☐ Local experience
☐ VE team judgment
☐ Others (specify):

……
……
……...

2.2.5 Function analysis for the housing project as a whole to be developed focusing on:

☐ One main goal.
☐ Multiple goals.
☐ Leave it to VE team judgment
☐ Others (specify):

……
……
……..

2.2.6 Quality Model to be used:

☐ Once at the beginning of VE workshop.
☐ During evaluation of proposals.
☐ Following evaluation of proposal to identify how close are proposals from owner attributes.
☐ Elsewhere (specify):

……
……
……

2.2.7 For evaluation, the project will be divided according to the following levels (more than one selection is possible):

☐ System, (the project as a whole)
☐ Subsystem (i.e. buildings, site works)
☐ Component (i.e. dwellings, utilities…etc)
☐ Part (like bedrooms, kitchens)
☐ Others (specify):

……
……
……

2.2.8 Evaluation of ideas during evaluation phase has to take into consideration :

☐ Impact of idea of capital cost
☐ Impact of idea of annual operation and cost
☐ The two components above
☐ Others (specify):

……
……
……

2.2.9 Calculation of present worth of future payments to be made using the formulas (more than one selection is possible):

☐ Present value (PV) of annuities (A) with interest rate (i)

$$PV = A \times \frac{(1+i)^n - 1}{i(1+i)^n}$$

☐ Present value (PV) of future payment (F) with interest rate(i)

$$PV = \frac{F}{(1+i)^n}$$

☐ Others (specify):

……
……
……

2.3 Post Workshop Phase:

2.3.1 Feed back of the impact of implementation of VE recommendations is to be made to (more than one selection is possible):

☐ The certified Value Engineer
☐ The VE team
☐ The owner
☐ The project manager
☐ Others (define):

……..
……
……..

2.3.2 Other evaluations would be helpful for future development, like (more than one selection is possible):

☐ The beneficiaries (the users) from the project
☐ The maintenance engineer/company.
☐ The Architect
☐ Others (define):

……..
……
……..

2.4 General comments and suggestions by the professional

……
……
……
……
……
……
……
……
……
……
……

2.5 General comments by the researcher related to the interview:

……
……
……
……
……
……
……
……
……
……
……
……
……
……

Appendix E

Results of Structured Interviews

Table E1 , comments and remarks of professionals for the Pre- Workshop Stage

	Prof. 1	Prof. 2	Prof. 3	Prof. 4	Prof. 5	Prof. 6	Prof. 7	Prof. 8
2.1 Pre-workshop								
2.1.1 Objectives of pre-workshop								
Clarify the concept of the project in concern to VE team.	agree	agree	agree	agree	agree	agree	agree	
Explore owner attitudes	agree	agree	agree	agree	agree	agree	agree	
Provide VE team with design information	agree	agree	agree	agree	agree	agree	agree	
Prepare quality model as model prepared by team not necessarily the VE team.	agree	agree	agree	agree	agree	agree	agree	
Preparation of other modeling to be used in the workshop (by CVS):	agree	agree	agree	agree	agree		agree	
Others				contractor will assist				
2.1.2 The quality model of the low cost housing project is to be prepared by								
The owner.	agree	agree	agree	agree	agree	agree	agree	
The beneficiaries	if known	agree	agree	agree		agree	agree	
Architect	agree	agree	agree	agree	agree	agree	agree	
Civil engineer	agree	agree	agree	agree	agree		agree	
Maintenance engineer	agree	agree	agree	agree		agree	agree	
Others	professional in Housing, financial expert	contractor will assist		local authority representative		add quality engineer		

Table E1, continued

	Prof. 1	Prof. 2	Prof. 3	Prof. 4	Prof. 5	Prof. 6	Prof. 7	Prof. 8
2.1.3 Which of the following models you think has to be prepared at this stage by the Certified Value Specialist (CVS):								
Cost model	agree	agree	agree	agree	agree	agree	agree	
Cost worth model	agree	agree	agree		agree	agree	agree	
Space model	agree	agree	agree	agree	agree	agree	agree	
Function analysis model	agree	agree	agree	agree	agree	agree	agree	
Life cycle model	agree	agree	agree	agree	agree	agree	agree	
Others								
2.1.4 Other arrangements to be prepared at this stage	provide as much information to be analyzed before workshop		conduct site visit by the team			conduct site visit by the team		

Table E2 , Comments and remarks of professionals for the Workshop Stage

	Prof. 1	Prof. 2	Prof. 3	Prof. 4	Prof. 5	Prof. 6	Prof. 7	Prof. 8
2.2 Workshop Stage								
2.2.1 The workshop stage to be implemented after:								
Completion of detailed design drawings								
Developing the concept design	agree	agree	agree	agree	agree	agree	agree	
developing fair cost estimation	agree	agree	agree	agree	agree	agree	agree	
developing bills of quantities								
Others							In cooperation with the architect	
2.2.2 The objective of the workshop stage should be:								
to analyze the project in terms of functions rather than elements	agree	agree	agree	agree	agree	agree		
to identify areas of high cost that has saving potential	agree	agree	agree	agree	agree	agree		
to generate ideas to overcome high cost and/or improve performance	agree	agree	agree	agree	agree	agree	agree	
Others		to improve schedule						
2.2.3 During workshop, it is preferred to focus on:								
Each function in the project							agree	
20% of functions of 80% of the cost.	agree	agree	agree	agree		agree		
Others					focus on uncertainties			

Table E2, continued

	Prof. 1	Prof. 2	Prof. 3	Prof. 4	Prof. 5	Prof. 6	Prof. 7	Prof. 8
2.2.4 At the start of the workshop stage, space model is applied by comparing design value of spaces to								
Standards.	agree	agree						
Local experience			agree		agree	agree	agree	
VE team judgment				agree			agree	
Others	considering local experience	considering local experience						
2.2.5 Function analysis for the housing project as a whole to be developed focusing on:								
One main goal.			agree	agree				
Multiple goals.	agree	agree			agree	agree	agree	
Leave it to VE team judgment								
Others (specify):								
2.2.6 Quality Model to be used:								
Once at the beginning of VE workshop.					agree			
During evaluation of proposals.		agree	agree	agree		agree	agree	
Following evaluation of proposal to identify how close are proposals from owner attributes.								
Elsewhere (specify):	as needed							

TableE2, continued

	Prof. 1	Prof. 2	Prof. 3	Prof. 4	Prof. 5	Prof. 6	Prof. 7	Prof. 8
2.2.7 For evaluation, the project will be divided according to the following levels:								
System, (the project as a whole)	agree	agree	agree	agree	agree	agree	agree	
Subsystem (i.e. buildings, site works)	agree	agree	agree	agree	agree	agree	agree	
Component (i.e. dwellings, utilities…etc)	agree	agree	agree	agree	agree	agree	agree	
Part (like bedrooms, kitchens)	agree	agree	agree	agree	agree	agree	agree	
Others (specify)	bottom to top							
2.2.8 Evaluation of ideas during evaluation phase to take into consideration :								
Impact of idea of capital cost								
Impact of idea of annual operation and cost								
The two components above	agree	agree	agree	agree	agree	agree	agree	
Others (specify)								
2.2.9 Calculation of present worth of future payments to be made using the formulas:								
Present value of annuities with interest rate								agree
Present value of future payment								agree
others								interest rate between 10-12%

Table E3, Comments and remarks of professionals for the Post- Workshop Stage

	Prof. 1	Prof. 2	Prof. 3	Prof. 4	Prof. 5	Prof. 6	Prof. 7	Prof. 8
2.3 Post Workshop Stage:								
2.3.1 Feedback of the impact of implementation of VE recommendations is to be made to :								
Certified Value Engineer	agree	agree	agree	agree		agree		
VE team	agree	agree	agree	agree	agree			
The owner	agree	agree	agree	agree	agree		agree	
The project manager	agree	agree	agree					
Others (define):	none	consultant	relevant institutions					
2.3.2 Other evaluations would be helpful for future development, like								
The beneficiaries (the users) from the project	agree	agree	agree	agree		agree	agree	
The maintenance engineer / company.	agree	agree	agree	agree		agree		
The Architect	agree	agree	agree	agree	agree	agree	agree	
Others (define)								

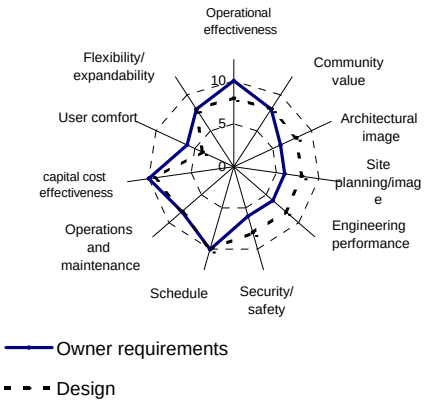
Appendix F

Sheets used
in the case study

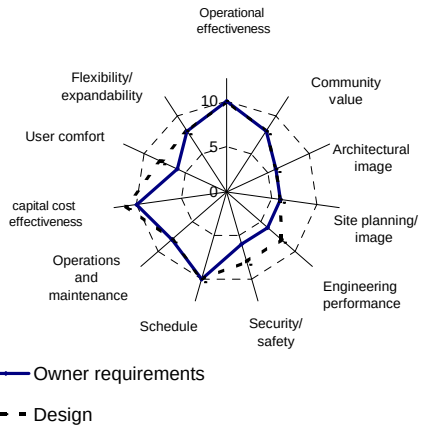
Project: The Japaneese Project for Rehousing refugees whose shelters were demolished in Kh/Younis
VE Study
Quality Model

					design value		after VE study	
Element	**Factor**	**employer input**	**value -employer input**	**Limitations**	**design value**	**desing value- analysed**	**design value**	**value after VE**
operations	**Operational effectiveness**	very high	10		high	8	high	10
	Flexibility/expandability	high	8		high	8	high	8
	User comfort	poor	6		poor	4	poor	8
Resources	**capital cost effectiveness**	very high	10	$ 3,200,000	$ 3,430,000	9.33	$ 2,865,905	11.17
	Operations and maintenanc	high	8		high	8	high	8
	Schedule	very high	10	26 weeks	26 weeks	10	26 weeks	10
Technology	**Security/safety**	fair	6		high	8	high	8
	Engineering performance	fair	6		high	8	high	8
Image	**Site planning/image**	fair	6		high	8	high	6
	Architectural image	fair	6		high	8	high	6
	Community value	higg	8		high	8	high	8

