The Implementation and Effectiveness of Value Engineering in the United Arab Emirates

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Abstract

This thesis examines the implementation and effectiveness of Value Engineering in the United Arab Emirates and is restricted to major building construction projects. The aim of the reasurch is to investigate possible areas of improvement and could potentially enhance the effectiveness of the managent and control of the Value Engineering process, for building construction project in the Unietd Arab Emirates.

The objectives of the research is to use the data collected to formulate a model for improvement of the Value Engineering process used in building construction projects in the United Arab Emirates. Before a model to be formulated, the following hypotheses need to be addressed.

- Value Engineering is currently being effectively implemented
- Value Engineering currently provides tangible and measurable benefits
- Current practices in the application of Value Engineering can be improved

A triangulation approach is employed, with data collected using questionnaires, semi structured interviews and case studies. The data collected was analysed and critically assessed to compare the Value Engineering process conducted in the United Arab Emirates with current best practice and to identify specific area for improvement..

Based on the literature review, it became evident that the following seven (7) key factors raised by the researchers were identified for the potential to effect improvements.

1. Structure and Method of the Value Engineering process.
2. Timing and execution of the Value Engineering and workshop studies.
3. Composition of the Workshop team.
4. Understanding of the Value Engineering process.
5. Value Engineering during the Construction phase.
6. Performance measurement based on costs.
7. The effect of environment and culture on Value Engineering

A model for improving the effectiveness of Value Engineering in the United Arab Emirates was then developed, validated and refined, based on the responses of seventy two (72) experienced clients, construction professionals, value engineers, project mangers and contractors. The responses from expatriates and Emirates nationals were also compared and the following recommondations were incorporated in the model.

The identified improvement into the design consultant agreement is to:-

- Include Value Engineering in the overall project programme.

The identified improvement recommendations for the design stages are:-

1. Conduct Value Engineering workshop by the end of the preliminary design stage.
2. Establish involvement of end-user and who has experience in construction from project management consultant or client's representative.
3. Specific consideration of the culture and environment in the United Arab Emirates.
4. Develop management awareness and commitment.
5. Implement the new regulations to achieve certification on sustainability (Estidama).

The identified improvement recommendations for the construction stages are:-

1. Conducting Value Engineering review after the award of construction.
2. Monitoring and auditing Value Engineering cost benefits.
3. Controlling variations and change orders.
4. Verifying Value Engineering recommendations adopted are achieved.
5. Cultivate company culture and environment to maximise the benefits of Value Engineering.
6. Ensure the new regulations to achieve certification on sustainability (Estidama).

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Certificate of Originality

I hereby declare that this thesis is a result of developing a significant topic within the professional work of the author. The author holds a senior position of Acting Manager, Projects Control Department for a client organization, Abu Dhabi National Oil Company (ADNOC) and has responsibilities for planning and cost control for Design and Construction of infrastructure and building projects for the Civil Projects Division.

The motivation for this research is to investigate possible area of improvement that could potentially enhance the effectiveness of the Value Engineering particularly in building construction projects in the United Arab Emirates.

This is to certify that I am responsible for the work submitted in this thesis, that the original work is my own except as specified in acknowledgements or in footnotes, and that neither the thesis nor the original work contained therein has been submitted by others to this or any other institution for a degree before.

Signature

…………………………………

Ratnam Jeyakumar BSc (Hons), MSc, MRICS.

Date

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Authors Publications

1. *"Value Engineering for construction projects in United Arab Emirates"*, The Proceedings of the 2nd International conference on Value Engineering and Value Management (2009), SAVE International, October 16-17, 2009, Beiging, China.

2. *"Performance of Value Engineering in United Arab Emirates"*, The proceedings of the 5th Research Student Workshop (2010), The Research Office, Faculty of Advanced Technology, University of Glamorgan.

Contents Summary **Page No.**

List of Contents Page No.

List of Contents   Page No.

List of Contents **Page No.**

List of Contents **Page No.**

List of Contents Page No.

List of Contents Page No.

List of Contents **Page No.**

List of Contents **Page No.**

List of Contents **Page No.**

List of Figures — Page No.

List of Figures   Page No.

List of Tables Page No.

List of Tables Page No.

CHAPTER 1

INTRODUCTION

1.1 Introduction

This thesis examines the implementation and effectiveness of Value Engineering in the United Arab Emirates. The aim of the research is to assess whether the process of the Value Engineering being applied in construction projects in the United Arab Emirates provide the benefits claimed, and whether potential improvements can be achieved.

This introduction presents a definition of Value Engineering, background to the research, aims and objectives, scope of the research and an overview of Value Engineering used in construction projects in Abu Dhabi, United Arab Emirates.

The global impact of the current economic downturn has posed serious challenges to the United Arab Emirates construction industry since 2009. Most companies are confronted with fierce competition. Some companies have lost nearly all their work, as the projects on which they were working were stopped. It was an unexpected global situation, especially after the previous three (3) to five (5) years of high construction activity in United Arab Emirates. Customers are becoming more demanding and while losses in revenue and jobs were expected during 2009, re-evaluation of company operations moves into other markets and the launching of new, more efficient technologies provided some strategies to maintain competitiveness.

The United Arab Emirates' construction market saw a dramatic growth over the decade prior to 2009. Despite the current economic downturn, *"significant construction developments are planned up to 2030"*, Abu Dhabi Urban Planning Council (2007). The construction market is in the early stages of applying Value Engineering, but it is not yet widely applied in United Arab Emirates. However, market trends indicate that in United Arab Emirates, Value Engineering will become a necessary element of construction due to cost fluctuations, shortages in energy supply and rising market competition. Also recent building regulations, Abu Dhabi Urban

Planning Council (2010) *"require a more holistic approach to building design which encompasses sustainability"*. These requirements can also be incorporated into the Value Engineering process in order to achieve the aim of transforming Abu Dhabi, United Arab Emirates in to a model of sustainable urbanisation.

"*Value Management has been used in the construction industry to achieve better value for money for decades. If implemented successfully, this group problem-solving methodology can reduce costs while maintaining or improving performance and quality requirements in a project*", Shen et al. (2005). "*The benefits of a successful Value Management study in construction include savings in project costs, clarifying the client's objectives, improved communication between stakeholders, and enhanced creativity through the interaction of the participants of the Value management study*", Shen and Chung, (2002). The realisation of these benefits depends very much on the performance of the Value Management studies. "*The performance measurement of Value Management studies is, however, rarely conducted in practice, due to the lack of appropriate and rigorous measurement framework for this purpose*", Lin et al. (2004). This is one of the serious problems hindering the wider use of Value Management in construction, because the client organisations need to be convinced of the claimed benefits, and be able to measure and monitor the performance of Value Management studies to ensure that these benefits are fully achieved.

According to Dallas (2006), Value Engineering is a *"specific and very effective technique to optimise the cost-effectiveness of a design"*. Siterman (2009) claims that *"the application of Value Engineering at the beginning of the project would lead to 'build efficiency' in a project*. Also, Siterman (2009) stated that *"this efficiency in building results from savings in capital cost, compressing the construction schedule, improving constructability, optimising energy consumption, meeting the latest rules and regulations and enhancing owner's investment"*. In addition to this, operating costs can be reduced by optimising energy consumption. Therefore, the author's research was aimed at establishing, if effective implementation of Value Engineering in United Arab Emirates projects is, or could be, beneficial to all stakeholders in the construction process.

Carrying out of Value Engineering early in a project is beneficial in the design of equipment and systems which can also lead to a cost and time effective projects. Roe (2009) claims that:-

- *The functionality of the project is improved as well as savings both on initial and life-cycle costs.*
- *Designs performed by consultants are critically reviewed prior to committing to a fully detailed design, thus reducing subsequent time and costs for amendments and revisions.*
- *Assures best value for money for the life cycle of the building.*

Clients in the United Arab Emirates can rightly claim to be innovative and be prepared to embrace new management, environmental and technological developments. Major projects such as the "Free Trade Zone", Burj Khalifa Tower, tallest building in the world to date, Palm Island housing complex, could not have been constructed without the client's commitment to such high quality and challenging projects. *"These clients have also embraced developments in management systems such as Quality Management which have been promoted by the government"*, Seraphim (2005). Value Engineering management, encompassing Value Engineering (see Figure 1.1), is now required to be implemented on government funded projects. *"Management systems involve people, and people are influenced by external factors such as environment and culture"*, Nadem (2009). Therefore, a process such as Value Engineering, originating in the USA, is likely to need some adaptation if it is to meet the specific environment found in the United Arab Emirates. There is currently limited information on this aspect in relation to Value Engineering in United Arab Emirates; hence this will form a key element of this research thesis.

Based on the Figure 1.1, it can be seen that Value Engineering extends from the detailed design stage to construction completion. This thesis investigates the management and control of the Value Engineering process in the United Arab Emirates construction projects.

Value Management		
Value Planning (Strategic)	Value Engineering	Value Analysis

RIBA PLAN OF WORK	Briefing		Sketch Plans		Working Drawings				Construction	Post-Construction
	Inception	Feasibility	Outline Proposals	Scheme Design	Detail Design	Production Information	Bills of Quantities	Tender Action	Construction	Post-Occupancy Evaluation

Figure 1.1 Typical Value Management study programme for building-type projects (Source: Brian and William, 1995).

1. 2 Value Management and Value Engineering

"Value Management has a business focus and is strategic in nature whilst Value Engineering, a subset of Value Management, has a greater technical focus", Kelly, Male and Graham (2004). According to Kelly, Morledge and Wilkinson (2006), *"Value Management is a team-based activity that is concerned with making explicit the package of whole-life benefits a client is seeking from a project or projects at the appropriate cost. Whereas Value Engineering is a subset of Value Management* (as shown in Figure 1.1), *is a team-based activity and is concerned with making explicit the package of whole-life benefits that a client is seeking from the technical delivery of the project"*. Therefore, Value Management has a business focus, is strategic, and is concerned with ensuring that the business, social, environmental and technical parameters are defined, while Value Engineering is a process that aims to ensure that the correct technical aspects of the project are delivered during the design and construction phases to meet the stated project parameters.

While Value Engineering is a technical process, it has to be organised and managed in a structured way. The precise technical specifications and parameters can vary significantly between projects; however the management and control of the Value Engineering process should be executed in a consistent way and based on accepted "best practice".

1.2.1 Value Management

Value Management is defined as "*the process by which the functional benefits of a project are made explicit and appraised consistent with a value system determined by the client*", Kelly, Male and Graham (2004). Value Management mainly focuses on the business aspects of the project, which is a fundamental reason why a client organisation needs the project in the first place. The business aspects of a project is defined in terms of need, finance, return, risks and time horizons as a strategic phase of the project. Value Management ensures that the technical aspect of the project is in alignment with the business project, to deliver value for money. Value Management addresses not only the business and technical aspect of the projects, but also the objective and subjective elements of value. Therefore, *"Value Planning, Value*

Engineering and Value Analysis form a subset of Value Management", Ashworth and Hogg (2000) as shown in Figure 1.1.

1.2.2 Value Planning

"Value planning is applied during concept phase of a project", Kelly, Male and Graham (2004). *"*The term *'value planning' has arisen in a growing number of organisations to describe more strategic-type value studies undertaken at the early conceptual design stage"*, Norton and McElliot (1995).

1.2.3 Value Engineering

"The process of making explicit the functional benefits a client requires from the work or parts of a project at an appropriate cost during design and construction", Kelly, Male and Graham (2004). Further, Kelly, Male and Graham (2004) stated that Value Engineering can also be *"The process of identifying and eliminating unnecessary cost during design and construction".* Therefore, the Value Engineering methodology can be concisely stated as a tool that helps construction industry improve cost effectiveness.

There is a potential for misunderstanding here, "eliminating unnecessary costs" can be misinterpreted as "cost cutting". The objective of the Value Engineering is in fact "cost effectiveness". It is quite feasible that Value Engineering may result in a recommendation to increase the initial project construction cost in order to provide a net longer term saving, e.g. by energy efficiency and / or maintenance over the lifetime of the project. Therefore, it looks at life cycle costing.

In this research work, the author focused only on the effectiveness of Value Engineering in the United Arab Emirates, during design and construction, as project operational costs were not available.

1.2.4 Value Analysis

The definition of Value Analysis is an *"organised approach to prioritising the necessary functions at the lowest cost*", Kelly, Male and Graham (2004). Value

Analysis was seen to be a cost validation exercise that did not affect the quality of the product. The straight omission of an enhancement or finish would not be considered value analysis. Also Kelly, Male and Graham (2004) stated that the "*Value Analysis is an organised approach to the identification and elimination of unnecessary cost. Value Analysis shall be carried out on the completion of the project*", Ashworth and Hogg (2000).

1.3 Green Buildings and Sustainable Construction in the United Arab Emirates

Sustainable development is a relatively new trend within the Construction industry in the United Arab Emirates, whereby organisations seek economic development approaches that benefit the local environment and improve the quality of life. Sustainable development is a very important concept for the United Arab Emirates, "*the heavy reliance on natural gas and the increasing demand for the air-conditioning and desalination have made the United Arab Emirates one of the biggest carbon emitters on a per capita basis*", Salama et al. (2009). Hence, "*it is very important to reduce the energy consumption and CO2 emissions from buildings*", Wilen (2008).

'*Green Building and sustainable design have experienced explosive growth over the past decade in response to the adverse impact of development in the natural environment and the need to mitigate this impact. High performance, sustainable design aims to provide the needed function with the highest degree of environmental sustainability possible at, ideally, the lowest initial on life cycle costs. The Value Engineering Methodology can make an important contribution to the significant transformation occurring in the construction industry'*, Paget (2008).

Abu Dhabi, United Arab Emirates has an ambitious vision to be one of the leading sustainable cities of the 21st Century. "*The Urban Planning Council and the development community are working together to make this vision a reality*", Abu Dhabi Urban Planning Council (2010).

In the United Arab Emirates, the Abu Dhabi Government has established a clear vision for sustainability as a basic requirement for the foundation of all new developments occurring in the Emirate of Abu Dhabi. "*The development of sustainability program* *was started in 2003 and in 2009 it was implemented*", Abu Dhabi Urban Planning Council (2010).

1.4 Background of Value Engineering

Increasingly Value Engineering has become an important tool in the construction industry, used globally, to improve project effectiveness. "*Value Engineering practices have been widely applied to major projects, but mainly in Design and Procurement but only in the early stages of construction*", Kelly et al. (2004). The objective of Value Engineering is to achieve improved cost effectiveness without compromising function and performance, reliability, quality and safety requirements.

"*The Value Engineering principles and methodology provides a systematic approach in searching for alternative solutions that preserve the functionality and reliability of constructed facilities*", Cheah and Ting (2005). The identification of these elements can lead to the elimination of such unnecessary costs. There is a need for research in Value Engineering to eliminate unnecessary cost and to enhance the value of the money expended.

Presently, there is no published evidence that Value Engineering in the Middle East is being effectively implemented. "*Market trends show that there is rising competition in the construction industry as a result of the recent economic downturn in 2009*", Luke (2009). This would also be expected to stimulate the desire for more cost effective investment by both developers and clients in order to reduce their exposure to financial risk. Therefore, Value Engineering is being seen as an important tool for construction projects in United Arab Emirates. This is particularly relevant in times of recession where value for money is of prime importance.

1.5 Background of Research

This section explains the basis for the author's motivation for researching the topic of "implementation and effectiveness of Value Engineering in the United Arab Emirates".

The author's experiences of Value Engineering, whilst holding a senior position as "Acting Manager, Projects Control Department" in a governmental organisation in Abu Dhabi, United Arab Emirates, provided access to current project data for conducting research into practices of Value Engineering in the United Arab Emirates and address the issues raised below.

The issues raised were found, based on the subsequent literature review of Chapter 3, to be an area of research that had the potential to develop knowledge in the area of Value Engineering.

In the researchers' experience, Value Engineering principles and the methods are not being applied in the United Arab Emirates in a way that can achieve the maximum potential benefits for construction projects. This perception is supported by others, "*Value Engineering is considered by some to be applied as a cost cutting tool by many construction companies, design consultants and clients in the United Arab Emirates*", Forman and Roberts (2010).

In view of the current financial development crisis, which began in 2009, it is especially relevant for the United Arab Emirates construction industry to realise potential benefits offered by Value Engineering. Claims of increased performance, sustainable designs, lower initial and life cycle costs become more appealing in relation to investment in construction projects.

Many clients and consultants are looking for the effective application of Value Engineering to reduce the initial capital cost by cutting down unnecessary cost generated during the design, construction and operability stages of projects. However, the majority of published information is focused on the pre-construction stages. Based on the author's survey on recently completed building projects and individual discussion with the various owners and individual consultants, it was found that proper implementation of Value Engineering is essential in order to remove unnecessary cost and to meet a set budget. Due to the cyclical nature of construction in the United Arab Emirates, it is beneficial to improve Value Engineering approach in the United Arab Emirates so that improved returns on investments can be achieved.

1.6 Aims and Objectives

The aim of the research is to investigate possible areas of improvement that could potentially enhance the effectiveness of the management and control of the Value Engineering process, for building construction projects in the United Arab Emirates.

In order to achieve the above aims and objectives it will be necessary to:-

1. Gain an insight into current practices in the United Arab Emirates and compare them to what is currently perceived as best practice internationally. This will establish if the current management and process control, information exchange and timetabling structures are in place and being implemented. Also, to investigate if there are external factors, such as environment and culture, that will require modification to current recommended practices, based on cultures outside the United Arab Emirates, in order to meet the specific needs of the United Arab Emirates.

2. Collect evidence in order to identify the cost benefits that are currently being achieved by the application of Value Engineering for construction projects, in the United Arab Emirates.

   A further issue here is assessing "*value*" gained. Because of the complexity of the projects and their special technical aspects, it quickly became apparent to the researcher that the value outcomes had to be restricted to the "business focus" identified in Section 1.2, namely, the project completion time and overall success in eliminating "unnecessary cost" or project cost saving. This was measured by utilising pre and post Value Engineering cost estimates and also what the actual achieved project cost saving was at the end of the construction period. The evidence of project operational and maintenance costs, were not available to the researcher, and is hence assumed to be what the Technical Value Engineering evaluation forecast.

   This approach is consistent with the statement made at the end of Section 1.2, namely that this research is restricted to the "*management and control*" of the Value Engineering process.

3. The above two elements have the potential to provide evidence on which to identify areas for improvement of Value Engineering in United Arab Emirates which could then be used as a basis for making specific improvement and recommendations. These recommendations are then externally validated.

The objectives of the research is to use the data collected to formulate a model for improvement of the Value Engineering process used in building construction projects in the United Arab Emirates. Before a model to be formulated, the following hypotheses need to be addressed.

Considering the above demand, the following research hypotheses are set in relation to the United Arab Emirates.

- Value Engineering is currently being effectively implemented
- Value Engineering currently provides tangible and measurable benefits
- Current practices in the application of Value Engineering can be improved

It is only when these three issues can be verified that formulation of a model for improvement can be developed.

A ‘SMART’ Value tree in Figure 1.2 represents the research process used to formulate an improvement of ‘model’ in this thesis.

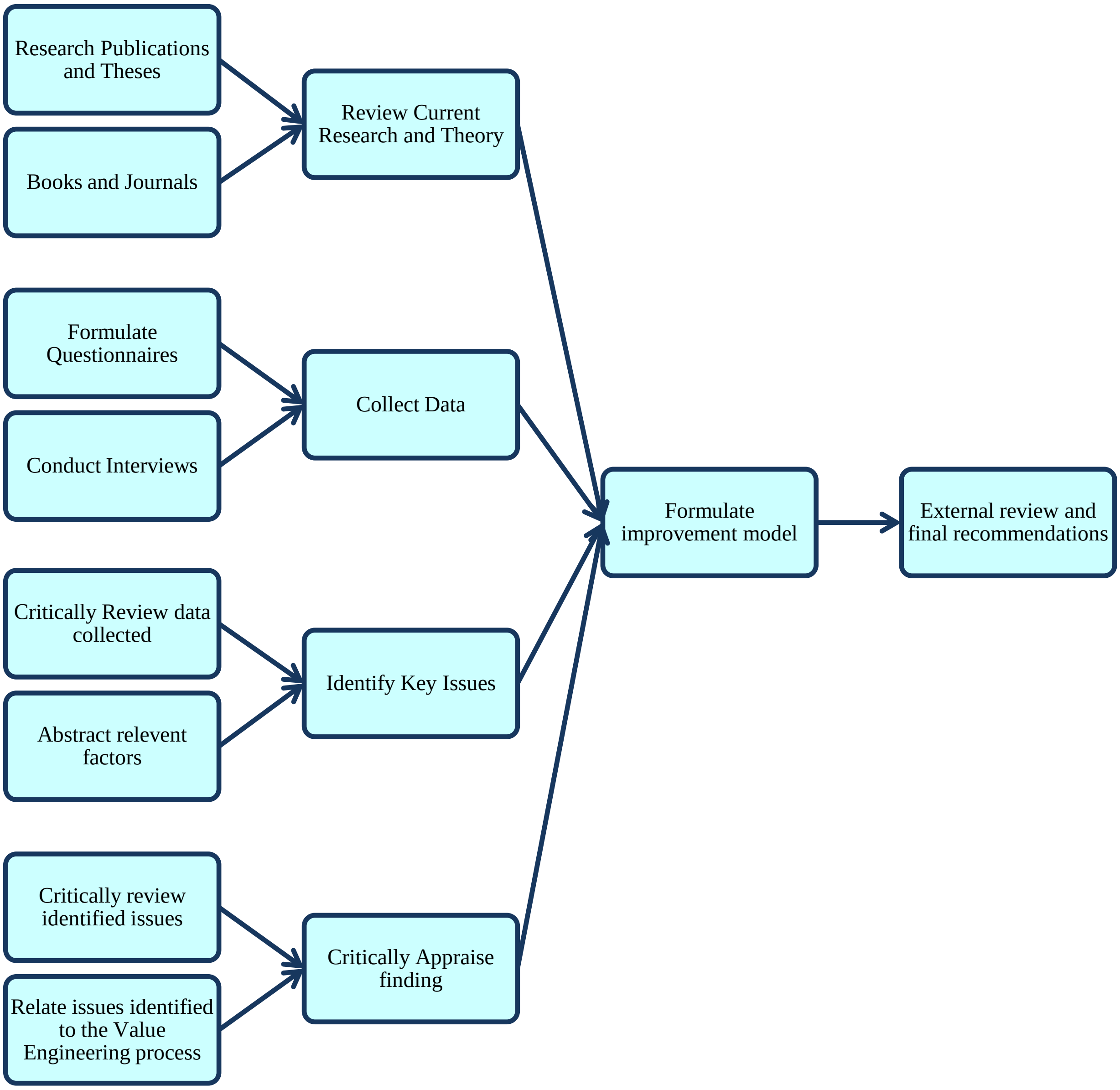


Figure 1.2 SMART value tree for the research process.

1.7 Limitation of the scope of the research

An underlying assumption had to made that the technical appraisal aspects of Value Engineering meet the basic precepts of, at least, maintaining the specified functionality, quality and performance required. The determination of precise technical compliance for all the constituent engineering disciplines involved in complex building projects is outside the scope of this research. Hence, predicted and actual overall ‘costs’ of the projects are used as the measured principle ‘outcome’ of the management of the Value Engineering process in the context of this research.

1.8 Scope of Research

To address the research objectives stated above, the following key data collection elements are employed:-

i) Review the current Value Engineering practices prevailing in construction projects in Abu Dhabi, United Arab Emirates, using literature review, questionnaires and structured interviews.

ii) Case studies of three (3) completed construction projects to verify, if the implemented Value Engineering practices are beneficial and tangible to the construction Industry.

These are required in order to understand current practices in Value Engineering in the United Arab Emirates and how they relate to practices worldwide. Also, to evaluate the effectiveness of implementation i.e. do the claimed outcomes match with what is been achieved in practice?

1.9 Layout of Thesis and Chapters

The layout of thesis contains eight (8) chapters which are illustrated in the flow chart Figure 1.3.

Chapter 1 provides an introduction to Value Engineering, background of research, prime aim and objectives of research, scope of research over view of Value Engineering for Abu Dhabi, United Arab Emirates construction projects and summary.

Chapter 2 presents the introduction, general research methodology, quantitative research, survey, case study research, qualitative research, structured interview, development of recommendations for improvements, research structure, comparison between quantitative and qualitative research, analysis of data by quantitative and qualitative method, research design, research flow chart and summary.

Chapter 3 is a literature review covering Value Engineering for projects, Value Engineering job plan, methods and techniques of Value Engineering, Value Engineering research work carried out by various researchers.

Chapter 4 presents brief history of United Arab Emirates, economic issues in the United Arab Emirates and the cultural and environmental issues affecting the Value Engineering in the United Arab Emirates construction industry.

Chapter 5 describes questionnaire structure and structured interview format used to assess the current effectiveness of Value Engineering in the United Arab Emirates construction projects. This collects both quantitative and qualitative information and includes a summary of findings.

Chapter 6 details case studies of three (3) completed construction projects in Abu Dhabi, United Arab Emirates to provide quantitative information on the implementation of Value Engineering in the United Arab Emirates.

Chapter 7 provides a discussion of findings, includes an overview of three (3) completed projects, questionnaire findings, and structured interviews and relates these to the thesis hypotheses. It discusses how Value Engineering can potentially be improved, specifically for Abu Dhabi, United Arab Emirates construction projects. An improvement model is developed and validated.

Chapters 8 and 9 present a summary and recommendations to improve effective Value Engineering practice for construction projects in Abu Dhabi, United Arab Emirates, followed by the final conclusions in Chapter 9.

(Chapter 1)

INTRODUCTION

Introduction, Green building and sustainable construction, background of Value Engineering, Background of research, aim and objectives and scope of research.

(Chapter 2)

RESEARCH METHODOLOGY

Review of research methodology, comparison between Quantitative and Qualitative research, the methodolgy adopted for the research, literature survey and research structure.

(Chapter 3)

LITERATURE REVIEW

Value Engineering process, methods of Value Engineering, Value Engineering techniques, Value Engineering overview, Value Engineering research work carried out by various researchers and identify key research issues.

(Chapter 4)

THE ENVIRONMENT AND CULTURE FOR VALUE ENGINEERING IN UNITED ARAB EMIRATES

Brief history of United Arab Emirates, present construction economic issues in the United Arab Emirates, the influence of culture, background to the United Arab Emirates construction industry, culture effects on engineer's role in the United Arab Emirates and the infulence of environment and culture on Value Engineering in United Arab Emirates.

(Chapter 5)

QUESTIONNAIRE DESIGN ANALYSIS AND REVIEW

Questionnaire Survey, Structured Interviews and summary of the findings.

(Chapter 6)

CASE STUDIES

Case studies of three (3) completed projects in Abu Dhabi, United Arab Emirates and the Value Engineering Workshop outcome including analysis.

(Chapter 7)

DISCUSSION OF FINDINGS

Detailed analysis, evaluation and findings of three (3) case studies, questionnaire and structured interview findings, formulation and improvement of model including validation, summary of findings and benefits of applying the model.

(Chapter 8 and 9)

SUMMARY AND RECOMMENDATIONS

Determining the validity of hypotheses, recommendations for the improvement in the implementation and effectiveness of Value Engineering for construction projects in Abu Dhabi, United Arab Emirates.

CONCLUSIONS

Figure 1.3 Layouts of Thesis and Chapters

1.10 Summary

The potential benefits of applying Value Engineering to construction projects in the United Arab Emirates have been recognised. However, there is limited information available as to how effectively this is being implemented and what benefits actually accrue.

The author shall have findings on data collected from construction professionals engaged in such projects by questionnaires and semi-structured interviews and includes case studies of three (3) completed projects in Abu Dhabi, United Arab Emirates.

1.11 References

1. Ashworth, A. and Hogg, K. (2000), *Added value in design and construction*, Pearson Publication Ltd., United Kingdom.
2. Abu Dhabi Urban Planning Council (2007), *Plan Abu Dhabi 2030*, *Urban Structure Framework Plan*, Abu Dhabi, United Arab Emirates.
3. Abu Dhabi Urban Planning Council (2010), *The Pearl Rating System for Estidama, Building Rating System Design and Construction version 1.0*, Abu Dhabi, United Arab Emirates.
4. Brian, R.N. and William, C.M. (1995), *Value Engineering in Saudi Arabia*, SAVE International Conference, pp 9-17.
5. Cheah, C.Y.J., and Ting S.K. (2005), *Appraisal of Value Engineering in construction in Southeast Asia*, International Journal of Project Management, 23, pp 151-158.
6. Dallas, M.F. (2006), *Value and Risk Management A Guide to Best Practice*, Lackwell Publishing Ltd, U.K.
7. Foreman, C. and Roberts, J., (2010), *Meed, Middle East Business since 1957*, pp 6- 22, Volume 54 No. 24. William Gibbons, U.K.
8. Kelly, J., Male, S. and Graham D. (2004), *Value Management of construction projects*, Blackwell Publishing, United Kingdom.
9. Kelly, J., Morledge, R. and Wilkinson, S. (2006), *Best value in construction*, Blackwell Science Limited, United Kingdom.

10. Lin, G.B., Shen, Q.P. and Fan, S.S. (2004), *A Framework for Performance Measurement of Value management Studies in construction*, Proceeding of the 3rd International Conference on Construction and Real Estate Management, China Architecture & Building Press, Hong Kong, pp 307-311.
11. Luke, A. (2009), *Forming Features, What strategies are formworks companies implementing,* i*n order to counteract the Economic slowdown*? Construction week investigates, Construction Week, May 2-8, pp 27-28.
12. Nadem, A.B.A.T. (2009), *Understanding and Preventing Construction Conflict, claims and Disputes, A critical in-depth study into their causes and recommendations to control in the United Arab Emirates,* PhD Thesis, University of Glamorgan.
13. Norton, B.R. and McElliot W.C. (1995), *Value Management in Construction: A Practical Guide,* Macmillan Press Ltd., London, United Kingdom.
14. Paget, S. (2008), *Value Engineering and sustainability*, Annual Conference Paper and Presentation Abstracts, SAVE International.
15. Roe, B. (2009), *Value Engineering for Sustainable Data Centres,* Built Environment, Nov-Dec 2009.
16. Seraphim, D. (2005), *Implementing TQM principles in a construction company in the U.A.E*; PhD Thesis, University of Glamorgan.
17. Salama, M. and Habib, A.P. (2009), Investigating the cases of variation within the Construction Projects in U.A.E. In: Dainty, ARJ (Ed) procs 25th Annual ARCOM Conference, 7-9 September 2009, Nottingham, UK, Association of Researchers in Construction Management, pp 949-957.
18. Shen, Q.P. and Chung, J.K.H. (2002), "A group decision support system for value management studies in the construction industry". *International Journal of Project Management*, 20, pp 247-252.
19. Shen, Q.P., Lin G.B., Kelly, J. and Sun, M. (2005), "*Measuring the Processes and Outcomes of Value Management Studies in Construction*". Proceeding of the 7thInternational Value Management Conference – Why Re-Invent the wheel, Hong Kong Institute of Value Management, 2-3 June, Hong Kong.
20. Siterman, E. (2009), *A "perfect storm" boosts Value Engineering in Dubai*, Construction Week from 07 April 2012, www.constructionweek online.com.
21. Wilen, J. (2008), *Sustainable building and green buildings,* United Arab Emirates.

CHAPTER 2

RESEARCH METHODOLOGY

2.1 Introduction

This chapter describes the research methodology adopted by the author for determining the effective implementation of Value Engineering in building construction projects in Abu Dhabi, United Arab Emirates. The first part of this chapter deals with methodology adopted for research. The remaining part deals with the layout of the research work, which is directed towards improving effectiveness of Value Engineering.

2.2 Review of Research Methodology

The main aim of this research is to improve the building construction process by assessing the effectiveness of the application of Value Engineering principles. The framework planned by the author aims to address the research objectives and to achieve specific improvement in the construction projects. The following sub-sections review currently accepted research methods.

2.2.1 Type of Research Methods

In general, *"there are three types of research methodologies: quantitative, qualitative and a combination of both methods called triangulation or mixed method*", Punch (1999); Fellows and Liu (2003); Neuman (2006). *"Research is a systematic investigation to find an answer to a problem*", Blaxter et al. (2006) *"while research methodology refers to the principles and procedures of logical thought processes which are applied to this investigation*", Fellows and Liu (2003), Klien and Myers (1999) and Kagioglou et al. (1998) introduce a nested approach to describe a hierarchical model of research methods that is divided into three main inter-related themes: research philosophy, research approaches and research technique, as shown in Figure 2.1. The research philosophy found at the outer ring guides the inner research approach and research technique. The research approach consists of domain theory generation and testing methods. The research technique comprises data collection tools.

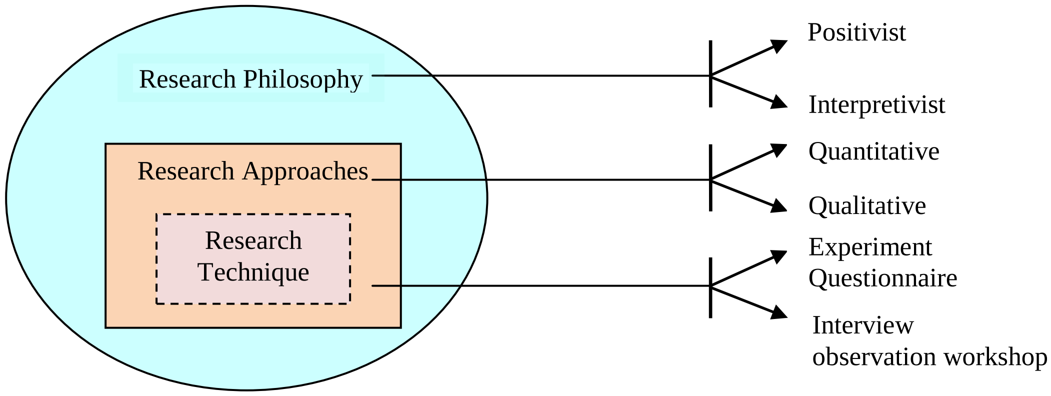


Figure 2.1 Nested approach of research methodology, Kagioglou et al. (1998)

Prior to discussing the methodology adopted in this study, the following sections review the characteristics, advantages and disadvantages of these research methods.

"There are three (3) main types of research methodologies, quantitative, qualitative and a combination of both methods called triangulation or mixed method", Fellows and Liu (2003) and Neuman (2006).

2.2.2 Quantitative Research

"The quantitative research methods are regarded as specific and positive research methods for gathering factual data and studying the relationship between facts in order to find out how such facts and relationship accord with the theories of previous research", Fellows and Liu (2003) and *"determines whether a hypothesis holds"*, Creswell (1994). In addition, *"quantitative methods can be employed to establish general laws or principles"*, Burns (2000).

The quantitative research tends to involve either the use of experimental methods or the use of structured questionnaires and interviews, often conducted with large number of participants. In this research work, the author was restricted in using such methods as a consequence of the relatively small sample possible. *"It often involves the collection of a large amount of data sets if compared with the qualitative approach"*, O'Leary (2004). Three main approaches are used in data collection for quantitative research, Fellow and Liu, (2003), namely:

- *Asking questions of respondents by questionnaires and interviews;*
- *Carrying out experiments; and*
- *'Desk Research' using data collected by others.*

Here, two commonly used quantitative research methods are explained.

2.2.2.1 Surveys

This is a method in which the research systematically asks a large number of people the same question and then records their answers. *"It is appropriate for analysis of groups' interactions; the collection of original data for describing a population too large to observe directly; investigating attitudes and orientation in a large population; and describing the characteristics of a large population"*, Neuman (2006).

There are two main types of data collection methods in survey research, which includes face-to-face or telephone interviews and the questionnaire survey. The advantage of this survey lies in gathering data from a relatively large number of respondents within a limited time frame. It is thus concerned with a generalised result when data is abstracted from a particular sample or population. The disadvantage is that little insight is usually obtained regarding the causes or the processes behind the phenomenon being studied. Also, survey studies are subject to some well-known biases. For example, *'respondents may change their answers either consciously or unconsciously, to show themselves in a better light or to confirm to the expectation of those who are studying them'*, Naoum (1998).

2.2.2.2 Experimental Research

"Experimental research is best suited to known problems or issues where the variables involved are identified, or are, at least, hypothesised with some confidence", Fellows and Liu (2003). Hence, *"it can be thought of as systematic trial and observation trial because the answer is not known beforehand, observation because the result must be carefully recorded, and systematic because all good research is planned and purposeful"*, Melville and Goddard (1996).

According to Fellows and Liu (2003), *"there are two approaches to experimental research-laboratory experiments and field experiments"*. Laboratory experiments are usually carried out to test relationships between identified variables, by holding all except one variable constant and then testing the effect on dependent variables by changing one independent variable. This is done with a view of making generalised statements applicable to real world situation. *"Field experiments are not conducted in specially built laboratories but in dynamic social, industrial, economic and political areas"*, Gallier (1992). The key strength of experimental research is its control and logical rigour in establishing evidence for causality. In general, *"experiments tend to be easier to replicate, less expensive and less time consuming than the other techniques"*, Neuman (2006), *"but it is extremely difficult in a study involving human individuals"*, Alasuutari (1998).

2.2.3 Qualitative Research

"The qualitative research method is regarded as naturalist, subjectivist or interpretive research method and tends to focus on exploring in much detail a smaller number of instances which are seen as being interesting or illuminating", Blaxter et al. (2006). *"Its data sets are relatively small scale"*, O' Leary (2004) and *"chiefly non- numeric, such as in the form of text and image"*, Punch (1998). This is because it aims *"to investigate and gain insight into the beliefs, understandings, views, opinions, etc. of people involved in depth rather than breadth"*, Fellows and Liu (2003). *"The tools for qualitative research are action research, case study, ethnographic research and ground theory"*, Neuman (2006). *"The analysis of qualitative data involves filtering, sorting and other manipulations to prepare them for analytic techniques"*, Fellows and Liu (2003). Detailed discussions of qualitative research approach are presented as follows.

2.2.3.1 Ethnographic Research

"Ethnographic research in its broadest sense may be defined as the science of cultural description and is best accomplished by immersing oneself in the socio-cultural situation under study", Lang and Heiss (1984). *"The focus of investigation is on the everyday behaviour (e.g. interactions, language, rituals) of the people in the group, with an intent to identify cultural norms, beliefs, social structures, and other cultural*

patterns", Leedy and Ormord (2001). *"Some researches in the field of information systems appear to turn to ethnographic research for information systems"*, Hughes et al. (1992), and *"design and evaluation of information system"*, Myers (1999). The key strength of this method is that it gives a detailed view of the entire cultural scene by pulling together all aspects learned about the group and showing its complexity. *"The disadvantages is that it may have limited generalisibility to other topics or domains and it takes a lot longer than most other kinds of research"*, Mohamed (2006).

2.2.3.2 Action Research

"Action research is a vague concept but it has been defined as research that involves practical problem-solving which has theoretical relevance", Humford (2001). *"Active involvement by the researcher is essential for identifying, promoting and evaluating problems and potential solution"*, Fellows and Liu (2003); Foster (1972). *"Action researches intend not only to contribute to existing knowledge but also to help resolve some of the practical concerns of the people, or clients, who are trying to deal with a problematic situation"*, Gill and Johnson (2002).

2.2.3.3 Case Studies

"The case study approach is problem-oriented and is applicable to an individual, a group of people, an institution, or a whole community", Lang and Heiss (1984). Yin (2003) defined the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, when the boundaries between phenomenon and context are not clearly evident, and with multiple sources of evidence. *"It differs from action research in that the case study researcher seeks to study (organisational) phenomena and not to change them, unlike the action researcher who is often directly involved in planned organisational change"*, Avision et al. (2001).

According to Johnston et al. (1999), good and effective case study research should have the following elements:

- The research must begin with hypotheses developed by theory;

- The research design must be logical and systematic; and
- The findings must be independently evaluated.

Hence*, "case studies are best used in studies that require deeper understanding of how and why things happen"*, Yin (2003) *"rather than testing the relationships between them"*, Gordon and Langmaid (1998).

Case studies can be either single or multiple. The single case study is analogous to a single experiment, and many of the same conditions that justify a single experiment also justify a single case study. It is appropriate where the objective is to develop a new theory rather than to test, develop or prove an existing theory or to establish statistical generalisation. *"When there is more than one single case, the study has to use multiple-case studies. In this situation, the term (single or multiple case studies) refers to the way in which the results of the study can be interpreted, in other words, what is the best way to consider the study either as serial (single) or parallel (multiple) designs"*, Ganah (2003).

"The key strength of case study research is that it is suitable for learning more about a little known or poorly understood situation", Leedy and Ormrod (2001). *"It also enables the researcher to compare a number of different approaches to the same problem in sufficient detail as to be drawn out lessons which have general applicability"*, Moore, (2000). In addition, *"case studies can help in achieving greater realism in research, and requires a responsibility holistic research"*, Graham (2000). They may also be useful for investigating how an individual or program changes over time, perhaps as the result of certain circumstances or interventions.

"The weakness of cases studies is that they are usually restricted to a single event or organisation; providing a limited basis for additional 'scientific' generalisation", Yin (2003). Hence, they are often used as an example of processes, their antecedents and outcomes; this process may last for months or years and the resultant delay in the publication of the research results can mean that when they are published they may be out-of-date. Another weakness is that the data collection and analysis process *"maybe*

influenced by the researcher's interpretation of events, documents and interviews", Drake et al. (1998).

2.2.4 Triangulation

"Triangulation is the combination of quantitative or qualitative methods in the study of the same phenomenon", Amaratunga et al. (2002). It can be a very powerful tool to gain insight and results, to assist in making inference and in drawing conclusion, as illustrated in Figure 2.2. The initial and obvious benefit of this is that it will involve more data, thus being likely to improve the quality of the research, Denscombe (2003). Furthermore, researchers see things from different perspectives and understand the topic in a more rounded and complete fashion than would be the case with data drawn from just quantitative approaches, Fellow and Liu (2003); Denscombe (2003). For example, using a quantitative method such as a questionnaire survey can provide a broad idea of the subject studied, and combining it with qualitative methods such as interview or case studies provides a better understanding of the same study. Most importantly the triangulation approach provides an opportunity to corroborate findings that can enhance the validity of the data. *"They do not prove that the researcher has 'got it right', but they do give some confidence that the meaning of the data has some consistency"*, Denscombe (2003).

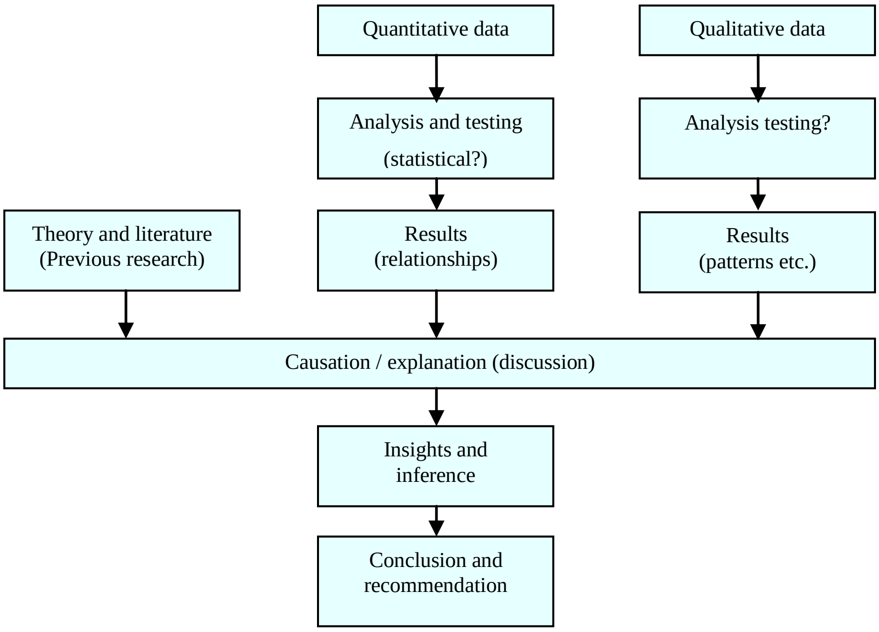


Figure 2.2 Triangulation of quantitative and qualitative Data, (Source: Fellow and Liu, 2003)

According to Easterby-Smith et al. (2001), there are four distinct categories of triangulation: theoretical, data, investigator and methodological:

- *Theoretical triangulation* involves borrowing models from one discipline and using them to explain situations in another discipline

- *Data triangulation* refers to research where data is collected over different time from different sources

- *Investigator triangulation* is where different people collect data on the same situation and the results are then compared

- *Methodological triangulation* uses both quantitative as well as qualitative methods of data collection. These are extremely diverse and include questionnaires, interviews, telephone surveys and field studies.

Through the aforementioned review, these quantitative and qualitative research methods have their own distinguishing characteristics, strengths and weakness. This is why the use of triangulation research is often encouraged. Table 2.1 shows a summary of comparisons between the two methods.

Major research methodologies have been briefly reviewed as above. In the following sections, the research is designed and methods selected based on in-depth understanding of the research objectives.

Table 2.1 Distinguishing characteristics of quantitative and qualitative methods

[Neuman (2006); Abdullah (2003); Amaratunga et al. (2002) and Leedy and Ormrod (2001)]

Characteristics	Quantitative Research	Qualitative Research
Purpose	• To explain and predict • To confirm and validate • To test theory	• To describe and explain • To explore and interpret • To building theory
Process	• Focused • Known variables • Established guidelines • Statistic design • Context free • Detected view	• Holistic • Unknown variable • Flexible • Emergent design • Context-bound • Personal View
Research Procedures	• Procedures are standard, and replication is frequent	• Research procedure are particular, and replication is very rare
Data Collection	• Representative, large sample • Standardised instruments	• Informative, small sample • Observation, interview
Theory	• Theory is largely caused and is deductive	• Theory can be causal or non-casual and is often inductive
Data Analysis	• Analysis proceeds by using statistic, tables or charts and discussing how they show relates to hypothesis	• Analysis proceeds by extracting themes or generalisation form evidence and organising data to present a coherent, consistent picture
Reporting Finding	• Numbers • Statistic, aggregated data • Formal voice, scientific style	• Word • Narratives, individual quotes • Personal voice, literary style
Strengths	• Provide wide converge of the range of situation • Fast and economical • Where statistic are aggregated from large samples, they may be considerable relevance to policy decisions	• Data gathering methods seen as natural than artificial • Ability to look at change process over time • Ability to understand people's meaning • Contribute to theory generation
Weakness	• Tend to be rather inflexible and artificial • Not very effective in understanding process • Not very helpful in generating theories	• Data collection can be tedious and require more resources • Analysis and interpretation of data may be more difficult • Harder to control the pace progress and end-points of research process

2.3 The methodology adopted for the research

The main aim of the research is to investigate possible areas of improvement that could potentially enhance the effectiveness of the Value Engineering in building Construction Projects in the United Arab Emirates. In order to achieve this aim and the specific objectives in accordance with Section 1.6 both quantitative and qualitative research approaches were adopted by the author.

It became apparent at an early stage in this research that there was very limited published information relevant to this research. The primary potential sources of data identified by the author were:-

1. Construction specialists working on projects in the United Arab Emirates (Designers and Contractors).

2. Value Engineering specialists with experience of projects in the United Arab Emirates (Consultants and Client Employees).

3. Records of projects executed in the United Arab Emirates that were accessible to the researcher.

In order to utilise all available information it was therefore necessary to use the triangulation, or ‘mixed method’, described in Section 2.2.4. The overview of link between data and analysis is shown in Figure 2.3.

The research methods employed were selected as being as most appropriate to each of the three primary data services identified above. The rational for the selected methods are explained below under the data source headings.

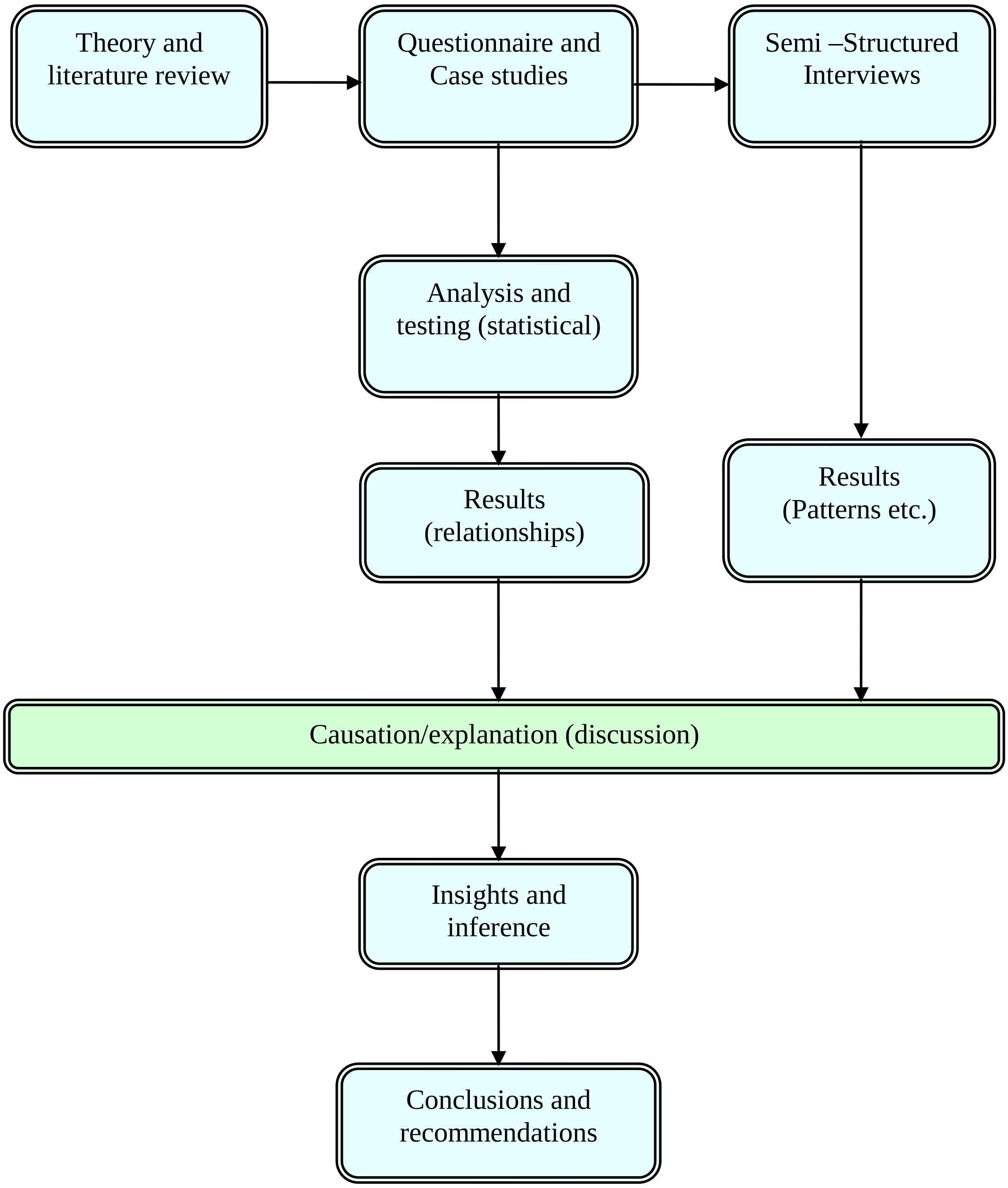


Figure 2.3 Combined method of analysis and data collection used in this research.

2.3.1 Data from Construction Specialists.

A questionnaire format was used in this case for the following reasons:-

- As large a sample as possible could be targeted in a limited time.
- This could be used to collect both qualitative and quantitative data.

This data could enable an overview of the perception and application of Value Engineering by construction professionals in the United Arab Emirates. It is accepted that there would be some bias and subjectivity in the data but by taking as large a sample as possible it would provide a focus for more detailed investigation.

2.3.2 Data from Value Engineering Specialists

There are a limited number of Value Engineering specialists working in the United Arab Emirates, and a limited number of these would be likely to agree to contribute to this research. Hence, a more specific and targeted approach to data collection from this group was required.

It was decided that a survey based on a semi-structured interview would be the most appropriate for the following reasons.

1. Specific issues identified in the literature review and from the initial questionnaire returns from construction professionals in the United Arab Emirates, could be incorporated in a second questionnaire used as a focus for face to face interviews.

2. In-depth questioning on targeted issues can be used to gain greater insight into specific areas of this research.

3. Respondents are in a better position to comment on how Value Engineering practice in United Arab Emirates follows accepted practices and what are the attainment outcomes.

2.3.3 Case Studies

The author was fortunate to have full records of three major projects in the United Arab Emirates that had used the Value Engineering process.

This enabled the author to:-

A. Assess the implementation and outcomes of the Value Engineering and compare with accepted practices and accepted norms.

B. Assess if the 'processes' and 'outcomes' match the views and perceptions expressed in the first two data sets.

Whilst the numbers of case studies are limited, it can provide an in-depth insight into Value Engineering practices in the United Arab Emirates.

2.3.4 Modelling for improving the effectiveness of Value Engineering application.

Having collected and evaluated the data collected, a 'model' can be constructed on the basis of insights and inferences gained. Modelling is the process of constructing a model, a representation of a designed or actual object, process or system. *"For a representation of reality, it must include the essential features of reality whilst being reasonably cheap to construct and operate and easy to use"*, Fellows and Liu (2003). The modelling process is depicted in Figure 2.4.

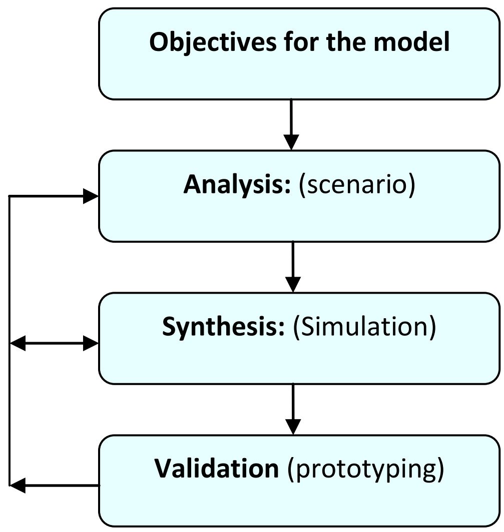


Figure 2.4 Modelling process

It is necessary to demonstrate that the proposed Value Engineering model could work well in a building construction projects. With this objective in the mind, three methods can be used to accomplish this objective:

1) Analysis (Scenario)

The scenario design often combines with other research models, such as case study or survey (interview and questionnaire) in order to identify all possible scenarios and key factors in each scenario, Glenn and Gordon (2003).

2) Synthesis (Simulation)

Simulation is used to assist prediction of the behaviour of reality and / or to revise a model to enhance its predictive accuracy or predictive capability; Morgan (1984) suggests a variety of proposals for simulation;

- Explicitly mimic the behaviour of a model.
- Examine the performance of alternative techniques.
- Check mathematical / analytic model.

In developing the model the researcher examined the data to identify deficiencies and areas of improvement and hence provide guidelines for improvement in a 'model' form.

Due to the nature, uniqueness and scale of the projects 'simulation' could not be meaningfully achieved.

3) Validation (Prototyping)

Research can be generally, individual work which discovers and describes existing reality (explorative research) or which aims at creating a new reality (e.g. new technology or processes) that needs to be evaluated and justified. The research described in this thesis aims at developing a model framework that can be used in improving the effectiveness of Value Engineering applications. Laudon and Laudon (2002) defined *"prototyping as a process of building an experimental system quickly and inexpensively for demonstration and evaluation, so that the users can gain better information"*.

2.3.5 Evaluation

Evaluation is used to represent the appraisal of the whole system. Within evaluation, it is generally agreed that there are two sub-sections, namely verification and validation, which are defined as follows, Miles et al. (2000):

- Validation is the process which determines whether or not a system meets the required specification and is suitable for its intended purpose. Validation ensures that the model has been formulated in the intended manner.

- Verification is the process of ensuring that the product does not contain any technical errors. Verification ensures that the model has been formulated correctly.

In this research the validation of the model was achieved by independent evaluation by Value Engineering professionals with experience of United Arab Emirates construction projects. The model was then revised and amended appropriately.

2.4 Literature Survey

An extensive range of literature such as books, journal papers, industrial and academic reports, internet information and discussion was reviewed in this research works in order to:

- ➢ establish the general background to research

- ➢ allow the research issues to be identified

- ➢ provide the historical knowledge of the research topic and also ensures that the most current developments and thinking

The critical review of literature is mainly focused on the following:

- ➢ Various aspects of Value Engineering current practices prevailing in the United Arab Emirates including, relevant construction management factors, particularly any implemented practices where any financial benefits related to reduction of unnecessary costs without compromising design specifications, functionality, operation and maintenance of the projects.

- Value Engineering principles, methods and their applications to various construction project types were reviewed covering the Middle East, USA, UK and Asia.

- Recommended management procedures and control models were also reviewed and discussed for the application of Value Engineering to improve practices for achieving financial benefits to the construction projects.

The literature was updated and reviewed throughout the research to ensure that the most current reviewed publications were consulted and considered in this research.

Based on a literature survey carried out by the author, specifically for the construction projects in Abu Dhabi, United Arab Emirates, the current practices of Value Engineering are summarised and are presented in Chapter 3. The literature survey directed the author to specific aspects of research in relation to the effective applications of Value Engineering in Abu Dhabi, United Arab Emirates based projects. In this study, the measurement of current performance relevant to this research was carried out on the case studies of three (3) completed projects in Abu Dhabi, United Arab Emirates.

2.5 Details of Data Collection

- **Questionnaire Survey 1**

  This requires both factual and subjective responses from participants.

- **Semi-Structured Interview based on Questionnaires 2 and 3**

  This again generated a mixture of factual and subjective information.

- **Case Studies**

  These provide factual data from three (3) construction projects.

2.5.1 Questionnaire Survey No.1

This survey was distributed to a range of professionals working in the construction industry in the United Arab Emirates. The objective here is to gain an overview of the experience and perception that these groups of people have of Value Engineering, and relevant issues identified in the literature review. It is appreciated that some of the answers would be subjective and contains opinions; however it can provide a useful insight into the perception that construction professionals, across a wide spectrum, have of the Value Engineering process.

This use of a questionnaire enables a wide range of viewpoints on a range of factors relevant to this research to be collected and evaluated quite rapidly.

2.5.2 Semi-Structured Interviews based on Questionnaires Nos. 2 and 3

This data set addresses exclusively to the Value Engineering specialists with experience of working in the United Arab Emirates.

This questionnaire targets specific areas of relevance to the research identified in the literature review. By using these questionnaires as a basis for the accompanying interview it is possible to obtain an in-depth evaluation of the issues raised. This provides an insight into how Value Engineers view the implementation of the process in the United Arab Emirates. This can provide a deeper understanding of the topic and allows the respondents to express and to qualify their opinions.

The format used was to have a series of ‘trigger questions’ and then use a series of related issues to the trigger questions, to stimulate discussion. This provides a more in-depth evaluation of the issues raised.

The interviews, based on a set of questions, were conducted to obtain information from experienced Value Engineering Specialists. The questions were based on knowledge obtained from the literature review and the author’s experience on Value Engineering in the construction projects. The topics covered for interviews are as follows:

- The current status of Value Engineering practices in the United Arab Emirates including application situations, procedures, documentation required, factors for consideration and decision criteria.

- Major influencing factors and benefits achieved in Value Engineering in the United Arab Emirates.

- Factors needed to be researched in order to improve the current situations and application practices for Value Engineering in the United Arab Emirates.

All responses from interviews were categorised based on the respondents' professional grouping and whether they were an Emirati or not. The responses were also compared with the key research issues identified in the literature review. The findings of the semi structural interviews are presented in Chapter 5 and discussed in Chapter 7.

2.5.3 Case Studies

The author carried out three (3) case studies representing a range of residential, commercial and hospital building construction projects in Abu Dhabi, United Arab Emirates. The project description and scope of works are detailed in Chapter 6. In this case study research, the author assessed the Value Engineering findings and predicted benefits for the completed three (3) construction projects, during the design stage and prior to the tendering stage. Then, to evaluate if the predicted benefits, were fully achieved during the construction stage, the findings were analysed to assess the effectiveness of Value Engineering applications in the United Arab Emirates and to seek potential methods of improvements. The research findings of the case studies are presented and discussed in Chapter 6 and 7.

The reason why they are used in this study is that they provide an insight into how Value Engineering is being applied in specific cases and provides the opportunity to collect factual information on processes and outcomes. It then becomes possible, using the previously noted questionnaires to compare perception, viewpoint and performance.

Perception (of a range of professionals working in construction)

↓

Viewpoint (of specialists in Value Engineering)

↓

Performance (over selected case studies)

All the data are sourced in the United Arab Emirates and hence, accurately reflect what the current situation is in relation to these issues.

2.6 Research Structure

The research structure is divided into six (6) main stages which are shown in the Figure 2.5 and detailed in the following sections. These are aimed at addressing the three hypotheses:

- Value Engineering is currently being effectively implemented.
  - Does it conform to what are widely agreed to be an acceptable implementation process?

- Value Engineering currently provides tangible and measurable benefits.
  - Are projected and attained benefits assessed and evaluated, if so at what stages of the project?

- Current practices of application of Value Engineering can be improved.
  - Based on the research findings, is there evidence that the current practices can be improved?

Once these issues have been addressed, it will be possible to assess whether recommendations for improvement can be made and hence, if an improvement 'model' can be formulated.

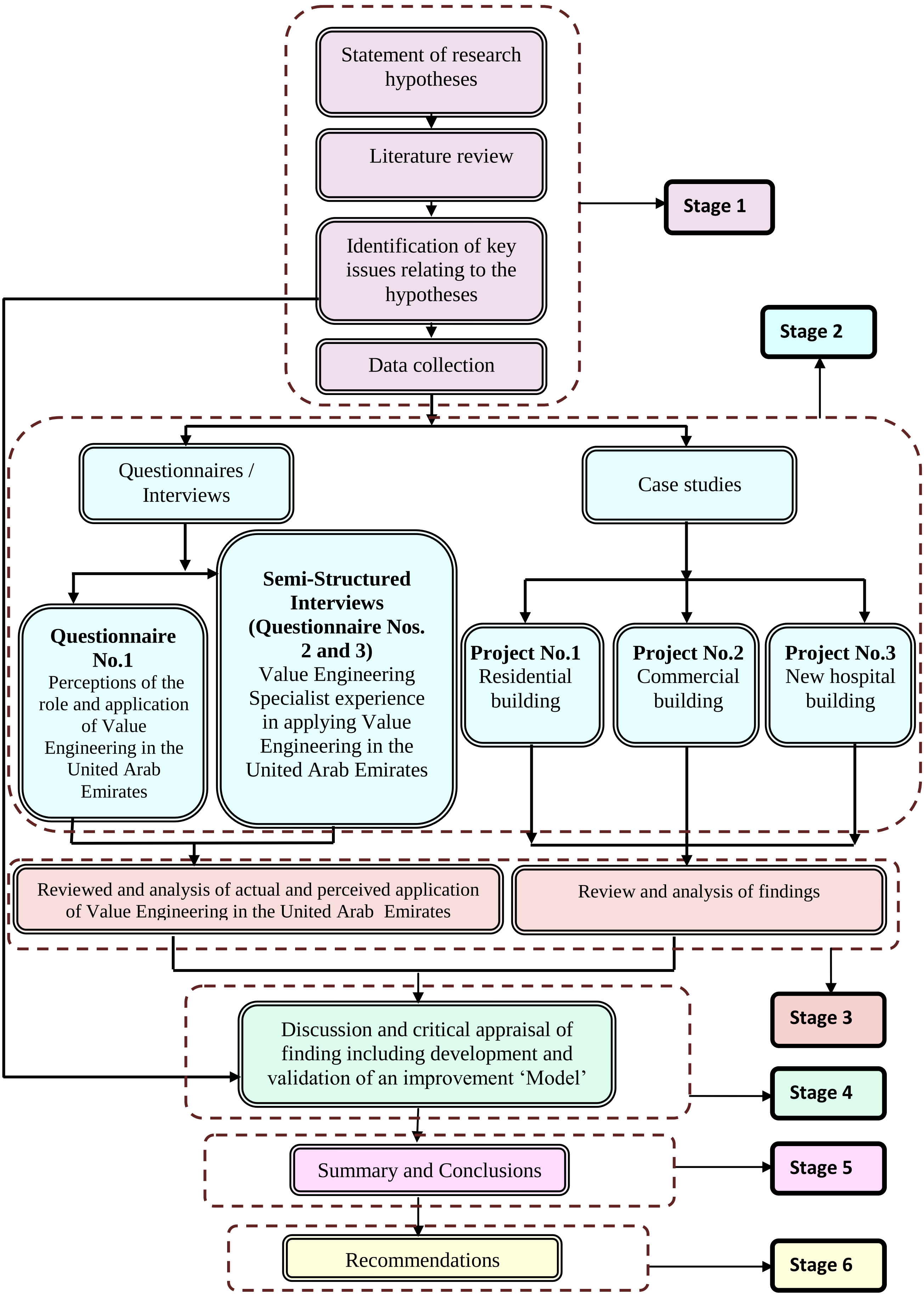


Figure 2.5 Research Structure Flow Chart

2.6.1 Stage 1 - Literature review and Identification of Key Issues

A literature review is conducted to establish what is currently regarded as the best practices and expert views in the field of Value Engineering. Of particular note is any published information relating to its application in the United Arab Emirates.

Appraisal of this information leads to the identification of key issues relating to the hypotheses which form the basis of the formulation of the questionnaire and items for particular consideration in the case studies.

2.6.2 Stage 2 – Data Collection

The data Information is collected by two methods, Questionnaires together with Semi-Structured Interviews and Case Studies.

2.6.2.1 Questionnaires

Questionnaire No. 1 was prepared on the basis of factors identified in the literature review.

This was issued to a range of professionals in the construction industry in the United Arab Emirates in order to ascertain their perceptions on the role, implementation, and benefits of Value Engineering.

2.6.2.2 Semi-Structured Interviews based on questionnaires 2 and 3

Questionnaires Nos. 2 and 3 were prepared on the basis of factors identified in the literature review and in questionnaire 1.

These were only completed by members of companies specialising in applying Value Engineering in the United Arab Emirates. These questionnaires No. 2 and 3 were used as a basis for discussion and contain more detailed questions on the practical application and current management of Value Engineering in the United Arab Emirates.

2.6.2.3 Case Studies

Due to the author's role, seniority and experience within his employers' organisation extensive and detailed project information was accessible. As this research is focused on the construction in Abu Dhabi, United Arab Emirates, three (3) projects were selected as being representative of major projects in the region.

Case Study 1 - Residential building projects

- Ruwais Housing Complex Expansion – Phase III
  Married Accommodation and related Facilities including Infrastructure.

Case Study 2 - Commercial building projects

- ADNOC Group of Companies Headquarters – Phase I and II

Case Study 3 - Hospital building projects

- Ruwais Housing Complex Expansion – Phase III
  New Hospital and related Facilities including Infrastructure.

The results from these different aspects of building construction were deemed to provide a more representative evaluation of current Value Engineering implementation in the United Arab Emirates.

2.6.3 Stage 3 - Review and Analysis of findings

This was undertaken in two steps.

Step 1: The results from the data collection stage were examined individually and a summary of the analysis of each separate set of data presented.

Step 2: The findings of the two separate data sources, questionnaires and case studies were then collated and critically appraised and discussed.

2.6.4 Stage 4 – Discussions and Critical appraisal

This appraises the findings of data collection to evaluate if the key issues, identified in the literature review, are being successfully addressed. The hypotheses are then reviewed to evaluate if improvements are viable. Any improvement possibilities can then be identified and be used to develop a 'model' for improvement.

The developed model can be further independently validated and improved by incorporating comments from clients and professionals in the United Arab Emirates.

2.6.5 Stage 5 - Summary and conclusions

The summary provides an overview of the above findings and the validity of the hypotheses established. The key findings are stated in the conclusions.

2.6.6 Stage 6 – Recommendations

The proposals for future research resulting from the findings in Stages 4 and 5.

2.7 Summary

This chapter describes the background and rationale for the research methodology employed. The research work is based on literature review, framework development, and data collection and modelling. The findings of each part of research are used to contribute to the development of the next stage of study.

2.8 References

1. Abdullah, A. (2003), *Intelligent Selection of Demolition Technique*. PhD Thesis, Loughborough University, Berkshire.
2. Alasuutari, P. (1998), *An Invitation to social research*, Sage Publication, London.
3. Amaratunga, D., and Baldry, D., Sarshar, M. and Newton, R. (2002), *Quantitative and Qualitative Research in the Built Environment: Application of 'Mixed' Research Approaches*, Work Study, vol.551, pp 17-31.

4. Avison, D., Baskerville, R. and Myers, M. (2001), *Controlling action research project*, Information Technology and People, Vol.14, pp 28 – 45.
5. Blaxter, L., Hughes C. and Tight M. (2006), *How to research,* 3rd edition, Open University Press, England.
6. Burns, R.B. (2000), *Introduction to research,* Sage Publication, Thousand Oaks, California, United States.
7. Creswell, J. (1994), *Research Design: Qualitative and Quantitative Approaches*, Sage Publication, Thousand Oaks, California.
8. Darke, P., Shanks, G. and Broadbent, M. (1998), *Successfully Competing Case Study Research: Combining Rigour, Relevance and Pragmatism*, Information system Journal, Vol. 8, pp 273-289.
9. Denscombe, M. (2003), *The good research Guide - for small-scale social research project*, 2nd edition, Open University Press, Maidenhead, Philadelphia.
10. Easterby-Smith, M., Thorpe, R. and Lowe, A. (2002), *Management Research: An Introduction*, Sage Publication, London.
11. Fellows, R. and Liu, A. (2003), *Research method for construction,* 2nd edition, Blackwell Publishing, Oxford, United Kingdom.
12. Foster, M. (1972), *An Introduction to the Theory and Practice of Action Research in Work Organisation*, Human Relations, vol.25, pp 529-556.
13. Gallier, R. (1992), *Information System Research: Issues, Methods and Practical Guidelines*, Blackwell Scientific, Oxford.
14. Ganah, A.M. (2003), *Computer Visualisation Support for Billability*, PhD thesis, Loughborough University.
15. Gill, J. and Johnson, P. (2002), *Research Method for Managers*: 3rd Edition, Sage Publication, London.
16. Glenn, J.C. and Gordon T.J. (2003), *Futures Research Methodology*, ACUNU Millennium Project.
17. Gordon, W. and Langmaid, R. (1998), *Qualitative Market Research: A Practitioner's and Buyer's Guide*, Gower, Aldershot.
18. Graham, M.P. (2000), *The Strategic Phase of Privately Financed Infrastructure Project*, PhD Thesis, University of Leeds.

19. Hughes, J.A., Randall, D. and Shapiro, D. (1992), *Faltering from Ethnography to Design*, Proceeding of CSCW 92. ACM 1992 Conference on Computer-Supported Cooperative Work: Sharing Perspective, New York: ACM Press, pp 115-123.
20. Humford, E. (2001), *Advice for an Action Researcher*, *Information Technology and People*, Vol.14, pp 12-27.
21. Johnson, W.J., Leach, M.P. and Liu A.H. (1999), *Theory Testing using Case Studies in Business-to-Business Research*. Industrial Marketing Management, Vol.28, pp 201-213.
22. Kagioglou, K., Cooper, R., Aoud, G., and Sexton, M. (1998), *Rethinking Construction: The Generic Design and Construction process Protocol, Engineering, Construction and Architectural Management*. Vol. 7, pp 141-153.
23. Klien, H.K. and Myers, M.D. (1999), *A set of Principles for conducting and evaluating interpretive field studies in information systems*, MIS Quarterly, Vol.23, pp 67-94.
24. Lang, G. And Heiss G. (1984), *A Practical Guide to Research Methods*, University Press American. Lanham.
25. Laudon, K.C. and Laudon, J.P. (2002), *Management Information System: Managing the Digital Firm*, 7th Edition, Prentice Hall, New Jersey.
26. Leedy, P.D. and Ormrod, J.E. (2001), *Practical Research Planning and Design*, 7th edition, Prentice – Hall, New Jersey.
27. Melville, S. and Goddard, W. (1996), *Research Methodology: An Introduction for Science and Engineering Students*, Creda Press, Cape Town.
28. Miles, J.C., Moore, C.J., Kotb, A.S.M. and Jaberisan, H.A. (2000), *End User Evaluation of Engineering Knowledge Based Systems*, Civil Engineering and Environmental Systems, Vol.17, pp 293-317.
29. Mohamed, F.S. (2006), *Integrating Knowledge Management Processes into Site management Practices*, PhD thesis, Loughborough University.
30. Moore, D. (2000), *How to do Research*, Library Association Publishing Ltd., London.
31. Morgan, B.J.T. (1984), *Element of Simulation*, Chapman and Hall, London.
32. Myers, M.D., (1999), *Investigation Information System with Ethnographic Research*, Communication of the AIS. Vol.2, pp 1-20.
33. Naoum, S.G. (1998), *Dissertation Research and Writing for Construction Students*, Elserier Butterworth Heinemann.

34. Neuman, W.L. (2006), *Social Research Methods: Qualitative and Quantitative Approaches:* 6th edition, Pearson Education, Boston, United States.

35. O'Leary, Z. (2004), *The essential guide to doing research,* sage publication, Thousand Oaks, California, United States.

36. Punch, F.K. (1999), *Developing effective research proposals*, 2nd edition, Sage publications, United Kingdom.

37. Punch, F.K. (1998), *Introduction to social research: Quantitative and Qualitative approaches*, Sage publications, United Kingdom.

38. Yin, R. K. (2003), *Case study research: Design and methods* (3rdedition.). Thousand Oaks, CA:Sage.

CHAPTER 3

LITERATURE REVIEW

3.1 Introduction

Value Management is concerned with the management and control of the overall objective of "*making explicit the package of whole-life benefits to clients"*, Kelly, Morledge and Wilkinson (2006). While Value Engineering is seen by the above authors as a subdivision of Value Management, focusing on the technical issues, to ensure that the correct technical project is delivered during the design and construction phase.

As a subdivision of the overall 'Value' process of a project, Value Engineering has to be managed in a way that is compatible with the overall Value Management ethos.

While Value Engineering has a technical focus it still has to be managed in an effective way in order for the desired output to be achieved. Kelly, Male and Graham (2004) establish this link "*Value Management necessitates that the technical aspect of the project delivers value for money".* This identifies the basis for this thesis namely, that to achieve the necessary technical output that process needs to be managed in such a way as to provide the best 'value' to the client.

3.2 Value Engineering Process

3.2.1 Concept of Value Engineering

The Value Engineering concept began in the late 1940s, "*to consider alternatives that performed the same function. It was soon discovered that many of the alternatives provided equal or better quality at a reduced cost, leading to the first definition of approach to the identification and elimination of unnecessary cost where unnecessary cost is defined as a cost which provides neither use, nor life, nor quality, nor appearance, nor customer features*", Kelly, Morledge and Wilkinson (2006).

So Value Engineering predates Value Management and was born of necessity, due to shortages of materials during World War II. It was recognised that it was possible to maintain functionality while reducing cost. In the post war era the emphasis has changed, namely reducing cost, but maintaining or even improving functionality over the project.

Value Engineering has more recently been described by Kelly, Male and Graham (2004) as "*a process of identifying and eliminating unnecessary cost during design and construction,* they also stated that *Value Engineering is the process of making explicit the functional benefits a client requires from the whole or part of a project at an appropriate cost during design and construction. The approach is not without its critics".* However, Dallas (2006) states *"the associated functions to which a component contributes are ignored, resulting in cost cutting in which functionality is lost".* Therefore, Value Engineering is clearly not a cost cutting exercise; rather it is a process of identifying and eliminating unnecessary cost during the design and construction stage. Dallas (2006) shows that the opportunities for change over the project life, Figure 3.1.

This indicates that a holistic approach is required so that overall project objectives are not compromised. It is eminently possible that the cost of one component element can increase, if it provides an overall cost benefit to the project.

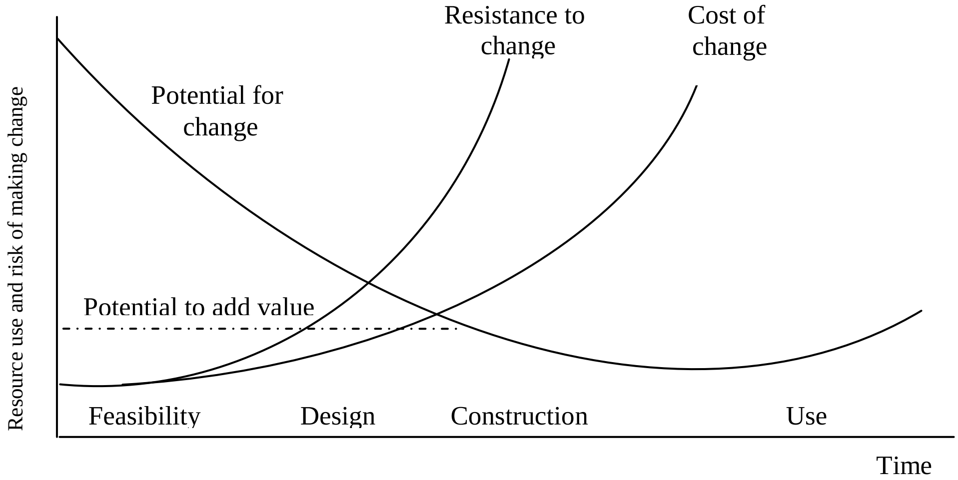


Figure 3.1 Change in opportunities with time (Source: Dallas, 2006)

3.2.1.1 Best Value in Construction

In order to understand Value Engineering, it is necessary to understand the concept of "Value". The Oxford English Dictionary definition of the word *"*Value" is *'the worth desirability or utility of a thing, or the qualities on which these depend'*. Woodhead (2005) defines that value is a personal perspective of your willingness to pay for the performance delivered by a product, process or project.

'Value is subjective with different people applying different criteria to assess whether they are getting good value', Dallas (2006). Dallas further states that, in the context of construction*, "the balance between how well the building satisfies the owner's expectations and the sacrifices, in terms of resources used, he must make in order to get it"*. The question therefore arises 'what is the basis of Value that those involved in Value Engineering need to use as a basis for assessment?' There are two primary but distinct sources that are widely accepted in building construction.

- The following documents are normally to be supplied to the Value Engineering team in brief. This is usually prepared by the project management team or, a Value Engineering 'Facilitator' and provide:-

  a) The 'wants' and 'needs' expressed by the client

  b) A technical specification covering the project

  c) Legal and regulatory requirements that apply at the project location

This establishes a framework within which the Value Engineers can operate in terms of what are acceptable alternatives or not.

- The technical performance considerations appropriate to their particular profession can be complex issues e.g. substituting one air conditioning system may have an effect on the maintenance and running cost of the project over many years. It can also have an impact on the architectural and civil engineering aspects of the structure of the building. It is in this aspect that the design engineers from different disciplines need to work together towards a common goal. This is not always an optimal solution and a compromise is often required in order to achieve an acceptable enhancement in value for the overall project.

3.2.1.2 Risk in Value Engineering

When considering "Value" risk cannot be ignored, and this will usually be considered as part of the "risk assessment" that engineers have to consider as part of their technical design assessments.

Dallas (2006) recognises this as an important issue and states that a project needs to have maximum value and minimum uncertainty. Dallas further states that Value Management targets the first of these requirements, whereas risk management targets the second requirement, as part of effective project management. Therefore, in order to achieve the best value, risk management and value management should be applied on every significant construction project.

Qie and Yang (2007) explain risk as: - "*Risk is a statistical concept used to describe the state of affecting people or possibility of the impact of negative events in the special time and space*".

Dallas (2006) identified the link between risk and reward in construction. "*It is necessary to take risks, if one is to maximise the benefits (or value) of an organisation. The first major benefit of risk management is that it enables senior management to embark upon projects in full knowledge that they will be able to control risk and thereby maximise their rewards".*

Dallas (2006) also states that the formal risk process delivers the following benefits for the project team:

- It requires that the management infrastructure is in place to deliver successful outcomes. This includes setting clear, realistic and achievable project objectives from the onset.

- It establishes the risk profile of the project, enabling appropriate allocation of risk, so that the party best placed to manage it has the responsibility for doing so. Risk allocation is a key component of contract documentation.

- It allows the team to manage risk effectively, concentrate resources on the things that really matter, resulting in the risk reduction as the project proceeds. It also enables them to capitalise on opportunities revealed through the use of the process.

- It improves confidence that the project will be delivered to the owners' and the end users' expectations, within the constraints of time and cost and to the required quality.

- Quantification of risk assists management in the tasks of raising the necessary funds and, later, controlling the project by judicious applications of the risk allowances. Where the project forms part of a larger portfolio of projects, it enables the transfer of risk allowance from on project to another.

- It provides a mechanism for reporting risk on a regular basis to the appropriate levels of management, detecting escalating risks in an orderly manner to obtain direction from the highest levels.

The above issues are all relevant, especially the first two and last. Due to this overlap between risk and value there should be a feedback from the Value Engineering team into the risk management process and vice versa.

3.2.1.3 Integrated Value and Risk Management

Dallas (2006) stated that the benefits listed at the end of Section 3.2.1.2 can be realised if risk is an aspect considered by the Value Engineering team. Also, Dallas stated the following benefits are also noted:

- The processes are complementary enabling each to augment each other.

- Both disciplines require a deep understanding of the project. The discipline of acquiring the deep understanding helps the team to make better-informed decisions and improves communication between them. Improved communications lead to improved understanding. The process is cyclical.

- The framework provided by the value and risk management processes improves communication between members of the team and external stakeholders, so that they can arrive at better solutions faster.

- The records of value and management studies provide an audit trail to demonstrate that activities that add value and reduce risk where actively managed. This enables third parties to understand the basis for decisions that have been made.

- The existence of good records provides the basis for learning from past experience and continuously improving performance.

3.2.1.4 Value and Value Management

Value Management provides a method to explore the client’s needs by identifying inconsistencies and relaying this information that the project team can easily understand. Dallas (2006) identifies the following benefits of employing Value and Value Management:

I It defines what the owners and the end-users mean by value, and provides the basis for making decisions, throughout the project, on the basis of value, and it provides a means for optimising the balance between differing stakeholders’ needs.

II It provides the basis for clear briefs that reflect the client’s priorities and expectations, expressed in a language that all can understand. This improves communication between all stakeholders so that each of them can understand and respect other’s constraints and requirements.

III It ensures that the project is the most cost-effective way of delivering the business benefits and provides a basis for refining the business case. It addresses both the monetary and non-monetary benefits.

IV It supports good design through improved communications, mutual learning and enhanced team working, leading to better technical solutions with enhanced performance and quality, where it matters. The methods encourage challenging the status quo and developing innovative design solutions.

V It provides a way of measuring value, taking in to account non-monetary benefits and demonstrating that value for money has been achieved.

It can be appreciated that this is an essential element of the overall functioning of the Value Engineering process.

Items I and II enable a clear brief to be provided for the Value Engineering process for making decisions and meet the client's expectations.

Item IV helps to promote good communications and team functioning throughout the Value Engineering process.

Items III and V are key to the validating aspect of the Value Management process of which Value Engineering is a part.

3.2.1.5 Leadership in Energy and Environmental Design (LEED)

The built environment has a profound impact on our natural environment, economy, health and productivity is now being recognised globally. The construction industry also now has the technology, building science and operations available to 'build green' and maximise both economic and environmental performance.

There is a developing desire based largely on energy costs and sustainability to make progress internationally. The Kyoto agreement is an identification of this. The United States Green Building Council (USGBC) is coordinating with the establishment and evolution of a natural consensus effort to provide the industry with the tools necessary to design, build and operate the buildings that deliver high performance inside and outside of the building.

Green building practices can substantially reduce and eliminate negative environmental impacts and improve existing unsustainable design, construction and operational practices", New Construction Reference Guide (2007).

The LEED green building rating system for new construction and major renovation provides a set of performance standards for certifying the design and construction phase of buildings, New Construction Reference Guide (2007).

United States Green Building Council established the following rating system in to six (6) categories for construction:

- Sustainable sits
- Water efficiency
- Energy and Atmosphere
- Material and resources
- Indoor environmental quality
- Innovation in design

Different levels of green building certification are awarded based on the total credits earned, New Construction Reference Guide (2007).

The above indicate that Value Engineers are facing new challenges. Increased conformance requirements will also challenge the management system that supports their activities by ensuring information is assembled and communicated to Value Engineers, so that they consider this as an additional 'value' issue that has to be incorporated into their design considerations. Green building and sustainable design have experienced explosive growth over the past decade in response to the adverse impact. Paget (2008) highlights that sustainable design and Value Engineering can achieve cost effective and high performance construction with lower life cycle cost effect.

3.2.1.6 Sustainable applications towards Green Developments

Climate change is widely accepted as a feature in the modern era. The contribution of mankind to the process remains to be resolved. However, it is widely accepted that a reduction in carbon emissions can mitigate the projected extremes of global warming. As per recent studies, construction and development contribute to environment pollution in terms of increased carbon foot print. According to Kelly at el. (2006) "*Building a Greener Future towards zero carbon Development"* is one of the dynamic slogans which turned people's thoughts towards 'a green society' in the United Kingdom.