QM, Initial design



QM, after VE study



Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**

VE study

space model

B: basic function
RS: required secondary
S: secondary

area	cost= design value worth= VE target

system **Level 1**	*subsystem* **Level 2**	*component* **Level 3**	*part* **Level 4**	Function verb	noun	type	area cost	worth	cost/worth	***remarks***
Project							**16085.2**	**15598.7**	**1.03**	
The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis	**Buildings**						**14374.6**	**13888.1**	**1.035**	3% saving opportuinity in buildings
		Type A1(19 No.)					**44.2**	**44.3**	**1.00**	ammend design
			Bedroom1	accommodate	beds	B	13.1	14.5	0.90	increase space
			Bathroom	serve	persons	B	3.9	3.9	1.00	
			kitchen	serve	persons	B	11.2	6.5	1.72	poor value
			corridores	link	areas	RS	8.1	4.5	1.80	poor value
			living room	gather	family	RS	0	7	0.00	add space
			Partitions	seprate	spaces	RS	7.9	7.9	1.00	
		Type A2(40 No.)					**62.2**	**59.2**	**1.05**	
			Bedroom1	accommodate	beds	B	14.8	14.5	1.02	
			Bedroom2	accommodate	beds	B	18.5	12.5	1.48	poor value
			Bathroom	serve	persons	B	3.9	3.9	1.00	
			kitchen	serve	persons	B	11.2	6.5	1.72	poor value
			corridores	link	areas	RS	5	6	0.83	increase space
			living room	gather	family	RS	0	7	0.00	add space
			Partitions	seprate	spaces	RS	8.8	8.8	1.00	
		Type A3(58 No.)					**79.8**	**71.2**	**1.12**	ammend design
			Bedroom1	accommodate	beds	B	13.3	14.5	0.92	increase space
			Bedroom2	accommodate	beds	B	18.5	12.5	1.48	poor value
			Bedroom3	accommodate	beds	B	16.2	12.5	1.30	poor value
			Bathroom	serve	persons	B	4.1	4.1	1.00	
			kitchen	serve	persons	B	8.6	8.6	1.00	
			w.c	serve	persons	B	0	2	0.00	add space
			corridores	link	areas	RS	9.1	8	1.14	poor value
			living room	gather	family	RS	0	9	0.00	add space
			Partitions	seprate	spaces	RS	10	10	1.00	
		Type A4(44 No.)					**97.3**	**99.9**	**0.97**	ammend design
			Bedroom1	accommodate	beds	B	11.8	14.5	0.81	increase space
			Bedroom2	accommodate	beds	B	12.4	12.4	1.00	
			Bedroom3	accommodate	beds	B	16.2	12.5	1.30	poor value
			Bedroom4	accommodate	beds	B	17.3	12.5	1.38	poor value
			Bathroom	serve	persons	RS	4.1	4.1	1.00	
			kitchen	serve	persons	RS	8.6	9.5	0.91	increase space
			w.c	serve	persons	RS	2.5	2.5	1.00	
			corridores	link	areas	RS	12.5	11	1.14	poor value
			living room	gather	family	RS	0	9	0.00	add space
			Partitions	seprate	spaces	RS	11.9	11.9	1.00	
		Type A5(10 No.)					**121.5**	**123.1**	**0.99**	ammend design
			Bedroom1	accommodate	beds	B	11.8	14.5	0.81	increase space
			Bedroom2	accommodate	beds	B	12.4	12.4	1.00	
			Bedroom3	accommodate	beds	B	16.2	12.5	1.30	poor value
			Bedroom4	accommodate	beds	B	17.3	12.5	1.38	poor value
			Bedroom5	accommodate	beds	B	18	14.5	1.24	poor value
			Bathroom	serve	persons	B	4.1	4.1	1.00	
			kitchen	serve	persons	B	8.6	9.5	0.91	
			w.c	serve	persons	RS	2.5	2.5	1.00	
			corridores	link	areas	RS	12.5	12.5	1.00	
			living room	gather	family	RS	0	10	0.00	add space
			Partitions	seprate	spaces	RS	18.1	18.1	1.00	
		Stairs		connect	floors	B	**10.6**	**10.6**	**1.00**	
		Stairs (87 flr. stair)					**10.6**	**10.6**	**1.00**	
	SITEWORKS						**1700**	**1700**	**1.00**	
		Paths		imorove	image	S	1700	1700	1.00	maintain for image

Project: The Japaneese Project for Rehousing refugees whose shelters were demolished in Kh/Younis
VE Study
Uniformat presentation

				Masterformat																
		UCI		General requiremenrts	Siteworks	Concrete	Masonry	Metals	Wood- plastic	Thermal & moisture protection	Doors and windows	Finishes	Specialties	Equipment	Furnishings	Special conditions	Conveying systems	Mechanical	Electrical	**Total unioformat costs**
01	Foundations	011	Standard foundations		33182	584880														618,063
		012	Spec. foundations																	0
02	Substructure	021	Slab on grade																	0
		022	Basement excavation																	0
		023	Basement walls																	0
03	Suprtructure	031	Floor construction			664093														664,093
		032	Roof construction					4063	1346											5,409
		033	Stair construction			52215						30580								82,794
04	Ext. Closures	041	Exterior walls				172132			8382		252589								433,103
		042	Exterior doors and windows								121622									121,622
05	Roofing	05	Roofing			1224				21765										22,989
06	Int. Const.	061	partitions			8321	64611													72,932
		062	interior finishes								93583	349044								442,627
		063	specialties																	0
07	Conveying System	07	elevator																	0
08	Mechanical	081	plumbing			11421												231937		243,358
		082	H.V.A.C																	0
		083	Fire protection																	0
		084	Special mechanical system																	0
09	Electrical	091	service & distribution																116526	116,526
		092	lighting and power																77876	77,876
		093	special electrical system																	0
10	Gen. Cond. OH&P	101	general conditions & OH	156085																156,085
		102	Profit	84046																84,046
11	Equipment	111	fixed & movable equipment																	0
		112	furnishings																	0
		113	special construction																	0
12	Sitework	121	site preparation		5384															5,384
		122	site improvement		12482	140071	56004	47336			27639									283,532
		123	site utilities																	0
		124	off site works																	0
			Total Masterformat	240,131	51,048	1,462,225	292,746	51,399	1,346	30,148	242,844	632,212	0	0	0	0	0	231,937	194,402	3,430,438

Project: The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis
VE study
cost- worth model of the functions of 78% of the cost

VI : value index =cost / worth

Function	Cost	estimated worth	worth	VI	Remark
Floor construction	814,050	14374 m2 @ 50$/m2	**720,000**	1.13	**poor value**
Standard foundations	757,625	10614 m2 @ 45$/m2	**480,000**	1.58	**poor value**
Exterior walls	530,300	14376 m2 @ 35$/m2	**500,000**	1.06	**poor value**
Interior finishes	427,860	14377 m2 @ 27$/m2	**390,000**	1.10	**poor value**
Plumbing	298,310	171 units @ 1500$/unit	**260,000**	1.15	**poor value**
Site improvement	347,555	171 units @ 1600$/unit	**275,000**	1.26	**poor value**
total evaluated functions	**3,175,700**		**2,625,000**	**1.21**	**poor value**

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**

VE STUDY
Presentation phase

recommendation of architecture

	item evaluated	capital cost saving	p.w of annual operation& maintenance	other annual income
A-01	cancellation of external emulsion paint for tyrolean finished external walls	47495.38	9289	0
A-02	cancellation of external emulsion paint for tyrolean finished and lime free plastered external walls	6315.789	1235	0
A-03	replace marble sills for windows with mortar sills	6557.018	1282	0
A-04	replace jointi fill material for joints from sikaflix to mastic bitumen	1973.684	386	0
A-05	Replace internal walls paint from emulsion to policed	18267.54	3573	0
A-06	change chips of terrazzoo tiles from marble to local limestone	27000	5281	0
A-07	change thresholds from terrazoo with marble chips to terrazzoo with local limestone	1052.632	206	0
A-08	change top of kitchen worktop from local marble to granite	-9541.4	-1866	0
	total	99120.65	19386	0
	grand total	**118507**		

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**

VE STUDY
Presentation phase

Item: Architecture
No. of proposals 8
current poposal Code: A-01

evaluation

Item: cancellation of external emulsion paint for tyrolean finished external walls
Original Design External walls finished with tyrolean and external quality emulsion paint

Proposed Design maintain tyrolean finish only

Discussion The item could easily be eliminated without consequencies, furthemore; such cancelation is in compliance with the owner quality requirements

Advantages: reduction in cost without effect on performance

Disadvantages: external colour of the building will gradually be changed to darker colour

Cost evaluation:
1st: capital cost

	item	Function	Function type	unit	quantity	unit rate	total
1	**original design**						
	emulsion paint for exterior walls	improve image	S	m2	41,150	1.15	47,495
				--	0	0	0
							47,495
	item			unit	quantity	unit rate	total
1	**Proposed changes**						
	exterior walls with tyrolean only			--	0	0	0
				--	0	0	0
							0

2nd: Life cycle cost summary

interest rate: **10%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	47,495	950	0
Proposed	0	0	0
persent worth	47,495	9,289.2	0.0
Savings	47,495	9,289	0
total saving in present worth =		**56,785**	

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**

VE STUDY
Presentation phase

Item: Architecture

No. of proposals 8

current poposal Code: A-02

evaluation

Item: cancellation of external emulsion paint for tyrolean finished and lime free plastered external walls

Original Design External walls finished with tyrolean and external quality emulsion paint

--

Proposed Design maintain tyrolean finish only

Discussion The item could easily be eliminated without consequencies, furthemore; such

-- cancelation is in compliance with quality requirements

Advantages: reduction in cost without effect on performance

--

Disadvantages: external colour of the building will gradually be changed to darker colour

--

Cost evaluation:

1st: capital cost

	item	Function	Function type	unit	quantity	unit rate	total
1	**original design**						
	emulsion paint for exterior walls	improve image	S	--	4,800	1.32	6,316
				--	0	0	0
							6,316

	item	unit	quantity	unit rate	total
1	**Proposed changes**				
	exterior walls with tyrolean only	--	0	0	0
		--	0	0	0
					0

2nd: Life cycle cost summary

interest rate: **10%**

Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	6,316	126	0
Proposed	0	0	0
present worth	6,316	1,235.2	0.0
Savings	6,316	1,235	0
total saving in present worth =		**7,551**	

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**

VE STUDY
Presentation phase

Item: Architecture
No. of proposals 8
current poposal Code: A-03

evaluation

Item: replace marble sills for windows with mortar sills
Original Design local marble sills for windows

Proposed Design mortar sill 1:2, 4 cm fairfaced

Discussion the proposed change maintain the same fucntion as local marble function is levelling underneath of aluminum windows

Advantages: reduction in cost without effect on performance

Disadvantages: lower image than marbe

Cost evaluation:
1st: capital cost

	item	Function	type	unit	quantity	unit rate	total
1	**original design**						
	local marble sills for windows	maintain level	RS	m.r	1,150	7.89	9,079
				--	0	0	0
							9,079

	item	Function	type	unit	quantity	unit rate	total
1	**Proposed changes**						
	mortar sills	maintain level	RS	m.r	1,150	2.19	2,522
				--	0	0	0
							2,522

2nd: Life cycle cost summary

interest rate: **10%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	9,079	182	0
Proposed	2,522	50	0
present worth	6,557	1,282.4	0.0
Savings	6,557	1,282	0
total saving in present worth =		**7,839**	