The 'Green' revolution proposals require new developments to be sustainable. According to Otto (2007) sustainable design means that which creates *"products, places, processes and systems"* which optimise *"human well-being now and the future without compromising the well-being of the planet"*. Lee and Guerin (2010) highlight that key benefits of sustainable buildings construction are to reduce the cost of operation and enhance the Indoor Environment Quality. Kamaruzzaman et al. (2011) states that well designed green building would provide *"better and healthier environment for occupants".*

The United Arab Emirates has a large carbon footprint in relation to its size. Green building and its application in the United Arab Emirates is being actively promoted. Studies by Frost and Sullivan show: *"United Arab Emirates alone produced around 6.5 million tonnes of waste in 2009, which is 22% of the total waste generated from GCC region",* Jacob (2010).

A number of construction pioneers in the United Arab Emirates also adopt the concept of greening in order to facilitate the sector in broad perspectives. *"Sustainability is every one's job"* is one of the key slogans of green campaign by Parsons Consultancy in the United Arab Emirates. The report of Sustainability (2009) highlights the five distinguished areas, which the concept of 'greening' begins with as, *"workplace, knowledge management, training, supply chain management and socio-cultural factors".*

3.2.1.7 Sustainability and Construction Industry in the United Arab Emirates

United Arab Emirates is one of the fastest growing countries in the Middle East region. In keeping with the green initiative, United Arab Emirates established 'Emirates Green Building Council' in the year 2006, to protect the environment and to ensure sustainable developments in the country. Due to this, every industry is required to achieve their green objectives. Sustainability and Greening is also one of the biggest 'slogans' that they have adopted for in the construction recently: *"Sustainable application is one of the key areas that the United Arab Emirates is looking for in order to save energy and reduce its carbon foot print"*. There are several landmark projects which could also achieve remarkable ranking in the LEED certification. According to LEED professionals working for Dubai Chamber they achieved a high ranking for the 'Dubai Chamber Building' without high investment, Dubai Chamber of Commerce (2009).

Sustainable applications and its concepts in the United Arab Emirates construction industry are still at an early stage. The Council on Tall Buildings and Urban Habitat (CTBUH) 8th World Congress (2008) describes that, the aim of rulers of the United Arab Emirates want to enhance the condition of living through sustainable and green applications to meet global environmental challenges. With regard to the current practices, considerable applications on greening and green initiatives have been established to achieve a greener environment. According to Jacob (2010) sustainable initiatives for construction are effective in terms of economic viability and can prove attractive to clients. Therefore, there are several companies also seeking to act on the same initiative. Some of the key initiatives that United Arab Emirates has already adopted to make sustainable buildings are waste segregation (paper and Poly Vinyl Carbonate material collected separately) and minimise excess printing, Jacob (2010). It is recognised that the United Arab Emirate's capital Abu Dhabi promotes green initiatives, such as 'Masdar city', with the establishment of zero carbon emission buildings and practices. Also there is a *"motivation towards energy conservation and usage of sustainable energy in order to ensure utilisation of sunlight"*, Jacob (2010). Jacob further emphasises that United Arab Emirates government needs to create a mandatory program for green office initiatives.

"United Arab Emirates professionals think green, but do nothing about it", Jacob (2010). According to news highlights in Khaleej Times, Jacob (2010) the argument is *"whether 'true greening' is embedded in the minds of professionals of United Arab Emirates or is there only 'green washing' going on"*. According to Jacob (2010), 88% of Middle East professionals want to actively go towards green offices, but 52% of their employers want to take action on it.

With the rising demand in world green initiatives, like other countries, the United Arab Emirates has its own initiatives for sustainable developments for a green environment. The government's recent campaign for 'Go Green' is one of the dynamic initiatives towards sustainable developments. Even though the 'green concept' has a considerable history, its concepts and applications in the United Arab Emirates are still in its infancy. It is recognised that Value Engineering has a role to play in this process.

"Value methodology can make an important contribution to this significant frame formation (i.e. greening) occurring on the construction industry", Paget (2008).

3.2.1.8 Sustainability Building Rating Systems in the United Arab Emirates

Abu Dhabi Urban Planning Council (2010) introduced the Pearl Rating System for "Estidama" in design and construction projects. Estidama which means "sustainability" in Arabic is the initiative which has the stated aims of *"transforming Abu Dhabi in to a model of sustainable urbanisation"*. Its aim is to create more sustainable communities, cities and global enterprises and to balance the four factors, namely environmental, economic, cultural and social as shown in Figure 3.2.

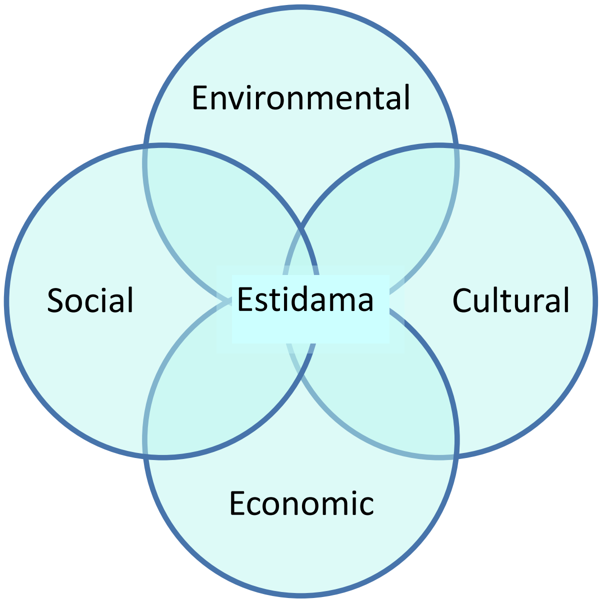


Figure 3.2 The Four Pillars of Estidama. (Source: Abu Dhabi Urban Planning Council, 2010)

The aspirations of Estidama are incorporated into ‘Plan 2030’ and other Urban Planning Council policies such as the development code. Estidama is the first program of its kind that is tailored to the Middle East Region.

The Urban Planning Council has introduced the ‘Pearl Rating System’ for Estidama with the aims of addressing the sustainability of a given development throughout its life cycle from design through construction to operation. The Pearl Rating System also provides design guidance and detailed requirements for rating a project’s potential performance in relation to the four (4) pillars of Estidama. To achieve the ‘Pearl Rating System’, the Urban Planning Council has set out the following seven (7) fundamental categories to attain more sustainable development:

- Encouraging cross-disciplinary teamwork to deliver environmental and quality management throughout the life of a project.
- Conserving, preserving and restoring the region’s critical natural environment and habitats.
- Improving the quality and connectivity of outdoor and indoor spaces.

- Reducing water demand and encouraging efficient distribution and alternative water source.

- Targeting energy conservation through passive design measures, reduced demand, energy efficiency and renewable sources.

- Ensuring consideration of the “whole-of-life” cycle when selecting and specifying materials.

- Encouraging innovation in building design and construction to facilitate market and industry transformation.

This demonstrates the commitment of the government of the United Arab Emirates to sustainability and is a factor for serious consideration in the design of future building projects in the region.

The Society of American Value Engineers (SAVE) was formed in 1959 as a professional society dedicated to the advancement of Value Engineering through a better understanding of the principles, methods and concepts involved, now known as SAVE International. While not the only approach it was found to be extensively used in the United Arab Emirates, hence it is detailed in what follows. The concept of Value Engineering can be applied at any point in a project including construction. However, typically, the earlier it is applied, the higher the return on the time and effort invested. The three (3) main stages of a project and Value Engineering applications are explained hereunder, based on the SAVE International (2007) guidelines.

3.2.2 Stage I - Planning

At the Planning stage of development, there are additional benefits to be derived from a Value Engineering Workshop. An independent team shall be appointed to review the following program in accordance to SAVE International (2007).

- Perform a functional analysis of the facility

- Obtain the owner / user’s definition of value

- Define the key criteria and objectives for the project
- Verify / validate the proposed program
- Review master plan utility options
- Offer alternative solutions
- Verify if the budget is adequate for the developed program

SAVE International (2007) identify the benefits of Value Engineering are potentially significant and include the following:-

- Any changes to the program at the early planning stage have little impact on the schedule and redesign costs.
- The project will be developed with minimum changes, redesigns and a greater understanding by all parties of what will be the final function and space allocations.
- An independent team can bring a fresh outside view of alternate solutions from other similar projects.

3.2.3 Stage II - Design

This is the stage that most Value Engineering participants initially become involved, when the design has at least made it to the schematic stage. Most construction industries require at least one (1) Value Engineering session at the design stage on projects. The primary tool available to the Value Engineering team is the Workshop and typically a 40 hour session or less for smaller or less complex projects.

"The Value Engineering Workshop is an opportunity to bring the design team and owners together to review the proposed design solutions, the cost estimate and proposed implementation schedule and approach, with a view to implementing the best value for the money", Kelly, Morledge and Wilksinson (2006). Therefore, the definition of what is good value on any particular project will vary in some respects

from client to client and project to project and forms part of the information phase described below.

3.2.3.1 Methodology and Approach

During the actual Workshop portion of the Value Engineering study, the five-step Job Plan is followed, as prescribed by SAVE International (2007). The Value Engineering Job Plan follows five key steps are described below:-

1. Information Phase
2. Speculation (Creative) Phase
3. Evaluation (Analysis) Phase
4. Development Phase (Value Management Proposals)
5. Presentation Phase (Report / Oral Presentation)

3.2.3.2 Information Phase

Based on the SAVE International (2007), at the beginning of the Value Engineering Study, it is important to:

- Understand the background and decisions that have influenced the development of the design through a formal design presentation.

- Analyse the key functional issues governing the project. The functions of any facility or system are the controlling elements in the overall Value Engineering approach. This procedure forces the participants to think in terms of function and the cost and impacts associated with that function.

- Define Owner's objectives and key criteria governing the project.

- Determine Owner's definition of Value.

3.2.3.3 Speculation (Creative) Phase

This step in the Value Engineering study involves the listing of creative ideas as stated by SAVE International (2007):

- The Value Engineering Team thinks of as many ways as possible to provide the necessary function within the project areas at a lesser initial or Life-Cycle Cost which represent improved value to the client.

- Judgment of the ideas is prohibited.

- The Value Engineering Team is looking for quantity and association of ideas, which will be screened in the next phase of the study.

- Many of the ideas generated in the creative phase are a result of work done in the function analysis. This list may include ideas that can be further evaluated and used in the design.

3.2.3.4 Evaluation (Analysis) Phase

In this phase of the project, the Value Engineering Team together with the Owners and / or Users evaluates the selected ideas as listed below by SAVE International (2007):

- Defines the criteria to be used for evaluation.

- Analyses and judges the ideas resulting from the creative session. Ideas found to be impractical or not worthy of additional study are discarded. Those ideas that represent the greatest potential for cost savings and value improvement are developed further. A weighted evaluation is applied in some cases to account for impacts other than costs (such as schedule impacts, aesthetics, etc.).

3.2.3.5 Development Phase

During the development phase of the Value Engineering study, many of the ideas are expanded into workable solutions. The development consists of the following steps based on SAVE International (2007):

- Description of the recommended design change.
- Descriptive evaluation of the advantages and disadvantages of the proposed recommendation.
- Cost comparison and Life Cycle Costing calculations.
- Each recommendation is presented with a brief narrative to compare the original design method to the proposed change.
- Sketches and design calculations where appropriate, are also included in this part of the study.

The following highlights relevant issues raised in SAVE International (2007). "*One of the most important factors in the development phase is life cycle costs. It would be necessary to recommend changes that would increase the initial capital construction cost of a project and have major implications upon the owner's ability to operate and maintain the facility".* For instance, design criteria have changed in recent years due to fluctuations in increased costs of fuel and other energy sources required for heating, cooling and operating buildings and facilities, as a result the life cycle costing of future developments plays a major part in potential recommendations.

"*Life cycle costing is a technique to assess the total cost of ownership. It entails the calculation of costs applying to the total life cycle of the facility",* Waddle (2008). Additional costs such as the design and construction are ongoing, costs such as operations and maintenance of the completed project, have therefore to be considered.

It is vitally important to consider life cycle costing during the design stage as the design solutions selected may have major implications upon the operational and maintenance costs of the final outcome for its entire life. The operational and maintenance costs can apply over many years on a building project, may be several decades. Hence, *"it is possible for these costs to far outweigh the initial capital costs of the project. It is not all reducing costs; in many cases an increased level of expenditure can generate additional benefits for the projects stakeholders by means of reduction of the long term operating costs",* Waddle (2008).

The main elements of cost identified by SAVE International are indicated below:

- The cost of feasibility studies.
- Land acquisition.
- Professional fees for design, project management, legal advice etc.
- Construction and furnishings and fittings.

These costs are normally well established and focused upon when making decisions about the project. In addition to the above come operational costs, these may be divided into two broad levels, namely generic and functional. Generic costs are those costs related to aspects such as fuel, electricity, cleaning and security, whereas functional costs related to costs such as staffing.

- Acquisition costs are those incurred between the decision to proceed with the procurement and the entry of goods or services to operational use.

- Operational costs are those costs incurred during operational life of the asset or service.

- End life costs are those associated with the disposal, termination or replacement of the asset or service. In the case of assets, disposal cost can be negative because the asset has a resale value.

The above principles can be applied from the smallest simplest projects through to the most complex projects.

3.2.3.6 Presentation Phase

The last phase of the Value Engineering study is the presentation of the recommendations in the form of a written report. A briefing / oral presentation of results is made to the Owners and Users, as well as the Design Team representatives. The recommendations, the rationale that went into the development of each proposal and a summary of key cost impacts are presented at that time so that a decision can be made as to which Value Engineering proposals will be accepted for implementation and incorporation into the design documents. This is an approach that is widely accepted, Dallas (2006), and Kelly, Male and Graham (2004).

In addition to the monetary benefits, a Value Engineering Workshop provides a valuable opportunity for key project participants to come together, then step aside and view the project from a different perspective. The Value Engineering process therefore produces the following benefits, Kelly, Male and Graham (2004):

- Opportunity to explore all possible alternatives
- Forces project participants to address "value" and "function"
- Helps to clarify project objectives
- Identifies and prioritises Owner's value objectives
- Implements the accepted proposals into design
- Provides feedback on results of the study

3.2.3.7 Post Study Phase

The post study phase may be considered under three sub-phases, which are as follows:

- Report preparation and review phase
- Implementation phase
- Follow-up phase

3.2.4 Stage III - Construction

During this phase, Value Engineering is still possible through the use of Value Engineering Change Proposals, this view is favoured by Kelly, Male and Graham (2004), "*Contractors can be provided with monetary incentives to propose solutions that offer enhanced value to the owner and share in the financial benefits realised".* The owner will need to consider contractor generated proposals very carefully, from a life-cycle perspective and a liability perspective. The evaluation of a Value Engineering Change Proposal can be treated in the same way as to change order during construction, with issues such as schedule and productivity impacts being considered along with the estimated cost savings generated.

3.3 Methods of Value Engineering

There are four (4) clearly identifiable and commonly employed approaches to Value management, Kelly, Male and Graham (2004). Briefly the four (4) approaches are:-

The 'charette'

This is a meeting following the compilation of the client's brief, attended by those members of the client's organisation which have contributed to the brief and the full design team. This meeting is conducted under the chairmanship of the Value Manager.

The '40 hours study'

A study of the design development to the sketch design stage by a team comprised of design professionals who have not been involved with the design to date again under the chairmanship of the Value Manager.

The 'Value Management Audit'

A study of the proposals made by a subsidiary company, of a large holding company, of the capital to fund a project. This study will be undertaken by a Value Management Team in order to ensure that the parent company is receiving value for money.

The 'Contractor's change proposal'

In this solution a clause in the construction contract allows the contractor to suggest changes to the proposed design in order to reduce the construction costs. The contractor receives a bonus in exchange for any accepted proposal.

3.3.1 The Charette

The charette is a structural appraisal of the brief by a team comprising, the Value Engineer as chairman, the client representative who contributed to the brief and the design team.

This method seeks to rationalise the client's brief through the identification of the function of the spaces specified. The analysis through function at a meeting involving the client's staff and the design team should ensure that latter understand fully requirements of the former. The procedure proposed by Kelly, Male and Graham (2004) is:

- Following the preparation of the brief, but prior to the commencement of design, the client appoints a Value Engineer either through a marketing exercise by the Value Engineering Team Co-ordinator or through in-house knowledge. In collaboration with the initial point of client contact the Value Engineering Team Co-ordinator would outline the process to be undertaken. This would include an exploration of the project problem in order to target possible internal contacts within the client organisation that may need to be interviewed as part of the preparatory steps preceding a Value Engineering study. As part of this preparatory process, it is likely that potential client representatives will emerge to be included as members of the charette team. Their representation on the team may need to be cleared with senior management.

- The Value Engineer arranges a one or two day meeting depending on the complexity of the project and brief. This does not include the time for the Value Engineering Team Co-ordinator to investigate the project briefing problem within the client organisation, develop an agenda for the study and produce a final report.

The success of this stage is critical to the subsequent Value Engineering process as it focuses the basis of the evaluation system the team will use to judge client requirements.

The client representative has to have a clear understanding of client ‘wants’ and ‘needs’ and the chairman needs to identify and issues of doubt, ambiguities or misunderstanding. Failure to do this would have its likely outcome of undermining the Value Engineering process and reduce the quality and ‘value’ of the process. In extreme cases it could require detailed design work to be abortive and require a further Value Engineering exercise being required.

3.3.2 The 40 hour study

“The 40 hour study is the most widely accepted format approach to Value Engineering, indeed the initial training of Value Engineering as laid down by the society of American Value Engineers (SAVE) is based on 40 hours training workshop”, Kelly, Male and Graham (2004). The study involves the review of the sketch design of project by a second design team under the chairmanship of a Value Engineering coordinator. *‘It applies all of the stages of the job plan within a 40 hour week and is seen as being quick and effective’* according to Kelly, Male and Graham (2004). Kelly et al. (2004), also recommend the following procedure:

- The client should inform the members of the design team at any time of their bid that the project will be the subject of a Value Engineering exercise. This is important both from a human relations aspect and also from the point of view of establishing how the design teams are to cover the cost of any redesign work arising out of the exercise. Some clients require the members to cover this cost within their fee bid. Others state at the time of the fee bid that the design team members will be reimbursed for any necessary redesign work on an hourly basis.

- The client appoints the Value Engineering Team Co-ordinator, the Value Engineer and in discussion with design team establishes the date for the study. Normally the Value Engineering Team Co-ordinator will submit a fee bid which covers the cost of the complete Value Engineering exercise described here under.

- The Value Engineering Team Co-ordinator will appoint a Value Engineering Team, normally 6 to 8 professionals in a mix that reflects the characteristics of the project under review, so for instance a project with a large amount of mechanical and electrical servicing may attract the team including four members with these professional backgrounds. These team members will be drawn from professional practice and may or may not have any previous management experience. The team members are paid by the Value Engineering Team Co-ordinator.

- The study is normally held near the site of the proposed project, either in a hotel or in a room provided by the client within the client's office.

- The date of the study is a key date for the design team and the Value Engineering team. The design team must complete to sketch design stage, one week before the date of the study. This includes the architectural design and also the structural, mechanical and electrical engineering designs. The completed drawings are sent to the Value Engineering Team Co-ordinator for distribution to the team during the week preceding the study.

During the week of the study, the team will follow strictly the stages of the job plan. It is the logical step by step approach to the generation of alternative technical solutions which makes Value Engineering unique. A typical program for 40 hours workshop is provided diagrammatically in Figure 3.3. This diagram summarises the activities involved in a typical workshop.

PROJECT START	Client informs design team of intention to hold VM study at their time of appointment.
	Client appoints VMTC.
WEEK BEFORE WORKSHOP	VMTC appoints VM team.
	Design team sends all information to VMTC.

WORKSHOP

W O R K S H O P	*Monday Morning* – Phase 1 (Information) Client and design team Architect present Scope of project to VM team.
	Monday Morning – Phase 2 (Creativity) Brainstorming session to search for alternatives.
	Tuesday Morning – Creativity Continues.
	Tuesday Afternoon – Phase 3 (Evaluation).
	Wednesday – Phase 4 (Development). Best ideas from Phase 3 developed into Feasible costed technical alternatives.
	Thursday – Development Continues.
	Friday Morning Selection of optimum cost technical alternatives.
	Friday Afternoon – Phase 5 (Presentation) Above alternatives presented to client and design teams' architect. VM team disperses.

POST-WORKSHOP ACTIVITY

NEXT WEEK	VMTC prepares detailed report and sends to client.
LATER	Phase 6 – (Feedback). VMTC informed of ideas put into practice.
DESIGN CONTINUES	

Figure 3.3 Pre-Workshop Activity – (Source: Kelly and Male, 1992)

Kelly and Male (1992) present case studies of a workshop and within these case studies an example of a variation in the usual 40 hours workshop technique is provided. This gives a description of the procedures of the Office of Management and Budget (OMB). The procedures revolve around a three phase process, comprising:

Phase 1 - Orientation

Phase 2 - Workshop

Phase 3 - Implementation

The latter two phases resemble that of a conventional Value Engineering Workshop, but the first phase of orientation represents an interesting contribution to Value Engineering. This approach is widely employed in the United Arab Emirates, as evidenced in the case studies of this research.

3.3.3 The Value Engineering Audit

The Value Engineering Audit is a service offered by Value Engineers to large corporate companies or government departments to review expenditure proposals forwarded by subsidiary companies or regional authorities. The procedures employed follow exactly those of the job plan.

Following the review, the Value Engineer will submit a report detailing the primary objective and the most cost effective method for its realisation.

3.3.4 The Contractor’s Change Proposal

The Contractor’s change proposal (or Value Management Change Proposal) is a post tender change instigated by the contractor. Kelly et al. (2004) report that the United States government includes a clause in their conditions of contract which states that contractors are encouraged to submit ideas for reducing the cost. If the change is accepted by the design team, then the contractor shares in the saving at the agreed rate.

The benefit of the clause is that it allows the contractor to be pro-active and use construction / engineering knowledge to improve a facility at on-site stage.

The disadvantage of the clause is that the contract may be delayed while the design team investigates the viability of the change. For this reason changes tend to be relatively superficial.

There is also a danger that if the changes are not examined in realistic way consequential effects on some other aspects of the design may be overlooked.

3.4 Value Engineering Techniques

Palmer, (1990) states that five phases of a job plan are carried out during a 40 hour workshop and each stage has techniques to aid its successful implementation. The techniques used are defined by Palmer (1990) in Table 3.1 below:

Table 3.1 Techniques used within a 40 hour workshop – (Source: Palmer, 1990)

Job Plan Phase	Technique used
Information Phase	Functional Analysis
Creative Phase	Brainstorming
Analytical Phase	Evaluation
Development Phase	Report Writing
Presentation Phase	Oral Presentation

These techniques are essentially the traditional and well documented techniques of Value Engineering, Mukhopadhyaya (2009) and Kasi (2009).

As this research is primarily addressing the management of the process and overall outcomes of the process, these techniques are noted below with relevant references but, are not described in detail.

3.4.1 Techniques used during the Information Phase

There are used to identify and prioritise 'functional' requirements.

Method	Main characteristic	Reference
Functional analysis	Used to identify the principle functional requirements of a project	Kelly and Male (1993)
Functional Analysis System Technique (FAST)	Provides a hierarchic analysis of function presented in a block diagram format	Seely (1996), and McGeorge and Palmer (1997)
Diagramming procedure	Verb-noun descriptions produced during functional analysis are noted on cards. These can then be readily moved to assemble a diagram relating functional dependency	Norton and McElliot (1995)
Functional hierarchy models	A tree diagram that displays the hierarchical relationships of functions	Norton and McElliot (1995)

Various researchers have their own preferences, but the essential function of these methods is to identify an importance rating of desired 'functions' in the project, identify dependencies and hierarchy, so as to assist in prioritisation.

Of these methods the FAST method is strongly favoured by the Society of American Value Engineers (SAVE). However, there are critics of the method, notably McGeorge and Palmer (1997).

3.4.2 Techniques used during the Creative Phase.

These aim to assist in generating improvements during Value Engineering Workshop.

Method	Main Characteristic	Reference
Brainstorming	A problem solving 'conference' to generate a large number of ideas in a short time	Hayden and Parsole (1996)
Gordon Technique	Similar to brainstorming but team leader only defines the 'general problem', so ideas are less restricted than the above method	Norton and McElliot (1995)
Delphi Technique	Generates ideas by allowing members to submit ideas to the group anonymously, (e.g. in writing) claimed to limit domination of ideas by dominant individuals	Green and Popper (1990)
Synetics	Similar to the Gordon technique, but uses 'analogies' to aid creativity	Kirk and Sprekelmeyer (1993)
Check listing	Uses a list of standard prompts e.g. who? what? how? where? when? etc. Each point is used to focus a group discussion	Norton and McElliot (1995)

Again all are valid methods that have their followers, so it is largely a matter of personal preference.

3.4.3 Techniques used during the Analytical Phase

Here ideas generated in the Creative Phase are assessed on some agreed priority basis.

Method	Main Characteristic	Reference
Criteria Scoring Matrix	Ideas are ranked on criteria and weighted to provide an output score. Computerised formats are also available.	Norton (1992)

3.4.4 Techniques during Development Phase

Ideas are researched and technical experts team members are used to make design proposals supported by calculations. Life cycle costing techniques are then used to compare 'total cost of ownership' for competing alternatives, Norton and McElliot (1995).

3.4.5 Techniques during the Presentation Phase

At this stage the communication of the results of the Value Engineering study is delivered to decision makers and original design team. This is usually presented orally to a set agenda, Norton and McElliot (1995).

3.5 Value Engineering Overview

"*The origin of Value Engineering can be traced back to the days of world War II, when there was a material shortage, in the manufacturing sector due to an increased consumption for utilisation to war*", Cheah and Ting (2005). Value Engineering in the Middle East was in limited use even though it has been introduced in the early 80's. Columnist (2009) highlights that the demand for application of Value Engineering raised due to collapsing economy in the United Arab Emirates and its application became more important.

The author carried out a literature review covering recent research papers of Value Engineering. From this review it became evident that the issues raised by researchers in terms of reflective implementation of Value Engineering could be conveniently grouped under seven (7) headings, namely:-

1. Structure and Method of the Value Engineering Process.
2. Timing and execution of the Value Engineering and workshop studies.
3. Composition of the Workshop Team.
4. Understanding of the Value Engineering Process.
5. Value Engineering during the Construction phase.
6. Performance Measurement based on costs.
7. The effect of environment and culture on Value Engineering.

The articles reviewed have therefore been, retrospectively assembled under these headings for ease of comparison. These seven headings will be referred to as 'issues' that have to be addressed, if the Value Engineering Process is to be effectively implemented.

3.5.1 Structure and Method of the Value Engineering Process

The structural framework of Value Engineering and its process needs to be understood by the Value Engineering team in order to achieve successful benefits to the Project. Various researchers indicated their findings are as follows:

Ghosh (2008), states how Value Engineering application became successful in a company and discuss how benefits were achieved in projects. This paper starts with the process of developing top management confidence by convincing them of the possible benefits from Value Engineering. This was recommended to be done by organising and designing Value Engineering awareness programs for various levels of managers. Further, he recommended setting Value Engineering goals, through the company's strategic objectives. He emphasised developing Value Engineering training materials, including inputs from both Value Engineering experts and live case studies. This was to involve identification of improvement areas, selection of a cross functional team, conducting Value Engineering workshops and review mechanism for Value Engineering. This was to culminate in a presentation to top management by the team, and its approval for change proposals. This paper also talks about the concerns of what might cause interruption and retardation in the progress of Value Engineering applications in an organisation. Besides the successes, in the company, this paper deals with the role and responsibilities of value practitioners towards society, industrial communities, the country and above all for the world to achieve global improvement in the areas like industry, health, services, education, etc.

Woodhead and Garnett (2006), present numerous theories on how firms create value for the project. Woodhead and Garnett (2006) further explained the view that Value Engineering and Value Management: "*requires a structural approaches to enquiry, analysis, problems and opportunities facing firms*". Lin (2003), developed a performance measurement framework to measure both the processes and outcomes of Value Management studies, from his literature review he found that thirteen (13) factors have impact on the performance measurement in Value Management studies and identified a theoretical framework for measurement and performance for Value Management studies.

According to Male, Kelly, Gronqvist and Graham (2007), Value Management focuses on projects value system evolution and resolution in the context of project management or organisational management. A systematic approach of Value Management application would lead to stakeholder benefits. In defining Value Engineering in different parameters Waddle (2008) highlights that, *“Value Engineering has been defined as systematic method to improve the value of goods and services by using an examination. Value as defined is the ratio of function to cost. Therefore, value can be increased by either improving the function or reducing the cost”.* SAVE’s Value Engineering methodology was used by Stringer (1995) to compare personal finances to a typical Value Engineering project, discussed how early planning and execution is more effective in achieving financial goals, and further examined the various stages of the Value Engineering methodology to demonstrate how it can be applied to enhance personal finances. Stringer (1995) concluded that “*the use of Value Engineering principles and methodology to enhance our personal finances is valid, appropriate and can be very effective*” and also Dasgupta and Mujumdar (2000) presented a case study method adopted in institutionalising a Value Engineering technique and explained how successfully an industry of fairly large size nurtured Value Engineering through organisation.

Payne and Beardsall (2005) discussed a completed project using the Value Management approach. This project had Value Engineering as one of its stages together with knowledge management principles, tools and techniques in an innovative way that led to fresh insights into the project. The analysis was done in the form of a FAST diagram by identifying the knowledge flows, their mechanisms, their effectiveness, and the value delivered for each of the lower order functions. The approach developed appears mechanistic, but in practice it creates a common language for conversations about knowledge management and value to the business. The mechanistic approach works well in an organisation that focuses on processes and systems. Linking knowledge flows directly to business needs has won the attention of senior managers who might otherwise not have appreciated the value of knowledge management.

Al-Yousefi, et al. (1999) reviewed value methodology and its impact on public and private sectors. The first paper published by Al-Yousefi, et al. was devoted to governmental implications due to applying Value Engineering as a technique utilised as a tool for enhancing project function and optimising cost, while the second paper highlights the ‘History of Value Engineering in Saudi Arabia’ and then focused on how effectively the Value Engineering technique was used on private projects resulting in wide acceptance among the stakeholders. Also, Al-Yousefi, et al. (1999) discussed some highlights on the influence of Value Engineering on Saudi engineering practices where the Value Engineering was spread over a decade and as many as (three hundred) 300 projects were reported to have benefited, across the kingdom, and saved 1.50 billion US dollars.

Based on the above findings of various researchers, it is evident that the Value Engineering method and its process need to be clearly defined and understood by the Value Engineering Team.

The above papers indicate that both understanding and commitment to the Value Engineering ethos is important. Also that for successful implementation it needs to be conducted in a well managed environment, under the umbrella of ‘Value Engineering’. It is a logical conclusion that in order to assess the Value Engineering is being effectively applied, the way it is structured and managed, is a factor for consideration.

3.5.2 Timing and Execution of the Value Engineering and Workshop Studies

Various researchers have addressed the issue of when, and in what form, the Value Engineer investigation and review is to be best conducted. In theory, Value Engineering can be undertaken at any stage of the design process. Generally, the earlier the study is undertaken the more effective it will be. It provides the opportunity to rationalise design before it is so firmly established that any change will significantly increase design and planning costs. In practice the timing is often critical, although it should be stated that there can be no guarantee that an optimum designed project will certainly emerge’. Columnist (2009) states that *“the changing economy has generated a perfect storm of demand for Value Engineering. There is an armada of projects underway or on the boards, yet there is time to calmly consider quality and efficiency*” which highlights the demand for the application of Value Engineering due to a recession hit economy in the United Arab Emirates and, its applications becoming more important.

There is no widely agreed 'ideal time' for implementing Value Engineering. The following researchers offer a different viewpoint for conducting the Value Engineering in design stage.

"The question of when the Value Engineering study should be carried out is a difficult one to answer. Basically the procedure can be beneficial at any stage of the building process from inception until completion, carrying out of Value Engineering application for a project is beneficial in vital ways in the designing stage, in a most cost effective way", Roe (2009). However, it is apparent that the potential benefits from a study differ at different periods through the project cycle.

"It is widely recognised that the majority of building cost is committed during the early stages of the design process", Siterman (2009). Value Engineering applications at the beginning of the project would lead to 'build efficiently'. Hence, to delay the application of Value Engineering into the construction phase would therefore severely limit its potential impact.

The benefits which can be achieved by Value Engineering are clearly far greater if it is applied early in the design process. However, there is a paradox in that the Value Engineering methodology, described above, requires the pre-existence of a design solution upon which the study can focus. It is widely argued that this paradox is best solved by applying Value Engineering at the sketch (or 'outline') prior to embarking on detailed design stage.

While there is no universal agreement, current thinking is that it is not recommended that Value Engineering studies are embarked upon after the 50 to 60 percent of the preliminary design has been complete, stated by Seely (1996). Unfortunately, Value Engineering studies are often commissioned by clients when it becomes apparent that the cost of the building outweighs its worth. Seely also noted that "*This is sometimes only recognised when the detailed design is 70 percent completed. Value Engineering* *at this point can only take place in a very hostile environment and tends to be viewed solely as a cost cutting exercise. The chances of a satisfactory outcome are therefore considerably less than at sketch design stage".*

"*The forty (40) hours workshop is the most popular format for the implementation of the Value Engineering job plan at the sketch design stage*", Kelly, Male and Graham, (2004). This approach involves the assembly of an 'alternative design' team for a five (5) day period. The workshop should preferably take place in a venue away from normal work environment such as a local hotel, so that team members should be free from other distractions for the duration of the exercise. It is likely that the first day of the workshop will consist of the information phase. The speculation phase will probably be completed within the morning of the second day, leaving two and a half days for the evaluation and development phases before the presentations on the last afternoon.

"*The timing of the Value Management study can be critical*", Carter (1991/92). "*Currently, such studies / workshops are conducted at between 10 to 35 percent stage of the design process*", Kelly and Male (1988).

Martin (1998) described that "*the value programs must be periodically reviewed and analysed to determine if they provide intended benefits. Practical, quantifiable measurements are needed to maintain and improve any Value Program*". This is an interesting viewpoint in that it recognises that the timing of the operations should be reviewed. This implies that there is no 'optimum time.' This seems sensible, as a project of different size and technical complexity would be expected to present different scenarios to the Value Engineers and Designers. The overall consensus from the above researchers is that conducting the Value Engineering review needs to be done before the detailed design stage begins. Kelly, Male and Graham (2004) state the end of the design concept stage, while Seely (1996) is in favour of 50% to 60% of the preliminary design stage. While there is no universal agreement on timing, author's concern that the late timing of Value Engineering Workshop shall result in reduction in beneficial outcomes.

The forty (40) hour workshop format for the Value Engineering review is identified by Kelly and Male (1988) as the most popular format. This is also promoted by the Society of American Value Engineers, SAVE International (2007).

3.5.3 Composition of the Workshop Team

The fundamental aspect of Value Engineering is the use of a multi-disciplinary team. The type of study will dictate the actual disciplines involved, but team must always possess a variety of professions to give the team a broader information base than the designer has at his disposal. Dell' Isola (1982) emphasises that "*the Value Engineering co-ordinator must be present to direct the team towards the objectives of the study and draw out their solutions, thus the co-ordinator must have experience and knowledge of Value Engineering studies*".

The main area of dispute regarding the composition of the team is whether the team should consist of entirely external members to the project or involve the original design team. The use of an external Value Engineering team has often caused conflict, as design team in some cases see the study as a direct criticism of their work. It is also argued that an external team would not have the depth of knowledge and familiarity the design team has with the project. However, the same could be said for the lack of familiarity the original design team would have with the techniques of Value Engineering. Taking the argument a step further, *"a Value Engineering team consisting entirely of original design team is clearly likely to restrict the creativity and level of free thinking within the team",* Green and Popper (1990). This disadvantage can be balanced by developing understanding and commitment as noted in Section 3.5.1.

A range of researches, notably Kelly and Male (1988), Green and Popper (1990) together with Norton and McElliot (1995) and Dell' Isola (1973) all support the use of an external team in Value Engineering. The principal given being impartiality, judgement on the designs merit alone and a fresh approach to the design challenges.

The above study highlights the following issues in relation to the composition of the workshop.

- The designers of the project may or may not be members of the Value Engineering team. If so, care must be taken to foster co-operation towards a common objective rather than interpret reviews and alteration proposed on criticism. There is a danger in this because of conflict between team members which are likely to be counterproductive in terms of financial outcome.

- The Value Engineering Co-ordinator, often called the 'Facilitator' has a key role to play in focusing the team and guiding them through the process. Hence, the 'Facilitator' needs an understanding of the overall Value Management process and has proven management skills.

The aim of the value methodology is to increase organisational value through a union of strategy, tactics and operations with emphasis on cost effectiveness, and or profitability. The link between the value study and the organisation is the role of management in value improvement and value management. The two key management roles are senior manager and the value manager, SAVE International (2007).

A Senior Manager will need to provide clear leadership and make strategic expectations explicit in a purposeful and prioritised manner. The senior manager needs a clear understanding on potential benefits from a value study, support the study and give approval for the required expenditure. The roles and responsibilities of the Value Manager (an organisation's designated manager of value) vary throughout the project. Further, the Value Manager is responsible to ensure value methodology activities are co-ordinated and performed effectively in order to meet the goals and objectives of the organisation. Another important role of a value manager is to ensure a required amount of pre-workshops have taken place in order to conduct an effective value workshop.

Value team members are 'Technical Champions' who are expertise in the relevant field and they are to ensure, participate all meetings, gather information, analyse them, identify functions, contribute ideas, evaluate ideas, develop alternatives and present results. The team leader is the co-ordinator and the facilitator who is planning, leads and facilitates the value study. A team leader needs to be well trained and qualified, and his responsibilities can be highlighted. SAVE International (2007) recommend the following responsibilities:-.

- Ensure proper application of value methodology
- Guide the team to complete study sessions like pre and post workshop studies
- Delegate responsibilities among team members
- Schedule follow up meetings and set meeting targets as per agenda
- Keep team members together to ensure the quality of work

3.5.4 Understanding of the Value Engineering Process

The need to understand the process you are involved in and are expected to contribute to is self evident. This is certainly clearly demonstrated in the publications reviewed below.

Cheah and Ting (2005) concluded that *“there is a lack of understanding of Value Engineering concepts by industrial practitioners in Southeast Asia and a need for government to take a lead role in promoting Value Engineering practices”.*

Male and Kelly (2007) reported that *“literature suggests that Value Engineering remains ill understood has a lack of professional standing and has been quoted as being in decline or at the least having a dire status”.* The analysis set out in this paper, based upon the work of various researchers, identifies a clear need for Value Engineering to have an enhanced profile professionally and to be differentiated from other management methodologies.

As Value Engineering is an element of the overall Value Management process it is essential that it is integrated into the overall project management process. This requires an understanding of the Value Engineering process. It has been shown earlier in this chapter that Value Engineering addresses fundamental aspects of a project i.e. cost, time, quality, risk and sustainability. These have to be considered in order to address the ‘Values’ that are important to the client.

Yeo and Qiu (2003) present reviews of the fundamental differences in assumptions between the traditionally passive approach and active real approach model. The role of various real options in expanding the range of opportunity, technology investment and business acquisition decision as real options are discussed and illustrated. Traditional project evaluation based on discounted cash flow analysis ignores the potentials to an investment from managerial flexibility and innovations. A real option approach that borrows ideas from financial options offers a fresh perspective. The paper critically reviews the fundamental differences in assumptions between the traditionally passive approach and the active real options model. Further, the roles of various options in expanding the bandwidth of opportunity, technology investment and business acquisition decision as real options are discussed and illustrated. Woodhead (2005) uses the case of paired comparison to articulate links between tools and techniques, the processes that are used within Value Engineering.

Upon review of various tools and techniques mentioned above, it shows that a proper understanding of the Value Engineering process is needed for the project.

3.5.5 Value Engineering during the Construction Phase

According to Neap and Seran (2009), Value Management aims to maximise the functional value of a constructed facilities. This concluded that Value Engineering is very much a team effort, and if done by a team other than the design team, it is likely to be more effective. Construction frequently requires changes to the design that extend into the construction period. This may be initiated by such things as unexpected ground conditions, changes in legislation or codes of practice, client requests for functional or aesthetic changes, change in funds available and enforced change in construction method or sequence.

In such situations the contractor is part of the construction team. A view supported by Egan (1998), and Latham (1994) which led to the NEC contract being developed in the UK based on a partnership theme. A contract form that is, being used in the United Arab Emirates. It has been argued by Fist (1988) and Sneden (1988) "*that Value Engineering is more suitable for use during the construction phase by the adoption of contractor incentive clauses*".

There is wide agreement that Value Engineering should extend into the construction stage of the project. Dallas (2006) recognises that the potential to add value extends into the construction period and the cost of change also increases compared to its use earlier in the project Figure 3.1. If there is a potential to add value, then, it is relevant to the Value Engineering process. Sneden (1988) indicated that the contractor may need incentives to contribute to the process by suitable clauses in the contract. In a commercial venture, this does not conflict with the business plan for the project.

Al Duaji, Awaida, and Kollarayam (2007) described that *"the variation orders in the construction projects play an important role in determining the cost and time of the projects"*. The question that arises is whether the variations are as a result of design changes. If so, then an improved Value Engineering process may be able to reduce them. Also, if there are changes in one aspect of the work, does it have an effect on some other area? In this case there would be merit in conducting a Value Engineering review.

The inter relationship between Value Management and risk management is widely recognised, Dallas (2006). Sameh (2008) addresses the risks involved in the United Arab Emirates construction industry and his study reveals that economic risks such as inflation, sudden changes in prices, shortage in material and labour supply are significant. Also, Sameh (2008) includes other risks such as unrealistic construction schedule, improper intervention and changes in design. Further, Sameh's study lays the foundation for comparisons with other countries, which helps international companies interested in working in the United Arab Emirates, understand and identify the risks involved and assist local companies in negotiating their contracts with a proper allocation of risks. His study also helps in decision making regarding risk response planning and control and as it sheds light on risks in a booming United Arab Emirates construction industry. Risk identification and assessment is an important step in project risk management and shows the significance of several risks that are present in the industry. Such factors can impinge on Value Engineering and require consideration, but are not central to this research which focuses on the overall management of the Value Engineering process.

Dallas (2006) noted the benefits of integrating value and risk into a single process. In particular, Dallas noted the following benefits relevant to the above recommendation.