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**

VE STUDY
Presentation phase

Item: Architecture

No. of proposals 8

current poposal Code: A-04

evaluation

Item:	replace jointi fill material for joints from sikaflix to mastic bitumen
Original Design	Apolysulphide sikaflex 20 X 10mm to jointand aluminum cover 8cm wide, 3mm thick.
Proposed Design	replace sikaflix with bitumenouse mastic
Discussion	both materials perform the same function that is prevent moisture
Advantages:	reduction in cost without effect on performance
Disadvantages:	may flow if not properly injected in the joint

Cost evaluation:

1st: capital cost

	item	Function	Function type	unit	quantity	unit rate	total
1	**original design**						
	sicaflix and aluminum cover sheet	prevent moisture	RS	--	750	11.40	8,553
				--	0	0	0
							8,553
	item	Function	type	unit	quantity	unit rate	total
1	**Proposed changes**						
	Bitumenous mastic and aluminum cover	prevent moisture	RS	--	750	8.77	6,579
				--	0	0	0
							6,579

2nd: Life cycle cost summary

interest rate: **10%**

Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	8,553	171	0
Proposed	6,579	132	0
present worth	1,974	386.0	0.0
Savings	1,974	386	0
total saving in present worth =		**2,360**	

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**

VE STUDY
Presentation phase

Item: Architecture
No. of proposals 8
current poposal Code: A-05

evaluation

Item: Replace internal walls paint from emulsion to policed
Original Design one coat pimer followed by two coats high quality emulsion paint

Proposed Design Three coats Ploliced paint

Discussion Both the proposed and the original paint gives the same appearance despite the high quality the original paint is, it is not washable

Advantages: reduction in cost without effect on performance

Disadvantages: The proposed colour is of less quality but still the proposed paint acts as a primer if the benificiary tends to change paint type

Cost evaluation:
1st: capital cost

	item	Function	type	unit	quantity	unit rate	total	Note
1	**original design**							
	Emulsion paint to internal walls	comfort sight	S	m2	41,650	1.32	54,803	
				--	0	0	0	
							54,803	
	item	Function	type	unit	quantity	unit rate	total	
1	**Proposed changes**							
	Policed paint to internal walls	comfort sight	S	m2	41,650	0.88	36,535	project requirement
				--	0	0	0	
							36,535	

2nd: Life cycle cost summary

interest rate: **10%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	54,803	1,096	0
Proposed	36,535	731	0
prsent worth	18,268	3,572.8	0.0
Savings	18,268	3,573	0
total saving in present worth =		**21,840**	

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**

VE STUDY
Presentation phase

Item: Architecture

No. of proposals 8

current poposal Code: A-06

evaluation

Item: change chips of terrazzoo tiles from marble to local limestone

Original Design Terrazzoo tiles with marble chips to floors

Proposed Design terrazzoo tiles with local limestone chips and to pass testing

Discussion The proposed alternative in case of passing test may be of less quality than the original, but it is durable and resists wearing

Advantages: reduction in cost without effect on performance

Disadvantages: Image is lower than the original. Absorbtion is higher.

Cost evaluation:

1st: capital cost

	item	Function	Function type	unit	quantity	unit rate	total
1	**original design**						
	terazoo tile with marble chips	maintain level	R.S	m2	10,260	8.77	90,000
				--	0	0	0
							90,000

	item	Function	Function type	unit	quantity	unit rate	total
1	**Proposed changes**						
	terazoo tile with local limestone chips	maintain level	R.S	--	10,260	6.14	63,000
				--	0	0	0
							63,000

2nd: Life cycle cost summary

interest rate: **10%**

Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	90,000	1,800	0
Proposed	63,000	1,260	0
prsent worth	27,000	5,280.7	0.0
Savings	27,000	5,281	0
total saving in present worth =		**32,281**	

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**

VE STUDY
Presentation phase

Item: Architecture
No. of proposals 8
current poposal Code: A-07

evaluation

Item:	change thresholds from terrazoo with marble chips to terrazzoo with local limestone
Original Design	Threshold with marble chips
Proposed Design	The same specification of the proposed, but local limestone chips are used instead of marble
Discussion	Such change is necessary to match the proposed tile
Advantages:	Matching the proposed tiles in addition to reduction in cost
Disadvantages:	lower image than terrazoo tiles of marbe chips

Cost evaluation:
1st: capital cost

	item	Function	type	unit	quantity	unit rate	total
1	**original design**						
	(item/s to be changed)	service buildi	R.S	--	300	7.89	2,368
				--	0	0.0	0
							2,368
	item	Function	type	unit	quantity	unit rate	total
1	**Proposed changes**						
	(alternative/s)	service buildi	R.S	--	300	4.39	1,316
				--	0	0	0
							1,316

2nd: Life cycle cost summary

interest rate: **10%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	2,368	47	0
Proposed	1,316	26	0
present worth	1,053	205.9	0.0
Savings	1,053	206	0
total saving in present worth =		**1,259**	

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**

VE STUDY
Presentation phase

Item: Architecture
No. of proposals 8
current poposal Code: A-08

evaluation

Item:	change top of kitchen worktop from local marble to granite
Original Design	local marble kithcen cabinet
Proposed Design	maintain the same description but change top surface to granite
Discussion	The proposed change was to suit the function of the worktop where it is subjected to bleaches and chemicals that local marble can not resist
Advantages:	The original item is not sustainable and tends to change in color the proposed is durable and resisive to spilled bleaches
Disadvantages:	Higher cost, but it is cost effective change

Cost evaluation:
1st: capital cost

	item	Function	Function type	unit	quantity	unit rate	total
1	**original design**						
	local marble kitchen cabinet	service building	R.S	m.r	272	114.04	31,010
				--	0	0	0
							31,010
	item			unit	quantity	unit rate	total
1	**Proposed changes**						
	Granite marble kitchen cabinet	service building	R.S	m.r	272	149.12	40,551
				--	0	0	0
							40,551

2nd: Life cycle cost summary

interest rate: **10%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	31,010	620	0
Proposed	40,551	811	0
prsent worth	-9,541	(1,866.1)	0.0
Savings	-9,541	-1,866	0
total saving in present worth =		**-11,408**	

Project: The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis

VE STUDY
Presentation phase

Recommendations of strucure

Proposal code	item evaluated	capital cost saving	p.w of annual operation& maintenance	other annual income
ST-01	change raft foundation to single footings	258180	0	0
ST-02	Redesign columns and slabs	133465	0	0
	total	391645	0	0
	grand total	**391645**		

Project: The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis

VE STUDY
Presentation phase

Item: Structure

No. of proposals 2

current proposal Code: ST-01

evaluation

Item: change raft foundation to single footings

Original Desig Raft foundation at shallow depth that enables no need for ground slab

Proposed Des traditional single footing system composed of footings, column necks, groun beams and ground slab

Discussion The system proposed will minimize cost and it is well known and easy to achieve with local labors. The system extends schedule by 15 days but this can be mitigated as described in the presentation of the VE report

Advantages: High cost reduction
The system is workable on the sandy soil of the project

Disadvantage Consumes extra 15 days

Cost evaluation:

1st: capital cost

	item	Function function	type	unit	quantity	unit rate	total
	original design						
1	excavate for foundations	access level	R.S	m3	2,700	0.88	2,368
2	Backfilling with selected excavared materials	protect building	R.S	m^3	2,700	1.75	4,737
3	Filling with imported clean sand around foundations	protect building	R.S	m^3	4,350	3.95	17,171
4	Backfilling with imported kurkar under foundations ,	improve capacity	R.S	m^3	2,600	4.39	11,404
5	Blinding beds for foundations	maintain level	R.S	m^3	565	61.40	34,693
6	R.C B300 for raft foundations	sustain loads	B	m^3	4,500	131.58	592,105
7	R.C B250 for ground beam for raft	sustain loads	B	m^3	15	140.35	2,105
							664,583

	item			unit	quantity	unit rate	total
	Proposed changes						
1	excavate for foundations	access level	R.S	m3	5,000	0.88	4,386
2	Backfilling with selected excavared materials	protect building	R.S	m^3	3,600	1.75	6,316
3	Filling with imported clean sand around foundations	protect building	R.S	m^3	4,000	4.39	17,544
4	Backfilling with imported kurkar under foundations ,	improve capacity	R.S	m^3	2,600	4.39	11,404
5	Blinding beds for foundations	maintain level	R.S	m^3	200	61.40	12,281
6	R.C B250 for foundations	sustain loads	B	m^3	1,410	96.49	136,053
7	R.C B250 for ground beams	sustain loads	B	m^3	850	122.81	104,386
8	Ground slab 10 cm thick	protect building	R.S	m2	10,000	11.40	114,035
							406,404

2nd: Life cycle cost summary

interest rate: **10%**

Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	664,583	0	0
Proposed	406,404	0	0
present worth	258,180	0.0	0.0
Savings	258,180	0	0
total saving in present worth =		**258,180**	

Project: The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis

VE STUDY
Presentation phase

Item: Structure
No. of proposals 2
current rpoposal Code: ST-02

evaluation

Item:	Redesign columns and slabs
Original Design	Columns with high rienforcement content and hollow block slab 26 cm thick
Proposed Design	Increase size of columns and main steel ratio 1% Reduce slab thickness to 23 cm
Discussion	The proposed changes can easily be achieved and rearrangement of columns at lower spacing enables such changes
Advantages:	Getting the same functions at lower cost slab thickness reduction reduce own weight and load on foundations
Disadvantages:	None

Cost evaluation:

1st: capital cost

	item	Function function	type	unit	quantity	unit rate	total
1	**original design**						
2	R.C B300 for stub columns	protect bars	RS	m3	115	192.98	22,193
3	R.C B300 for columns	sustain loads	B	m3	675	263.16	177,632
4	R.C steel trowelled slab 26cm thick	sustain loads	B	m2	14,650	31.58	462,632
							662,456

	item			unit	quantity	unit rate	total
1	**Proposed changes**						
2	R.C B250 for stub columns	protect bars	RS	m3	115	166.67	19,167
3	R.C B300 for columns	sustain loads	B	m3	900	166.67	150,000
4	R.C slab 23cm thick with steel troweller for roof slab only.	sustain loads	B	m2	14,650	24.56	359,825
							528,991

2nd: Life cycle cost summary

interest rate: **10%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	662,456	0	0
Proposed	528,991	0	0
present worth	133,465	0.0	0.0
Savings	133,465	0	0
total saving in present worth =		**133,465**	

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**
VE STUDY
Presentaion phase

Recommendations of site general

Proposal code	item evaluated	capital cost saving	p.w of annual operation& maintenance	other annual income
S-01	delete opening in boundary wall	36184	7077	0
S-02	change 20 cm thick boundary wall parts to 15 cm thick	614	120	0
S-03	change concrete of boundary wall and steps from B300 to cast	22982	0	0
S-04	replace plaques at each unit by 4 signboards	1776	0	0
	total	61557	7197	0
	grand total	**68754**		