- *The records of value and risk management provide an audit trail to demonstrate the activities that add value and reduce risk were actively managed.*

- *The existence of good records provides the basis for learning from past experience.*

This aspect is also consistent with the risk and Value Management systems. It follows that the auditing process be conducted and hence the audit needs to consider risk and value when assessing performance.

3.5.6 Performance Measurement based on Costs

It was stated in the project aims and objectives (Section 1.6) that this research is based on the assessment of performance on the business outcome for the project. The central issue of 'cost' in Value Engineering context is reviewed here.

Colacchia (1995) states the *"cost estimates are essential for the acceptance and implementation of Value Engineering proposals and the objective is to draw attention to the importance of the cost estimate as one of the driving factors required to establish successful Value Engineering proposals"*.

These cost estimates provide the client with a measure for comparison between alternatives; hence it needs to be accurate as once the proposal in accepted there is a financial commitment. In arriving at such a decision it is important to realise that these decisions are made not purely on cost. It is evident from discussions in Section 3.5.5 that the 'risk assessments' will play a part in the decision making stage. A proposal may offer potential savings, but not at a risk level that the client or project management team are prepared to accept.

Glover (1992) presents a Value Management case study conducted in a service industry and details the innovative techniques developed and used in the construction of the Functional Analysis System Technique, (FAST) diagram and the application of Sensitivity Analysis to it. Glovers studies revealed that approval of 80% of the almost five hundred (500) Value Engineering items studied, and showed net cost savings of US Dollars 300 million which also supports the findings made by Brian and William (1995) indicating that well administrated Value Management should yield a cost reduction in the order of 5% to 10% in construction projects.

These particular research papers are relevant to this research for the following reasons.

- It indicates justification for the clients belief that overall 'cost savings' can be anticipated. It is a statement that belies the complexity of the system that has 'Engineered' these savings. This can give rise to the simplistic and incorrect view that Value Engineering is about 'cutting cost'.

- Many researchers express the 'success' outcome of using Value Engineering as cost reduction based on the initial project 'estimate' after the Value Engineering process is completed.

- Brian and William (1995) qualified the expected saving by the statement that this needs to occur in the context of an overall '*well administered Value Management system'.*

Zimmerman and Hart (1982) stated that "*studies invariably shows that all designs have unnecessary cost regardless of how excellent the design team may be".* Green and Popper (1990) indicated that *"Unnecessary cost has been identified as being essential in nature. The unnecessary cost inherent in a given building design can be defined as the additional cost of building that design compared to the cost of building optimum design*.

Both the above, authors recognise the potential to improve the design in order to eliminate the 'unnecessary cost'. Green and Popper (1990) proceed to explain that achieving the 'optimum design' is not really feasible and some compromise is needed for what can be achieved within the programming constraints of the project.

The concept of unnecessary cost is an integrated part of the Value Engineering principle. In any Value Engineering study, it is the search for unnecessary cost in the design that is the power behind any reductions in cost that may result. In such an exercise the basic principle is to identify those items which contain the highest proportion of cost, identify their primary functions and then remove any cost which does not contribute to this function or serve any other useful purpose i.e., the 'unnecessary cost'.

Green and Popper (1990) states that *"since costs which are unnecessary cannot be identified until an alternative solution is found which is cheaper than the original, it must be seen that unnecessary cost is essentially identified in the design process being reviewed"*. This explains why a Value Engineering study cannot take place unless a design already exists. From this, an alternative solution can then be sought to remove the unnecessary cost contained in the original solution.

From the discussion in Section 3.5.2, it also follows that the greatest cost benefits occur earlier in the design process i.e. during the 'feasibility' (or outline) design stage. The above implementation is supported by Zimmerman and Hart (1982) who stated that *"regardless of how capable or how overwhelmingly able the designer is, there will always be some unnecessary cost hidden in his design. The designer is under pressure to meet the date and hence a viable, reliable plan needs to be formulated. With that set of circumstances, the design grows and it takes form. Once the project is formed under pressure, the designer becomes wedded to the project as it is, and may be unable to review it for unnecessary cost"*. Such unnecessary costs may become evident at later stages and result in variation even during construction.

Nalewaik (2007) described the importance of the project audit, which not only tests the accuracy of invoices and other changes incurred against the construction project, but may include a review of the process used in project management and project cost and schedule control, and a comparison of those processes to industry's best practices. Thus, the audit function is an essential project control tool. Further, it can verify the enforcement of compliance with existing policies and procedures, revision of policies and procedures to incorporate the owner's value and current (actual) practices by the project team and identify any improvements to the project management structure. Unnecessary cost occurs in all designs it is an important point for the designer to understand that unnecessary costs in a design are not a reflection of the designer's abilities as a professional, but rather a management problem that needs to be addressed.

3.5.6.1 Change Orders of Value Engineering during Construction

"*Construction projects in the United Arab Emirates are no different from the point of views of having to react to change. Hence 'change orders' or 'variations' to planned works are a common occurrence"*, Nadem (2009).

Kelly, Male and Graham (2004), recognised that while the greatest benefits of Value Engineering accrue during the design phase, the site operations stage is also recognised as relevant, particularly the construction project planning stage. As 'changes' during construction will almost certainly require adjusting the project plan, the case for reviewing Value Engineering at this stage becomes a logical consequence.

Also, Molly (2007) discussed the change order management practices and strategies to resolve change requests that occur during a construction project. Change in the construction industry is inevitable, and it occurs to some degree during almost every construction project.

Nutakor (2007) carried out an empirical study of the factors that account for the difference between bid price and final cost in construction. This was conducted through qualitative and quantitative investigations, the results of this study identified and quantified seven factors namely *"change orders, level of scope definition, bid process, contract risks, market conditions, risk management and performance issues"*. Of these factors, risk and performance are certainly two issues which are considered in Value Engineering and hence may have some impact on final cost.

3.5.6.2 Project Claims during Construction

Nadem (2009) stated that "*Claims result from ambiguities and incompleteness of design"* and hence there is a link to Value Engineering as it can be included as one of the factors upon which the Value Engineering team can base their evaluation.

Knowing where, historically, claims have occurred can be considered during the Value Engineering process with a view to limiting their occurrence and hence improving the projects "value".

Zaneldin (2006) presents the results of a study of the types, causes and frequency of construction claims in the Emirates of Dubai and Abu Dhabi using a data from one hundred and twenty four (124) claims for projects in both the Emirates. According to the results of Zaneldin's study, it is recommended that special consideration should be given to contract clauses dealing with change orders, disputes, variations, extra work conditions and delays. The main and essential steps that can minimise risks and deal with the aforementioned identified causes by Zaneldin (2006) are as follows:-

- Allowing reasonable time for the design team to produce clear and complete contract documentation.
- Having a clear written contract with no ambiguity, by using special contracting provisions and practices that have been used successfully on past projects.
- Developing co-operative and problem solving attitudes on projects through a risk-sharing philosophy between the Owner and the Contractor.

Zaneldin's research findings provide assistance, to all parties to a contract, on how to reduce liability by avoiding the main causes of claims and accordingly, minimise delays and cost overruns in construction projects.

3.5.7 The Effect of Environment and Culture on Value Engineering

This is widely appreciated as a significant and complex issue, Dallas (2006). For the above reason it is dealt with in Chapter 4. However, it is worth noting that in relation to the Value Engineering process the following issues have to be resolved to produce an effective Value Engineering outcome:-

- To be able to interpret the clients project requirements and produce a feasible design solution
- To work effectively as a team in the Value Engineering workshop
- To appreciate and respond to the overall cultural and environment in which the project is to be constructed

Failure to achieve the above outcomes would undermine the Value Engineering process and all have an environmental or cultural aspect.

There is some doubt as to the effect of the cultural impact on Value Engineering in the United Arab Emirates as evidenced by SAVE International (2007), who stated that in the United Arab Emirates *'political, social and cultural risks were insignificant'*. This is noted as an item for further investigation in this thesis.

3.6 Questions arising from the literature review

Current research shows that Value Engineering principles are widely used throughout the United States of America, United Kingdom, Canada, and Australia. However, in the Middle East, including the United Arab Emirates, there is limited published information on the extent and effectiveness of its application. The situation is that there are many construction claims in contracts in the United Arab Emirates. Zaneldin (2006) describes projects that are delayed, mainly, due to Change Orders between Contractors and Owners. Similarly, Nadem (2009) identifies changes by clients and designers as a major cause of cost and time delays. It is possible that a more effective Value Engineering approach could limit the required number of changes or at least mitigate the cost and time implications.

The question arises as to whether there are deficiencies in applying Value Engineering in the United Arab Emirates and if so, how can they be rectified. From the literature review the following questions need to be addressed in the following chapters, as they have been shown to have a direct impact upon the outcome of Value Engineering approach. Any deficiencies in implementing these applications mean that there will be a potential for improvement.

- Is the structure and method of the Value Engineering process being employed consistent with that which is accepted internationally?

- Are the Value Engineering processes being conducted at the stages to maximise potential benefits?

- Does the contractor become involved in the Value Engineering process?

- What level of understanding of the Value Engineering process do those have involved in construction?

- Does the Value Engineering approach extend beyond the design stage?

- Is the process currently successful and how is success of implementation being assessed?

- Are there specific factors that need consideration in relation to construction projects in the United Arab Emirates?

These questions form the basis for the seven (7) heading that were identified to retrospectively collate the research papers in Section 3.5.

3.7 References

1. Abu Dhabi Urban Planning Council (2010), *The Pearl Rating System for Estidama, Building Rating System Design and Construction version 1.0*, Abu Dhabi, United Arab Emirates.
2. Al Duaij, J., Awaida T., and Kollarayam, A. E. (2007), *Performing Value Analysis on Construction Project Variation Orders*, Cost Engineering International Journal, June pp 23-27.
3. Al-Yousefi, A.S., Al Khuwaiter, A., Al Oshaish, S. and Shublaq, E. (1999), *Value Engineering in Saudi Arabia*, SAVE International Conference, pp 9-17.
4. Brian, R.N. and William C.M. (1995), *Value Management in Construction, A Practical Guide*, London.
5. Carter (1991/1992), *A study of Value Management and Quantity Surveying practice*, Surveyors Publications, London.
6. Cheah, C.Y.J and Ting S.K. (2005), *Appraisal of Value Engineering in Construction in Southeast Asia.* International Journal of Project Management, Vol. 23, pp 151-158.
7. Colacchia, G.V. (1995), *Estimating for Value Engineering*, SAVE International proceedings.

8. Columnist, G. (2009), *Value Engineering in Dubai* (online) available from 06 April 2012, www.constructionweekonline.com.
9. Dallas, M.F. (2006), *Value and Risk Management A Guide to Best Practice*, Lackwell Publishing Ltd, U.K.
10. Dasgupta, R. and Mujumdar, K.J. (2000), *Value Engineering Management in an Industry – A case study of GGL* , SAVE International Conference proceedings, pp 40- 43.
11. Dell' Isola, A.J. (1973), *Value Engineering in the Construction Industry*, Construction Publishing, Washington.
12. Dell' Isola, A.J. (1982), *Value Engineering in the Construction Industry*, 3rd Edition, Van Nostard Reinhold, New York.
13. Dubai Chamber of Commerce (2009), LEED Facts, Project Profile, Dubai Chamber of Commerce & Industry Head Quarters, LEED Existing Certification Award.
14. Egan, J. (1998), *The Egan Report: Rethinking Construction*, DOE London.
15. Fist, E.R. (1988), *Construction Project Administration*, 3rd Edition, Willy, New York.
16. Ghosh, A. K. (2008), *Success of Value Engineering Applications in Organisations in the competitive world*, SAVE International 2008 Annual Conference.
17. Glover, N. (1992), *Value management Applied to Organisational Effectiveness*, International Conference of the Society of American Value Engineers (SAVE), pp 158-168.
18. Green, S.D., Popper, P.A. (1990), V*alue Engineering: The search for Unnecessary Cost*, Occasional paper no.39, Chartered Institute of Building, Ascot.
19. Hayden and Parsole (1996), *Value Engineering in the Construction Industry*, 3rd Edition, Van Nostard Reinhold, New York.
20. Jacob, A. (2010), "*UAE professionals thinking green, but not doing*", retrieved on 02 February 2012, www.khaleejtimes.com.
21. Kamaruzzaman, S. N., Egbu C.O., Zawawi, E.M.A, Ali, A.S., Che-Ani, A. I. (2011), "*The effect of indoor environmental quality on occupants' perception of performance: A case study of refurbished historic buildings in Malaysia*", Energy and Buildings, 43, pp 407–413.
22. Kasi, M. (2009), *Function Approach to Transportation Projects, A Value Engineering Guide*, Alfred Basesch & Company.

23. Kelly, J. and Male, S. (1988), *A study of Value Management and Quantity Surveying practice*, Surveyors Publications, London.
24. Kelly, J. and Male, S. (1992), *Value Management: Enhancing Value or Cutting Costs*, The QS Bulletin.
25. Kelly, J., Male S. and Graham D. (2004), *Value Management of construction projects*, Blackwell Publishing, United Kingdom.
26. Kelly, J., Male, S. (1993), V*alue management in design and construction: The economic management of projects*. E & F N Spon, London.
27. Kelly, J., Morledge, R., and Wilkinson, S. (2006), *Best value in construction*, Blackwell Science Limited, United Kingdom.
28. Kirk, S. J., and Spreckelmeyer, F. K. (1993), *Enhancing value in design decisions*. S J Kink, Detroit, USA.
29. Latham, M. (1994), Constructing the team, Final Report of Government Industry Review of Procurement and Contractual Arrangements in the UK Construction Industry, HMSO, London.
30. Lee, S. Y. and Guerin, D.A. (2010), '*Indoor environmental quality differences between office types in LEED-certified buildings in the US*', Building and Environment, 45, pp 1104-1112.
31. Lin, G. (2003), *Developing a performance measurement framework for Value management Studies*, *Delivering Value today and Tomorrow*, pp 1-8 (downloaded from internet).
32. Male, S., Kelly, J. Grongqvist, M. and Graham, D. (2007), *Managing value as a management style for projects*, International Journal of project Management, Vol.25, pp 107-114.
33. Martin, S.J. (1998), *Constructively Measuring Value Programs Effectiveness, SAVE International Conference Proceedings*, pp 239-248.
34. McGeorge, D. and Palmer, A. (1997), *Construction Management New Directions*, Blackwell Science, U.K.
35. Molly, K.K. (2007), *Six steps for Successful Change Order Management*, Cost Engineering, Vol. 49/No.4, April, pp 12-19.
36. Mukhopadhyaya, A.K. (2009), *Value Engineering Mastermind, from concept to Value Engineering Certification*. SAGE Publication, California.

37. Nadem, A.B.A.T. (2009), *Understanding and Preventing Construction Conflict, claims and Disputes, A critical in-depth study into their causes and recommendations to control in the United Arab Emirates,* PhD Thesis, University of Glamergon.
38. Nalewaik, A. (2007), *Construction Audit – An Essential Project Controls Function, Cost Engineering,* October, pp 20-26. (34) Norton, B.R. and McElliot, W.C. (1995).
39. Neap, H.S., Seran, A. (2009), *Owner's Factor in Value–Based Project Management in Construction*, Journal of Business Ethics, Mar, page no. 99.
40. Norton, (1992), *A Value Engineering Case Study*, Chartered Quantity Surveyor, September, Page No.7.
41. Norton, B.R. and McElliot W.C. (1995), *Value Management in Construction: A Practical Guide,* Macmillan Press Ltd., London, United Kingdom.
42. Nutakor, G. (2007), *Assessing Final Cost of Construction at Bid Time*, International Journal of Cost Engineering, June,Vol.49/No.6, pp 15-21.
43. Otto, B. K. (2007), "*Sustainable Office Design: Unlocking Performance and Productivity*", Morgan Lovell - Inspiring office transformation, retrieved on 02 February 2011 from www.morganlovell.co.uk/useful-info/white-papers.
44. Paget, S. (2008), *Value Engineering and sustainability*, Annual Conference Paper and Presentation Abstracts, SAVE International.
45. Palmer, A. (1990), *A Critique of Value Management*, Technical Information Service No. 124, Ascot.
46. Payne, J. and Beardsall, D. (2005), *Application of Value Management to the Understanding and Improvement of knowledge Management, Delivering Value Today and Tomorrow,* pp 1- 8.
47. Qie, W.H and Yang, M. (2007), *Theory and Practice of Project Value Management*, Beijing, China Machine Press, page no. 89 and pp 124-143.
48. Roe, B. (2009), *Value Engineering for Sustainable Data Centres*, Built Environment, Nov-Dec 2009.
49. Sameh, M. El-Sayegh. (2008), *Risk assessment and allocation in the United Arab Emirates construction Industry*, International Journal of Project Management, Vol.26, pp 431-438.
50. Seely, I.H. (1996), *Building Economics – appraisal and Control of building Design and Efficiency,* Macmillan Press Ltd, U.K.

51. Siterman, E. (2009), *A "perfect storm" boosts Value Engineering in Dubai*, Construction from 07 April 2012, www.constructionweekonline.com.
52. Sneden, J.A. (1988), *A Value Engineering Incentive*, The Chartered Quantity Surveyor.
53. Stringer, R.A. (1995), *Value Engineering a Nation- South Africa: A Case Study*, SAVE proceedings, pp 309-314.
54. The CTBUH 8th World Congress (2008).Tall and Green; Typology for a Sustainable Urban Future. The Council on Tall Buildings and Urban Habitat (CTBUH), 3-5 March, Dubai, United Arab Emirates.
55. Sustainability Report (2009), Parsons Corporation, Pasadena, U.S.A.
56. US Green Building Council (2007), *New Construction & Major Renovation Reference Guide*, Third edition, 2007.
57. Value Methodology Standard and Body of knowledge (2007), *SAVE International*, Value Standard, 2007 edition.
58. Waddle, T. W. (2008), *The Contractor's Role in building Cost reduction After Design (Bringing a Project into Budget)*, The International Journal of Cost Engineering, February, pp 14-23.
59. Woodhead (2005), *Paired Comparison: why tools and techniques with the value methodology*, Save International, San Diego, California, June 26-29th.
60. Woodhead, R.M. and Garnett, A.J. (2006), *Value Engineering and theories of the firm "45th Annual Conference of the Society of American Value Engineering International (SAVE International)*, Savannah, Georgia, June 5-7th.
61. Yeo, K.T. and Qiu, F. (2003), *The Value of management flexibility – a real option approaches to investment evaluation*, International Journal of Project Management Vol. 21, pp 243 – 250.
62. Zaneldin, E.K. (2006), *Construction claims in United Arab Emirates: Types, causes, and frequency*, International Journal of Project Management, Vol. 24, pp 453-459.
63. Zimmerman, L.W. and Hart, G.D. (1982), *Value Engineering: A practical approach for Owners, Designers and Contractors*, Van Nostrand Reinhold Company, New York.

CHAPTER 4

THE ENVIRONMENT AND CULTURE FOR VALUE ENGINEERING IN THE UNITED ARAB EMIRATES

4.1 Introduction

This chapter presents an introduction to the construction culture, environment and geography of the United Arab Emirates and especially construction projects in Abu Dhabi. It also reviews current economic issues affecting construction in Abu Dhabi projects and as well as in the United Arab Emirates. The cultural and environment issues with respect to design and construction including the impact on Value Engineering in the United Arab Emirates are also reviewed.

Also, this chapter includes the influence of environment and culture on architectural design including hot weather conditions and selection of materials compatible with climate condition in the United Arab Emirates.

The existing publications on culture and environment specifically in relation to Value Engineering, both within the United Arab Emirates and globally were found to be very limited.

4.2 Brief History of United Arab Emirates

The United Arab Emirates lies between 22°50’ and 26° north latitude and between 51° and 56°25’ east longitude. It shares a nineteen kilometre border with Qatar on the northwest, a 530 kilometre border with Saudi Arabia on the west, south, and southeast, and a 450 kilometre border with Oman on the southeast and northeast. The land border with Qatar is one over which in 1993 the United Arab Emirates continued to have a dispute in the Khawr al Udayd area. The largest Emirate is Abu Dhabi and occupies 87 % of the United Arab Emirates total area of 71,000 square kilometres. The smallest Emirate is Ajman and occupies only 260 square kilometres, Benesh (2008).

Figure 4.1 A Map of the United Arab Emirates, (Source: Samarrai and Souwed, 2006)

The United Arab Emirates stretches for more than 650 kilometres along the southern shore of the Persian Gulf. Most of the coast consists of salt pans that extend far inland. The largest natural harbour is at Dubai, although other ports have been dredged at Abu Dhabi, Sharjah and elsewhere. Numerous islands are found in the gulf and the ownership of some of them has been the subject of international disputes with both Iran and Qatar. The smaller islands, as well as many coral reefs and shifting sandbars, are a menace to navigation. Strong tides and occasional windstorms further complicate ship movements near the shore.

Prior to withdrawing from the area in 1971, Britain delineated the internal borders among the seven Emirates in order to prevent territorial disputes that might hamper the formation of the federation. In general, the rulers of the Emirates accepted the British intervention, but in the case of boundary disputes between Abu Dhabi and Dubai, and also between Dubai and Sharjah, conflicting claims were not resolved until after the United Arab Emirates became independent. The most complicated borders were in the Al Hajar al Garbi Mountains, where five of the Emirates contested jurisdiction over more than a dozen enclaves, Benesh (2008).

The historic connection with the United Kingdom has meant that English is widely spoken and British Standards and condition of contract are commonly encountered in the construction industry in the region.

The climate of the United Arab Emirates, generally, is hot and dry. The hottest months are July and August, when average maximum temperature reach above 48^{o} C on the coastal plain. Average minimum temperatures in January and February are between 10^{o} C and 14^{o} C. The average annual rainfall in the coastal area is fewer than 127 millimetres, but in some mountainous area annual rainfall often reaches 350 millimetres. Rain in the coastal area falls in short, torrential bursts during the summer months, sometimes resulting in floods in ordinarily dry wadi beds. The region is prone to, occasional, violent dust storms, which can severally reduce visibility, Benesh (2008).

Until oil was discovered in 1958, the area was one of the most impoverished and backward in the world, Fairservice (2007). Nomadic herding, date growing, coastal fishing and trade, chiefly through Dubai, provided a bare existence. By the early 1970's petroleum production from enormous offshore and mainland reserves, primarily in Abu Dhabi and Dubai, resulted in an increase in income of hundreds of millions of dollars. With this revenue came a building boom, especially in the two oil producing sheikhdoms, of new homes, schools, office buildings, pipelines, oil storage facilities, ports, roads and air fields. It also brought the beginning of a welfare state, Samarrai and Souwed (2006).

"*The United Arab Emirates has one of the highest living standards in the world*", Benesh (2008). The population of the United Arab Emirates is one of the most diverse in the Middle East. As to the Government estimates nearly 22% are national, Asians and other nationalities are 55% while 10 % being Westerners and East Asians, Benesh (2008).

The Supreme Council, consisting of the Seven Sheikhs, is the highest authority in the land. It selects a President, a Vice-President, a Prime Minister and a Cabinet. Each Sheikh has almost absolute power in his own domain. He appoints representatives to the forty (40) member legislature that meets in the provisional capital of Abu Dhabi.

4.2.1 Facts in brief about the United Arab Emirates

- Capital is Abu Dhabi.
- Official language is Arabic.
- The total Area is 83,600 km^2. The United Arab Emirates has some 700 kilometres of coastline, including 100 kilometres on the Gulf of Oman, Samarrai and Souwed (2006).
- Current estimated population is 7.2 million at the end of 2011 and the figure is expected to grow by 7.6 million at the end of 2012 (www.uaeintract.com).
- Natural resources are dates, melons, tomatoes, fish, shrimp, fossil fuel and natural gas.
- The flag of the United Arab Emirates, adopted in 1971, has a vertical red strip on the left side of the flag and three horizontal stripes of green, white and black (top to bottom).
- Basic unit currency is Emirati Dirham. One hundred fils equal one Dirham.

4.3 Present Construction Economic Issues in the United Arab Emirates

4.3.1 Overview of the Economic Situation in the Construction Industry

Luke (2009) described the construction industry in the United Arab Emirates of that time as one of the sectors most affected by the economic downturn of 2009. Some customers lost nearly all their work, as the projects which they were working on were stopped. It was an unexpected global situation, especially after the previous three to five years of high construction activity in Dubai. Reports from firms operating in the Middle East show that not all the changes taking place during the current economic downturn are negative. While losses in revenue and jobs were expected during 2009, re-evaluations of company operations, moves into other markets and the launching of new, more efficient technologies provided some effective means that allowed the firms to remain competitive.

Stewart (2009) was more optimistic and reported that the Abu Dhabi property sector would continue to grow because the market was based on genuine demand, rather than being based on speculation. Stewart further stated that the continuation of genuine demand would continue to support the construction industry that has been largely motivated by speculation in other areas of Gulf Cooperation Council (GCC). The onset of a recession has resulted in falling rents and shortage of end-users for speculative construction and also, in challenges in finance for new development. Laws to cover both investors and developers have also been recently changed. Looking beyond 2010, Abu Dhabi has a host of projects and mega-projects under way including US Dollars 27 billion Saadiyat Island, the US Dollars 22 billion Masdar City, the US Dollars 15.8 billion Al Raha Beach and US Dollars 11.7 billion Das Island. Hence, there are grounds for longer term optimism in the construction industry, Stewart (2009).

Stewart (2009) also noted the following issues which have a bearing on Value Engineering in the region :

- The construction industry's current priority is to ensure that the businesses overhead cost base is not so inflated that it consumes these lower margins, so some cost cutting is likely to be required.

- The pressure to minimise contract prices on construction projects is widespread.

- There are price sensitive customers and cost conscious ones and there is a significant difference between the two that needs to be appreciated.

4.3.2 Recent economic issues affecting the United Arab Emirates Construction Industry

The following sections are abstracts from published articles containing relevant information to the above heading.

4.3.2.1 Governments Act to restore confidence

In late 2007, as problems stemming from securitised mortgage deals in the US began to be revealed, "*there was a feeling that the Middle East would be able to go through this crisis without suffering,*" says Jean-Christophe Durand, regional director for the Gulf Cooperation Council at French bank BNP Paribas. "*But as we looked at the crisis unfolding globally, we noticed that it really started to hit the Gulf Cooperation Council at least six months after the rest of the world,*" Martin (2009).

A series of measures introduced by regional governments are helping to repair the damage caused by the global financial crisis. *"In the United Arab Emirates, a fund of UAE Dirhams 120billion (US Dollars 32.7billion) has been made available by the government to shore up banks, along with facilities to swap dirhams for dollars to ease the problem of a lack of dollar funding"*, Martin (2009).

Although it took some time for the financial crisis to have an impact on the operations of the local banking sector, it hit the financing plans of major projects around the region much earlier.

4.3.2.2 Contractors look for fresh opportunities

Having invested heavily in staff and equipment over the past five years, the collapse in the Gulf real estate market has left regional construction firms struggling to secure enough work. But infrastructure projects offer cause for optimism.

The rapid market downturn was not anticipated. The first nine months of 2008 were record months for the Middle East's real estate sector. Property prices continued to soar, developers dared to launch projects that were even bigger than those they started in 2006 and 2007, and the construction industry was under pressure to meet high demand, Foreman (2009).

"By the end of 2008, Dubai's largest government-backed real estate developer, Nakheel, had cancelled projects such as the US Dollars 790 million Trump Tower on the Palm Jumeirah and laid off more than 500 staff", Foreman (2009).

4.3.2.3 Scaling back of new projects

"Developers across the Gulf are starting to scale back or delay the rollout of their new projects. The rapid down turn in the real estate market has resulted in difficulties for the construction industry, but a much larger concern is the lack of new projects being awarded", Foreman (2009).

Foreman (2009) stated that in the first five months of 2009, just US Dollars 4.1 billion of new contracts were awarded and the figure for the first half of the year is expected to come in well below the US Dollars 23 billion that was awarded in the same period of the previous year.

The imbalance in Dubai is offset by markets elsewhere in the region where there is still demand for contractors. Despite falling property prices, Abu Dhabi is currently tendering for US Dollars 7 billion worth of major projects and, for contractors that do the bulk of their work in Dubai, it presents an opportunity to employ its spare capacity, Foreman (2009).

Although many of the residential building projects where construction work was scheduled to start in 2009 year have been delayed, a lot of tenders are still being issued, especially for hotels, as the Abu Dhabi Tourism Authority pushes ahead with its plans to more than double the number of hotel rooms in the Emirate to 25,000 by 2012, Foreman (2009).

4.3.2.4 Downturn delays capacity expansion of project

Power and water projects are being put on hold across the region as utilities providers lower their demand projections in the wake of the credit crunch, and developers struggle to secure funding, Maree (2009).

"There will be four types of projects in the Middle East: projects that must go ahead, downsized projects, delayed projects and cancelled projects", Maree (2009).

In most countries, the economic slowdown has led utility companies to revise their demand growth projections downwards. Dubai, which has been hit hard by the down-turn, is expected to lose as much as 20 percent of its population over the next year, which will have a significant impact on the emirate’s electricity demand, Maree (2009).

4.3.2.5 Slow progress hits confidence of contractors

Despite its undoubted financial strength, contractors are not completely confident in Abu Dhabi’s prospects. *“Abu Dhabi is positive, but it seems to us that clients remain unconvinced about the Emirate”* says Phillipe Dessoy, General Manager at Belgian contractor Six Construct Besix. *“There are plenty of tenders and we are putting in lots of bids, but there are few decisions being made, which is a bit worrying”*, Proto (2009).

Abu Dhabi construction veterans advise caution in investing with too much hope in the emirate as a saviour for the United Arab Emirates construction sector. *“The pace of business in Abu Dhabi is slower than in Dubai, thanks mostly to its practice of reviewing costs, in the hope that in a few months’ time, project costs will be even lower”*, Proto (2009).

4.3.2.6 The Impact in Dubai, United Arab Emirates

The industrial areas of Al-Quoz, Ras Al-Khor and Jebel Ali have made a large contribution to the emirate’s economy in recent years, not least the construction sector. As work comes to a halt on many projects and migrant workers return home, the effect on the emirate’s population could be significant. *“Economists predict that by the end of year 2009, Dubai’s population will have shrunk by as much as 17 percent, largely due to the fall in construction activity and migrant workers returning home”*, Forman (2009).

The situation has changed significantly since 2008, when contractors could not find all the workers they needed. Some contracting companies even bought or built their own labour camps. *“With strong demand and low availability, worker accommodation looked like a better investment than luxury apartments at the time”*, Forman (2009).

4.3.2.7 Developers focus on affordability

With the global economic downturn reducing the value of luxury Gulf properties, developers are concentrating on fulfilling demand from those on lower incomes.

"The Gulf property sector has been going through a tough time in recent months, with prices dropping by up to 40 percent in the worst hit market in the United Arab Emirates, since their peak in the summer of 2008. The systemic shock to the Gulf's real estate sector caused by the global financial downturn is no better illustrated than in the recent mergers and restructurings announced in Dubai", Evans (2009).

4.3.2.8 Infrastructure projects plans feel pain

In 2009, many real estate projects across the Gulf were put on hold or cancelled as the financial crisis hit and developers could no longer afford to build them. In 2010, a number of government-funded infrastructure projects were put on hold, which raised concerns about the future of state-backed projects in the region, Al-Hammadi (2010).

It is not surprising that Dubai's, estimated US Dollars 1.10 billion, Al-Sufouh tram scheme is on hold, given the number of projects that have stalled, or, delayed in this Emirate. But news that the estimated US Dollars 4 billion Qatar-Bahrain Causeway is on hold, will be more of a shock. The reasons for the delay are a combination of funding and political issues, but of greater concern, is that it may be the first of many transport schemes in the region to be put on hold, Al-Hammadi (2010).

4.3.2.9 Contractors are now risk averse

Winning work in the Gulf is not easy for contractors. Governments and real estate developers have put many developments on hold, and with few projects moving forward, there is simply not enough work to go around.

To make matters worse, for the projects that are going ahead, the pricing is extremely competitive. *"The margins have been squeezed so tight that companies now complain that winning bidders are winning work at cost, or in extreme cases, below cost. This* *leaves contractors with a choice of either stopping bidding for contracts and looking for work elsewhere or taking on new work and run the risk of losing money"*, Foreman and Roberts (2010).

While the contractor should be well aware of the risks involved, the client is often unaware of the problems that cut-throat pricing might create problems for a project in the long term.

If a contractor is losing money in a project, they can either raise the top line and get more money from the client, or lower the bottom line and reduce costs. Getting more money from the client means claims, and although claims are often the norm rather than the exception on projects, they are something that clients and contractors should try to avoid rather than encourage.

Foreman and Roberts (2010) stated that Cutting costs should be more of a concern to clients. Value Engineering exercises before the job starts may be able to reduce costs without negatively impacting on the finished product, but more often than not cutting costs while a project is under construction means poor quality construction. In such a market, there is the risk of project failures when the firm building them loses money and end up handing over a substandard finished product.

4.3.2.10 Squeezing contractor's margins

In 2008, the Gulf appeared to be the most lucrative market in the world for construction companies. Foreman and Roberts (2010) stated that "*There were close to US Dollars 2 trillion of construction projects planned or under way and with a limited number of contractors capable of taking on major projects, the big players could name their price and command double-digit margins*.

Today the situation has been reversed and the demand for contractors has collapsed, resulting in insufficient projects to keep companies busy, and *"fierce competition means margins have been squeezed so tightly that contractors are now looking for more profitable opportunities outside the region"*, Foreman and Roberts (2010).

4.3.3 Impact of Construction Market conditions on Value Management.

The effect of recession of the United Arab Emirates construction market, noted in Section 4.3.2 has led to clients in the United Arab Emirates and globally, to be more cautious with their investments in the construction sector. As funding for the project becomes restricted, the maximising of the cost effectiveness of the investment becomes a major consideration. Foreman and Roberts (2010) identified that the pressure on contractors to reduce their margins and also cautioned that the *'cutting of costs'* is an issue of concern for clients.

Value Engineering aims to reduce costs without negatively impacting on the finished project. It is thus an approach that offers potential benefit to clients in current market conditions. Clients in the United Arab Emirates are embracing Value Engineering, but Foreman and Roberts (2010) caution that cutting costs while a project is under construction means poor construction. In such a financial climate, while the temptation to cut costs is great, it would be prudent to consider conducting a further Value Engineering review during the construction stage. This would seem to be appropriate if there are changes in specification or requirements by the client.

In this way Value Engineering offers a structured approach to re-assessing the costs rather than cutting cost and reduces the quantity. Care needs to be exercised however, as Value Engineering should not be viewed as an unqualified cost cutting exercise.

4.4 The Influence of Culture

Construction operations in the United Arab Emirates are influenced by the prevailing culture and environment. It is necessary therefore to be aware of these factors when researching the implementation of Value Engineering in this area of the world, as they may well influence the effectiveness of implementing such a method.

4.4.1 Human Resources

The management structures of many companies are influenced by legislation demanding a majority share of partnerships or companies are held by United Arab

Emirati nationals. This has resulted in a senior management structure composed of Arabs with overseas specialist advisors and operational managers. Lower levels of management are often staffed by experienced personnel, and the weighting of local and overseas employees depends on the company policy, but influenced by the national objective to encourage the training and employment of United Arab Emirates nationals, refer to as an ‘Emiratisation’ policy, Benesh (2008). The workforce is predominantly from the Indian sub-continent. According to Hofstede and Hofstede (2005), both Arab countries and India score highly on the power distance scale.

The characteristics in the workplace that arise as a result of a large power distance culture, according to Hofstede and Hofstede (2005) are :-

- Hierarchy in organisations reflects existential inequality between higher and lower level
- Centralisation is popular
- There is a wide salary range between the top level and bottom level of the organisation
- Managers rely on superiors and on formal rules
- Subordinates expect to be told what to do
- The ideal boss is a benevolent autocrat, or “good father”
- Subordinate-superior relations are emotional
- Privileges and status symbols are normal and popular
- White-collar jobs are valued more than blue-collar jobs

As Value Engineering often depends on critical evaluation, it is possible that a large power distance culture might be in conflict with its effective implementation. This results from those of lower standing or status in the Value Engineering workshop groups being reluctant to express their views or offer constructive suggestions. Seraphim (2005) identified those two components in particular that had an influence on total quality implementation that could also impact the Value Engineering.

- Employee empowerment appears in direct conflict with a culture in which subordinates expect to be told what to do and are afraid of expressing a disagreement with their superiors.

- Communication might be strongly impeded by a culture of unquestioned obedience to superior's decisions, and non-consultation of subordinates during decision making. Hofstede and Hofstede (2005) also believe that such culture implies that *"contacts between superiors and subordinates are supposed to be initiated by superiors only",* which might render bottom-up communication more difficult. The high number of hierarchical layers in the organisation might also prove an obstacle to direct communication. Finally, those difficulties of communication linked to a large power distance culture are reinforced by the multi-lingual and multi-cultural characteristics of the workforce as well as by the low level of literacy among the workforce.

- Team working, particularly when mixing several level of hierarchy, can be perceived by the employees of higher hierarchal levels, as a threat that endangers their privileges and status.

In a company where the vast majority of employees are men, it is expected that the 'masculinity score', as defined by Hofstede and Hofstede (2005), should be higher than when taking into consideration a mixed population of men and women.

Where the prevalent culture in the company is more masculine than feminine, Hofstede and Hofstede (2005) claimed that *"from the most feminine to the most masculine country, the range of Masculinity Index scores for men is about 50 percent wider than the range for women"*. It was substantiated by Seraphim (2005) that, for the United Arab Emirates Company studied, that the culture was predominantly masculine and revealed in Table 4.1 below.

Table 4.1 Comparison between the Masculine characteristics and the company characteristics.

Masculine characteristics in the work place, Hofstede and Hofstede (2005)	Characteristics of the company studied by Seraphim (2005)
Management: decisive and aggressive	True
Resolution of conflicts by letting the strongest win	If one considers that this element is opposed to the feminine opposite "Resolution of conflicts by compromise and negotiation", it is certainly true. Compromise and negotiation is felt as a weakness, particularly in management.
Rewards are based on equity	True
Preference for large organisations	This item is difficult to judge
People live in order to work	True, Employees have accepted expatriation and hard living conditions in order to work in the United Arab Emirates.
More money is preferred over more leisure time	True, Employees are routinely working overtime in order to earn more
Careers are compulsory for men, optional for women	True
There is a lower share of working women in professional jobs	True
Humanisation of work by job content enrichment	This item is difficult to judge
Competitive manufacturing and bulk chemistry	The organisation is operating in competitive manufacturing

Thus, the cultural characteristics in the organisation, identified by Seraphim (2005), are considered to be in direct conflict with factors having a recognised impact in successful Quality Management implementation, namely:-

- Communication systems
- Employee participation
- Involvement and empowerment
- Team working

The same principles apply in Value Engineering where an open and free exchange of ideas is important when looking at a wide range of potential options and interactions in order to determine the most cost effective solution.

4.4.2 Organisational Culture

The organisation culture is a result of the shared assumptions, beliefs, values and norms of the company, which shares patterns of behaviour, Amanda (1993). Every company or establishment has its own culture, as do its employees. The company culture usually is influenced by its members, to a greater or lesser extent. George (2003) stated that *"The company culture is also influenced by the reflection of the owner's culture interacting with the staff culture",* also, "*the nation's culture influences the organisation's operational life*".

4.4.2.1 Factors influencing Organisation Culture

Companies have a culture just as people have their personalities. Company culture is the collection of beliefs, norms, accomplishments and attitudes of the owner or owners, employees and of the surrounding environments.

Literature on the nature of culture often refers to organisational cultures, with reference to organisations, not only as companies or workplaces, but as any group of people organised for a particular purpose. *"The culture of an organisation describes the unique way in which people act or interact within it"*, Greenwood (1997) and

Smircich (1983) identifies two broad theoretical approaches *"Organisational culture can be conceived, firstly, as something an organisation has, as something emerging from social interaction, or secondly, as something an organisation is"*. A third approach suggests that culture is something an organisation does to its members and society. Wajcman (1998) suggests that culture is both produced and reproduced through the negotiation and sharing of symbols and meanings. Crucially, culture is something that is learned; *"the result of mental programming"*, Hofstede (2003) and Powell (2009) states that *"culture is simultaneously the shape of human actions and also the outcome of that process"*. This dynamic concept of culture highlights the limits of individuals to manipulate culture changes, because ultimately it is not something individuals can control. Wajcman and Martin (2002) state that a variety of cultures can coexist within a single organisation. Brown (1995) describes that these are subcultures.

Organisational cultures are derived from a variety of sources within and outside of that organisation. Brown (1995) lists the most important of these as being: national culture, the organisation's leaders, the nature of its business activities, and its environment. *"The culture of an organisation is the product of a variety of factors. It pervades all aspects of the workplace, and has a great influence on the occupational identity acquired there"*, Powell (2009). This will be shown in Section 4.6 to be particularly relevant to the United Arab Emirates.

Organisational culture is an important issue, particularly when operating on an international basis. Where companies have all or part of their projects designed by overseas companies, this is also relevant. There is no specific definition for organisational culture, but most people agree that culture is the "whole" and it is more than the sum of its parts. Culture is affected by the norms and rituals of its group members. Mullins (1993) confirms that the culture of an organisation develops over time, *"There are a number of key elements and factors that have been recognised as being inherent within organisations. These elements have been labelled and make-up what is known as 'organisational culture'. The culture of organisation develops over time in response to a complex set of factors. Through the accumulation of many years work various key influences can be identified as playing an important role in the development of any culture within an organisation"*.

In order to identify organisation culture, it is necessary to review the major factors that impact on the culture character, which will be used in the appraisal of the implementation of Value Engineering in the United Arab Emirates.

History and Ownership of the Establishment

The history, age of an organisation and the ownership characteristic of any establishment, has an impact on its working environment. It influences the company in the degree of centralisation of ownership, which affects the power culture and control of the resources. It also helps in stabilising the company's working environment.

Hodgetts and Luthans (1991) emphasised culture as "*the total of the inherited ideas, beliefs, values and knowledge which constitutes the shared bases of social action and the total range of ideas. In addition to activities of a group of people, with shared traditions are transmitted and reinforced by members of the group*".

The cultures of organisations that specialise in different lines, products or services are different. For example, the culture of construction organisations is different from the culture of an educational organisation or health organisation.

Advances in technology, such as, internet and telecommunications, have encouraged international market organisations and construction companies to think globally. As a consequence, 'culture' in the last twenty years has become an important issue to an organisation's management style.

Culture also influences the decisions and thinking process of employees, their feelings and their actions towards all surrounding events. The culture of an organisation is reflected by its employee's performance of their tasks, setting of objectives and the administration of the necessary sources to achieve the planned objectives.

Size and extent of companies

The size and extent of companies or firms influence their organisational culture. Top management influences the selection procedure of the organisational structure and its culture.

In large organisations structure must be formalised, they have to depend on organised structured groups in order to perform efficiently. They have to control their activities by setting up co-ordination meetings, with a daily follow-up procedure for monitoring the work progress. Small companies tend to be more flexible in their management system.

The size of a company characterises the type of organisation culture. Large companies generally try to adopt "Role Culture", George (2003).

Technology adopted by the organisation

The impact of this factor depends on how sophisticated and advanced the systems are adopted by the organisation. George (2003) highlights that "*the repeated programmes and operations and mass production tend towards the role culture, which is usually followed by large organisations having multiple and large operations".* Handy (1993) emphasises that the *"kind of technology will have an effect on the culture and the structure*". The complexity of operations and production tends to lead towards a "role culture". The routine and programmable operations are more suitable to a "role culture", while one-off job unit production is suited to "power culture" or "task culture". Controlling the quality of any product is more easily monitored in a "role culture", while growth and goals are more effective in organisations adopting power or task cultures.

Therefore, the Value Engineering is a process and theory predicts that a role culture would be the most appropriate for its implementation.

Goals and Objectives of the organisation

For Value Engineering to be effective the goals and objectives of the project must be clearly defined. Objectives and future expectations vary from one organisation to another. A clear definition of goals and objectives is therefore essential. The organisation must therefore identify, agree and embody these requirements in its company procedures.

Environmental factors affecting organisation

Environmental factors affecting organisations, establishments and community cultures are many, among them are:

- Economic condition.
- Competition and market size.
- Geographical and social factors.
- Political factors.

These will vary between nations and also with time. Nations differ; hence “role culture” is suitable for some, while for the others “task culture” is appropriate, George (2003). As the world moves towards a global economy with many large international companies, it is feasible that while an “international culture” may evolve, it will have to adapt to regional and national factors.

For example an international company operating in the United Kingdom and the United Arab Emirates have a different relationship basis with its clients in those countries. They would have a different format and etiquette requirements for meetings while the technical and support functions at the two locations would have great similarities. In the United Kingdom, relationships between the company and its clients tend to be more formal and legally based; while in the United Arab Emirates they have a more personal bias.

People’s attitude

A person’s mental attitude, behaviour and habits depend on learned individual habits, even within the same nation, community or family. It is widely agreed that individuals are influenced by their cultural background, which in turn influences their views towards social interaction and also their response towards authority. Hence, “organisational culture” needs to be structured to maximise the organisation’s performance interaction with the local culture.

4.4.2.2 Interaction between National and Organisational Culture

Alder (1991) confirmed that organisational culture does not moderate or erase the impact of a national culture, *"When they work for a multinational corporation it appears that Germans become more German, Americans become more American and so on."* Nations seem to be proud of their culture, as it is a part of nations' history.

Nations try to maintain their own culture within a firm, Laurent (1983) supported by Hofstede's (1980) findings that "*power distance, uncertainty avoidance, masculinity, individualism",* have significant impact on the organisational performance and on the individual's cultural value within the organisation.

Organisations' cultures are not easily replaced. The differences between the organisational culture of an international firm and their subsidiaries, causes problems which needs a continuous co-ordination, interpretation and understanding to control the system.

Seraphim (2005) stated that *"An organisation working in a multinational environment needs to develop a unique hybrid culture that retains a basic cultural norm and that allows its efficient operation, consistent with its strategic commercial aims. It must not alienate other cultures but allow some flexibility so that there can be an integration of cultures, without the loss of either cultural identity"*.

4.4.2.3 Human Cultural Impact on Organisations

This section examines the impact of culture on human behaviour, which ultimately influences organisations.

Political and economic factors are leading to increased global interactions. Working with people with different values and beliefs, languages, customs and history can cause misunderstandings. It is an enormous challenge to companies working in an international environment to understand how to effectively manage these differences and similarities in order to successfully avoid misunderstandings.

The cultural impact on human behaviour is embodied generally in the elements of society, "*The results indicated that miscommunications and negative perceptions invoked Emiratis perceptions of social distance from their western co-workers; that is, negatively perceived co-workers were categorised in negative out-group stereotypes. However, many Emiratis reported positive communications with their expatriate co-workers*", Willemyns, Hosie and Lehaney (2011).

Language

The use of the Arabic language in the Gulf Region is an advantage when dealing with clients. While English is widely understood, learning some Arabic has advantages by indicating desire to embrace local culture, George (2003).

The benefits are summarised below:

- It is possible to communicate with clients from various Emirates using a common language – Arabic.
- The language helps in penetrating the societies and developing personal contacts.
- The language helps incomers to enter the society and it creates a healthy group atmosphere.
- The language helps in having productive meetings, gatherings and conversation.

George (2003) noted that *"Some of the legal disputes and problems come from language interpretations. International organisation's experts or members should attempt to understand the host country's language and vice versa"*.

Education

The educational system adopted by a nation acts as a guideline and it directs its culture. The political authority decides the strategies of future educational plans for their country, depending on the social, economical, educational and statistical researches conducted by the nation's experts.

Countries' educational plans consider their "*religion, history and languages*". Further, it is to be appreciated with "*future advance technology adaptations*" and to be "*designed to teach the societies' moral, manners and ethics*", George (2003).

Religion

The religion has a major influence in controlling cultural values, morals and customs. It is clear that religions in different countries have distinct cultural beliefs. The religion and values in some countries are strictly obeyed and respected, as religion directs and controls those nation's culture and beliefs.

The regulations and rules of Arab Countries are taken from the dominant religion Islam, for example, they may have particular business practices or they may have particular attitudes towards women in business.

Family

A community consists of a number of families. The family is the smallest cell or unit in a community. It controls the cultural values learned or inherited from their parents and ancestors. This means that the family has a direct impact and influence on the nation's cultural values. As far as United Arab Emirates is concerned, cultural value for "family" is high. "*Emiratis place high value in families, especially children, they should provide, pleasant environment for extended Emirati families to socialize together in a traditional neighbourhood environment",* Urban Street Design Manual (2009).

History

History consists of a sequence of past events. These events give an insight into a nation and their culture. Knowing more about the history of the host country helps in categorising the people of that country, their habits, beliefs, the way they respond and their working capabilities. These insights can help international firms in their pre-planning and implementing advanced technology in foreign countries. While history is important, it should not be a barrier to useful changes and in the acceptance of global development.

4.5 Background of the United Arab Emirates Construction Industry

The United Arab Emirate's construction industry has faced many new challenges since the year 2009. Clients are demanding an ever increasing performance from the industry, not only in terms of time and cost, but also in quality and value. According to Neap and Seran (2009), *"Value Management aims to maximise the functional value of constructed facilities of a project to the owner. The process is team oriented approach to problem solving"*. Neap and Seran further emphasises that "*Value based project Management can help to maximise functional value of construction facilities based on Client's value system*".

Neap and Seran (2009) also comment that the use of Value Engineering is already making an important contribution to those demands on major United Arab Emirates construction projects. Value Engineering goes hand in hand with an emerging client – oriented construction industry. There is also a new *"can do"* approach apparent on many prestigious projects in the United Arab Emirates, while it is true that the success of Value Engineering depends upon these changes, its use also encourages them. Neap and Seran (2009) stated that the use of Value Engineering epitomises the current changes in attitude in the United Arab Emirates construction industry.

Jeyakumar (1999) indicated that *"Many clients and professionals in the United Arab Emirates mistakenly believe Value Engineering to be a cost cutting exercise"*. It is important for the United Arab Emirates construction industry to understand that Value Engineering is a much wider concept than buildability, and that is not a method of "cost-cutting". Further, the study demonstrated that there were significant potential benefits to be gained by the application of Value Engineering during the design of building developments.

A major risk in applying Value Engineering is the tendency to reduce what is a methodology into a technique, without appreciating the fact that Value Engineering can be far more effective if the whole methodology and principles are fully understood. Value Engineering is not a cost reduction technique though it is claimed; it consistently leads to cost savings. More important are the benefits that can be achieved from better understanding of requirements, which means a more effective process and a more cost effective project.

4.6 Cultural Effects on the Engineer's Role in the United Arab Emirates

4.6.1 Introduction

Culture reflects the human aspect of the engineer's environment as it consists of beliefs, morals, habits and customs learned from others regardless what education they have done. Thus all engineers will, to a greater or lesser extent, be influenced by their cultural background, George (2003). When operating in a different culture, it is important to appreciate the values and norms of that culture which may be different from your own and have to be respected. Failure to appreciate these differences can result in the design of buildings that do not meet end user requirements. This will be evidenced in the case studies of Chapter 6 of this thesis. The Value Engineering process will therefore need to be aware of and react to the cultural factors identified below.

4.6.2 Essential Cultural Factors Affecting Projects in Abu Dhabi

The Emirate has a "*rich cultural context with the traditions stretching back thousands of years".* People from all over the world have selected the Emirates as their home since it has "*a unique blend of local culture, while sharing common characteristics"* with other global destinations, Abu Dhabi Urban Planning Council, (2007).

Abu Dhabi is a multicultural environment and historically many disputes and contractual problems remain even after handing over the projects because cultural factors were not considered during design or execution of the project. Therefore, it is important for all Value Engineers working in the private and government sectors as client representative, consultant or contractor to appreciate the following key influences.

Law of Sharia

In Muslim countries the law is based on religion. Non-Muslims are unlikely to be familiar with Sharia law and are likely to find it significantly different to the legal structure in their own cultures. Any company operating in the United Arab Emirates are well advised to investigate their rights, obligations and liabilities under this legal system, Samarrai and Souwed (2006).

Operational Procedures and Formalities

Design and execution of building works have to meet national and local building control and statutory requirements and receive the necessary permits and authorisations to precede, Building Works Regulations and the Executive by law (1994), Abu Dhabi.

The Urban Structure Framework Plan (2007) issued by Abu Dhabi Urban Planning Council, highlights the key destinations for planning'. It contained, "*principles, policies, geographic plan and schemes and associated commentaries, combine to provide an interim tool for evaluating development and growth propositions prior to full induction of a planning culture within the city"*.

This has to go through a formal administrative process in most of the countries that can be time consuming. *'Unless adequate time is allocated for procedures and formalities in projects they are likely to sustain delays and associated increase in cost',* George (2003).

Awareness of Local Language

The contract language is always Arabic and it is translated into English which is also widely used an understood. Using the Arabic language in the contract documents is an important aspect in Abu Dhabi and organisations should have an Emirati National as a 'local partner', who can help in advising and interpreting contract requirements, Samarrai and Souwed (2006).

Wrong Time Estimates

Productivity changes in the summer months, June to August, as a result of both heat and the reduced working hours at site. A large percentage of the work forces on projects are Indians and they are not acclimatised to the Gulf weather especially during summer. "*While pleasant most of the year, summer in the Emirates tend to be very hot and, in the coastal areas humid in the summer",* Abu Dhabi Urban Planning Council (2009). This will impact directly on the cost and time of the project. As a host country, it is necessary to inform all construction firms about weather effects. It has to be considered as a part of environment study and analysis, and make sure that the programme of work is checked carefully by a local engineer to consider hot season adjustments to avoid over optimistic progress estimates. This is relevant to Value Engineering as some technical decisions may be based on the timing of the construction stage completion or 'lead times' for supply and manufacture of mechanical or electrical equipments. The storage of equipment in a suitable temporary environment can be expensive.

Local Partner

Most design companies have a local national as a partner and according to the government rules the local must have at least 51% of the company bonds which authorise him to give an immediate decision, even if there is a conflict with other partners, Benesh (2008). It is not easy to change the opinion of a local partner if he confirms his decision, as this is a part of traditional culture, which can adversely affect the progress of work in projects. It is important therefore that the local partner is aware of and realises the benefits that can result from the Value Engineering process.

4.7 The Influence of Environment and Culture on Value Engineering in the United Arab Emirates

4.7.1 Impact of Environment on Technical Decisions

The environment can have a technical impact at different stages of the project, such as project initiation stage, design stage and construction stage. It is noted that "*adopt international best practices to the local climate and culture to create strong urban* *identity that is a contemporary expression of Arab culture and values"*, Urban Street Design Manual (2009). During the initiation and design stage, the adverse hot weather conditions is mainly taken into consideration to decide the grade of concrete, type of cement in construction, anti-corrosive aspects of the concrete, etc. With respect to the architectural finishes and fittings, the materials are chosen in such a way that they are long lasting, durable and suitable for local weather conditions. Budgeting and cost allocation for the air-conditioning systems portion of mechanical and electrical works are given due importance so that adequate quality and quantity of air conditioning units and cooling systems are considered properly, in order to adopt the hot climatic conditions.

District cooling systems are part of all major projects. The efficient designs of mechanical, electrical and plumbing works are strongly influenced by prevailing local weather conditions. Also, the interior fitting and fixtures, false-ceiling, wall claddings, floor tiles have to be appropriate for challenging local weather and humidity conditions.

All those above mentioned conditions play an important role in deciding the key items of the project and optimisations of cost and functionality of all those services are very important in decision making of Value Engineering process.

4.7.2 Influence of the Cultural aspects on the Architectural Design

The architectural preferences are mainly based on the culture, social set-up, ethnic behavioural patterns, religious and tribal considerations and the history of the society.

Aspect of architecture could made major changes in the construction. The architecture of the United Arab Emirate reflects many social and cultural aspects of the society, Mahgoub (1999). Architecture of the early stage is concern privacy was an important factor in the arrangement of the houses. *"The male reception was separated from other family private areas. It had direct access from outside without going through the house. The courtyard was restricted to family activities*", Mahgoub (1999).

Recently, construction in the United Arab Emirates has witnessed a new awareness of the importance of traditional and cultural values of architecture and this awareness generated new attitudes towards architecture. "*Many deserted old buildings were renovated and transformed into museums and, new buildings were built by features from traditional architecture*", Mahgoub (1999).

The architectural dimensions, aesthetic values, design and taste are strongly influenced by culture. The priorities to choose to add or delete is sometimes not simply based upon functionality, but also depend on cultural priorities. One has to consider these aspects in Value Engineering. The architectural preferences will tend to vary in the following items.

- Size, dimensions and configuration of the projects.
- Grouping pattern of the project segments within the project.
- Selection of materials with respect to finishes and fittings. Finishes in terms of pattern and colour will be influenced by cultural coincidence and harmony.
- Colour schemes are generally influenced by culture tastes and preference.
- Selection of design and patterns are influenced culturally.
- Electrical fittings and fixtures will have cultural impact.

To elaborate the above details, culturally people need bigger size rooms, a greater number of bedrooms as families are larger, women will have separate rooms and living hall, separate rooms for guests / visitors, separate provision for workers living in, etc. This will naturally increase the size of the building, which cannot be compromised by reducing the floor areas. This will impact on the Value Engineering process. While trying to optimise the size of the building to reduce / optimise cost, it has to be remembered that this item cannot be compromised.

The United Arab Emirates experienced a construction boom that changed the surrounding environment rapidly. Mahgoub (1999) argued that "*there is loss of identity in architecture and the built environment which are produced to satisfy technological advancement and profit making purposes. Some efforts are being made to produce architecture related to the area and needs of the society. Western ideas of* *architecture are being imported to satisfy desired images of progress and development*", Mahgoub (1999).

Similarly with respect to architectural finishes patterns and colour schemes, Emirates will have specific tastes and preferences suiting their cultural values. If such architectural patterns and finishes, for example, are not available locally, then extra effort is needed by the project team to spend money and time to import such items from overseas. A Value Engineering exercise may propose an alternate source of material which would be cheaper. However, in this circumstance when considered culturally important by the client, it may not be compromised. Hence, emotional sentiments can outweigh purely engineering or technical considerations. Moreover, in residential complexes, mosques, Majalis (community hall), dining area and special venues for ladies are considered it may not be compromised.

4.7.3 The Decision Making and Working Culture Influences on Value Engineering

Senior local managers and clients may make decisions based on emotion which may sometimes ignore a logically reasoned proposal from the Value Engineering team members. The selections of supplier / subcontractors are also sometimes, due to different political and cultural reasons, not simply on a methodical pre-qualification and tendering process. Having previously reviewed the Value Engineering process, Chapter 3, and Cultural and Environmental issues, in the earlier sections of this chapter, it is necessary to assess the interaction between them. This will be done by considering the main stages of the construction process in terms of the opportunities to influence the value of the project as used by Kelley, Male and Graham (2004), which are based on RIBA plan of work namely:

- Pre-brief
- Briefing
- Concept design
- Detailed design
- Site operations

The first four of the above list constitute the design process, these are amplified below.

Stage I Pre-Brief

This identifies the overall scope and purpose of the project and involves identifying the clients' 'needs' and 'wants'.

Stage II Project Briefing Study

This is concerned with establishing the technical aspects and specifications that have to be considered in order to address what the client has requested in the Pre-Brief stage. This sets out the technical control parameters within which the designer is constrained.

Stage III Concept Design

At this stage an outline design concept is produced that complies with the clients agreed project brief. The client now has something tangible to review together with an estimated cost plan and usually client approval is sought prior to commencing with more detailed design. It is at this stage that a Value Engineering Workshop to be conducted, although there is no universal agreement as to precisely defined. Kelly, Male and Graham (2004) propose the Value Engineering Workshop to be done at the 10% to 35% stage of the concept design, while Seely (1996) proposes the 50% to 60% stage.

Stage IV Detailed design Stage

Technical and financial issues dominate and the outline design is refined and fully detailed in preparation for issue of tendering.

The site operations at the construction stage should have little input from designers. However, *"modifications, amendments and revisions are regular occurrences in construction contracts worldwide and the United Arab Emirates is no exception"*, Nadem (2009). Client instigated changes at this stage will almost certainly have cost and time implications. The contract conditions then determine the liability for these changes. It can be appreciated from the above that a proactive role by the client is essential if the full benefits of Value Engineering are to be attained. This will be further reviewed in Section 4.8.

4.7.4 The Pre-Brief Stage

The pre-briefing stage is concerned with identifying the broad scope and purpose of the project. It is therefore about evaluating the clients' strategic needs and wants.

"The commercial objectives and the cultural values combined from the value system of the client organisation", Kelley, Male and Graham (2004).

In effect this is the basis of the client's value system that the Value Engineering process will use as a basis for evaluation. This will involve quality standards and general specification. In the United Arab Emirates, the Arab Islamic culture influences all aspects of life. Such a culture has a high 'masculine score' as defined by Hofstede and Hofstede (2005). As such clients, and client organisations, in the Emirates fall into the 'Power Culture' category. This can lead to suppression of new ideas and lack of compromise. It is likely that Value Engineering will propose changes that may need to be sanctioned by the client or client organisation. Consequently, care needs to be taken in creating an open and trusting relationship with clients where suggestions and alternatives are not perceived as a challenge or repudiation of the client's proposals.

"Understanding of client culture can create a remarkable trusting environment in which the word of mouth often replaces written documents", George (2003). In the United Arab Emirates, power is highly centralised with the requirement for nationals to be part owners in all enterprises. It is likely that client and client organisations have stronger political influence that would normally be the case in western culture.

"The formulation of the clients brief in the United Arab Emirates is not always adequately prepared", George (2003). The reasons cited were:

- Clients organisation often suffers from the lack of necessary engineering manpower to produce an effective project brief
- Hesitancy in committing funds at an early stage
- Insufficient experience of the construction process

These factors mean that for Value Engineering to be effective, great care needs to be taken at this stage to work with the client to lay the foundation for the following Value Engineering stage.

4.7.5 Project Briefing Study

This project briefing study focuses on the delivering of a ‘technical project’. In effect this translates the strategy agreed with the client in a construction format that specifies performance requirements for the constituted elements of the project.

There are also technical factors that are influenced by environment, such as, the availability and importing restrictions on labour and materials, the design codes that have to be used, quality procedures, and forms of contract.

It is normal practice in the United Arab Emirates for the design team to be multinational hence, there is a need to develop the team in order to appreciate and work sympathetically with the local cultural environment and develop a corporate culture for the design team and those outside the design team that may be involved in the Value Engineering process. The team approach is central to Value Engineering, and the basis is that an effectively functioning team can outperform the same number of people acting individually.

Goetsh and Davis (2003) define a team as a group of people with a common, collective goal and highlight that the collective goal aspect of teams is critical. Teams can outperform individuals, provided they are properly handled. Goetsh and Davis propose the conditions as Agreement exists as to the team’s mission; Members adhere to team ground rules; Fair distribution of responsibility and authority exists; People adapt to change.

Kondo (2002) claims that Total Quantity Management activities are characterised by the involvement and participation of all employees. This is required in order to permit close teamwork amongst people from different positions, departments and activities. An important precondition for teamwork to occur is that all the members of the group fully understand and accept the group's common aims. In addition, it is often better for the group's members to have slightly different standpoints and outlooks, as difference makes it easier for good creative ideas to surface among the members.

The above is similarly true for Value Engineering, where the prevalent culture is a "power culture", as it is found in the United Arab Emirates. In this case care needs to be exercised to develop organisational cultures that allow individuals the freedom to express opinions or suggest alternatives.

4.7.6 Concept Design

At this stage, the client has usually agreed the project brief. There are three major events at this stage:

- The validation of the concept design outline specifications and cost plan
- Produce at the end of the stage the final concept design prior to commencing detailed design
- Conduct a Value Engineering appraisal

Due to the likelihood of there being a multinational design team, or teams being involved in the projects in the United Arab Emirates, there is a risk that cultural factors may be overlooked. George (2003) noted that "*As a result of the involvement of a considerable number of expatriates owning or working in engineering firms in the United Arab Emirates project designs frequently do not consider the impact of local heritage in their design proposals*."

Other factors that the client may not have stated in the brief, as they would have been seen as the norm, can arise at this stage and cause additional redesign. The following examples in building design are to be considered.

- Provision of separate reception rooms for men and women
- Preventive measure for intrusive viewing through windows into living accommodation from outside
- Privacy in garden areas not to be overlooked

Such issues may only be detected after considerable time and cost have been expended in the design process.

4.7.7 Detailed Design

At this stage the technical and financial issues normally dominate. The United Arab Emirates presents a harsh engineering environment and when determining 'value', durability and maintenance considerations may well be determining factors.

George (2003) also noted that clients in the United Arab Emirates may only take special interest at this stage when there is something tangible to review. This can mean that significant design revisions may be instigated at a later stage than would be anticipated when employing a Value Engineering process. It should be noted that George (2003) was dealing with building projects of lower value and complexity than those examined in the case studies in this thesis.

4.7.8 Site Operations

Site operations in the United Arab Emirates present a unique combination of environment and culture. In order to recruit workers, a company has to present a group-visa in the labour office of the United Arab Emirates government. The number of requested visas must be documented and justified, in order to avoid companies bringing an excess of workers into the country.

Workers are selected for their skills, and staff are selected for their technical competency. Most of the postgraduate diplomas are technical diplomas such as construction drafting diploma, civil engineering degree, electrical engineering degree, etc. Due to on site language problems with manual works site training, site awareness and safety training is essential. Seraphim (2005) provides details of specific measures are undertaken by a company to overcome these difficulties.

Seraphim (2005) identified the autocratic management approach as one prevalent in the United Arab Emirates. This autocratic management approach was not limited to the communication with the workers, but extends its influence among staff who possessed the ability to communicate verbally and in most of the cases in writing (either in Arabic or in English), even if imperfectly.

This is also reported by a study carried out by Al-Zammy et al. (2002) on Yemeni management style, which indicates *that "Many managers and executives think their job is to control and administer and forget the role of leader"*. Without leadership and encouragement from the managers the need for change and the need to question the status quo, may not be identified as people will remain silent.

George (2003) observed that in some case studies the client actively participated only after construction had commenced. This resulted in major variations and substantial re-design. This client approach is a reflection of the culture where the client 'owns' the project and did not fully appreciate the project manager's role which required at the earlier agreement stage of key design elements.

A similar situation would undermine the benefits of the Value Engineering process. Hence, the client's participation in the process from an early stage is essential. The seasons, working hours, national holidays and the timing of Ramadan also have an impact on the productivity of site. Not appreciating these factors and incorporating into the project time estimate can render the projected completion time for the project in unrealistic manner. This will impinge on both time and cost, and reduce the benefits of using Value Engineering.

4.8 Influence on the Value Engineering process in the United Arab Emirates

From the above sections several key areas of influence on the application of Value Engineering can be identified which are special, if not unique, to the United Arab Emirates and hence require special consideration.

4.8.1 Client Influence

The clients for large building projects in the United Arab Emirates fall into the following groups.

- Government Departments - United Arab Emirates owned and funded
- Private individuals - United Arab Emirate Nationals self funding
- Ventures with local partners (with a 51% partnership and hence a majority holding) and a foreign organisation or individual with a shared financial input

It is important therefore that clients are aware of the following factors if they wish to gain the maximum benefits from employing Value Engineering.

- **A clear understanding of Value Engineering**

  A clear understanding that Value Engineering process is about removing unnecessary cost, whilst maintaining or improving functionality clients should guard against viewing Value Engineering as a vehicle for cost cutting. If clients need to reduce cost after the Value Engineering process has been completed and incorporated into the design, the logical step is to review the project brief. This can be done to investigate if elements of the performance or quality aspects can be downgraded. A project review would *"provide a possibility to re-value by the project Engineer to gain cost reduction",* Forman and Roberts (2010).

- **Providing a clear and realistic statement of strategic 'needs' and 'wants' at the pre briefing stage.**

  This lays the foundation for design process and needs to be well considered. 'Needs' have to be achieved, 'wants' are preferred options but gives the design team the opportunity to look at options and subsequently advise the client of the cost implications for review. This enables an effective brief to be formulated by the Value Engineering facilitator. The Facilitator may be an external consultant or from the design organisation.

- **Appraising the concept design and issuing approvals.**

  The client should ensure that this concept design meets his requirements. Any changes need to be communicated to the Value Engineering Facilitator and may require further consideration by the Value Engineering team or part of that team. This is an important decision stage as detailed design will proceed on the basis of the concept design. Subsequent requests for changes by the client will almost certainly incur additional design costs and time delay in finishing a completed design.

- **Issue and response to changes at the post tender and construction stage.**

  Changes at this stage will almost certainly have cost and time implications. As a contract will now be in place, there is also a legal obligation.

  Changes at this stage can also compromise the basis of the Value Engineering already completed and may necessitate a further Value Engineering review. However, at this stage very few alternatives will be available for the Value Engineering team to consider. The client should only issue change orders at this stage, if they are well considered and their implications on project cost and time are assessed.

  Any additional costs will have to be borne by some party to the contract. In the current economic climate with tight margins for contractors, delay in payments can result in severe cash flow problems for contractors. Forman and Roberts (2010) article "*Squeezing contractor's margins*" supports this conclusion.

4.9 Summary

It is evident from the above that many environmental and cultural factors influence the effective implementation of Value Engineering in the United Arab Emirates early client involvement and establishing an effective brief while in the Pre-Value Engineering phase have a direct influence on its potential success.

Client and end-user expectations for the project have to be met; there is often little room for compromise. The client, or end-user, in smaller projects may only take an active interest in the later stages of design, or even at the construction stage. It is essential, therefore the Value Engineering team use their knowledge of the culture to anticipate what is required and the management of the process involved seek information and approval of proposals at an early stage as possible.

Similarly, working effectively in multi-cultural and multi disciplined teams needs to be ensured if benefits are to be maximised. The harsh environmental factors in the United Arab Emirates will also challenge the designer's skills and resourcefulness.

The designers also need to appreciate construction factors that influence the design, particularly the probability of multi-ethnic and multi-national companies being used in both design and construction. There are also special technical issues to be addressed in relation to, e.g. material and performance specification, government regulations, accepted architectural practices etc.

It is essential therefore that the Value Engineering team considers the range of cultural and environmental issues that impact on the project, and have representative in the team with the knowledge and experience of working in the United Arab Emirates to advise them. Failure to do this will inevitably lead to time delays and additional costs, which can be substantial.

The current economic downturn has led to a sharp decrease in investment in construction with clients looking for cost effectiveness in their projects. There is evidence that Value Engineering is being perceived in the construction industry as one method that can improve cost effectiveness. Thus, it is feasible that Value Engineering will become increasingly employed in the United Arab Emirates.

4.10 References

1. Abu Dhabi Urban Planning Council (2007), Plan Abu Dhabi 2030, Urban Structure Framework Plan, Abu Dhabi, united Arab Emirates.
2. Alder, N.J. (1991), *International dimensions of Organisational Behaviour* (2nd edition), Published by PWS-Kent, Boston MA, United Kingdom
3. Al-Hammadi. A. (2010), *Middle East Business Intelligence (MEED),* Page no. 6, William Gibbons, U.K.
4. Amanda, S. (1993), *Approaches to Organisational Culture and Ethics*, Journal of Business Ethics, Jan 1993, Vol. 12.1.
5. Al-Zammy Y., Hoddell S.E.J, Savage B.M. (2002), *"Understanding the difficulties of implementing quality management in Yemen"*, The TQM magazine, Vol 14, No. 4, pp 240-247.
6. Benesh, G.C. (2008), *Culture Shock, A Survival Guide to Customs and Etiquette, United Arab Emirates*, Marshall Cavendish.
7. Brown, A. (1995), *Organisational Culture.* Esser: Pearson Education Limited.
8. *Building Works Regulations and the Executive By Law (1994)*, Department of Municipalities and Agriculture, Abu Dhabi Municipality.
9. Evans, S. (2009), *Middle East Business Intelligence (MEED),* Page no. 33, William Gibbons, U.K.
10. Foreman, C. and Roberts, J., (2010), *Meed, Middle East Business since 1957*, Volume 54 No. 24 page 6 - 22, William Gibbons, U.K.
11. Foreman, C. K. (2009), *Middle East Business Intelligence (MEED),* Page no. 28, William Gibbons, U.K.
12. Fairservice, I. (2007), *Dubai: Gateway to the Gulf*, Motivate Publishing, U.A.E.
13. George G.M. (2003), *The implementation of project management in the building construction field in the United Arab Emirates*, PhD Thesis, University of Glamorgan.
14. Goetsh, D.L., Davies S.B. (2003), *Introduction to total quality management for production, processing and services,* Upper Saddle River: Simon & Schuster.
15. Greenwood, M. (1997), *Discovering the individuals risk behaviour profile.* ARCOM 13th Annual Conference, 15-17 September 1997, Cambridge, UK.
16. Handy, C. (1993), *Understanding Organisation*, 4th edition, Benguin Group Publishers, U.K.

17. Hodgetts, R.M., Luthans, F. (1991), *International Management*, 3rd edition, McGraw Hill, New York, U.S.A.
18. Hofstede, G. (2003), *Cultures and organisations. Software of the mind: Intellectual cooperation and its importance for survival.* Second edition, London: Profile books.
19. Hofstede, G. (1980), *"Culture's consequences: International differences in work-related values"*, Sage, Beverly Hills, CA.
20. Hofstede, G., Hofstede, G.J. (2005), *"Cultures and organisations: Software of the mind",* Sage, Beverly Hills, CA.
21. Jeyakumar, R. (1999), *Value Engineering Application in the U.A.E., Dissertation thesis submitted for M.Sc. in Engineering Project Management to School of Built Environment*, University of Glamorgan.
22. Kelly, J., Male S. and Graham D. (2004), *Value Management of construction projects*, Blackwell Publishing, United Kingdom.
23. Kondo, Y. (2002), *The line-up of leadership*, The TQM magazine, Vol. 14, No.6, pp 339-344.
24. Laurent, A. (1983), *The Cultural diversity of Western Conceptions of Management*, 13, pp 75-96 International Studies of Management and Organisation Published by Penguin Group, U.K.
25. Luke, A. (2009), *Forming Features, What strategies are formworks companies implementing,* i*n order to counteract the Economic slowdown*? Construction week investigates, Construction Week, May 2-8, pp 27-28.
26. Mahgoub, Y. (1999), *Architecture of the United Arab Emirates*, Retrieved 24 July 2012, from Architecture of United Arab Emirates. http//victorian.fortunecity.com
27. Maree, K. (2009), *Middle East Business Intelligence (MEED),* page no. 18, William Gibbons, U.K.
28. Martin, M. (2009), *Middle East Business Intelligence (MEED),* page no. 8-9, William Gibbons, U.K.
29. Mullins, L.J. (1993), *Management and Organisational behaviour* (2nd Ed.), Published by PWS-Kent, Boston MA. U.K.
30. Nadem, A.B.A.T. (2009), *Understanding and Preventing Construction Conflict, claims and Disputes, A critical in-depth study into their causes and recommendations to control in the United Arab Emirates,* PhD Thesis, University of Glamergon.

31. Neap, H.S., Seran, A. (2009), *Owner's Factor in Value –Based Project Management in Construction*, Journal of Business Ethics, Mar, page no. 99.
32. Powell, A. (2009), *The (un) Balancing Act: The impact of culture on women engineering students gendered and professional identities.* P.H.D. Thesis, Loughborough University, UK.
33. Proto, A. K. (2009), *Middle East Business Intelligence (MEED),* Page no 40 and 41, William Gibbons, U.K.
34. Samarrai, H., Souwed, A. M. (2006), *Emirates and GCC Society*, University Book House, Al Ain U.A.E.
35. Seely, I.H. (1996), *Building Economics – appraisal and Control of building Design and Efficiency,* Macmillan Press Ltd, U.K.
36. Seraphim, D. (2005), *Implementing TQM principles in a construction company in the U.A.E.*, PhD Thesis, University of Glamorgan.
37. Smircich, L. (1983), *Concepts of Culture and Organisational Analysis. Administrative Science Quarterly*, 28 (3), pp. 339-358.
38. Stewart, J. (2009), *Abu Dhabi's genuine property demand will fuel construction, Construction Week,* March 14-20, page no. 10.
39. Urban Street Design Manual (2009), *Plan Abu Dhabi 2030, Next Generation Planning*, Abu Dhabi Urban Planning Council, Abu Dhabi.
40. Urban Structure Framework Plan (2007*), Plan Abu Dhabi 2030, Abu Dhabi Urban Planning Council*, Abu Dhabi.
41. Wajcman, J. and Martin, B. (2002), *Narratives of identity in modern management: The corrosion of the identity difference*, Sociology, page no.36.
42. Wajcman, J. (1998), *Managing Lime a Man: Women and Men in Corporate Management,* Cambridge; Polity Press.
43. Willemyns, M., Hosie, P. and Lehaney, B. (2011), *Communication and Social Identity Dynamic in UAE Organisation, International Review of Business Research Papers*, Vol. 7, March 2011, pp 245-256.

CHAPTER 5

QUESTIONNAIRE DESIGN ANALYSIS AND REVIEW

5.1 Introduction

The summary of the literature review of Chapter 3, and the environment and culture for Value Engineering in the United Arab Emirates, Chapter 4, identifies the specific areas that require investigation in order to address the research objectives and ultimately the hypotheses set for the thesis in Chapter 1.

This Chapter looks at data considered to be appropriate to be collected, using the questionnaire and semi structured interviews approaches stated in the research methodology of Chapter 2.

5.1.1 Structure and rationale for Data Collection

Because of the limited published information in relation to the implementation and performance of Value Engineering in the United Arab Emirates a two stage process of data collection was used, namely:-

Stage I — Initial appraisal of the perception of Value Engineering by a range of construction professionals currently working in the United Arab Emirates based on a questionnaire (Questionnaire No.1) approach.

Stage II — A detailed investigation of current practices in Value Engineering with Value Engineering practitioners working in the United Arab Emirates. This was conducted using both semi structured interviews using two further questionnaires (Questionnaire No. 2 and 3) as a basis for discussion.

The development of the questionnaires were designed to address the following seven (7) key issues identified in Chapter 3 as relevant to effective Value Engineering in United Arab Emirates.

Table 5.1 Listing of Key research issues identified (Section 3.5 of Chapter 3)

Issue No.	Description of key issues
1.	Structure and method of the Value Engineering process
2.	Timing and execution of the Value Engineering workshop studies
3.	Composition of the workshop team
4.	Understanding of the Value Engineering process
5.	Value Engineering during the construction phase
6.	Performance measurement based on costs
7.	The effect of environment and culture on Value Engineering

5.1.2 Relevance of Questionnaire Surveys and Semi-Structured Interview to this research

5.1.2.1 Questionnaire Surveys

Robson (2002) suggests that while questionnaires can be carried out for any research purpose, they are not well-suited to exploratory work, largely because open-ended questions are inefficient and ineffective. The most common use of questionnaires is to generate description and information about a wide range of people characteristics and relationships between characteristics. Beyond this, it is also possible to use questionnaires to provide explanations of phenomena studied and the patterns of results obtained, Robson (2002).

Langdridge (2004) suggests that questionnaires are particularly useful method for obtaining data from a large number of people. However, gathering data from a large number of people can be at the expense of the amount of information or details collected.

Fink (2006) states that questionnaires are a useful way of describing, comparing or explaining individual and societal knowledge, feelings, values, preferences and behaviour. Johnson and Turner (2003) also suggest that questionnaires are often used as part of the data collection process in multi-method studies. This primarily addresses research area to emphasise the understanding of the process.

The first questionnaire was issued to a wide range of construction professionals working in the United Arab Emirates. The main objectives were to gain an overall perspective of how Value Engineering was perceived within the industry and collect data relevant to the key research issues.

This component of the research was necessary as no previous research has presented data, specific to the United Arab Emirates that could be used. It can then provide a guide as to how relevant the findings of researches in Value Engineering globally are to the United Arab Emirates.

5.1.2.2 Semi-Structured Interviews

The semi-structured interviews were employed as they can provide a more informed and in-depth evaluation of the identified key research issues (see Table 5.1). This is achieved by selecting respondents who have considerable experience of the application of Value Engineering in the United Arab Emirates. This criterion did mean that the number of respondents that could contribute were limited.

This should provide more informed responses to the issues identified than from the first questionnaire. That questionnaire was issued to a range of construction professionals, who did not necessarily have experience in the Value Engineering process.

The format of the semi structured interviews was:-

STAGE I

Issue of Questionnaire 2, which focused on key issues other than performance measurement based on costs listed in Table 5.1, Item 6.

1. Discussion and clarification of each of the questions posed.

2. Extend the discussion for each of the questions posed based on a series of prepared themes relating to the question.

3. Provide the respondents with the opportunity to raise any related issues they considered relevant.

4. Record responses based on semi structured interviews.

The above process was repeated for each question on the questionnaire.

STAGE II

Issue of Questionnaire 3, which focused on performance measurement based on costs. The same four (4) steps procedure adopted for each question used for Stage I in Questionnaire 2. The relationship between data collection and the 'identified research issues' are summarised in Table 5.2.

Table 5.2 Relationship of questionnaires and interviews to the key research issues

Data Set	'Issue' number addressed	Summary table Reference
Questionnaire 1 (Issued for completion and return)	2. Timing and execution of the Value Engineering workshop studies. 4. Understanding of the Value Engineering process. 5. Value Engineering during the construction phase. 6. Performance measurement based on costs.	Table 5.3 (Section 5.2.2)
Questionnaire 2 (Used as the basis for a semi-structured interview)	1. Structure and method of the Value Engineering process. 2. Timing and execution of the Value Engineering workshop studies. 3. Composition of the workshop team. 4. Understanding of the Value Engineering process 5. Value Engineering during the construction phase. 7. The effect of environment and culture on Value Engineering.	Table 5.4 (Section 5.3.1)
Questionnaire 3 (Used as the basis for a semi-structured interview)	6. Performance measurement based on costs.	Table 5.4 Section 5.3.1

The relationship between the questions asked to the seven issues given above is provided in summary tables at the end of each data collection set.

5.2 Stage I Data Collection

5.2.1 Introduction

Data from this stage is derived from the first questionnaire issued, referred to as 'Questionnaire 1' in the remainder of this thesis. The questionnaire was distributed to a range of construction professionals working in the United Arab Emirates. It was realised that not all would be familiar with Value Engineering, however, the objective was to find out how Value Engineering is perceived by other construction professionals. This can be useful to promoting Value Engineering as it can identify misconceptions and gauge expectations and hence enable the Value Engineer to pre-empt or correct these when working with fellow professionals. This can assist in engaging the mix of construction professionals that may be involved in the Value Engineering process.

The respondents were selected from a range of consultancies based in Abu Dhabi and clients that have employed consultants for construction projects. A total number of 133 responses were received from a distribution of 150 questionnaires giving a response rate of 89%.

Questionnaire 1 is used to collect primarily data to gain an insight into the background of Value Engineering in the United Arab Emirates and targets research issues 2, 4, 5, and 6 in Table 5.1. This was issued to respondents for completion and return. Questionnaires 2 and 3 formed the basis of a semi-structured interview between the researcher and the individual respondents. Questionnaire 2 deals primarily with all research issues in Table 5.1 other than Item 6. Questionnaire 3 deals specifically with the Item 6 performance measurement based on costs. The questionnaires require qualitative responses; some will require a range of subjective and factual answers. These differences will be taken into account in the discussion of findings in Chapter 7. The rationale for these is stated below for each of the questionnaires.

5.2.2 Listing and rationale for Questionnaire 1

This section details the questions used together with the rationale behind the question asked. The questions used, and their relation to the research areas are summarised in Table 5.3 together with inter-relationship links between these questions.

It aims to provide an overview of how the main construction profession groups perceive the use and application of Value Engineering in the United Arab Emirates.

Table 5.3 Summary of Questionnaire 1

Sl. No.	Question Basis	Targeted Issue Table 5.2	Comment	Question Linking
1.	To which construction professional group do you belong?	4	Enables the data collected to be attributable to specific groups for comparison of responses to the following questions.	No link
2.	Do you think Value Engineering is understood by your profession in the UAE construction industry?	4	Investigates the degree of understanding thought to be associated with the respondents professional group.	Linking to Question Nos.9,12,13
3.	Are you aware that these professional groups regularly use the Value Engineering in all construction projects?	4	Investigate inter-profession group perceptions on Value Engineering use regularly	Linking to Question Nos.8,6
4.	Do you consider that Value Engineering is currently being actively implemented by your professionals?	4	Assess the standard of use of Value Engineering actively by the professional.	Linking to Question Nos.5,6
5.	Is current practice of Value Engineering useful to the construction industry in United Arab Emirates?	4 & 5	Indicates receptiveness to the concept of Value Engineering if their group don't use it (link to question 3) or recognise the potential on actual benefits. (links to question 6)	Linking to Question Nos. 3,6,8,10,11

Table 5.3 Summary of Questionnaire 1 – (Continued)

Sl. No.	Question Basis	Targeted Issue	Comment	Question Linking
6.	How do you rate the current performance of Value Engineering in the United Arab Emirates?	4 & 6	Indicates the respondents perception of Value Engineering and possibly familiarity	Linking to Question Nos. 2,4 &5
7.	Are these key success factors improved by the use of Value Engineering in terms of benefits to the project?	4	Where are main benefits of Value Engineering to be perceived	Linking to Question Nos. 6 & 9
8.	Which professional groups widely use Value Engineering?	4	Checks on consistency of question 3 and differentials between widely used and always employed	Linking to Question Nos.3,5 and 6
9.	Is Value Engineering used as a cost cutting process?	4	A key question on understanding and taken in conjunction with question 2	Linking to Question Nos.2 and 7
10.	Does Value Engineering provide net benefits to the construction industry?	4	Match for consistency with question 5	Linking to Question No.5
11.	Does Value Engineering improve design and effective life cycle cost?	4 & 6	Implies some evaluation process or perception (link to question 5)	Linking to Question No.5
12.	Should Value Engineering be done at design and construction stages?	4 & 2	Assess if the view of being specific to design is held	Linking to Question Nos.2 and 13
13.	Should Value Engineering be done by the end of the preliminary design stage?	4 & 2	Investigate if appreciation of timing of the value engineering workshop is important	Linking to Question No.2 & 12

5.2.3 Question and results from Questionnaire 1

Question 1

To which of the following construction professional groupings do you belong?