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**
VE STUDY
Presentaion phase

Item: Site General
No. of proposals 4
current proposal Code: S-01

evaluation

Item: delete opening in boundary wall
Original Design opening in the boundary wall with security bars

Proposed Design delete such element and replace with blockwork

Discussion The design element does not suit local culture and from previous observation such openings were closed directly after benificiaries hand over the units

Advantages: reduce cost
respect local traditions and need for privacy

Disadvantages: none

Cost evaluation:
1st: capital cost

	item	function	type	unit	quantity	unit rate	total
1	**original design**						
	Steel balustrade for boundary wall	protect space, improve image	S S	mr	1,000	48.25	48,246
	Nominally rienforced concrete under the steel balustrade	secure balustrade	S	m^3	15	131.58	1,974
							50,219
	item			unit	quantity	unit rate	total
1	**Proposed changes**						
	blockwork 15 cm	protect space	S	mr	1,000	14.04	14,035
				--	0	0.00	0
							14,035

2nd: Life cycle cost summary

interest rate: **10%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	50,219	1,004	0
Proposed	14,035	281	0
prsent worth	36,184	7,076.9	0.0
Savings	36,184	7,077	0
total saving in present worth =		**43,261**	

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**
VE STUDY
Presentaion phase

Item: Site General
No. of proposals 4
current proposal Code: S-02

evaluation

Item:	change 20 cm thick boundary wall parts to 15 cm thick
Original Design	some parts of the boundary wall are 20 cm thick
Proposed Design	Change such parts to 15 cm thick
Discussion	the proposal unifies the thickness of the boundary wall to 15 cm
Advantages:	reduce cost easier in construction since the wall has the same thickness
Disadvantages:	none

Cost evaluation:
1st: capital cost

	item	function fucntion	type	unit	quantity	unit rate	total
1	**original design**						
	Boundary wall 20 cm thick	maintain privacy	S	m^2	700	8.77	6,140
							6,140
	item			unit	quantity	unit rate	total
1	**Proposed changes**						
	Boundary wall 15 cm thick	maintain privacy	S	m^2	700	7.89	5,526
							5,526

2nd: Life cycle cost summary

interest rate: **10%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	6,140	123	0
Proposed	5,526	111	0
prsent worth	614	120.1	0.0
Savings	614	120	0
total saving in present worth =		**734**	

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**
VE STUDY
Presentaion phase

Item: Site General
No. of proposals 4
current proposal Code: S-03

evaluation

Item: change concrete of boundary wall and steps from B300 to cast in situ B200
Original Design Concrete used in boundary wall B300

Proposed Design maintain the same design but change concrete to B200 and to be casted in situ

Discussion The proposed change is sufficient for the non- structural concrete of the boundary wall and steps.

Advantages: Easy to construct
make use of waste of concrete imported to site
reduce cost

Disadvantages: none

Cost evaluation:
1st: capital cost

	item	fucntion function	type	unit	quantity	unit rate	total
	original design						
1	R.C B300 for foundations of boundary wall	sustain wall	R.S	m^3	200	149.12	29,825
2	R.C B300 for columns of boundary wall	tie blocks	S	m^3	100	228.07	22,807
3	R.C B300 for top beams of boundary wall	protect blocks	S	m^3	125	157.89	19,737
4	R.C B300 for external steps and beams	improve site	S	m^3	40	149.12	5,965
							78,333
	item			unit	quantity	unit rate	total
	Proposed changes						
1	R.C B200 for foundations of boundary wall	sustain wall	R.S	m^3	200	114.04	22,807
2	R.C B200 for columns of boundary wall	tie blocks	S	m^3	100	122.81	12,281
3	R.C B200 for top beams of boundary wall	protect blocks	S	m^3	125	122.81	15,351
4	R.C B200 for external steps and beams	improve site	S	m^3	40	122.81	4,912
							55,351

2nd: Life cycle cost summary

interest rate: **10%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	78,333	0	0
Proposed	55,351	0	0
present worth	22,982	0.0	0.0
Savings	22,982	0	0
total saving in present worth =		**22,982**	

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**
VE STUDY
Presentaion phase

Item: Site General
No. of proposals 4
current proposal Code: S-04

evaluation

Item: replace plaques at each unit by 4 signboards
Original Design copper plagues size 25 x 20 cm at each building holding information of donor

Proposed Design 4 2x3 meters signboards conveying the same information

Discussion The proposal tends to convey the same information required by donor at lower cost

Advantages: Cost reduction as well as that benificiaries will not maintain plaques
Disadvantages: none

Cost evaluation:
1st: capital cost

	item	function	function type	unit	quantity	unit rate	total
1	**original design**						
	copper plagues size 25x20cm at building	acknowledge donor	S	No	121	21.93	2,654
							2,654

	item	unit	quantity	unit rate	total
1	**Proposed changes**				
	signboard 2x3 meters	No	4	219.30	877
					877

2nd: Life cycle cost summary

interest rate: **10%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	2,654	0	0
Proposed	877	0	0
pesent worth	1,776	0.0	0.0
Savings	1,776	0	0
total saving in present worth =		**1,776**	

Project: The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis
VE STUDY
Presentation phase

recommendations of mechanical

	item evaluated	capital cost saving	p.w of annual operation& maintenance	other annual income
M-01	replace shower tray with reduced level ceramic floor tiles	12211	2388	0
	total	12211	2388	0
	grand total	**14599**		

Project: **The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**
VE STUDY
presentation phase

Item: Mechanical
No. of proposals 1
current rpoposal Code: M-01

evaluation

Item: delete shower tray
Original Design used shower tray 70x70cm in bathroom completed ith fittings

Proposed Design use reduced level non-slip ceramic instead

Discussion the design bothers usage of bathroom in addition to formation of bacteria at the edges of the shower

Advantages: maintaining the same fucntion at lower cost
easy to clean

Disadvantages: none

Cost evaluation:
1st: capital cost

	item	function	function type	unit	quantity	unit rate	total
1	**original design**						
	Shower tray Ariston 70x70cm with fittings	colletct water	S	No.	174	114.04	19,842
							19,842
	item			unit	quantity	unit rate	total
1	**Proposed changes**						
	reduced level shower place with fittings			No.	174	43.86	7,632
							7,632

2nd: Life cycle cost summary

interest rate: **10%**
Life cycle duration -year: **40**

	capital cost	annual operation& maintenance	other annual income
Original	19,842	397	0
Proposed	7,632	153	0
present worth	12,211	2,388.1	0.0
Savings	12,211	2,388	0
total saving in present worth =		**14,599**	

Project: The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis

VE STUDY
Presentation phase
summary of recommendations

	item evaluated	capital cost saving	annual operation& maintenance	other annual income
	Archtecture (8 proposals)			
A-01	cancellation of external emulsion paint for tyrolean finished external walls	47495	9289	0
A-02	cancellation of external emulsion paint for tyrolean finished and lime free plastered external walls	6316	1235	0
A-03	replace marble sills for windows with mortar sills	6557	1282	0
A-04	replace jointi fill material for joints from sikaflix to mastic bitumen	1974	386	0
A-05	Replace internal walls paint from emulsion to policed	18268	3573	0
A-06	change chips of terrazzoo tiles from marble to local limestone	27000	5281	0
A-07	change thresholds from terrazoo with marble chips to terrazzoo with local limestone	1053	206	0
A-08	change top of kitchen worktop from local marble to granite	-9541	-1866	0
	sub-total architecture	99121	19386	0
	grand total architecture		**118507**	
	structural (2 proposals)			
ST-01	change raft foundation to single footings	258180	0	0
ST-02	Redesign columns and slabs	133465	0	0
	sub- total structural	391645	0	0
	grand total structural		**446475**	
	Site general (4 proposals)			
S-01	delete opening in boundary wall	36184	7077	0
S-02	change 20 cm thick boundary wall parts to 15 cm thick	614	120	0
S-03	change concrete of boundary wall and steps from B300 to cast in situ B200	22982	0	0
S-04	replace plaques at each unit by 4 signboards	1776	0	0
	sub- total site general	61557	7197	0
	grand total site general		**78380**	
	Mechanical (1 proposals)			
M-01	delete shower tray	12211	2388	0
	sub- total mechanical	12211	2388	0
	grand total mechanical		**16642**	

SUMAMRY

	capital cost saving	annual operation & maintenance	other annual income
Archtecture	99121	19386	0
structural	391645	0	0
Site general	61557	7197	0
Mechanical	12211	2388	0
TOTAL SAVING	**564533**	**28971**	0
GRAND TOTAL SAVING IN PRESENT WORTH	**593504**		

Appendix G

Value Engineering Report

Value Engineering Report

The Japanese project

For

Re-housing refugees Whose Shelters

Were Demolished in Khan Younis

UNRWA- GAZA

1- Executive summary

This study aimed to review the re-housing project that will be implemented by UNRWA with Japanese fund. The revision will be according to a value engineering methodology proposed by the researcher. The aim of the study is to improve performance and/or reduce cost of the project.
The study was implemented by a group of professionals. The study could attain saving of the project reaching to 17% of the designed project in addition to improvement in the spaces of the housing units.

2- Introduction:

2.1 General:

The researcher proposed a value engineering methodology for low- cost housing in Gaza Strip as a main objective of his dissertation research. The research included a case study to clarify the methodology application techniques. The project in concern was selected for application as a case study since it is a massive housing project with emphasis on cost reduction due to financing difficulties.
Upon agreement of UNRWA –Gaza to facilitate study application; the researcher received all available information from UNRWA design unit. Then VE team was provided with information prior to workshop.
The workshop was conducted and the team followed the methodology with facilitation of all reports by the researcher.

2.2 Value engineering team:

The team of the study formation was as listed in Table G1:

Table G1, VE team

Member	specialty	experience	notes
Fareed Ashoure	Civil/ structural engineer	19 years of experience in building construction, structural design of buildings and design of infrastructure project.	Full attendance
Hossam Korraz	Architect	14 years of experience in building design with emphasis on low cost housing. He has research in low cost housing.	Full attendance
Mosa Hejazi	Contractor	25 years of experience in various filed of civil engineering. Class A contractor in buildings. He implemented massive housing projects for UNRWA.	Part time attendance
Usama El Sadawi	Civil engineer	20 years of experience in building design with emphasis on low cost housing.	Acted as a VE and worked on cost estimation of the project.

The choice of the engineers was based on the needed specialties that became clear after choosing items to be evaluated. The team could easily cover the subjects related to the study.

2.3 Value engineering workshop agenda:

To assure focus, VE workshop agenda was dedicated as follows:

- Review information
- Apply quality model
- Apply space model
- Apply Paretto law
- Apply cost worth model.
- Creativity
- Evaluation of proposals
- Presentation of ideas of VE.