(a) *Client* ☐

(b) *Design Consultant* ☐

(c) *Project Management* ☐

(d) *Quantity Surveyors* ☐

(e) *Value Engineering Consultant* ☐

(f) *Other (state)* ☐

It defines the five targeted groups plus an additional item for those outside these groupings. It also enables respondent's responses to be classified into six professional groups so as to establish if different targeted groups differ in respect to perception, expectation and application of Value Engineering.

Survey Response

Sl .No	***Distribution***	***Distribution***	***Response***
1	*Client*	*26*	*21*
2	*Design Consultants*	*35*	*34*
3	*Project Management*	*23*	*19*
4	*Quantity Surveyors*	*46*	*44*
5	*Value Engineering Consultant*	*13*	*10*
6	*Others (state)*	*7*	*5*
	Total	*150*	*133*

The above questionnaire survey was carried out for 150 number of professionals, out of which 133 responds were received from client, design consultants, project management, quantity surveyors and Value Engineering consultants, which represent 96% of the total responses received while the remaining 5 (4%) are management level professionals.

Question 2

Do you think that Value Engineering is understood by your profession in the United Arab Emirates construction industry?

Don't know ☐ *Yes* ☐ *No* ☐

This seeks to determine the perceived understanding of Value Engineering by their group. This is somewhat subjective but can be compared to responses in questions 9, 12 and 13.

Survey Response

(a)	*Yes*	114
(b)	*No*	18
(c)	*Don't' know*	1

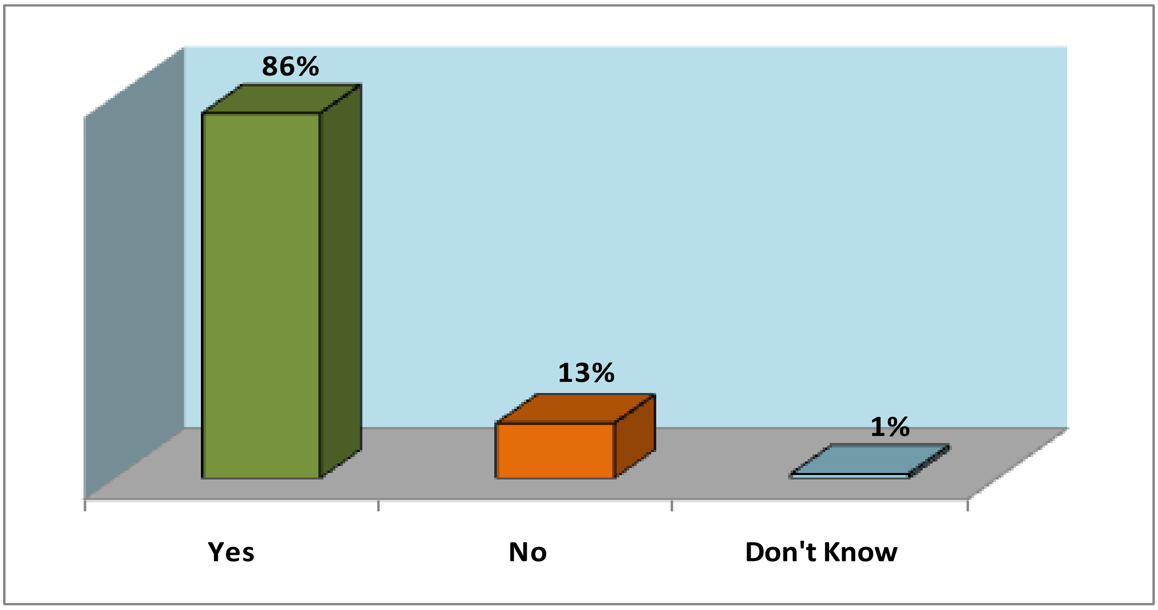


Figure 5.1 Survey Results for Question No. 2

The aim of this question is to examine the perceived understanding of Value Engineering by the professionals of construction industry in the United Arab Emirates. Therefore, this question is used to identify the number of respondents within groups that have an understanding of Value Engineering process. Figure 5.1 shows that 86% of respondents profess to understand Value Engineering, 13% of the respondents profess not to understand Value Engineering and 1% responded “Don’t Know”.

Question 3

Are you aware that these professional groups regularly use Value Engineering in all construction projects in the United Arab Emirates?

		Don’t know	*Yes*	*No*
(a)	*Client*	☐	☐	☐
(b)	*Design Consultant*	☐	☐	☐
(c)	*Project Management*	☐	☐	☐
(d)	*Quantity Surveyors*	☐	☐	☐
(e)	*Value Engineering Consultant*	☐	☐	☐

This is used to establish inter-group perceptions to the potential benefits of Value Engineering and leads on to question 6 linked to question 8.

Survey Response

	Client	**Design Consultant**	**Project Management**	**Quality Surveyors**	**Value Engineering Consultant**
Don’t know	22	15	19	22	11
Yes	81	83	86	78	107
No	23	26	23	26	9
Undecided	7	9	5	7	6
Total	133	133	133	133	133

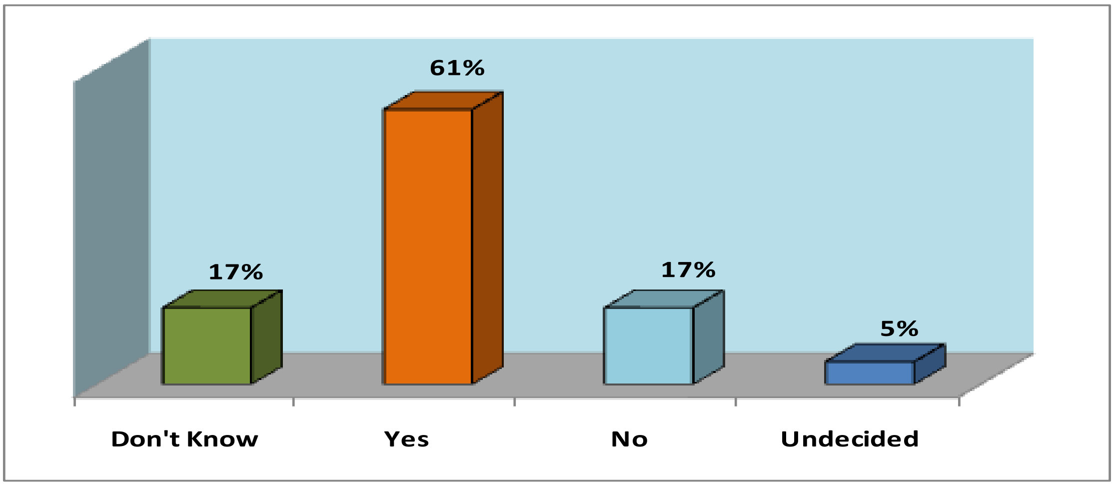


Figure.5.2 Client Survey Results for Question No. 3

In Figure 5.2 client survey results show that 17% of the respondents do not know that the Value Engineering is being used by professionals in the United Arab Emirates, 61% agree that Value Engineering was been used by professionals in the United Arab Emirates, 17% disagree and 5% of them are undecided.

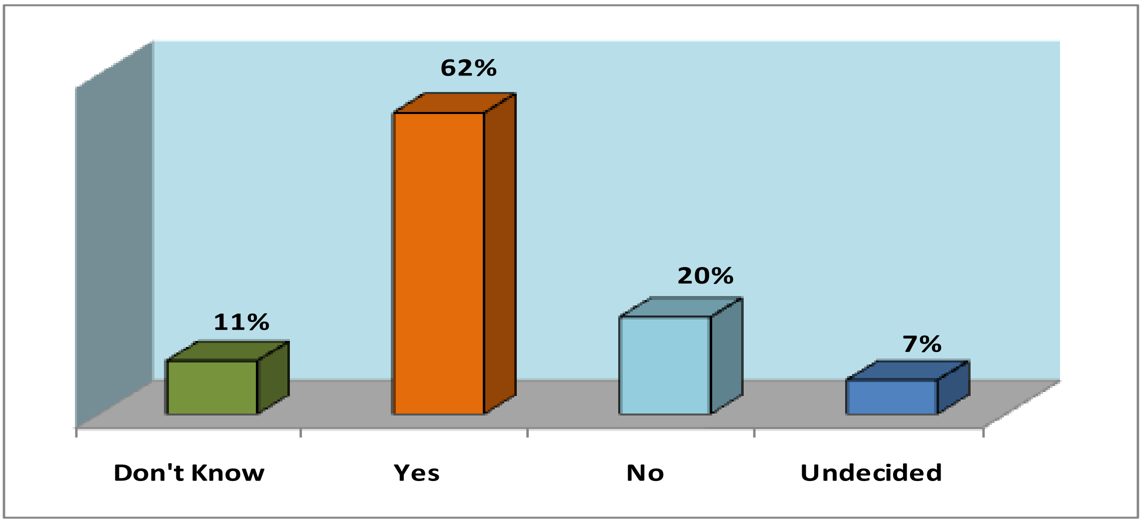


Figure 5.3 Design Consultant Survey Results for Question No. 3

In Figure 5.3 design consultant survey results show that 11% of the respondents do not know that the Value Engineering is been used by professionals in the United Arab Emirates, 62% agree that Value Engineering is been used by professionals in the United Arab Emirates, 20% disagree and 7% of them are undecided.

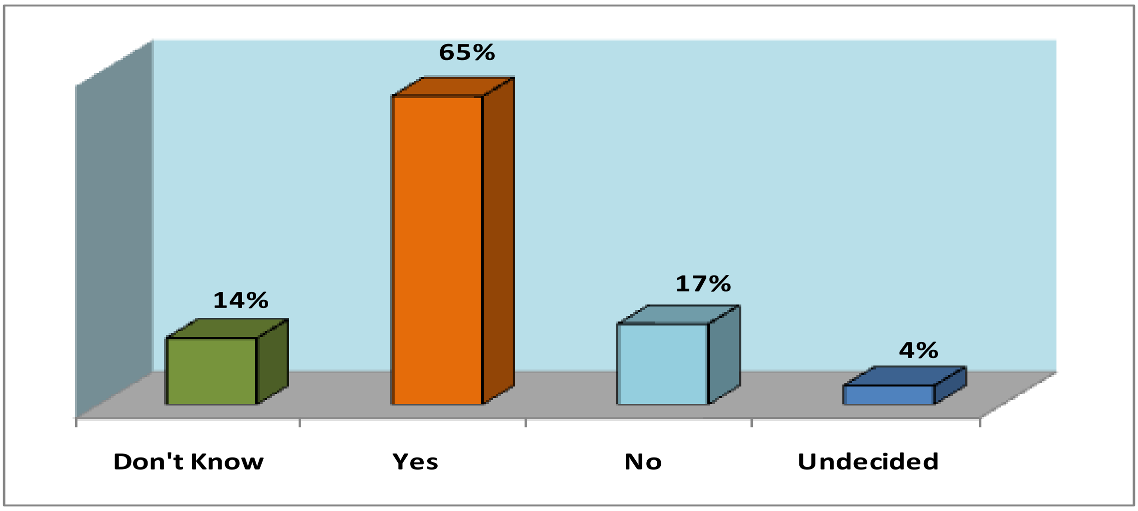


Figure 5.4 Project Management Survey Results for Question No. 3

In Figure 5.4 project management survey results show that 14% of the respondents do not know that the Value Engineering is been used by professionals in the United Arab Emirates, 65% agree that Value Engineering is been used by professionals in the United Arab Emirates, 17% disagree and 4% of them are undecided.

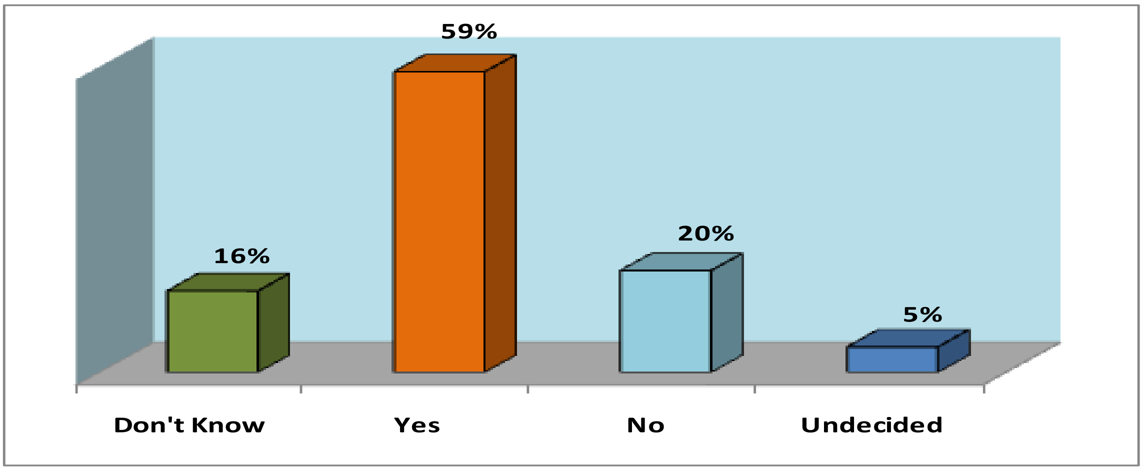


Figure 5.5 Quantity Surveyors Results for Question No. 3

In figure 5.5 quantity surveyors survey results show that 16% of the respondents did not know that the Value Engineering is been used by professionals in the United Arab Emirates, 59% agree that Value Engineering is been used by professionals in the United Arab Emirates, 20% disagree and 5% of them are undecided.

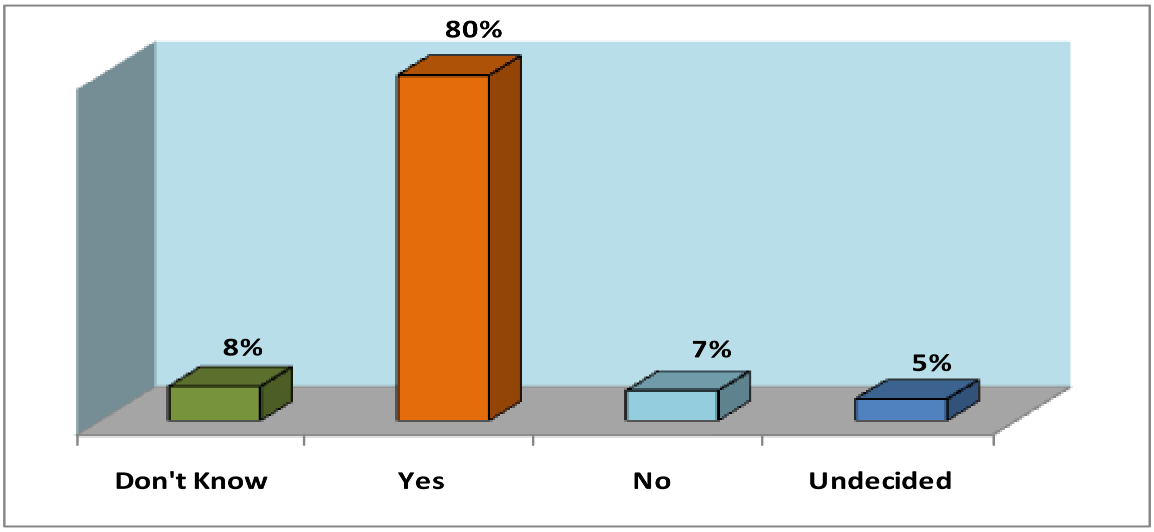


Figure 5.6 Value Engineering Consultant Survey Results for Question No.3

In Figure 5.6 Value Engineering consultant survey results show that 8% of the respondents do not know that the Value Engineering is been used by professionals in the United Arab Emirates, 80% agree that Value Engineering is being used by professionals in the United Arab Emirates, 7% disagree and 5% of them are undecided.

Question 4

Do you consider that Value Engineering is currently being actively implemented by your professional in the United Arab Emirates?

Yes ☐ *No* ☐

Is used to establish if the respondent feels their group could improve their implementation of Value Engineering.

Survey Response:

(a)	*Yes*	84
(b)	*No*	49
(c)	*Undecided*	0

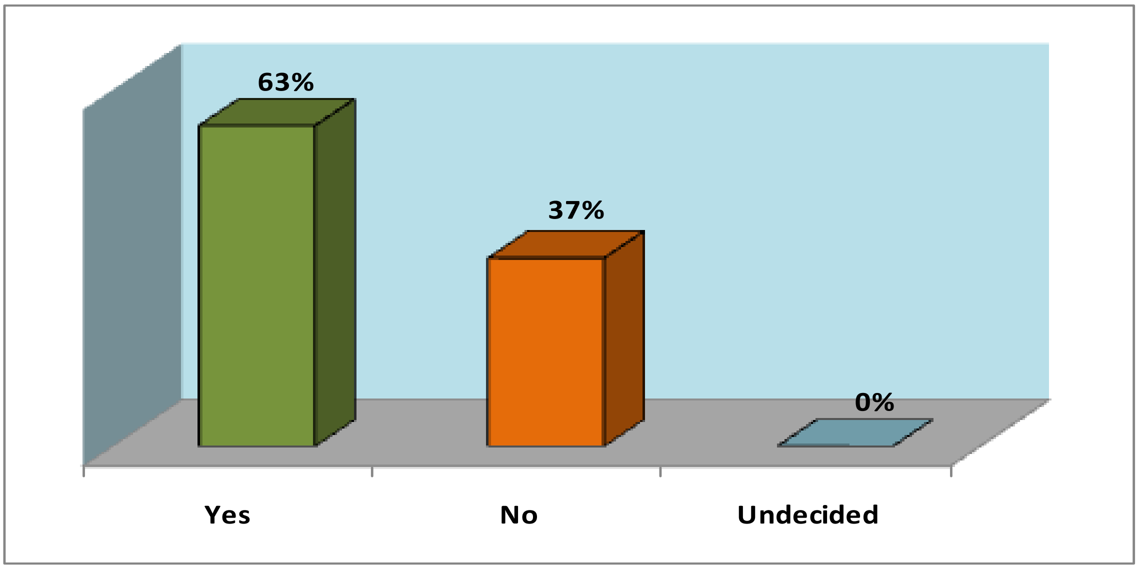


Figure 5.7 Survey Results for Question No. 4

In Figure 5.7 survey shows that 63% of the respondents agree that Value Engineering is being efficiently implemented within their profession, where as 37% disagree.

Question 5

Is current practice of Value Engineering useful to the construction industry in the United Arab Emirates?

Yes *No*

This is used to establish the receptiveness of respondents to the concept of Value Engineering if their group don't use it (from question 3) or recognise the potential benefits (links to question 6).

Survey Response:

(a)	*Yes*	115
(b)	*No*	18
(c)	*Undecided*	0

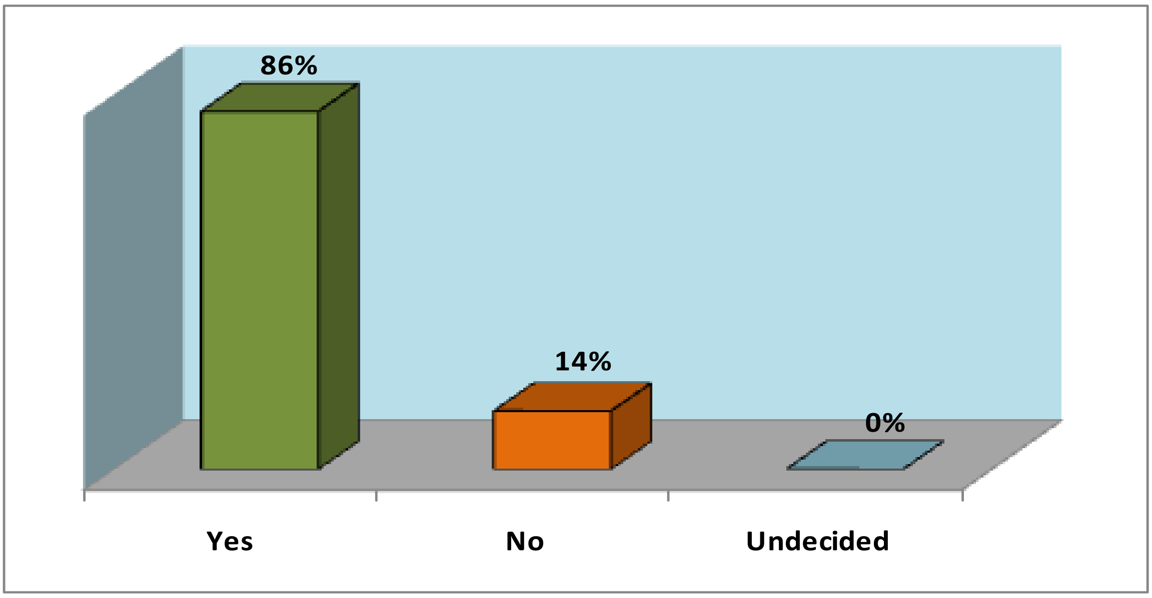


Figure 5.8 Survey Results for Question No. 5

In Figure 5.8 illustrates that 86% of the respondents believe that current practices of Value Engineering can be useful to the construction industry, whereas 14% disagree and 0% are undecided.

Question 6

How do you rate the current performance of Value Engineering as currently applied in the United Arab Emirates?

Poor	*Fair*	*Good*	*Very Good*
☐	☐	☐	☐

Respondents were asked to rate current Value Engineering performance on a four point scale. This indicates attitude and possible familiarity (links to questions 2, 3, 4 and 5).

Survey Response and Analysis:

a)	*Poor*	28
b)	*Fair*	66
c)	*Good*	38
d)	*Very Good*	1

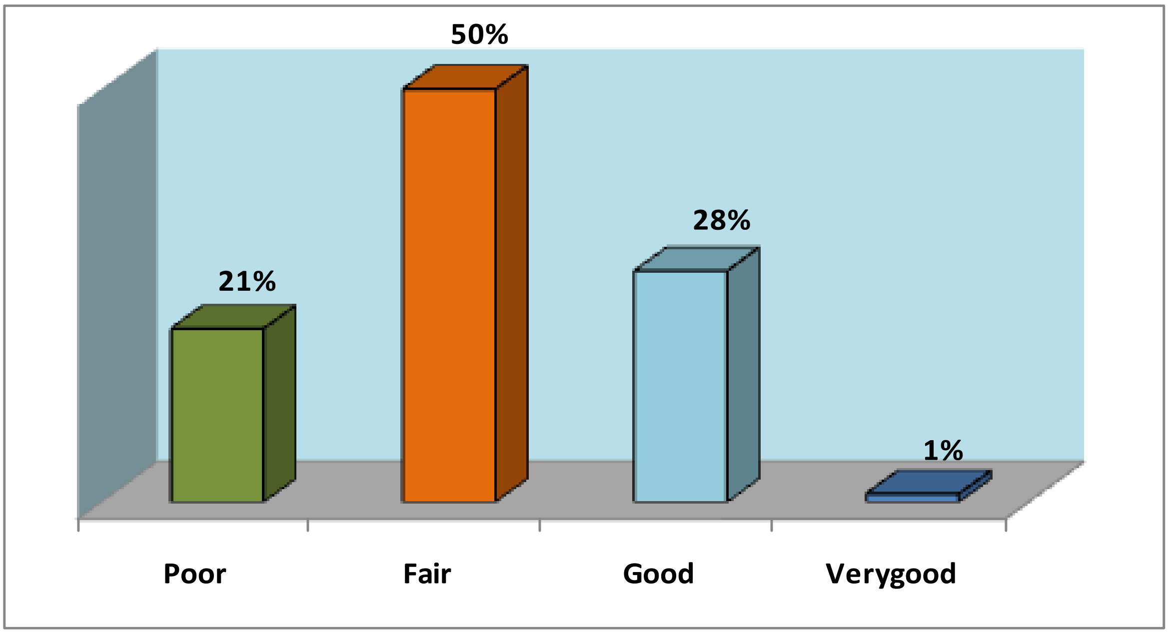


Figure 5.9 Survey Results for Question No. 6

In Figure 5.9 shows that 21% current performance of Value Engineering was found as poor, 50% as fair, 28% as good, while 1% was noted as very good. Based on above results, the responses from individuals indicated the perception that the Value Engineering performance is fair in the United Arab Emirates.

Question 7

Are these "Key Success Factors" improved by the use of Value Engineering in terms of benefits to the project in the United Arab Emirates?

		Yes	*No*
(a)	*Quality*	☐	☐
(b)	*Safety*	☐	☐
(c)	*Time*	☐	☐
(d)	*Cost*	☐	☐

This establishes which of the four recognised measures of a project success that the respondent identifies as benefiting from Value Engineering. Also it will be compared to the results from questions 6 and 9 in the discussion.

Survey Response:

	Quality	Safety	Time	Cost
Yes	89	87	86	126
No	40	36	44	5
Undecided	4	10	3	2
Total	133	133	133	133

a) Quality

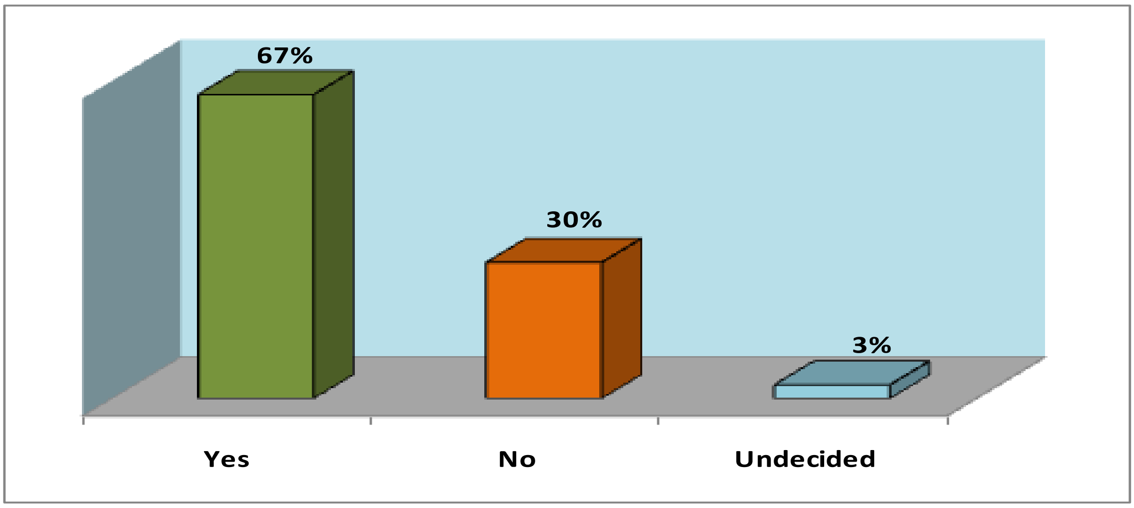


Figure 5.10 Survey Results for Question No. 7

In Figure 5.10 illustrates that 67% of the respondents believe that key success factors of Value Engineering improved the benefits to the project while 30% of respondents disagree and 3% were undecided.

b) Safety

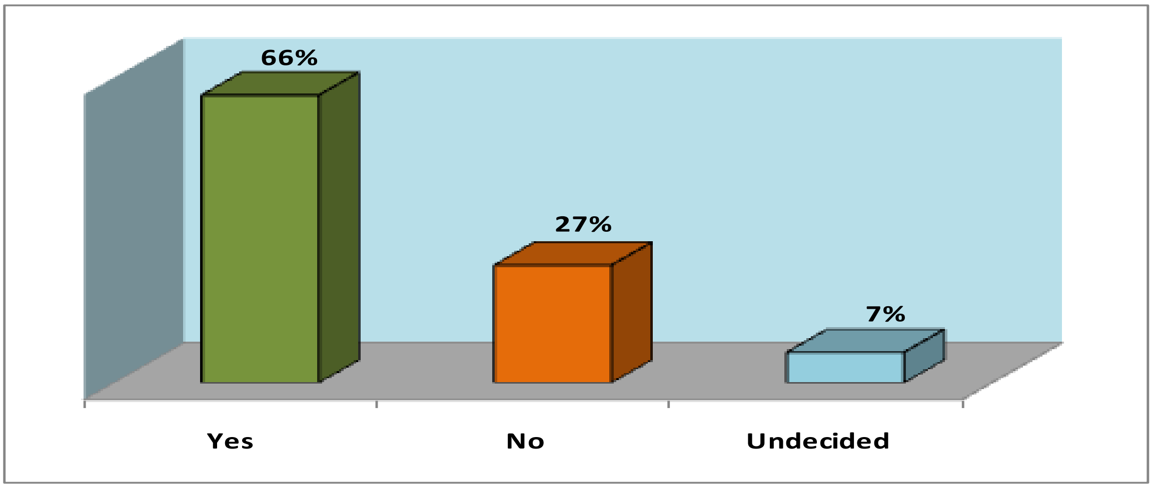


Figure 5.11 Survey Results for Question No. 7

In Figure 5.11 illustrates that 66% of the respondents believe that key success factors of Value Engineering improved the benefits to the project while 27% of respondents disagree and 7% were undecided.

c) Time

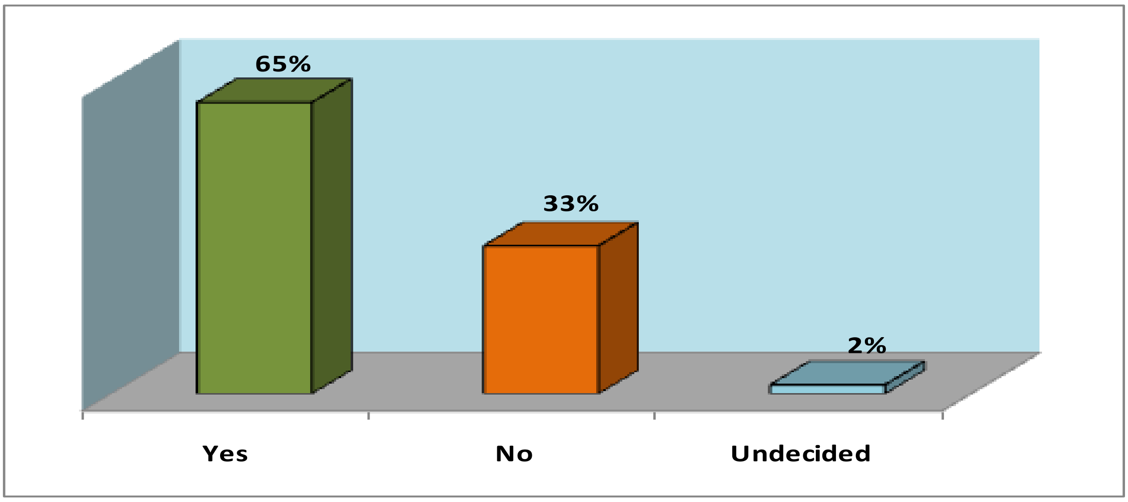


Figure 5.12 Survey Results for Question No. 7

In Figure 5.12, illustrates that 65% of the respondents believe that key success factors of Value Engineering improved the benefits related to time of the project while 33% of respondents disagree and 2% were undecided.

d) Cost

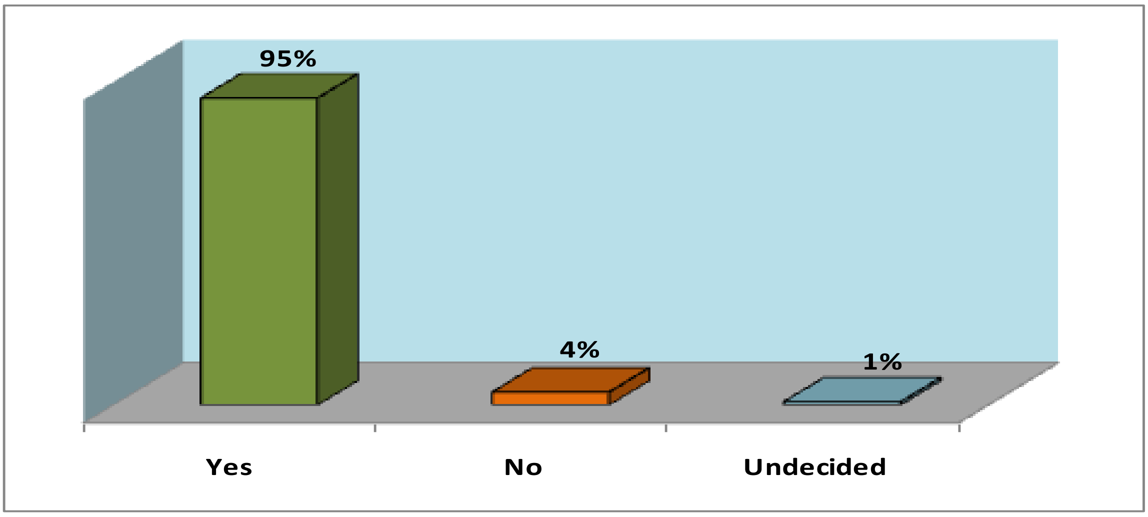


Figure 5.13 Survey Results for Question No. 7

In Figure 5.13, illustrates that 95% of the respondents believe that key success factors (cost) of Value Engineering improved the benefits to the project while 4% of respondents disagree and 1% were undecided.

Based on above results, it confirms that the Value Engineering was perceived as being primarily concerned with quantity, safety, time and cost savings by United Arab Emirates professionals.

Question 8

Do you agree that Value Engineering is widely used by the following groups in the United Arab Emirates?

	Yes	*No*
(a) Client	☐	☐
(b) Design Consultant	☐	☐
(c) Project Management	☐	☐
(d) Quantity Surveyors	☐	☐
(e) Value Engineering Consultant	☐	☐

Used to compare with question 3 for consistency of response and differentiates between widely used and always employed.

Survey Response

	Client	**Design Consultant**	**Project Management**	**Quantity Surveyors**	**Value Engineering Consultant**
Yes	85	74	78	73	110
No	43	55	50	48	12
Undecided	5	4	5	12	11
Total	133	133	133	133	133

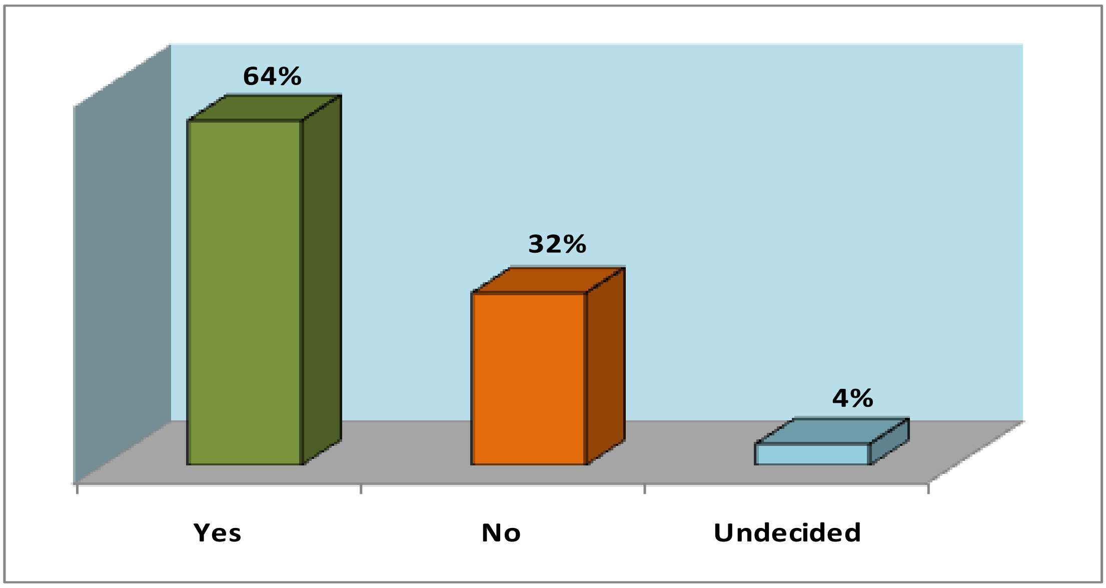


Figure 5.14 Client Survey Results for Question No. 8

In Figure 5.14 client survey analysis shows that 64% of the respondents agree that the Value Engineering is being used by professional groups in the United Arab Emirates, while 32% disagree and 4% of them are undecided.

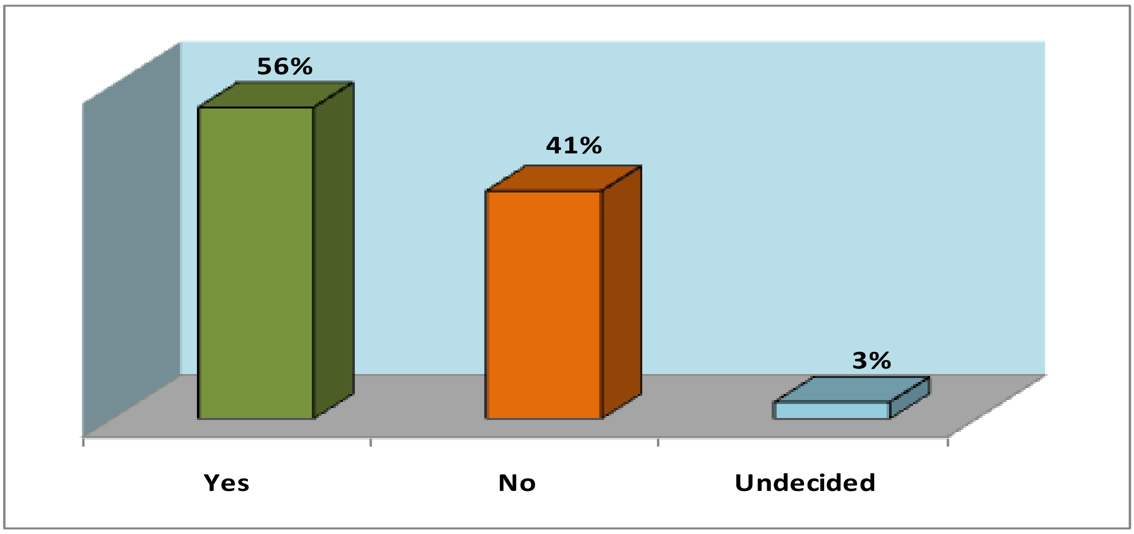


Figure 5.15 Design Consultant survey Results for Question No. 8

In Figure 5.15 design consultant survey analysis shows that 56% of the respondents agree that the Value Engineering is been used by professional groups in the United Arab Emirates, 41% disagree, 3% of them are undecided.

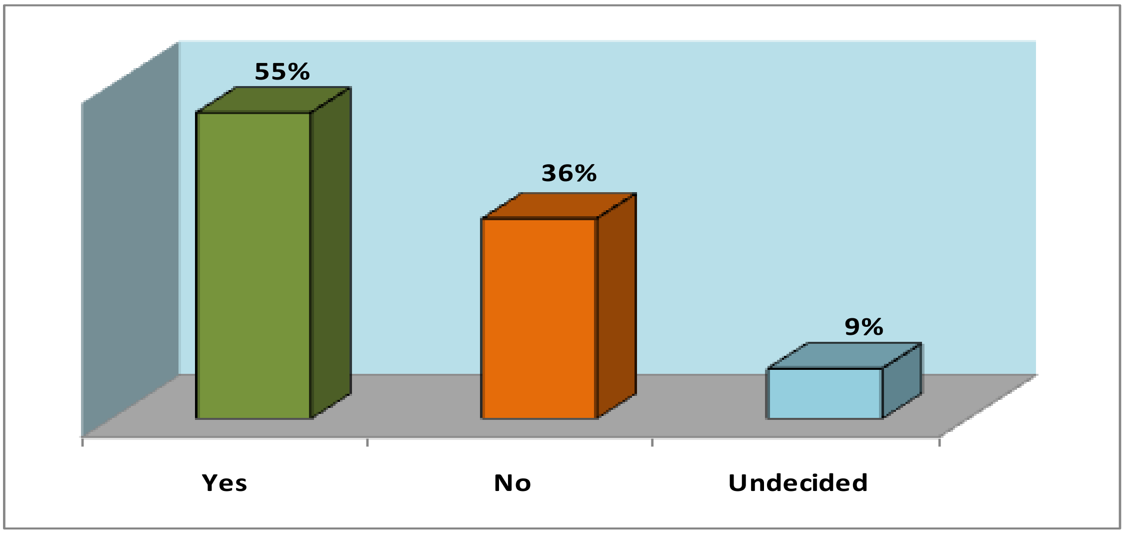


Figure 5.16 Project Management Results for Question No. 8

In Figure 5.16 project management survey analysis shows that 55% of the respondents agree that the Value Engineering was been used by professional groups in the United Arab Emirates, 36% disagree, 9% of them are undecided.