3- Project description

- Exact name: The project name is "The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis".
- Implementing agency: UNRWA is the implementing agency through two three departments:
  1. Construction of buildings: by Engineering & Construction Service Department.
  2. Infrastructure: by the Environmental Department.
  3. Social role: through Social Department.
- Project phases: The project will be divided into three phases, the first phase is composed of 171 housing units.
- Location: The project is located in the western part of Khan Younis on a governmental land.
- Area of land occupied by the project: The project will be built on an overall area of 130,000 square meters. 52,000 square meters were dedicated to phase 1 (in concern).
- Topography: the project was originally part of the sand dunes closed to the sea cost with slope from east to west with lower point in the middle. The difference in level originally reached up to 25 meters . UNRWA graded the site with smooth slope from east to west and from south to north. The final levels maximum difference is not exceeding 12 meters.
- Soil exploration: soil test was prepared to the whole site. Laboratory recommended cleaning the site from rubbish and trees and to compact soil with 8.0 tons roller up to -2.0 meters below foundations level and then compacting the remaining to be compacted at 25 cm thick layers and to reach minimum degree of compaction of 98%. Then foundations may be designed as strip foundations with allowable bearing pressure of 1.5 kg/cm2
- Water table: water table was not encountered up to the explored 15 meters. It is not anticipated to be existing before 40 meters depth.
- Estimated cost : the estimated cost of the project is 3.2 million US dollars.
- Schedule: 26 weeks are given to contractors as the period of implementation. UNRWA facilitates extra working hours if the contractor is in need of. The week contains 6 working days.

- Project components: UNRWA has its own standard for re-housing project. Table G2 summarizes the specifications in terms of spaces

Table G2, Housing units basic data

Code	beneficiaries	Area (m2)	bedrooms	bathroom	kitchen	Water closet
A1	1-2 persons	44.2	1	1	1	
A2	3-4 persons	62.2	2	1	1	
A3	5-7 persons	79.8	3	1	1	1
A4	8 and greater	97.3	4	1	1	1
A5	Two wife family	121.5	5	1	1	1

A stair case with an area of 10.5 square meters is added for the cases of extended families to facilitate building two to three storey buildings. Extended families benefit from units with codes A2, A3,A4,A5 while separated families benefit from units with codes A1,A2 with no stairs.

The dedicated units for phase 1 are listed in Table G3

Table G3, The composition of the project in terms of combination of housing units

	No of building	**No. of units**	**Stair yes/no**
Single storey			
A1	3	3	no
A2	18	18	no
A3	24	24	no
A4	30	30	no
A5	9	9	no
Two storey			
A1/A1	2	4	yes
A1/A2	1	2	yes
A1/A3	1	2	yes
A1/A4	1	2	yes
A2/A1	2	4	yes
A2/A2	1	2	yes
A2/A3	2	4	yes
A2/A4	1	2	yes
A3/A2	2	4	yes
A3/A3	4	8	yes
A4/A2	1	2	yes
A4/A3	6	12	yes
Three storey			
A2/A2/A2	1	3	yes
A3/A2/A2	1	3	yes
A3/A3/A2	2	6	yes
A4/A3/A3	1	3	yes
A4/A3/A1	2	6	yes
A3/A3/A1	1	3	yes
A2/A3/A1	1	3	yes
A1/A2/A1	1	3	yes
A3/A4/A1	1	3	yes
A5/A2/A4	1	3	yes
A3/A2/A3	1	3	yes

(note: A1/A2/A3 : The ranking of the types of units from bottom to top).

The number of each unit can be summarized as in Table G4

Table G4, Summary housing units' types

Type	Number	Remark
A1	19	
A2	40	
A3	58	
A4	44	
A5	10	
Stairs (single floor stair)	87	

- Estimated cost: According to UNRWA quantity surveyor, no case estimation was made to this phase in terms of cost of each type in particular. He could estimate the average of each unit at 19,000 US Dollars with an overall cost of phase 1 of 3.2 millions.
- Infrastructure: Infrastructure is not included in the three phases of the project. Due to the structure of UNRWA, it is being handled completely by the sanitary department.
- Case study focus: the case study will consider phase 1 of the project. The recommendations of the study can easily be applied to the later phases of the project. Infrastructure will not be considered due to the limitation of time and unavailability of information.

4- Owner attitudes (Quality model)

The quality model was developed during meetings with the parties among the owner contacted. It might be summarized according to Table G5

Table G5, Quality model parameters

No	Item	Level of importance to the owner	Notes
	1. Operations		
1	Operational effectiveness	V. high	The project forms the minimum requirements to function as a housing project.
2	Flexibility/expandability	high	Each unit suits present needs and it is designed to be expanded by the end user in future.
3	User comfort	fair	The project has an emergency nature.
	2. Resources		
1	Capital cost effectiveness	V. high	There is a limited budget of 12.6 millions to build 438 units.
2	Operations and maintenance	high	It is important to avoid high maintenance since many of the end users are very poor families who can not afford cost of maintenance.
3	Schedule	V. high	It is extremely important due to consideration of the donor and since UNRWA pays to the beneficiaries for rental since their houses were demolished.
	3. Technology		
1	Security/safety	fair	It is fair since building are not exceeding three stories in height.
2	Engineering performance	fair	There is no elevators or power generators.
	4. Image		
1	Site planning/image	fair	Focus is directed to the buildings rather that site. Site to contain the minimum to be functioning.
2	Architectural image	fair	
3	Community value	high	UNRWA considers this item of high importance in order to avoid social problems among beneficiaries and between the project and the neighbors.

5- Quality model application to the existing design

The VE team looked at the design information available and compared quality elements of the design with the owner requirements. The result was as follows:

- Design cost exceeded the allocated budget by 7%.
- Operational effectiveness of the design was lower than owner requirements.
- User comfort requirements are lower than that provided by the design especially with the absence of living room in each unit.

- Security/safety, engineering performance, site planning/image and architectural image are higher than the owner requirements.

Figure G1 expresses the design values of the quality model versus the owner requirements.

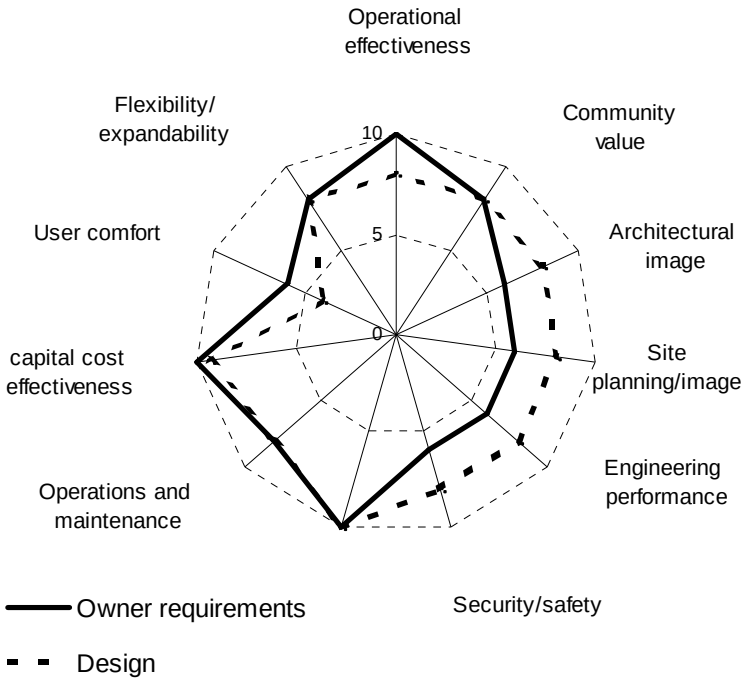


Figure G1, Design versus Quality Model

6- FAST model development

VE has concluded F.A.S.T diagram of the project according to Figure G2

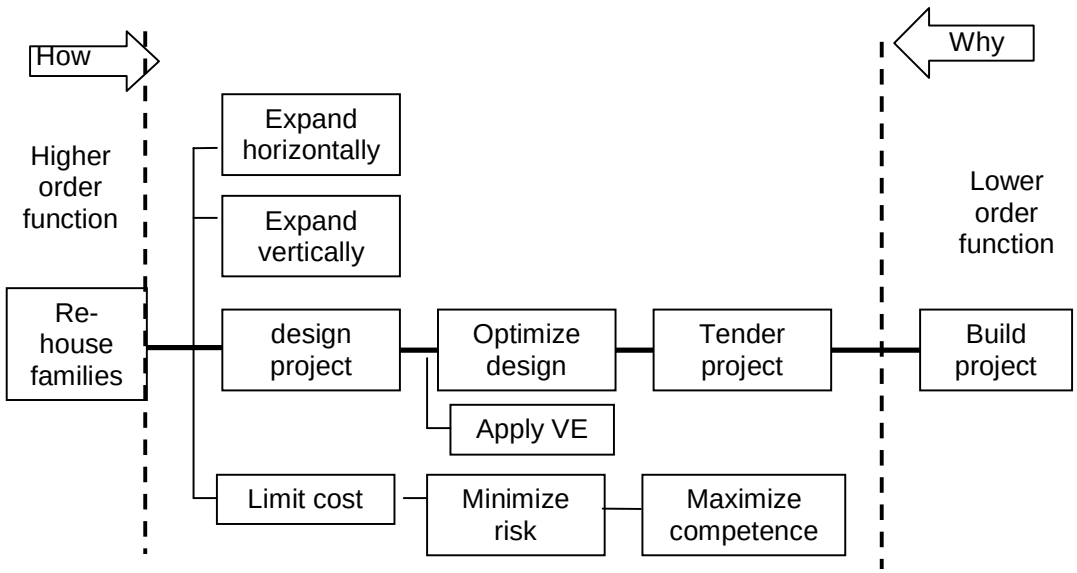


Figure G.2, FAST diagram of the re-housing project

Figure G2, FAST diagram of the re-housing project

7- Space model application

The space model was prepared in the pre-workshop phase. The VE team applied the space model to project. The result was as follows:

- There is a saving potential in the areas of the building of around 3.5%.
- In the mean time, improvement of the design is possible, and that could be through:
  - Add living room to each type of units depending on the family size.
  - Add a toilet unit to type A3 building that serves 5-7 persons.
  - Increase the area of the kitchen in types A4, A5
- So, the VE team recommended amending the design of the units taking into consideration the results of the space model. The potential saving will not be considered and it will be left as a margin to the designer in the amendment of the design.

Table G6 indicates the space model of the project.