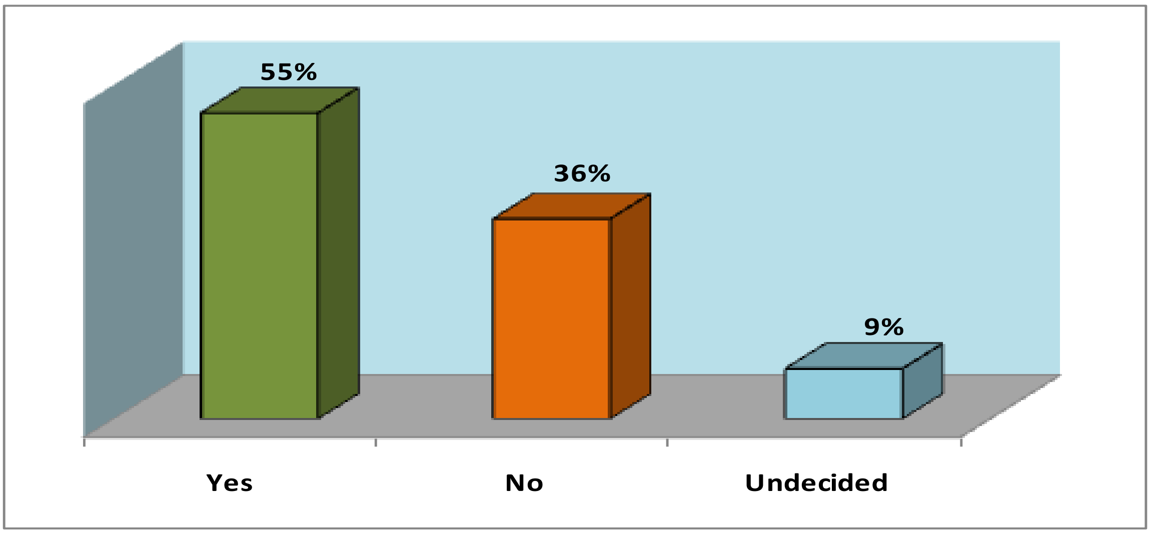


Figure 5.17 Quantity Surveyors Results for Question No. 8

In Figure 5.17 quantity surveyors analysis shows that 55% of the respondents agree that the Value Engineering is been used by professional groups in the United Arab Emirates, 36% disagree, 9% of them are undecided.

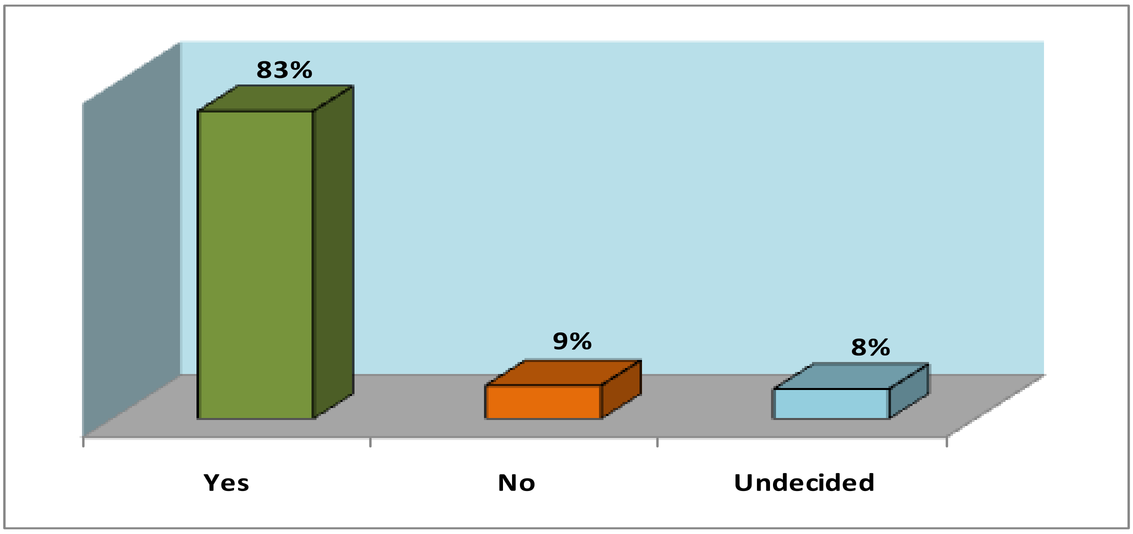


Figure 5.18 Value Engineering Consultant Results for Question No. 8

In Figure 5.18 Value Engineering consultant analysis shows that 83% of the respondents agree that the Value Engineering is been used by professional groups in the United Arab Emirates, 9% disagree, 8% of them are undecided.

Question 9

Do you agree that Value Engineering is used as a cost cutting process in order to reduce the project budgeted cost in the United Arab Emirates?

Yes ☐ *No* ☐

Checks on the prevalence of the common misconception of Value Engineering being primarily for "cost cutting" (links to question 2 and 7 for comparison).

Survey Response:

(a) Yes	121
(b) No	12
(c) Undecided	0

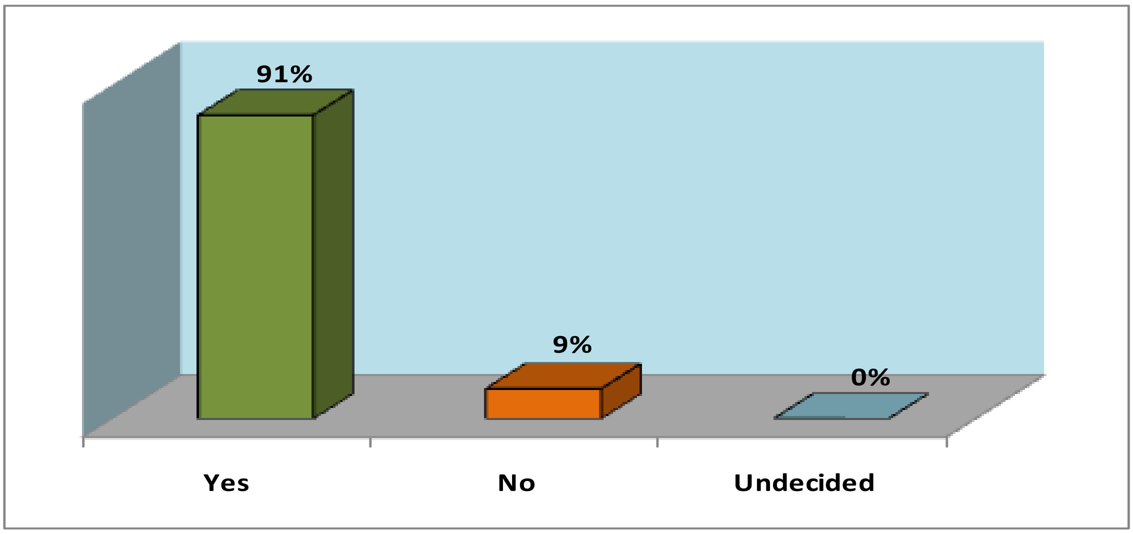


Figure 5.19 Survey Results for Question No. 9

In Figure 5.19 shows the main proportion of the respondents 91% agree that Value Engineering is cost cutting exercise, while 9% of the respondents believe that Value Engineering is not cost cutting exercise whereas, 0% of the respondents are undecided. Therefore, this response indicates the view that Value Engineering was interpreted by United Arab Emirates professionals as a cost cutting exercise.

Question 10

Do you consider that Value Engineering provides net benefits to the construction industry in the United Arab Emirates? *Yes* ☐ *No* ☐

Establishes the recipient's perception of Value Engineering and should be compared with the results of question 5 for consistency of response.

Survey Response:

(a) Yes	96
(b) No	37
(c) Undecided	0

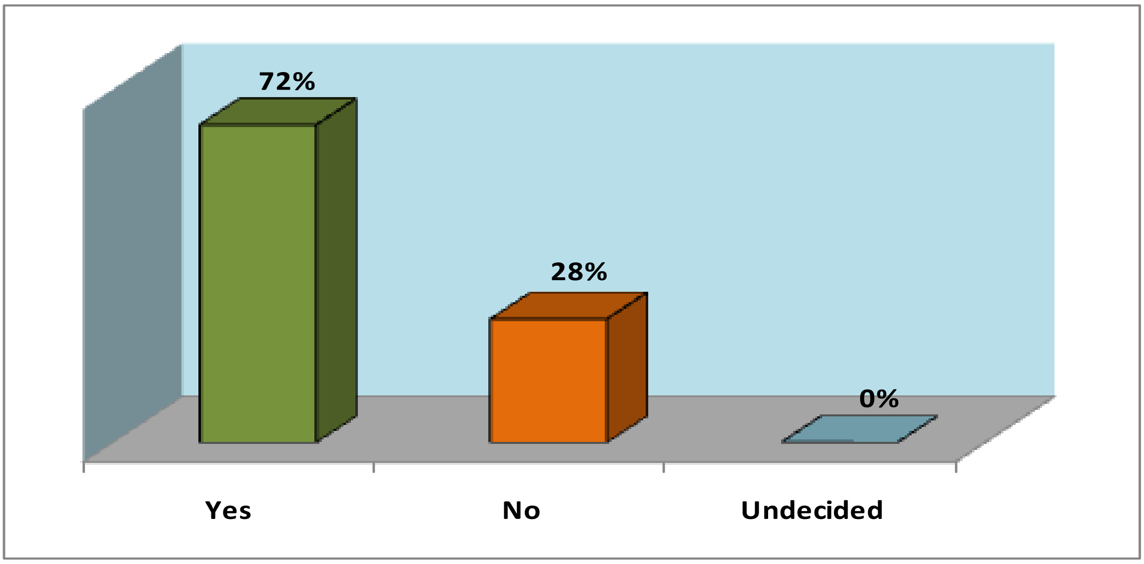


Figure 5.20 Survey Results for Question No. 10

In Figure 5.20 shows that 72% of respondents supporting the statement that Value Engineering is benefit to the construction industry in the United Arab Emirates, whereas 28% disagree and 0% are undecided.

Question 11

Is Value Engineering beneficial in terms of improving design and effective life cycle cost in the United Arab Emirates construction industry?

Yes	*No*
☐	☐

This explores the perceived link between design and life cycle costing in the construction. (Links to question 5)

Survey Response:

(a) Yes	97
(b) No	35
(c) Undecided	1

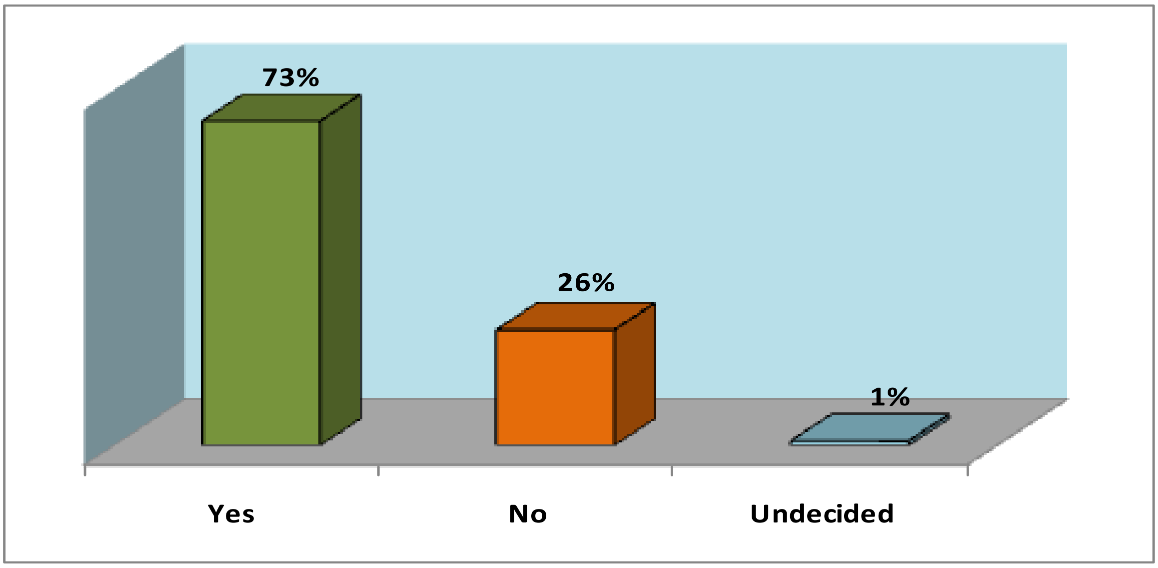


Figure 5.21 Survey Results for Question No. 11

In Figure 5.21 shows that the proportions of 73% respondents agree that Value Engineering is beneficial in improving the design and effective life cycle cost in the United Arab Emirates construction industry, 26% of the respondents disagree and 1% of the respondents are undecided.

Question 12

Do you believe that Value Engineering process shall be carried out during design and construction stage? *Yes* ☐ *No* ☐

Explores the attitudes to Value Engineering applied during construction phase. Assess if the view of the design stage being the main stage for Value Engineering is held.

Survey Response:

(a) Yes	92
(b) No	41
(c) Undecided	0

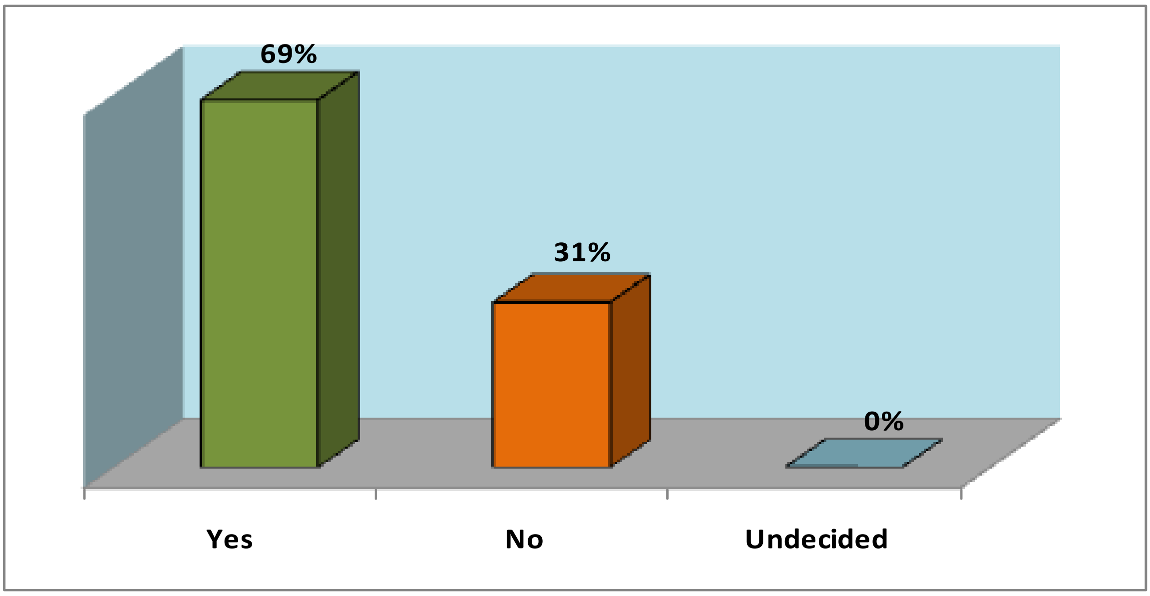


Figure 5.22 Survey Results for Question No. 12

In Figure 5.22 shows that the proportions of 69% respondents agree that Value Engineering is carried out during design and construction stage, whereas 31% respondents disagree and 0% of the respondents are undecided.

Question 13

Do you believe that undertaking Value Engineering by the end of the preliminary design is most productive? *Yes* *No*

Provides some check on consistency in response to question 12 and investigates, if timing of Value Engineering work shops is considered important.

Survey Response:

(a) Yes	110
(b) No	23
(c) Undecided	0

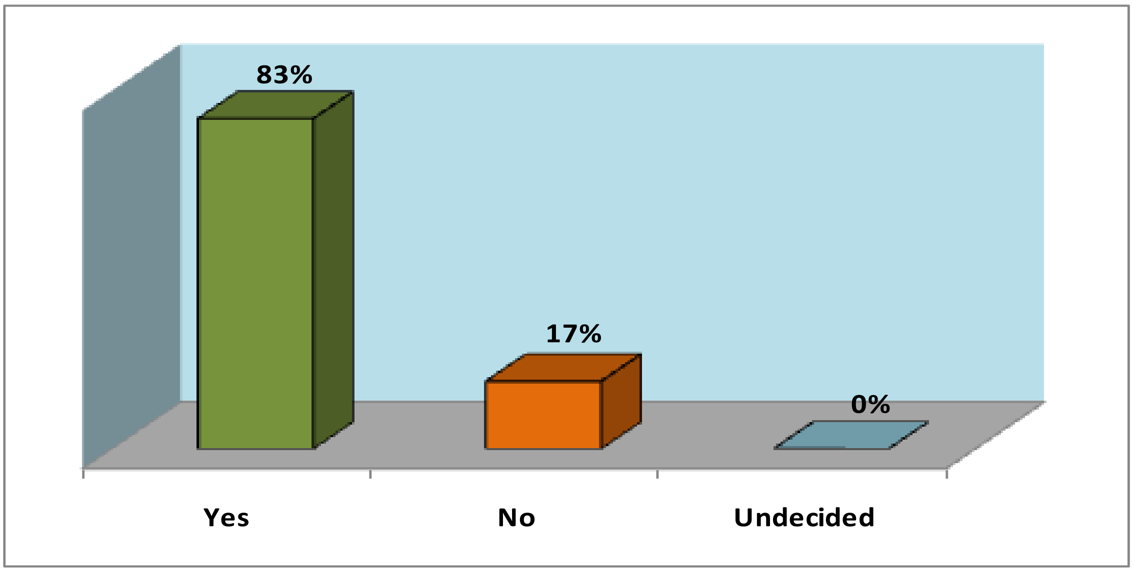


Figure 5.23 Survey Results for Question No. 13

Figure 5.23 indicates the survey response, which confirms that 83% of clients believe that undertaking Value Engineering by the end of the preliminary design is most productive, 17% disagree. Therefore, this supports the timing of the Value Engineering to be carried out by the end of the preliminary design is most economical.

5.2.4 Review of the results of Questionnaire 1

Question No.1

There was a good spread of responses from client, design consultant, project management, quantity surveyors and Value Engineering consultants, which is about 96% of the total and 4% from other professionals. This should therefore provide a representative view of a range of construction professionals in the United Arab Emirates.

Question 2 and 9

Based on the response and the analysis, 86% of respondents confirmed that they understand the Value Engineering process, whereas when compared with question 9 the misconception that Value Engineering was a cost cutting process was prevalent, with 91% of respondents. Hence, their perception of Value Engineering is that it is primarily a cost cutting exercise. This contradicts the basic objective of Value Engineering and indicates a misunderstanding over a range of construction professionals. The understanding of the importance of the timing of the Value Engineering process by respondent is evidenced in question 12 and 13.

Question 3

Identifies what professional groups regularly use Value Engineering:

Professional Group	% saying they do
Client	61%
Design Consultants	62%
Project Management	65%
Quantity Surveyor	59%
Value Engineering Consultants	80%

This indicates a consistent view across the professions that on average 65% are considered to employ value engineering while 35% considered that Value Engineering is not regularly used by the United Arab Emirates professionals.

Question 4

The opinion that Value Engineering is being efficiently implemented evoked a positive 'yes' response of 63%. Those considering it was not were the remaining 37%.

This indicates support for the idea that there is the potential for improvement in current Value Engineering application.

Question 5

86% of respondents consider that current practices in Value Engineering can be of benefit to the construction industry. This indicates the respondents to be receptive to application of Value Engineering to their industry.

It matches the proportion who said they understood Value Engineering (86%) in question 2. Comparing the responses to question 3 it can be interpreted that while the perceived actual use by professional is around 65%, there is a positive attitude to the application of Value Engineering. While considered beneficial, question 4 indicates the potential for improvement.

Question 6

This asks respondents to rate the current performance of Value Engineering in the United Arab Emirates. 29% of respondents rated current performance good to very good, while 71% rated the performance 'fair' to 'poor'.

Comparison with question 5 indicates significant scope for improving current practices and a receptiveness of professional groups to embrace the Value Engineering concepts. There are differences with question 4, as 63% of respondents believed Value Engineering was being effectively implemented. The question arises as to why the actual performance rating given in question 6 responses is so low.

Therefore, this indicates that performance of Value Engineering is not perceived as providing the results expected.

Question 7

Looks at which of the four key success factors are considered improved by Value Engineering.

Factor	% Agree
Quality	67%
Safety	66%
Time	65%
Cost	95%

Based on the above analysis, it indicates that cost is considered to be the principal measure of successful implementation of Value Engineering. Therefore, it confirms that the Value Engineering is perceived by professionals working in the United Arab Emirates as primarily aimed at optimising cost. This implies a lack of understanding of the ethos of Value Engineering by some respondents, and questions effectiveness of implementation (Question No. 9).

Question 8

Investigates which professional groups widely use Value Engineering.

Groups	% considered to use Value Engineering
Client	64%
Design Consultant	56%
Project Manager	55%
Quantity Surveyor	55%
Value Engineering Consultants	83%

The above result indicates that the Value Engineering is widely used by professionals working in the construction industry in the United Arab Emirates. Further, the results are consistent with question 3 giving confidence in the widespread involvement in Value Engineering over the professionals in all construction projects in the United Arab Emirates.

Question 9

91% of the respondents agree that Value Engineering is a cost cutting exercise, while 9% of the respondents believe that Value Engineering is not cost cutting exercise, whereas 0% of the respondents are undecided.

Therefore, the above response indicates that Value Engineering was considered by them as a cost cutting exercise by the United Arab Emirates professionals. It is to be noted that the argument is linked with question 2 (See question 2). So while respondents considered they understood the basis of Value Engineering, this response casts doubt on that assertion.

Question 10

The results of Question 10 show that 72% of respondents agree that Value Engineering was beneficial to the construction industry in the United Arab Emirates. The results broadly match those in question 5 with 86% of respondents agree that such practices can benefit construction industry in the United Arab Emirates.

Question 11

The survey analysis shows that 73% considered that Value Engineering improves design and life cycle costs in the United Arab Emirates. Again this shows the positive attitude to Value Engineering as reflected in questions 5 and 10.

Question 12

The results show that 69% of respondents consider that Value Engineering should be carried out during design and construction stage. The consensus view obtained from the literature review is that the greatest benefits from applying Value Engineering are achieved by the end of the preliminary design stage. This may indicate that design changes are being made at a more advanced stage. The case studies may provide further insight.

Question 13

The survey response confirms that 83% of clients believe that undertaking Value Engineering by the end of the preliminary design is most productive and by influence, before detailed design has started. Therefore, this supports the timing of the Value Engineering to be carried out by the end of the preliminary design is most economical.

5.2.5 Review of Questionnaire results under Research issues

5.2.5.1 Issue 2 – Timing and Execution of the Value Engineering Process

This was addressed in question 13 in Questionnaire 1. There was a wide agreement (83%) that Value Engineering is most productive when conducted by the end of the preliminary design stage which agrees with accepted views highlighted in the literature review of Chapter 3.

However, based on question no. 12 in Questionnaire 1, the survey indicates that 69% of respondents agree that Value Engineering to be carried out not only in the design stage but also in the construction stage. Yet in question 13 the consensus view is that most benefit occur by the end of the preliminary stage.

The question arising from the above is: "Do respondents anticipate change in design (variations) during the construction stage? As this would be a potential reason that would necessitate re-value engineering as a response to change". This issue will be re-evaluated on the completion of all data collection.

5.2.5.2 Issue 4 – Understanding of the Value Engineering Process

Based on the question 2 in Questionnaire 1, it indicates that 86% of the respondents consider themselves familiar with the understanding of the Value Engineering process. However, based on question 9 of Questionnaire 1 there is a view that Value Engineering is used as a cost cutting process in order to reduce the project budget cost in United Arab Emirates. This is not an uncommon misconception and has been reported by other researchers. In order to optimise the quality and cost of a project, Value Engineering applications are important from the early design stages. Hence, developers tend to bring them to projects in the planning stage, Columnist (2009). Columnist further emphasises that adaptation of Value Engineering would lead the project success as *"from many perspectives, this is an excellent change of focus"*.

Although, respondents understand the concept of the Value Engineering process they misinterpret it as primarily reducing cost, not the potentially improving other aspects such as project quality, safety and time. This indicates that there is a wide spread misunderstanding of the objective of Value Engineering in the United Arab Emirates. This further supports that data obtained in the survey of question 6 in Questionnaire 1, which rates current performance of Value Engineering in the United Arab Emirates where 29% of respondents rated current performance "good" to "very good", while 71% rated the performance "fair" to "poor". Value Engineers may be partly to blame for this misconception.

"It is easy to highlight 'Project Cost Saving' as a projected outcome of applying the Value Engineering process and it is easy to see why this would have great appeal to clients in particular. Maximisation of value delivered to the client by focusing on main three forms of cost, functions and aesthetic is the essence of Value Engineering", El-Alfy (2010).

Comparison with question 5 indicates significant scope for improving current practices and a receptiveness of professional groups to embrace the Value Engineering concepts. There are differences with question 4, as 63% of respondents believed Value Engineering was being effectively implemented. The question arises as to why the actual performance rating given in question 6 responses is so low?

Therefore, this indicates that performance of Value Engineering is not delivering the required result due to deficiencies in the implementation of Value Engineering procedures.

5.2.5.3 Issue 5 – Value Engineering in the Construction Phase

Based on question 12, the results show that 69% of respondents agree that Value Engineering is carried out during the design and construction stage. However, their interpretation indicates that the Value Engineering should not only to be carried out in the design stage but also in construction stage. This raises the question if design changes that affect construction arise that necessitates a further Value Engineering workshop. This is an issue that will be further considered when all data is collected, in chapter 7.

5.2.5.4 Issue 6 – Performance Measurement based on cost

Based on question 7 in Questionnaire 1, the *four key success factors are considered improved by Value Engineering responses are as follows:-*

Factor	% Agree
Quality	67%
Safety	66%
Time	65%
Cost	95%

The above analysis indicates that cost is considered to be the principal measure of successful implementation of Value Engineering by United Arab Emirates professionals.

This issue provides an initial insight into the relative importance of cost to overall project outcomes that are familiar to a range of professionals. In Value Engineering, function and performance are prime design objectives. These will be specifically addressed in the Questionnaire 3 which was only issued to Value Engineering specialists.

As per question 6 in Questionnaire 1, the response from respondents show that the rate the current performance of Value Engineering in the United Arab Emirates as 29% of respondents rated current performance good to very good, while 71% rated the performance 'fair' to 'poor'.

Based on the above analysis, it indicates that the performance of value engineering is not so effective compared to responses obtained from the implementation of Value Engineering processes.

5.3 Stage II Data Collection

5.3.1 Introduction

Questionnaire 1 examined the current perceptions and experiences of a range of construction professionals working in the United Arab Emirates. Questionnaire 2 and 3 were used as a basis for a semi-structured face to face interview with Value Engineering practitioners currently working in the United Arab Emirates. Interviewees were also encouraged to introduce any further issues deemed relevant.

The information required at this stage required specialist knowledge and experience of Value Engineering applications in the United Arab Emirates. There are a limited number of experienced Value Engineering specialists working in the United Arab Emirates and it was only possible to get six specialists to contribute to this research. However, those who contributed were from six different companies operating in the United Arab Emirates. It was considered that the quality of information provided from these experienced professionals is reliable and provides a meaningful data set to meet the objectives of this research as identified in Chapter 1.

The link between the identified research issues and the questionnaires are shown in the table below. Note that question three deals exclusively with performance measurement based on costs, this is consistent with the statement in Chapter 1, Section 1.7, namely, as this thesis is concerned with the management of the Value Engineering process. It is assumed that the technical appraisal aspect in Value Engineering meets the basic precept of maintaining functionality and desired quality. The determination of technical aspect of compliance is outside the scope of this research.

Table 5.4 – Identified 'issues' of research interest relevant to questionnaires 2 and 3

Issue No.	Issues of Research Interest	Questionnaire	
		2	3
1	Structure and method of Value Engineering process	✓	
2	Timing and execution of Value Engineering and workshop studies	✓	
3	Composition of the workshop team	✓	
4	Understanding of the Value Engineering process		
5	Value Engineering during the construction phase	✓	
6	Performance measurement based on costs		✓
7	The effect of environment and culture on Value Engineering	✓	

5.3.2 Listing and Rationale of Questionnaires 2 and 3

Questionnaire 2 collects factual data on specific issues relating to the implementation and management of Value Engineering in the United Arab Emirates.

Questionnaire 3 focuses on one issue namely performance measurement based on costs (issue 6). This has been specifically addressed in this questionnaire as it was identified in the literature review of Chapter 3 as an issue that has limited published quantitative evaluation.

However, the issues arising from the semi-structured interviews will develop a wider in-depth review. This will mean that when the results are discussed a range of research issues, listed in Table 5.4 are covered. Results will be first discussed under each of the questions in the questionnaires and subsequently reviewed in Sections 5.3.3 and 5.3.4 and subsequently under the stated seven research issues in Section 5.3.5.

5.3.3. Format and Results of Questionnaire 2 and Interview Discussion Agenda

Question 1

Theme Question

Are external consultants employed in the Value Engineering process?

Yes	No	Sometimes
4	2	0

This is to verify that any external Value Engineering consultant is employed in your organisation.

Discussion Issues

- What determines this?
- Who other than external consultants would be used?
- Are external consultants constrained by the client?
- What are main terms of employment if external?
- What are the client's motivations to use Value Engineering?
- Do you receive client feedback?
- Do United Arab Emirates clients have an understanding of the Value Engineering approach?
- Any other relevant factors?

Theme Question Response

The analysis of above Question 1 based on interviews conducted with professionals from six (6) organisational company's shows four (4) of them agree that the external

Value Engineering consultant was employed for Value Engineering process while two (2) of them disagree.

Discussion Response

External consultants are widely employed for the Value Engineering workshop in most of the organisations. The external consultant provides the leadership to co-ordinate the Value Engineering process, and he also,

- Gives a fresh look and independent views
- Can produce un-biased results
- Provides expertise

In addition, the following professional groups have been involved in the Value Engineering workshops.

- Design consultants
- Project management consultants
- Client representatives, quality surveyors and project managers
- Cost consultants

There are cases where external consultants are constrained because sometimes, the clients insist on specific needs and emphasise to achieve the projected cost savings. In most of the cases, the client's interest and understanding towards Value Engineering are simply 'cost-cutting'. However, clients do not constrain the consultant and they understand the process of Value Engineering. The main terms of the external consultants employment is to 'Facilitate', 'Lead' and 'Guide' the rest of Value Engineering team and provide conclusions and recommendations of the Value Engineering process.

Generally, the client's motivation to use Value Engineering is as a cost-cutting exercise that is systematic and as a vehicle to instruct the other stakeholders for cost reduction. However, some clients are keen to establish the 'value for money' concept.

Question 2

Theme Question

Is the Value Engineering process managed by your organisations management staff?

Yes	No	Sometimes
5	1	0

This is to verify whether it is managed by the organisations management staff.

Discussion Issues

- Who other than external consultants would be used?
- Are external consultants constrained by the client?
- What are main terms of employment if external?
- What are the client's motivations to use Value Engineering?
- Do you receive client feedback?
- Do United Arab Emirates clients have an understanding of the Value Engineering approach?
- If not who manages it?
- Are workshops held at clients building?
- To what extent is the client involved?
- Any other relevant factors?

Theme Question Response

The response of semi-structure interview indicate that five (5) of them agreed the Value Engineering process was managed by own organisations staff while one (1) disagreed.

Discussion Response

The Value Engineering process is usually managed by the client organisations management staff. The management engage an external consultant to co-ordinate the Value Engineering workshop and ensures the success of the Value Engineering exercise. Usually the Value Engineering workshops are held at the client's buildings or sometimes at the consultant's premises. The client involvement is important to ensure that the Value Engineering process is provided with clear set objectives. Mostly, the client is motivated to witness the Value Engineering workshop. Sometimes, a client representative also participates in the Value Engineering process.

Question 3

Theme Question

Does your company have documentation stating how the Value Engineering process is to be executed?

Yes	No	Sometimes
5	1	0

Provides information related to documented procedure for process the Value Engineering execution.

Discussion Issues

- What control do you have on the procedure to be adopted?
- Does the client provide a programme of events?
- Does the client have an effective Value Engineering procedure?
- Is there a link to their quality and risk procedures?
- Do their procedures relate to costing, and is this a sensitive issue?
- Any other relevant factors?

Theme Question Response

The semi structure response indicates that five (5) of them agree the companies have documentation procedure to execute the Value Engineering process while one (1) disagrees.

Discussion Response

The entire process of Value Engineering is generally well documented, including the agenda, opening meeting, the quantity-take off, questionnaires and all other relevant details of the Value Engineering process.

The main stages during the Value Engineering workshop are as follows:

- The co-ordinator ensures the agreed procedures are implemented
- The client witnesses to confirm that the procedure is adopted
- A post-process audit carried out on the procedure implementation

The Client would provide an agenda, list of activities, parties involved, time schedule and finishing of the Value Engineering. Value Engineering consultants have to provide the procedure and not expect the client to have their own procedures. This procedure is then used to guide the workshops team towards the stated objectives.

Question 4

Theme Question
How many people typically attend the Value Engineering workshops?

2-6	6-8	8-12	12-15	Over 15
	1	3	1	1

This is to assess the team size present at Value Engineering workshops.

Discussion Issues

- Is this an adequate number to achieve effective results?
- Do you have an influence on this?
- Any other relevant factors?

Theme Question Response

The semi-structured interviews indicate that the three (3) of them agree that 8-12 people required to attend Value Engineering workshop, one(1) agree for 12-15 participants, one (1) agree for 6-8 participants while another one(1) agree more than 15 people required to attend workshops.

Discussion Response

Attendance is typically of around 8 to 12 people. We generally recommend attendance by representatives from design consultants, project management consultants, client representatives and quantity surveyors involved in the project.

Question 5

Theme Question
What groups are represented at the workshops?

Group	Yes	No
Client	6	0
Architect	6	0
Project management consultant	6	0
Design consultant	6	0
Contractor	0	6
Subcontractors	0	6
Clients quantity surveyor	6	0
Other (state)	0	0

To verify what groups are presented when conducting the Value Engineering workshops.

Discussion Issues

- Is there adequate representation from the relevant disciplines?
- Do conflicts arise between respective disciplines! If so how are they resolved?
- Who advises on actual construction issues?
- Any other relevant factors?

Theme Question Response

The semi structure interviews indicates that six (6) of them agree that the workshop are attended by client, architect, design consultant, project management consultant and client quantity surveyor, while all six (6) reported that Value Engineering workshops are not attended by contractors and sub contractors. However, during the design stages the contractor and the sub-contractor are not appointed hence do not attend the Value Engineering workshop.

Discussion Response

All the respondents agreed that client, architect, design consultants, project management consultant, client representatives and client quantity surveyor were deemed essential. Construction issues would be addressed by the project management consultant and client as a contractor would not have been engaged at this stage.

Where there was experience from previous similar projects, then past issues and concerns would be raised in context of the current problem in order to eliminate or minimises their recurrence. This provides a feedback process for improvement but was dependent on individual’s experience.

Question 6

Theme Question

Who conducts Value Engineering workshops?

Job title	Yes	No
Facilitator / team leader	5	1
Architect	0	6
Quantity surveyor (cost consultant)	0	6
Client's organisation	1	5
Design consultant	0	6
Project management consultant	0	6
Other (state)	0	0

This is to identify who were involved in conducting Value Engineering workshops.

Discussion Issues

- Was this an influence on how effective they are?
- Are there external issues that arise specifically in the United Arab Emirates?
- Any other relevant factors?

Theme Question Response

The semi structure interviews indicated that five (5) of them agree that Value Engineering workshops would be conducting by facilitator / team leader, while one (1) responded that the in house client's organisation shall conduct Value Engineering workshop.

Discussion Response

A Value Engineering facilitator is usually employed, as an in-house workshop may be biased and ineffective. Workshops facilitated by external consultants are considered very effective. External influences such as authority requirements, design requirements, legal and statutory requirements are all external issues which influence the project outcome, so it is essential that detailed knowledge of these issues that are specific to the United Arab Emirates are addressed.

Question 7

Theme Question

What is the main objective of the Value Engineering process?

Objectives	Yes	No
Cost cutting exercise	1	5
Design improvement	0	6
Optimisation of cost, remove unnecessary cost and improve the functionality	5	1
Other	0	0

This identifies people's opinions of the prime objectives of Value Engineering.

Discussion Issues

- Was this an influence on how effective they are?
- Are there external issues that arise specifically in the United Arab Emirates?
- Who sets this?
- What is the clients influence?
- Are culture factors specifically addressed?
- Any other relevant factors?

Theme Question Response

The semi structure interview indicates that five (5) of them agree that Value Engineering objectives are optimisation of cost, remove unnecessary cost and improve the functionality, while one (1) responds that Value Engineering objective is a cost cutting exercise.

Discussion Response

While improving functionality and cost optimisation is widely accepted, the clients influence can be significant. In the case of the respondent who reported the main objective as cost-cutting, this reflected the client's prime expectation, which in Emirati society, means that it is a necessary outcome for the Value Engineering team to achieve. The proposals made would need to be accommodated in this aspect, as it is a reasonable expected final outcome from the client viewpoint.

The Value Engineering process was reported to specifically address issues of culture and the environment. The following were cited by respondents as specific issues the design team were required to consider:

- Architectural and interior design are very specific e.g. the size of rooms in offices reflects status. The space allocated to senior staff would be considerably greater than that expected in western society.

- Provisions in living accommodation for separate male, female and children areas are the cultural norm for Emirati families.

- Lighting and colour schemes are also influenced by cultural norm.

- The above effect of culture applies to commercial and governmental offices, and residential buildings where Emirati nationals work and live.

The specific material specification is also important. This is necessary to ensure the durability, functionality and performance of the design under such advance climate condition to suit the United Arab Emirates environment.

Question 8

Theme Question
What is the best time to conduct the Value Engineering workshops?

Project Stage	Yes	No
By the end of the feasibility	1	5
By the end of the conceptual design	2	4
By the end of the preliminary design	6	0
By the end of the detailed design	0	6
By the end of the construction	4	2

Identifies if "timing" is an important factor in achieving the benefits of Value Engineering for projects.

Discussion Issues

- Have you a preference?
- Does this usually meet your needs?
- Do you think employing workshops during construction could provide advantages?
- Any other relevant factors?

Theme Question Response

The semi structured interview indicates that six (6) of them agree that Value Engineering workshops shall be conducted by the end of the preliminary stage, while three (3) of them responded that Value Engineering workshops to be conducted during feasibility and conceptual design stages only. Also four (4) respondents indicated that workshops be conducted during the construction stage.

Discussion Response

All agreed that it was necessary to conduct the Value Engineering workshop by the end of the preliminary design stage. At this stage, there would be adequate details in terms of specification, cost information and other factors to carry out a detailed Value Engineering view. When specifically asked about employing workshops during construction all agreed it would definitely help in providing better solutions. It would help in:

- Build ability of the design
- Construction methodology
- Make use of the contractors' vast experience in providing better alternative solutions
- Address practical problems and design compatibility

Question 9

Theme Question

What format do the Value Engineering workshops take?

Description	Yes	No
Set agenda	5	1
Open discussion	1	5
Individual Issues	0	6

This is to understand if there are any fixed formats used for Value Engineering workshops.

Discussion Issues

- Are you happy with this?
- Could it be improved?
- Any other relevant factors?

Theme Question Response

The semi structure interview indicates that five (5) of them responded that Value Engineering workshops have a set agenda, while one (1) of them responded that Value Engineering workshops formats should be based on an open discussion.

Discussion Response

Value Engineering workshops, were expected to have the following stages;

- Opening meeting and introduction
- Distribution of areas
- Team formation
- Group discussion / summaries the points
- Open discussion / debate
- Validate the ideas addition, deletion, summaries, conclusion and recommendation.

Respondent were generally satisfied with this set agenda format, while there was an acceptance that it can always be improved based on the condition, situation and needs of the project.

Question 10

Theme Question
How many hours / days would normally be required to conduct the workshops?

8hrs	**16hrs**	**24hrs**	**32hrs**	**40hrs**	**Over 50hrs**
1day	**2days**	**3days**	**4days**	**5days**	**Over 5days**
0	0	0	0	6	0

Establishes how many hours are taken conducting workshops. This may correlate with the perceived importance given to Value Engineering by the respondent's organisation.

Discussion Issues

- Is this adequate?
- What does it depend on – project type, client, technical complexity?
- Any other relevant factors?

Theme Question Response

The semi structured interview response was that all respondents agree that Value Engineering workshops shall be conducted for five (5) days.

Discussion Response

One respondent reported that for a small project, a five (5) day of 8 hrs / day and forty (40) hours schedule workshop schedule is used, but recognised that it depends on the size and type of the project, client and technical complexity. However, forty (40) hours workshop is normally recommended.

Question 11

Theme Question

What advance information do attendees need prior to conducting the workshops?

Information required	Yes	No
Full contract details and cost estimate	6	0
Selected details relevant to individual members of the meeting	1	5
Statement of Value Engineering procedures	6	0
Agenda for meeting	6	0
Cost estimate	6	0
Client requirements	6	0
Other (state)	0	0

Provides information about the project scope of work, functionality of project agenda and client requirements are to be given in advance for attendees of workshop / meetings.

Discussion Issues

- Is this provided in time?
- Is it adequate?

- Any improvements?
- Do attendees get it in time?
- Any other relevant factors?

Theme Question Response

The semi structure interview indicates that six (6) respondents agreed that advance information is required relating to all above items prior to conducting workshops except selected details, while one (1) of them considered that only selected information is required related to the specialities of individual members.

Discussion Response

Prior to conducting workshops, the client usually provides the drawings, specifications, project brief, project location, duration of the project, conditions of contract and all other related information to be given to Value Engineering consultant.

Question 12

Theme Question

What advance preparation is required of the attendees to the workshops?

Advance requirements	Yes	No
Orientation meeting	3	3
Concept of Value Engineering	6	0
Constructability	6	0
Sustainable design	3	3
Standards / codes requirements	3	3
Client’s stated requirements	6	0
Other (state)	0	0

Is there any data such as project scope, drawings and requirements given to the concerned attendees?

Discussion Issues

- Do they do their homework?
- Do they understand what is expected of them?
- Any other relevant factors?

Theme Question Response

The semi structure interview indicates that six (6) respondents agreed that advance preparation is required related to the concept of Value Engineering, constructability and client's stated requirements prior to conducting workshops, while three (3) of them consider that only selected information is required relating to selected details such as orientation meeting, sustainable design, standard / codes requirements.

Discussion Response

The attendees should be given advance information such as drawings, specifications, project brief and related information in order to be familiar with the project and to conduct the workshops efficiently. However, there are occasions where some attendees do not have a full understanding of the Value Engineering process. When they have a lack of understanding of the process, they need to be briefed and guided by the Value Engineering consultants.

Question 13

Theme Question
Who would advise on the potential costs and benefits of any proposed changes arising from the workshops?

Group	Yes	No
Client	0	6
Design consultant	0	6
Cost consultant	6	0
Project management consultant	6	0
Others (state)	0	0

Based on workshop recommendations for the benefits achieved, who would be assessing / evaluating the potential benefits and costs?

Discussion Issues

- Are they the best ones?
- How accurate is this data?
- Could this be verified or audited?
- Any other relevant factors?

Theme Question Response

The semi structure interview indicates that six (6) respondents agreed that benefits of proposed changes arising from workshops are obtained from the cost consultant and project management consultant.