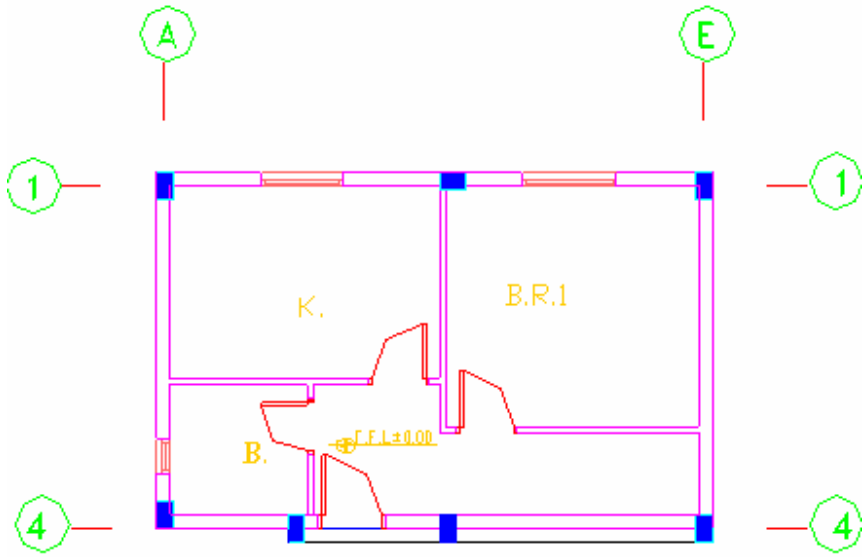
Table G6 , Space model

Project:	**The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis**									
VE study										
space model-fast										
B: basic function			area	cost= design value						
RS: required secondary				worth= VE target						
S: secondary										
system	*subsystem*	*component*	*part*	Function			area			
Level 1	**Level 2**	**Level 3**	**Level 4**	verb	noun	type	cost	worth	cost/worth	***remarks***
Project							**16085.2**	**15598.7**	**1.03**	
	Buildings						**14374.6**	**13888.1**	**1.035**	3% saving opportuinity in buildings
		Type A1(19 No.)					**44.2**	**44.3**	**1.00**	ammend design
			Bedroom1	accommodate	beds	B	13.1	14.5	0.90	increase space
			Bathroom	serve	persons	B	3.9	3.9	1.00	
			kitchen	serve	persons	B	11.2	6.5	1.72	poor value
			corridores	link	areas	RS	8.1	4.5	1.80	poor value
			living room	gather	family	RS	0	7	0.00	add space
			Partitions	seprate	spaces	RS	7.9	7.9	1.00	
		Type A2(40 No.)					**62.2**	**59.2**	**1.05**	
			Bedroom1	accommodate	beds	B	14.8	14.5	1.02	
			Bedroom2	accommodate	beds	B	18.5	12.5	1.48	poor value
			Bathroom	serve	persons	B	3.9	3.9	1.00	
			kitchen	serve	persons	B	11.2	6.5	1.72	poor value
			corridores	link	areas	RS	5	6	0.83	increase space
			living room	gather	family	RS	0	7	0.00	add space
			Partitions	seprate	spaces	RS	8.8	8.8	1.00	
		Type A3(58 No.)					**79.8**	**71.2**	**1.12**	ammend design
			Bedroom1	accommodate	beds	B	13.3	14.5	0.92	increase space
			Bedroom2	accommodate	beds	B	18.5	12.5	1.48	poor value
			Bedroom3	accommodate	beds	B	16.2	12.5	1.30	poor value
			Bathroom	serve	persons	B	4.1	4.1	1.00	
			kitchen	serve	persons	B	8.6	8.6	1.00	
			w.c	serve	persons	B	0	2	0.00	add space
			corridores	link	areas	RS	9.1	8	1.14	poor value
			living room	gather	family	RS	0	9	0.00	add space
			Partitions	seprate	spaces	RS	10	10	1.00	
		Type A4(44 No.)					**97.3**	**99.9**	**0.97**	ammend design
			Bedroom1	accommodate	beds	B	11.8	14.5	0.81	increase space
			Bedroom2	accommodate	beds	B	12.4	12.4	1.00	
			Bedroom3	accommodate	beds	B	16.2	12.5	1.30	poor value
			Bedroom4	accommodate	beds	B	17.3	12.5	1.38	poor value
			Bathroom	serve	persons	RS	4.1	4.1	1.00	
			kitchen	serve	persons	RS	8.6	9.5	0.91	increase space
			w.c	serve	persons	RS	2.5	2.5	1.00	
			corridores	link	areas	RS	12.5	11	1.14	poor value
			living room	gather	family	RS	0	9	0.00	add space
			Partitions	seprate	spaces	RS	11.9	11.9	1.00	
		Type A5(10 No.)					**121.5**	**123.1**	**0.99**	ammend design
			Bedroom1	accommodate	beds	B	11.8	14.5	0.81	increase space
			Bedroom2	accommodate	beds	B	12.4	12.4	1.00	
			Bedroom3	accommodate	beds	B	16.2	12.5	1.30	poor value
			Bedroom4	accommodate	beds	B	17.3	12.5	1.38	poor value
			Bedroom5	accommodate	beds	B	18	14.5	1.24	poor value
			Bathroom	serve	persons	B	4.1	4.1	1.00	
			kitchen	serve	persons	B	8.6	9.5	0.91	
			w.c	serve	persons	RS	2.5	2.5	1.00	
			corridores	link	areas	RS	12.5	12.5	1.00	
			living room	gather	family	RS	0	10	0.00	add space
			Partitions	seprate	spaces	RS	18.1	18.1	1.00	
		Stairs		connect	floors	B	**10.6**	**10.6**	**1.00**	
		Stairs (87 flr. stair)					**10.6**	**10.6**	**1.00**	
	SITEWORKS						**1700**	**1700**	**1.00**	
		Paths		imorove	image	S	1700	1700	1.00	maintain for image

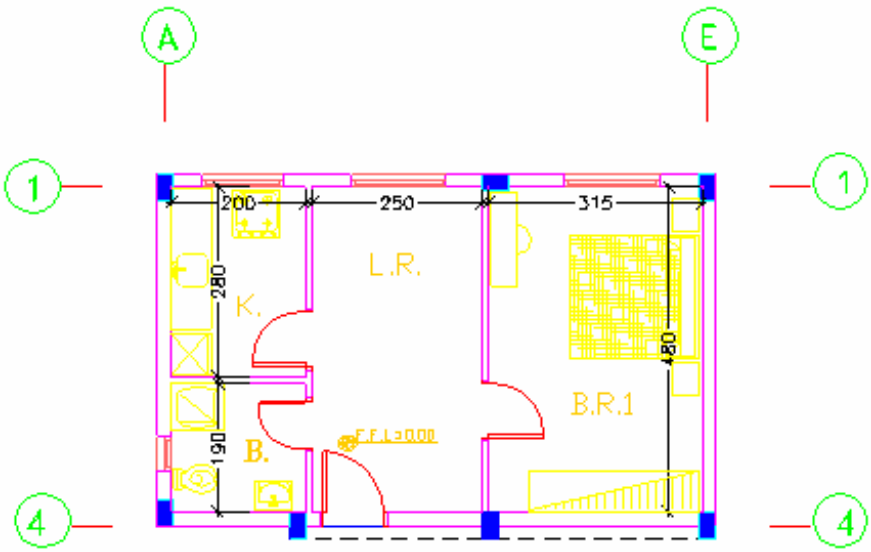
The Japanese project for re-housing refugees whose shelters were demolished in Kh/Younis

The following drawings DWG 1- DWG 5 were proposed as alternative design to improve the spaces value of the project.

A1 type

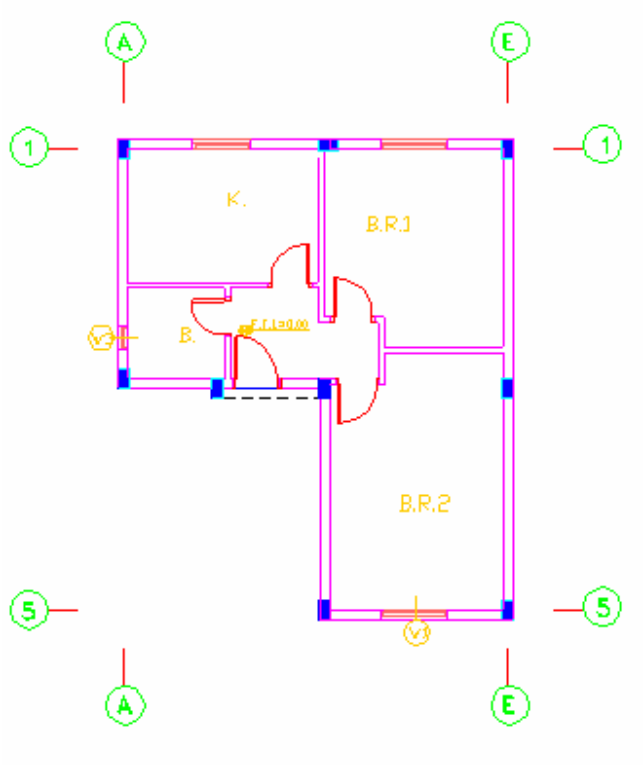


Original



Proposed

A2 type



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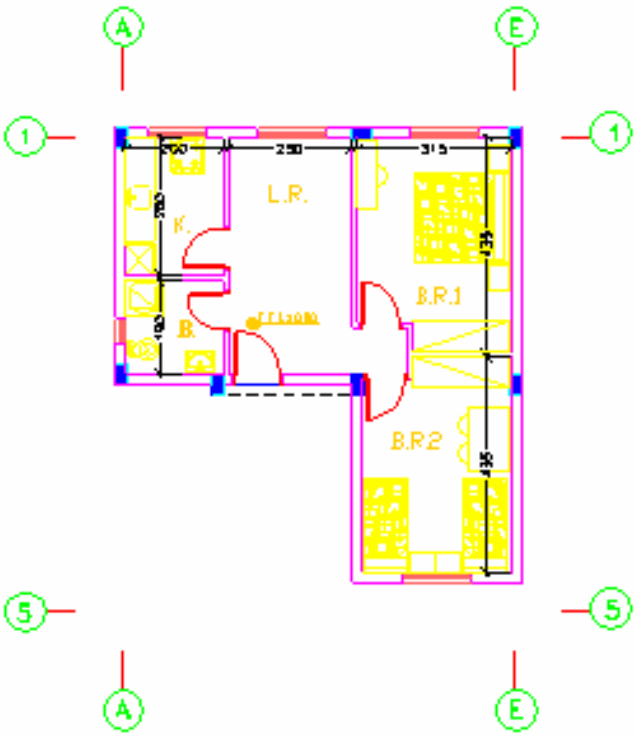
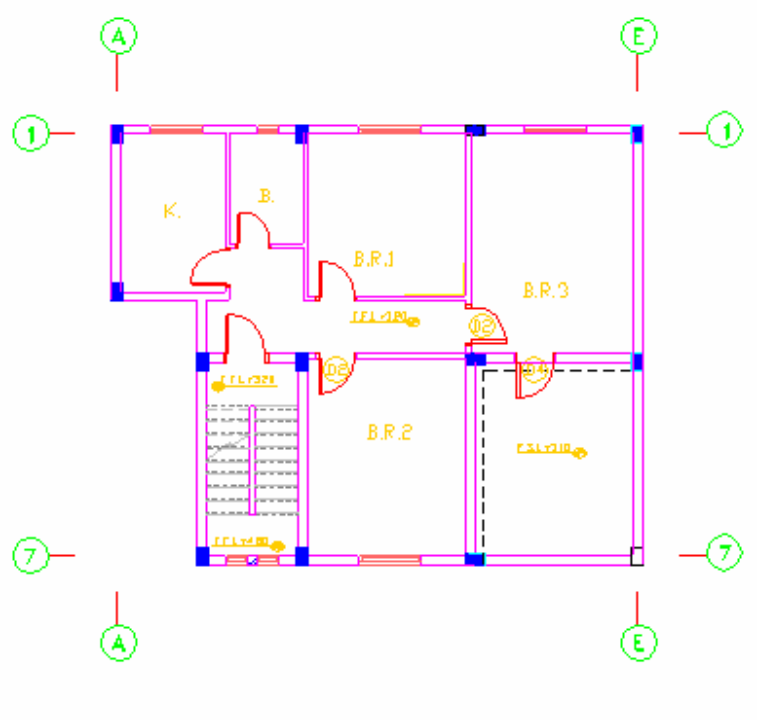
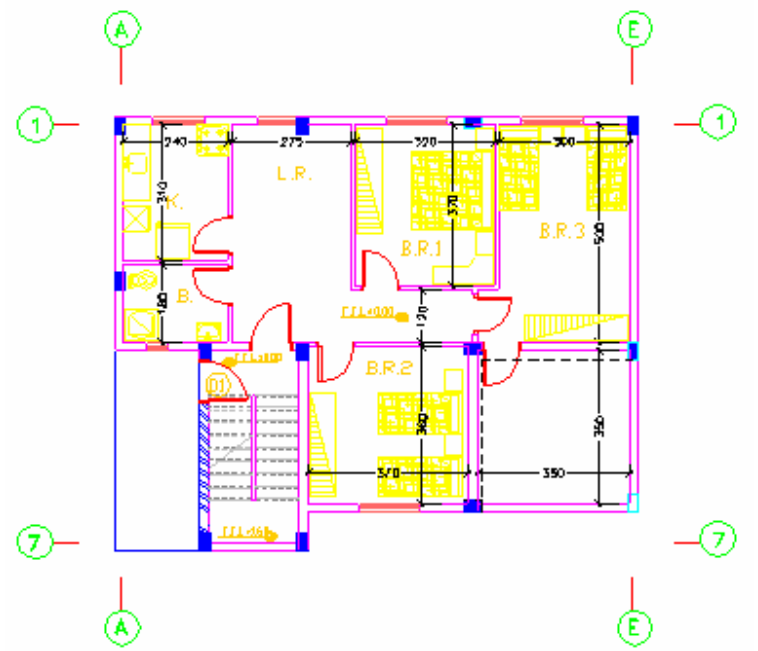


Proposed

A3 Type

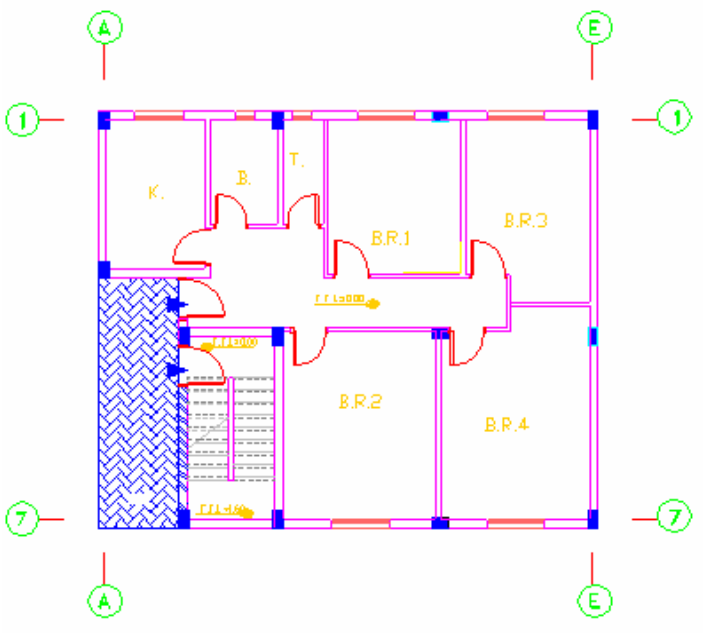


Original

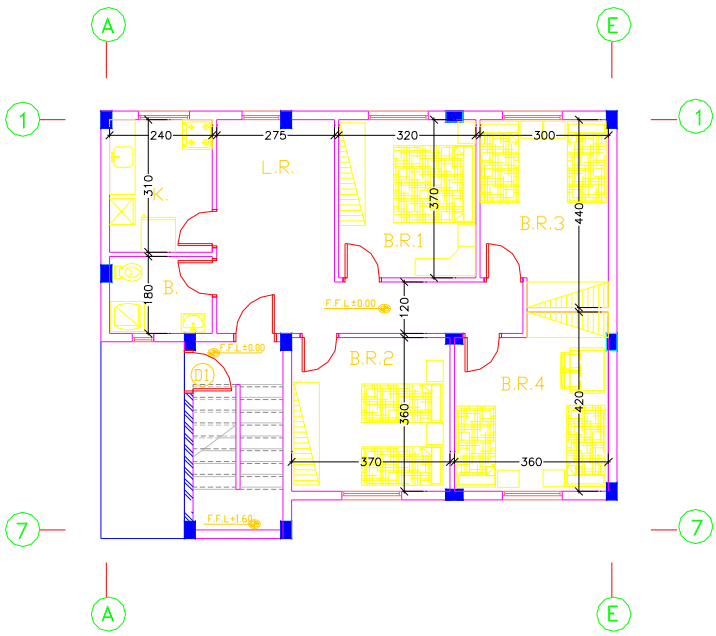


Proposed

A4 Type

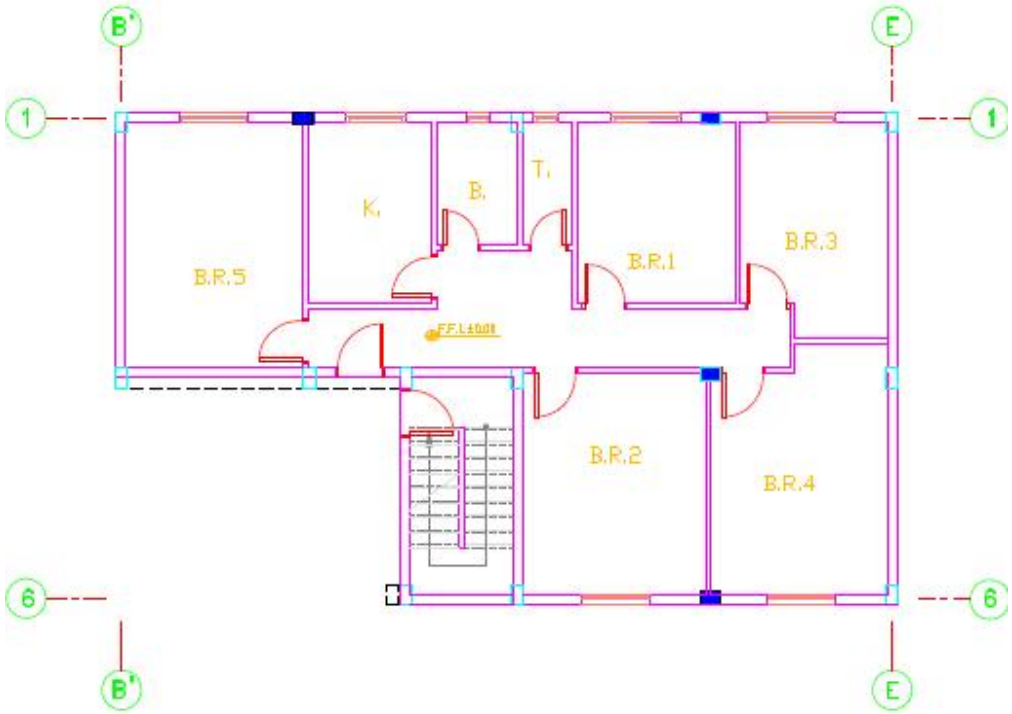


Original



Proposed

A5 Type



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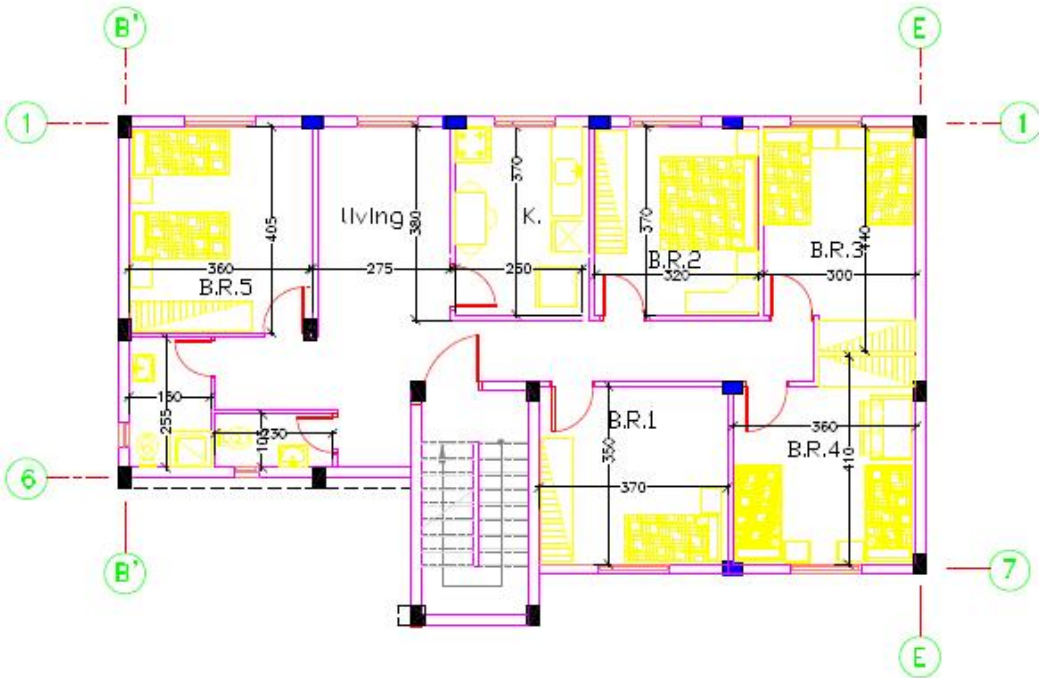

Proposed

8- Uniformat presentation

VE team transferred masterformat to uniformat as in Table G7.

Table G7, Uniformat presentation

	Project: The Japaneese Project for Rehousing refugees whose shelters were demolished in Kh/Younis																		
	VE Study																		
	Uniformat Cost Model																		
				Masterformat															
				General requirements	Sitework s	Concrete	Masonry	Metals	Wood- plastic	Thermal & moisture protection	Doors and windows	Finishes	Specialties	Equipment	Furnishings	Special conditions	Conveying systems	Mechanical	Electrical	**Total unioformat costs**
01	Foundations	011	Standard foundations		33182	584880														618,063
		012	Spec. foundations																	0
02	Substructure	021	Slab on grade																	0
		022	Basement excavation																	0
		023	Basement walls																	0
03	Suprtructure	031	Floor construction			664093														664,093
		032	Roof construction					4063	1346											5,409
		033	Stair construction			52215						30580								82,794
04	Ext. Closures	041	Exterior walls				172132			8382		252589								433,103
		042	Exterior doors and windows								121622									121,622
05	Roofing	05	Roofing			1224				21765										22,989
06	Int. Const.	061	partitions			8321	64611													72,932
		062	interior finishes								93583	349044								442,627
		063	specialties																	0
07	Conveying System	07	elevator																	0
08	Mechanical	081	plumbing			11421												231937		243,358
		082	H.V.A.C																	0
		083	Fire protection																	0
		084	Special mechanical system																	0
09	Electrical	091	service & distribution																116526	116,526
		092	lighting and power																77876	77,876
		093	special electrical system																	0
10	Gen. Cond. OH&P	101	general conditions & OH	156085																156,085
		102	Profit	84046																84,046
11	Equipment	111	fixed & movable equipment																	0
		112	furnishings																	0
		113	special construction																	0
12	Sitework	121	site preparation		5384															5,384
		122	site improvement		12482	140071	56004	47336			27639									283,532
		123	site utilities																	0
		124	off site works																	0
			Total Masterformat	240,131	51,048	1,462,225	292,746	51,399	1,346	30,148	242,844	632,212	0	0	0	0	0	231,937	194,402	3,430,438

The items of the Uniformat were ranked from the highest cost to the lowest as in Table G8.

Table G8, Items of Uniformat ranked in descending order

code	uniformat	cost	% of the total cost	accumulative cost	% accumulative
31	Floor construction	664,093	19%	664,093	19%
11	Standard foundations	618,063	18%	1,282,156	37%
62	interior finishes	442,627	13%	1,724,783	50%
41	Exterior walls	433,103	13%	2,157,886	63%
122	site improvement	283,532	8%	2,441,418	71%
81	plumbing	243,358	7%	2,684,776	78%
101	Gen. Cond. & over head	156,085	5%	2,840,861	83%
42	Exterior doors and windows	121,622	4%	2,962,483	86%
91	service & distribution	116,526	3%	3,079,009	90%
102	Profit	84,046	2%	3,163,055	92%
33	Stair construction	82,794	2%	3,245,849	95%
92	lighting and power	77,876	2%	3,323,725	97%
61	partitions	72,932	2%	3,396,657	99%
5	roofing	22,989	1%	3,419,646	100%
32	Roof construction	5,409	0%	3,425,055	100%
121	site preparation	5,384	0%	3,430,439	100%
12	Spec. foundations	0	0%	3,430,439	100%
21	Slab on grade	0	0%	3,430,439	100%
22	Basement excavation	0	0%	3,430,439	100%
23	Basement walls	0	0%	3,430,439	100%
63	specialties	0	0%	3,430,439	100%
7	elevator	0	0%	3,430,439	100%
82	H.V.A.C	0	0%	3,430,439	100%
83	Fire protection	0	0%	3,430,439	100%
84	Special mechanical system	0	0%	3,430,439	100%
93	special electrical system	0	0%	3,430,439	100%
111	fixed & movable equipment	0	0%	3,430,439	100%
112	furnishings	0	0%	3,430,439	100%
113	special construction	0	0%	3,430,439	100%
123	site utilities	0	0%	3,430,439	100%
124	off site works	0	0%	3,430,439	100%
	Total	**3,430,439**			

9- Paretto law application

Referring to Table G7, It was noticed that the first 6 items (out of 30) forms 78% of the total cost. This means 20% of the functions form 78% of the cost which is very closed to Paretto Law.

As a conclusion, the area of value engineering analysis and study will be mainly controlled by the first six functions that are listed in Table G8

Table G9, Items of 78% of the cost and forming 20% of the items

code	Uniformat	cost
031	Floor construction	664,093
011	Standard foundations	618,063
062	interior finishes	442,627
041	Exterior walls	433,103
122	site improvement	283,532
081	plumbing	243,358
Total cost		**2,684,776**

10- Application of Cost worth model:

Cost/worth model was applied. The VE team relied in cost estimation on their own experience as professionals engaged with the sector of building construction. Table G10 summarizes the result of the cost/worth analysis:

Table G10, Cost -Worth model

No.	Item	Cost $	estimated worth	worth	VI	Remark
1	Floor construction	814,050	14374 m2 @ 50$/m2	720,000	1.13	**poor value**
2	Standard foundations	757,625	10614 m2 @ 45$/m2	480,000	1.58	**poor value**
3	Exterior walls	530,300	14376 m2 @ 35$/m2	500,000	1.06	**poor value**
4	Interior finishes	427,860	14377 m2 @ 27$/m2	390,000	1.10	**poor value**
5	Plumbing	298,310	171 units @ 1500$/unit	260,000	1.15	**poor value**
6	Site improvement	347,555	171 units @ 1600$/unit	275,000	1.26	**poor value**
	total evaluated items	**3,175,700**		**2,625,000**	**1.21**	**poor value**

From the above table, the VE team concluded saving potential in the project. The item "standard foundations" has the highest value index " cost / worth " i.e. the poorest value. The result of this table was carried to the next step of the workshop.

11- Creativity

The VE developed alternatives to the components of the function of high cost. The alternatives are summarized and evaluated in Table G11. The ideas are accepted for development since the rank is greater than 7 for all.

Table G11, ideas generated and VE evaluation

Alt. No.	Idea	Advanta-ges	Disadvan-tages	rank
	Architecture			
A-01	cancel external emulsion paint for Tyrolean finished external walls	economy	appearanc e	8
A-02	cancel external emulsion paint for Tyrolean finished and lime free plastered external walls	economy	appearanc e	8
A-03	replace marble sills for windows with mortar sills	economy	appearanc e	8
A-04	replace joint fill material for joints from sikaflix to mastic bitumen	economy	none	8
A-05	replace internal walls paint from emulsion to policed	economy	durability	8
A-06	change chips of terrazzo tiles from marble to local limestone	economy	appearanc e	9
A-07	change thresholds from terrazzo with marble chips to terrazzo with local limestone	economy	appearanc e	9
A-08	change top of kitchen worktop from local marble to granite	durability	economy	9
	Structure			
ST-01	change raft foundation to single footings	economy, schedule	none	9
ST-02	redesign columns and slabs	economy, serviceability		9
	Site general			
S-01	delete opening in boundary wall	economy, security	none	10
S-02	change 20 cm thick boundary wall parts to 15 cm thick	economy	appearanc e	9
S-03	change concrete of boundary wall and steps from B300 to cast in situ B200	economy, schedule	durability	8
S-04	replace plaques at each unit by 4 signboards	economy	none	10
	Mechanical			
M-01	replace shower tray with reduced level ceramic floor tiles	economy, safety	none	10

12- Presentation

The VE developed alternatives to the components of the function of high cost. The alternatives are Referring to the available information, the VE team looked at the components of the items identified as

areas of high cost or elements having improvement potential and those components that had alternatives were discussed. A group of ideas were generated to overcome high cost elements as follows: Summary of evaluation phase is presented in Table G12

Table G12, Summary of recommendations

	item evaluated	capital cost saving	annual operation& maintenance
A-01	cancellation of external emulsion paint for Tyrolean finished external walls	47,495	9,289
A-02	cancellation of external emulsion paint for Tyrolean finished and lime free plastered external walls	6,316	1,235
A-03	replace marble sills for windows with mortar sills	6,557	1,282
A-04	replace joint fill material for joints from sikaflix to mastic bitumen	1,974	386
A-05	Replace internal walls paint from emulsion to policed	18,268	3,573
A-06	change chips of terrazzo tiles from marble to local limestone	27,000	5,281
A-07	change thresholds from terrazzo with marble chips to terrazzo with local limestone	1,053	206
A-08	change top of kitchen worktop from local marble to granite	-9,541	-1,866
	Total architecture	**99,121**	**19,386**
ST-01	change raft foundation to single footings	258,180	0
ST-02	Redesign columns and slabs	133,465	0
	Total structure	**391,645**	**0**
S-01	delete opening in boundary wall	36,184	7,077
S-02	change 20 cm thick boundary wall parts to 15 cm thick	614	120
S-03	change concrete of boundary wall and steps from B300 to cast in situ B200	22,982	0
S-04	replace plaques at each unit by 4 signboards	1,776	0
	Total site general	**61,557**	**7,197**
M-01	delete shower tray	12,211	2,388
	Total mechanical	**12,211**	**2,388**
	Grand total	**564,533**	**28,971**
	Grand total in present worth	**593,504 dollars**	

The Quality Model was assessed after VE study where the VE team found that the quality elements are in compliance with the owner attributes. Figure G3 shows the revised QM

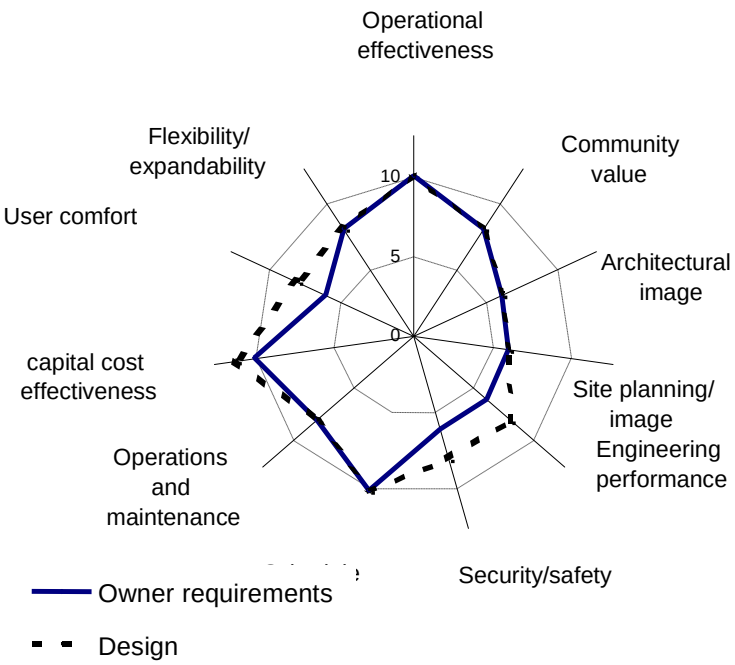

Figure G3, Revised Quality Model after the VE study

13- Recommendations

The VE team recommends the following:

- Apply proposed design changes
- Apply proposed changes to improve value of the design
- Divide the lot of the current tender to three lots, between 60-70 units in each lot to guarantee adherence to schedule and to minimize risk.