Discussion Response

The differences expressed here depend on who the respondent worked for. Six (6) respondents quoted cost consultant and project management consultant, as doing the costing. These six (6) respondents work for organisations that deal in costs that are commercially sensitive. In such cases the costing of ideas is done internally by the client organisation. The workshop team is then advised on the overall costing of their proposals. A cost manager would advise on potential cost and benefits of any proposed changes arising from the workshop. Most of the time, their advice is focused on cost-cutting. The data available is usually accurate, and it is feasible for this to be verified and activated.

Question 14

Theme Question

In what language will the meetings be conducted during Value Engineering workshops?

Arabic	English	Other
0	6	0

Is there consistency in language used for conducting Value Engineering workshops?

Discussion Issues

- Any other relevant factors?

Theme Question Response

The semi structure interview indicates that all six (6) respondents agreed that Value Engineering workshops will be conducted in English only.

Discussion Response

All respondents noted that the workshop meetings are conducted in English. However, some discussions between workshop members take place in Arabic language. Some of the attendees may face problems in conversing in English. So, naturally they tend to speak in Arabic.

Question 15

Theme Question

How many different nationalities are typically present at workshops?

1-2	2-3	3-4	4-5	More than 5
0	0	6	0	0

This is to assess the various international dimensions of those involved in Value Engineering workshops.

Discussion Issues

- Any cultural issues relating to this?
- Do they form an effective team?
- Any other relevant factors?

Theme Question Response

The semi structure interview indicates that all six (6) agreed that Value Engineering workshops to be attended by 3-4 nationalities.

Discussion Response

As the team comprises of different nationals, their knowledge background, experience, influence, priorities are all different. In this context, discussions always have disputes and different opinions. It is challenging for the facilitator to resolve the issues. They form effective teams within the group of Value Engineering process workshops. The different teams are formed in terms of disciplines and they discuss to elaborate the points raised.

Question 16

Theme Question

Is the Value Engineering workshops conducted during the construction stage?

Never	Mostly	Fully
6	0	0

To verify the possibility of workshops conducted during construction stage.

Discussion Issues

- Do you think this would have advantages?
- Under what circumstances would you consider this appropriate?
- Any other relevant factors?

Theme Question Response

The semi structure interview indicates that all six (6) respondents agreed that Value Engineering workshops are not conducted during construction stage.

Discussion Response

The respondents noted that Value Engineering workshops conducted during the construction stage would have an added advantage. It gives an opportunity for better alternate solutions in terms of buildability and constructability. Also it can consider 'Green Building' concepts.

This would be appropriate during the following situations.

- To improve the constructability by introducing new material or method.
- When there is a shortage of earlier proposed material.

Other relevant factors are as follows.

- When there is an amendment or option in the statutory requirements.
- To consider 'Green Building' concepts.

5.3.4 Format and Results of Questionnaire 3 and the Interview Discussion Agenda

Question 1

Theme Question

Does your company expect specific benefits from using Value Engineering?

Benefit	Yes	No
Time savings of the project	5	1
Cost savings of the project	5	1
Reduced variations during construction	5	1
Optimisation of cost, remove unnecessary cost and improve the functionality of the project.	6	0

Identifies the benefits expected from the Value Engineering process.

Discussion Issues

- Do these match what the client expects?
- Is it clear what the client's perception of 'value' is?
- Do you consider 'functionality' and 'performance' to be separate issues that have to be addressed?
- What feedback would you expect to get after the workshop recommendations have been submitted?
- What importance do you think the client attaches to the Value Engineering process?
- Any other relevant factors?

Theme Question Response

The structured interviews indicates that five (5) of respondents agreed that benefits arise from all the items shown in the table (time, cost, reduction in variations and functionality), while all six (6) responded that benefits arrived from optimisation of cost, removing unnecessary costs and improving the functionality of the project.'

Discussion Response

Most clients interpret that the Value Engineering process as basically a 'cost-cutting exercise'. But, some clients also expect the workshop to generate value based results. In these cases, the client has a clear understanding of the value to be achieved in the Value Engineering workshop.

Upon workshop recommendations being submitted, respondents expect feedback on the benefit of the workshop, and the effectiveness in conducting the workshop.

Client's attendance is important to the Value Engineering workshop in terms of satisfying their needs to achieve the cost savings as targeted.

Question 2

Theme Question

What level of change in project cost and time would you expect from using the Value Engineering process?

% change to original project cost estimate							
	0-3%	4-6%	7-9%	10-13%	14-16%	17-19%	Over 20%
Cost Savings	0	0	2	4	0	0	0

The above is to establish the perceived cost and time savings resulting from implementing the process of Value Engineering.

Discussion Issues

- Is this based on the findings from the workshop?
- Do you know if the client has a procedure to monitor the predicted outcome of the value engineering process?
- Are you aware of the influence of changes and variation on the Value Engineering predictions?
- Has, to your knowledge, Value Engineering been repeated later in detailed design or construction stages?
- Would there be tangible benefits?
- Any other relevant factors?

Theme Question Response

The structured interview indicates that four (4) agreed with 10-13%, while other two (2) agreed with 7-9%.

Discussion Response

The reduction in cost and time, based on the findings from the workshop, relate to the initial project time and cost estimate, made by the end of the preliminary design stage of the project. Some clients do have a procedure to monitor the predicted outcome of the Value Engineering process, while some do not.

The tangible benefits of Value Engineering by respondent were;

I. Reduction in project time

II. Reduction in project cost

III. Minimising project risk

The expected cost savings is 5-12% based on the outcome of the Value Engineering ideas. There are cases that the client set the target cost saving to be achieved, based on the budget.

Question 3

Theme Question
Does your company verify the outcome of recommended ideas conducted in Value Engineering workshop during construction stage?

Yes	No	Being Considered
0	6	0

To verify if the stated benefits in question 2 have been based on analysis or on a subjective view of Value Engineering.

Discussion Issues

- Does your company have the opportunity for a follow-up study?
- Do you consider that this would be a practical course to follow?
- Would it be desirable? If so to whom?
- What response would you expect from contractors if this was the case?
- Any other relevant factors?

Theme Question Response

The structured interviews indicated that all six (6) respondents stated that conducting Value Engineering outcomes are not verified during the construction stage.

Discussion Response

The recommended Value Engineering workshop ideas are not verified by the client or Value Engineering consultant. This limits the development of improvements. Where predicted benefits are not achieved, or benefits exceed expectations, the process cannot generate improvements due to the lack of data available, i.e. no feedback.

Question 4

Theme Question
At what project stages does Value Engineering usually deliver measurable benefits?

Project Stage	Yes	No
Feasibility	0	6
Preliminary design	6	0
Detailed design	0	6
Construction planning	0	6
Construction	6	0

This is to explore if experience of Value Engineering use and indicates sensitivity to the timing of the process.

Discussion Issues

- Could extending Value Engineering into other stages be worthwhile?
- When?
- How?
- Any other relevant factors?

Theme Question Response

The structured interview indicated that six (6) of them agreed that Value Engineering usually deliver measurable benefits by the end of the preliminary design and all six (6) agree that Value Engineering be extended into the construction stage.

Discussion Response

Measureable benefits can be delivered by the end of the preliminary design stage. Where alternative materials are specified then this can be reliably quantified and estimated. Similarly an alternative method can be estimated with some confidence to predict an achievable benefit.

All respondents agreed that extending Value Engineering into the construction stage has potential benefits, but that this was not currently done in the United Arab Emirates. The exception is when Value Engineering was undertaken late in the detailed design stage, or when a contractor had already been selected.

5.3.5 Review of Structural interview based on Questionnaires 2 and 3 results under research 'issues'

In the following tables the question numbers for each questionnaire are identified as

QA, B. Where A = Question number

B = Questionnaire number

E.g. Q4, 3 is question 4 on Questionnaire 3.

5.3.5.1 Structure and Method of the Value Engineering Process

Question No.	Findings
Q1,2	The use of external Value Engineering consultants is recommended by four (4) out of six (6) respondents. The main reasons quoted were the independence of appointing an external consultant and to ‘facilitate’, ‘lead’, and ‘guide’ the Value Engineering team.
Q2,2 and Q3,2	The process was well documented, usually based on the client’s specified procedures, but occasionally the external consultant supplied these documented procedures.
Q9,2	Value Engineering workshops are based on a set agenda approach and there was general satisfaction with this format.
Q13,2	All agree that the cost consultant and project management be involved on potential costs and benefits of proposals made by the Value Engineering team. However, the client on occasion uses an in house quantity surveyor to cost the proposals in order to safeguard commercially sensitive costing data.

5.3.5.2 Timing and Execution of the Value Engineering process

Question No.	Findings
Q8,2	Six (6) agree that Value Engineering is most effective by the end of the preliminary design stage only, while the remaining three consider the feasibility and conceptual stages of a project are relevant.
Q16,2	All respondents reported that Value Engineering workshops are not currently undertaken during the construction stage, but did consider that potential benefit would result. Namely;- ➢ consider alternatives to improve buildability ➢ respond to amendments and variations ➢ consider 'green building' concepts
Q10,2	All respondents were in favour of the five (5) days workshop but for smaller projects a two (2) days workshop has been employed.
Q11,2	Advance information supply to workshop delegates was standard practice. There were some differences on what individuals may inquire.
Q12,2	There was a difference of opinion in what advance preparation was required of delegates. One view was that full documentation be supplied while the second group restricted advance preparation to the concept of the Value Engineering process, constructability and client's requirements. There were cases where delegates were unsure of the process and required guidance.

5.3.5.3 Composition of the workshop team

Question No.	Findings
Q4,2	Typically 8-12 people attended workshops with representatives from the key elements of the project.
Q5,2	Six (6) of them agree that the workshops are attended by client, architect, design consultant, project management consultant and client quantity surveyor, while all six (6) disagree that Value Engineering workshops are attended by contractors and sub-contractors. However, during the design stage the contractor and the sub-contractor are not appointed in order to attend the Value Engineering workshop. Construction issues would be expected to be addressed by the project management consultant, as a contractor would not normally be appointed until the detailed design is complete.
Q6,2	The workshops are usually conducted by an external consultant. To be effective in this role it is considered necessary for this consultant to have detailed knowledge of issues specific to the United Arab Emirates, namely technical, environmental and cultural issues.

5.3.5.4 The Understanding of the Value Engineering Process

Question No.	Findings
Q3,2 & Q9,2	While the documentation and procedures generally comply with the internationally recognised set agenda approach, with the SAVE model commonly employed
Q7,2 & Q1,3	There are instances where cost cutting is a clearly stated client objective. Due to the cultural environment this then becomes a prime objective. In such a case, recommending an increase in the cost of an element of design to produce long term savings by life cycle costing would require a tactful presentation of the recommendation. However, the clients may feel justified in making this a required outcome as that is what Value Engineering leads the client to expect. It is then up to the Value Engineering team to advise on this in accordance with the principles and processes of Value Engineering.
Q1,2	While the above is true, according to some clients it is not universal.
Q1,3	There is a widespread view that Value Engineering does offer tangible potential benefits to a project.
Q8,2	While there is no universal agreement of the timing of workshops, it is considered to be best implemented by the end of the preliminary design stage. Therefore, current practice in the Emirates is at variance with accepted current recommendations.

5.3.5.5 Value Engineering during the construction phase.

Question No.	Findings
Q16,2	The recommendations made are largely accepted and implemented on projects; however the Value Engineering process usually terminates prior to the construction phase.
Q8,2	There is a widespread view that Value Engineering workshops provide the maximum benefits if conducted by the end of the preliminary design stage. However, there was recognition that further benefits would accrue if it was also used in the construction stage.
Q4,3	Value Engineering at the construction stage can occur if it is executed late in the detailed design or even after the contractor has been selected. In this case the contractor's construction knowledge is often required to implement revisions, which are done as variations to the planned construction programme.

5.3.5.6 Performance and Measurement based on costs

Question No.	Findings
Q2,3	There is a range of expected cost benefits from Value Engineering mostly in the 7% - 9% and 10% -13% range. Also a projected time saving on the project of 10%. These being based on the preliminary project cost and time estimates.
Q3,3	It is not standard practice in the Emirates to conduct a follow up study to monitor the benefits that are actually delivered by specific Value Engineering recommendations. There were perceived advantages in this and conducting Value Engineering workshops at the construction stage. However, it was anticipated that there would be reluctance on the part of contractor unless there were some shared benefits.
Q4,3	Respondents considered that measurable benefits are delivered at the end of the preliminary design stage by a change in material or method of construction. However, this could not be supported by evidence that during construction, this had delivered the predicted benefits.

5.3.5.7 The effect of environment and culture on Value Engineering

Question No.	Findings
Q7,2	There are several areas that environment and active impacts on the Value Engineering process in the Emirates. Workshops specifically address issues of culture. The plan and layout of occupied areas in domestic and commercial buildings have to conform to cultural norms in the Emirates. The size of rooms reflects status and separate rooms for men and women are expected. Lighting and colour schemes are also influenced by culture also. The technical specification of buildings is also, in many areas, specific to the Emirates. This specification is necessary to ensure functionality in the harsh climatic condition that prevails.
Q15,2	Typically workshops will have a multinational composition; typically 3 to 4 nationalities are normally in attendance.
Q14,2	English is normally the spoken language although some discussions may also be in Arabic.
Q6,2	The external consultants employed need to have knowledge of the issues that are specific to the Emirates, particularly local authority requirements, legal and statutory requirements.
Q7,2 & Q 1,2	The clients in the Emirates have a great influence in setting objectives for the Value Engineering process. Many, but not all, consider the process to be one to reduce cost, and hence, this becomes an essential outcome to be achieved and be a prominent aspect of the proposal submitted for approval. (Note also comments in 5.3.5.4).

5.4 Summary

This chapter presents findings from the questionnaires and semi-structured interviews carried out in the United Arab Emirates to obtain data on Value Engineering performance covering the seven (7) key issues as outlined in Item 5.1 of this chapter.

Questionnaire 1 was aimed at achieving an overview of Value Engineering by a range of construction professionals to client, design consultant, project management, quantity surveyors and Value Engineering Consultant. A total of 133 responses were reviewed. The perception of these professionals indicates that its application is not fully effective, thus there is a potential for improvement.

Questionnaires 2 and 3 and their associated semi-structured interviews were aimed at gaining an informed insight into Value Engineering practices in the United Arab Emirates. Thus, the interviewees were all Value Engineering professionals from different companies operating in the United Arab Emirates.

This data also identified specific factors for improving current practices in Value Engineering in the United Arab Emirates in relation to some of the research issues of Table 5.1. The above possibilities for improvements will be further reviewed in Chapter 7, discussion and findings. This is done after data of the actual implementation of Value Engineering is collected and assessed in the case studies presented in the following Chapter 6.

5.5 References

1. Columnist, G. (2009), *Value Engineering in Dubai*, (online) available from 06 April 2012, www.constructionweekonline.com.
2. El-Alfy, A.E.D. (2010), Designing *of sustainable building through Value Engineering*, Journal of Building Appraisal, Vol.6, pp 69-79.
3. Fink (2006), *How to Conduct Surveys: A step-by-step guide,* London: Sage.
4. Johnson, B. and Turner, L.A. (2003), *Data Collection Strategies in Mixed Methods Research. In: A. Tashakkori and C. Teddlie (Eds.) Handbook of Mixed Methods in Social and Behavioural Research,* Thousand Oaks. CA.: Sage.
5. Langdridge, D. (2004), *Introduction to Research Methods and Data Analysis in Psychology.* Harlow: Prentice Hall.
6. Robson, C. (2002), *Real World Research,* Oxford: Blackwell Publishing Company.

CHAPTER 6

CASE STUDIES

6.1 Introduction

Current research shows that Value Engineering principles are widely used throughout the United States of America, United Kingdom, Canada, and Australia. However in the Middle East, including the United Arab Emirates, there is limited published information on the extent and effectiveness of its application. The situation is that there are many construction claims in contracts in the United Arab Emirates. Zaneldin (2006) describes projects that are delayed, mainly due to Change Orders between contractors and owners. Similarly, Nadem (2009) identifies changes by clients and designers as a major cause of cost and time delays. It is possible that a more effective Value Engineering approach could limit the required number of changes or at least mitigate the cost and time implications. Also, El-Sayegh (2007) addressed the risks involved in the United Arab Emirates construction industry such as inflation, sudden changes in prices, shortage in material and labour supply. In most of the case studies, researchers carried out the Value Engineering during design stage, but the effect of implemented cost savings to the projects are still not fully verified in the construction and operation stages. Therefore, based on the above findings, it is evident that there is a need for research in respect to effective Value Engineering in building construction projects in the United Arab Emirates to remove the unnecessary costs and improve the safety, quality and functionality during design and construction, and compliance with local rules and regulations.

"Value for money in construction involves completing a project on time, cost and a level of quality that meets the client's needs. A good project will continue to provide value for money and meet end-user requirements throughout its life and will contribute to the environment in which it is located with a wide range of social and economic benefits. An early investment in design quality can help to deliver these benefits", DEFRA (2003).

In the construction industry, value for money involves completing a project on time; control cost and provides a level of quality that meets the need of the end-user. A good project will continue to provide value for money and meet user's needs throughout its lifetime, and will contribute to the environment in which it is located with a wide range of sociological and economic benefits. Saving money whilst at the same time, providing better value is a concept that everyone can support.

This Chapter presents the case studies of three (3) different completed projects carried out by author in Abu Dhabi, United Arab Emirates.

Case study 1 is the residential building project of Ruwais Housing Complex Expansion Phase III, Married Accommodation and related facilities, including infrastructure, is located 242 kilometres from the capital in the Western Region of Abu Dhabi, United Arab Emirates. The project comprises of seventeen (17) buildings consisting of six (6) storey buildings, which consist of seven (7) buildings of type F4 and ten (10) buildings of type F5 including a sub-station, a chiller yard, roads, walkways, play grounds and car parking.

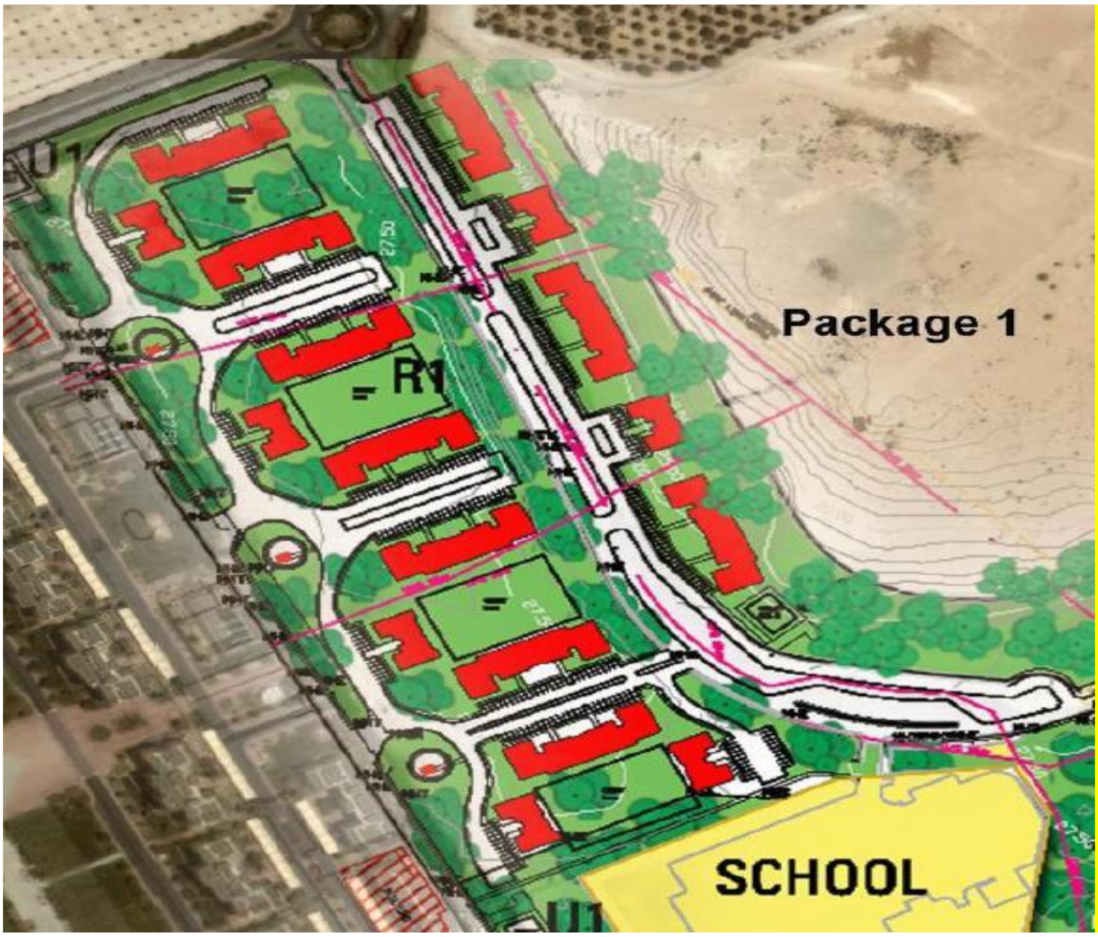
Case study 2 is the commercial building project of ADNOC Group of Companies Headquarters – Phase I and II, located in a prime location, is an architectural landmark on the "Corniche" in the city of Abu Dhabi, United Arab Emirates. The project comprises of four (4) commercial towers with nine (9) levels of car parking including external works and services. The project consists of two (2) twenty (20) storey office towers in the middle and two (2) twenty five (25) storey commercial towers on both ends.

Case study 3 is the hospital building project of Ruwais Housing Complex Expansion, Phase III, new hospital and related external works and services including infrastructure works. This project site is located two hundred and forty two (242) kilometres from Abu Dhabi, United Arab Emirates. The project comprises of a new fifty (50) bed hospital and facilities with a total built-up area of 21,000 square metres and includes the functions of Emergency units, radiology medical units, special services, physical therapy, maternity and neurology ward, laboratory and pharmacy, medical surgical ward, dental clinic and out-patient clinics.

The case studies provide the basis for a detailed evaluation of the management and implementation of Value Engineering in the United Arab Emirates that has not been presented by any other researches to date. This aims to provide factual data for a comparison of predicted cost savings with achieved cost savings up to the end of the construction phase of the projects and relate to the management of the Value Engineering process on these projects.

CASE STUDY 1

RUWIAS HOUSING COMPLEX EXPANSION – PHASE III
MARRIED STAFF ACCOMMODATION AND RELATED FACILITIES
INCLUDING INFRASTRUCTURE



6.2 CASE STUDY 1

6.2.1 Project Description

The project of Ruwais Housing Complex Expansion – Phase III, Married Accommodation and related facilities including infrastructure is located 242 kilometres from the capital in the Western Region of Abu Dhabi, United Arab Emirates. The project comprises of seventeen (17) buildings consisting of six (6) storey buildings which consists of seven (7) buildings of type F4 and ten (10) buildings of type F5 including a sub-station, a chiller yard, roads, walkways, play grounds and car parking. Type F5 buildings provide a total of two hundred and four (204) with two (2) bedroom flats and one hundred and twenty (120) with three (3) bedroom flats. The estimated built-up area is approximately 80,700 m^2. The layout of the project for this Case Study No.1 is presented in Figure 6.1 and the elevations of these buildings are shown in Figures 6.2 and 6.3 respectively.

The project was awarded to United Arab Emirates based design consultant with the award value of UAE Dirhams 4.20 million (US Dollars 1.14 million) for the period of eighteen (18) months. During the detailed design stage the client decided to conduct a Value Engineering workshop to optimise the cost and improve the design.

Upon completion of the design, the project was awarded for construction in three (3) phases with a total duration for the project of twenty four (24) months. The award value was UAE Dirhams 427.76 million (US Dollars 116.24 million). The project was awarded to United Arab Emirates based contractor in Abu Dhabi, United Arab Emirates.

CASE STUDY 1

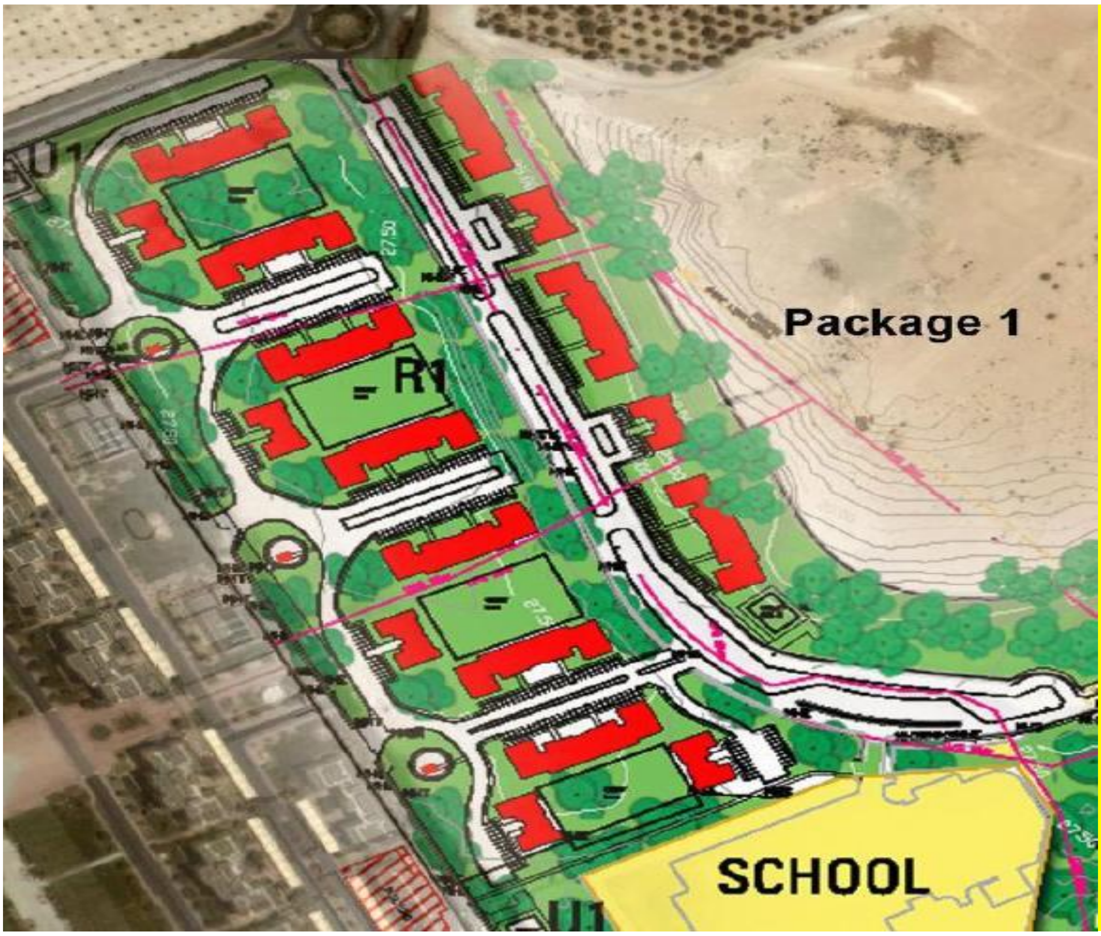


Figure 6.1 Layout of Ruwais Housing Complex Expansion – Phase III, Married Staff Accommodation in Western Region of Abu Dhabi, United Arab Emirates

CASE STUDY 1

Figure 6.2 Building, Type F4 - Two bedrooms and Three bedroom flats

Figure 6.3 Building Type F5 - Two bedroom flats

6.2.2 Value Engineering Analysis

The Value Engineering team on this project conducted a five (5) day workshop following the SAVE international job plan. The workshop was conducted in Abu Dhabi and its agenda is as follows:

Day 1

8:30 a.m. **Team members arrive**

- Welcome and opening remarks
- Team member introductions
- Objectives of workshop
- Workshop organisation and agenda

9:00 a.m. **Project design briefing (by design team)**

- Project goals and objectives
- Site and building layouts
- Mechanical and electrical systems
- Project cost estimate
- Value listening exercise

10:30 a.m. **Value models / function logic diagram**

- Quality model
- Cost model
- Individual building cost analysis
- Site cost analysis
- Detailed cost estimate
- Function logic diagram

11:00 a.m. **Force field analysis**

- Best project features
- Weakest features
- Ideas to enhance best features
- Ideas to improve weakest features

11:30 a.m. **Summary of force field findings (all Value Engineering teams)**

12:45 p.m. **Lunch / Prayer**

1:45 p.m. **Review of design documents and models (individual Value Engineering teams)**

- Organise into assigned teams
- Review latest drawings
- Study building description summary forms
- Review quality and cost models

2:30 p.m. **Function analysis phase (Value Engineering teams)**

- Prepare functional analysis systems technique (FAST) diagram
- Perform function cost worth analysis
- Complete cost models
- Finalise graphical function analysis
- Identify cost savings ideas which meet basic functions

5:00 p.m. **Adjourn**

Day 2

8:00 a.m. **Creativity phase (individual Value Engineering teams)**

- Brainstorm a large variety of ideas
- Generate ideas for basic function(s)
- Think of ideal solutions
- Modify and combine ideas

12:45 p.m. **Lunch / Prayer**

1:45 p.m. **Evaluation phase**

- List advantages and disadvantages of ideas
- Evaluate ideas by comparison
- Rank ideas for further investigation
- Consultation with specialists and manufactures

2:30 p.m. **Proposal development (individual Value Engineering teams)**

- Team member proposal development assignments
- Prepare design alternatives
- Weighted evaluation
- Consultation with specialists and manufacturers

5:00 p.m. **Adjourn**

Day 3

8:00 a.m. **Review status and progress of teams**

8:30 a.m. **Proposal development – (individual Value Engineering teams)**

- Cost estimate of alternatives
- Sketches of alternatives

12:45 p.m. **Lunch / Prayer**

1:45 p.m. **Life cycle cost analysis (individual Value Engineering teams)**

- Estimates of maintenance energy
- Replacements present worth life cycle cost calculations
- Sensitivity analysis

3:00 p.m. **Recommendation phase (individual Value Engineering teams)**

- Written proposals (present, proposed and discussion)
- Finalise sketches of present and proposed
- Update cost information
- Complete value summary sheets

5:00 p.m. **Adjourn**

Day 4

8:00 a.m. **Review status and progress of teams**

8:15 a.m. **Presentation preparation (individual Value Engineering teams)**

- Prepare Value Engineering graphs (Models, FAST and Value Summary)
- Present and proposed sketches
- Add cost information of Value Engineering graphs
- Finalise draft report for client

12:45 p.m. **Lunch / Prayer**

1:45 p.m. **Value Engineering presentation of proposals**

- Opening remarks
- Summary of Value Engineering process (Steps, Models and FAST)
- Value Engineering proposals and cost savings (Team Leader)
- Summary of value enhancements and potential cost savings

2:45 p.m. **Value Engineering presentation of proposals**

- Comments and discussion
- Remarks

4:00 p.m. **Comments and discussions**

Day 5

08:00 a.m. **Comments and discussion**

01:00 p.m. **Presentation and close-out session**

4:00 p.m. **Adjourn / Celebration**

Value Engineering schedule for activities for implementation as follows:

Task	Schedule
Value Engineering study workshop	4 days
Develop Value Engineering recommendations	1/2 day
Review of Value Engineering recommendations	1/2 day
Final Value Engineering report (includes client comments)	1 day
Value Engineering implementation	Throughout design and construction

The design criteria for the project included the following:

- Respect of the general planning spirit of surrounding housing facilities.
- Highest utilisation of existing services and utilities as appropriate.
- Meet design codes and housing standard requirements with respect to space utilisation efficiency and functional requirements.
- Safety environmental and safety requirements.
- Operation and maintenance costs of engineering systems to be considered in the design of new facilities.
- Meet safety and security requirements.

6.3 Value Enhancement Task Flow Activities

6.3.1 Pre-Work Shop Study

The pre-study preparation was carried out and covered the following activities:

- Identification of constraints to the Value Engineering study.
- Review of project documentation and distribution of information to team members.
- Finalisation of team and team assignments.

- ➢ Preparation of space model.
- ➢ Preparation of models such as energy, quality, life cycle costing, time, risk, etc.
- ➢ Finalisation of arrangements for workshop.

The Value Engineering study workshop was organised in three (3) different parts as indicated in Figure 6.4 below named as pre-workshop preparation, Value Engineering study workshop and post workshop implementation.

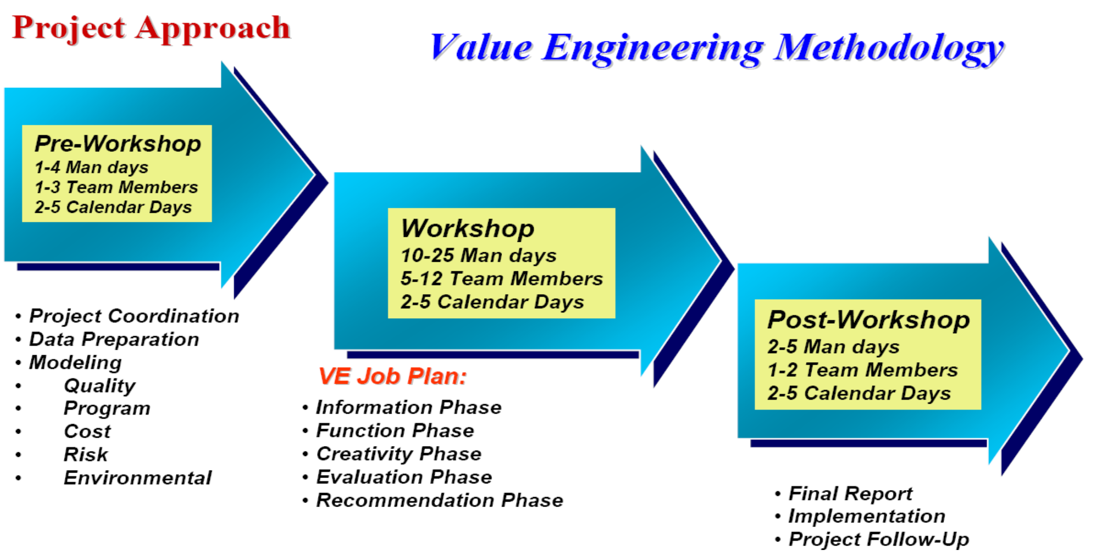


Figure 6.4 Value Engineering study workshop organised in three different parts.

The workshop followed, throughout all phases of the Value Engineering job plan as per the SAVE International recommendations, including information, function analysis, creativity, evaluation, recommendation and proposed development phases.

6.4 Value Engineering Job Plan

The Value Engineering job Plan followed five (5) key steps as per SAVE International Guidelines:

- ➢ Information phase
- ➢ Function phase
- ➢ Creativity phase

- Evaluation phase
- Recommendation phase

6.4.1 Information Phase

At the beginning of the Value Engineering study, it is important to understand the background and decisions that have influenced the development of the design. For this reason, the owner / designer normally presents orally, the building and process designs to the Value Engineering team. The site layout, building layout, process flows, process equipment, architectural, structural, mechanical and mechanical systems are discussed.

The information phase also includes further refinement of the cost, space and other models that are prepared before the workshop session. These models are updated based on information received during the owner / designer's initial requirements and functional analysis, which is as follows:

6.4.1.1 Economic Data

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

6.4.1.2 Other Data

- Project goals and objectives
- Project constraints

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

6.4.1.3 Building Process Data

- Plans
- Specifications
- Equipment lists
- Project cost estimate
- Geotechnical report
- Systems design calculations

6.4.2 Function Phase

The Value Engineering study utilised the data collected from the information phase to produce several new ideas and proposals unique to this type of study.

6.4.2.1 Function Logic Diagram

In order to understand the overall functions of the project, a 'Function Logic Diagram' was prepared to demonstrate to the Value Engineering Team. Reading from left to right, it is used to help to explain how the designer chose to solve the functions. The 'Function Logic Diagram' also helps to answer why these functions are important to the owner. The diagram normally translates production goals, objectives and tasks into a hierarchical logic diagram of functions for a better in-depth understanding of the owner's needs. The FAST diagram which was prepared by Value Engineering team leader just prior to this Value Engineering workshop was used as a baseline for this study.

6.4.2.2 Function-Cost-Worth

This technique associates tasks performed with functions required to satisfy customer needs. Costs are identified for performing the functions. The 'worth' is the least cost to perform the required functions.

Preparing the functional analysis helps to generate many of the ideas that eventually result in recommendations. This forces the Value Engineering team to speculate on alternative solutions to the proposed design. A function-cost-worth analysis was not normally performed as a primary proposed design or as a primary generator of creative ideas. A large number of ideas were generated during the force field analysis and brainstorm activities. A listing of the functions of the most critical or questionable building systems was made, in an attempt to generate more ideas.

6.4.3 Creative Phase

This step in the Value Engineering study involves the listing of creative ideas. During this time, the Value Engineering team thinks of as many ways as possible to provide the necessary functions within the project at a lesser cost to the owner. During this creative session, judgments of the ideas are not permitted. Ideas to enhance the best features and ideas to improve on the weakest feature are then generated. The best and weakest features are contained in this chapter section. The Value Engineering team is looking for quantity and association of ideas brought forth in the creative phase and are a result of work done during functional analysis. This list may include ideas that can be further evaluated and used in functional analysis. The creative ideas generated during the workshop are included in the chapter of Value Engineering report on the creativity / evaluation worksheet.

6.4.4 Evaluation Phase

In this phase of the project, the Value Engineering team judges the ideas resulting from the creative session. The advantages and disadvantages of each idea are discussed. Ideas are ranked based on the savings potential, redesign time and owner's acceptability. Ideas found to be worthy of additional study are given a higher ranking number for proposal development. A weighted evaluation is applied in some cases to account for impacts other than costs. Ideally, the Value Engineering team would like to develop all ideas, but time constraints usually limit the number that can be prepared. The ideas ranked highest by the Value Engineering team are selected for further review with members of the design team for their input.

During this phase, many of the ideas were expanded into workable solutions, which are presented in Table 6.1. This development of ideas consists of preparing estimated initial and life cycle costs, a descriptive evaluation of the advantages and disadvantages of engineering calculations and, as appropriate, proposed recommendations. It was considered important that the Value Engineering team convey the concept of their recommendation to the owner / design team. Therefore, each recommendation is prepared together with a brief narrative to compare the original design method to the proposed change. The sketches and associated materials, where appropriate, are also prepared in this part of the study.

Construction of a quality model is important for completing the project on time, cost and a level of quality that meets the specified needs. Further, the quality model was addressed in Figure 6.5, which was established by the Value Engineering team and was confirmed by end-user.

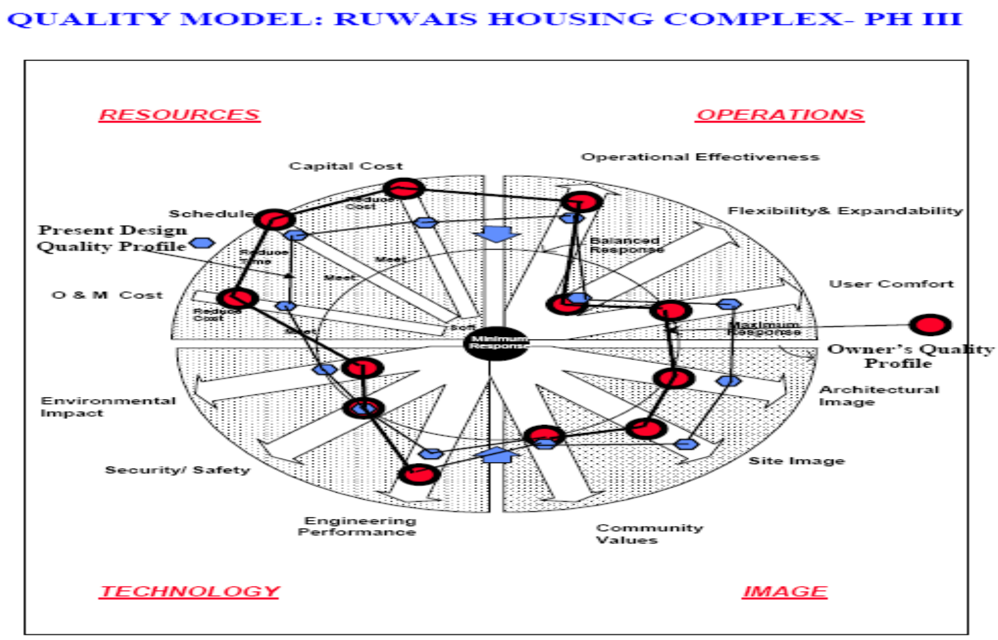


Figure 6.5 Quality Model established during Value Engineering analysis (Stephen and Alponse, 1995)

6.4.5 Recommendation Phase

The final phase of the Value Engineering study is the presentation of recommendations which is presented in Table 6.2. The Value Engineering recommendations are further screened by the Value Engineering team before formal presentation. The oral presentation of results made on the last day of the workshop to the owner / design team. The recommendations based on Table 6.2, rationalises the development of each proposal and a summary of cost savings are presented at this time, so that the owner / design team can initiate an evaluation of the Value Engineering recommendations.

6.5 Post Study Value Engineering during Workshop

The Value Engineering process in this project was assessed on its implemented recommendations during the construction phase. The findings for this case study are discussed in Section 6.6. The Value Engineering team involved in carrying out the analysis comprised of architectural / landscaping, structural, mechanical, plumbing and electrical professionals. Costing was undertaken by the client quantity surveyors. The main objective of the team was to address the following:

- Initial cost savings
- Life cycle cost savings
- Constructability
- Construction time / project schedule
- Improve project quality
- Satisfy end-user requirements
- Satisfy user requirements
- Satisfy code requirements
- Implementation of design
- Sustainable design
- Design to suite site condition
- Meet cultural requirements
- Match existing scheme
- Utilise local resource and materials

- Optimise logistics to project
- Minimise contractor risk
- Revisit preliminaries requirements
- Revisit ADNOC approval process
- Revisit engineering systems
- Revisit architectural systems
- Revisit spare materials requirements
- Revisit ADNOC procurement process / long lead items

The total potential life cycle cost savings associated with Value Engineering proposals were developed by the Value Engineering team, where appropriate, after establishing the life cycle costing data required for full development. The total net potential savings, after subtracting some value added cost items, was calculated. No mark-up factor was applied to cover the contingencies and escalation during construction as per available cost estimate.

Table 6.1 presents the summary of ideas from the outcome of Value Engineering and Table 6.2 presents the summary of ideas recommend and includes initial savings cost and life cycle cost savings covering site ideas, housing proposals, architectural, civil / structural, electrical and mechanical disciplines.

Table 6.1 Summary of Ideas from outcome of Value Engineering for Case Study 1

Sr.No.	No. of Ideas	Description	Rank
Architectural Ideas –External Works			
1	AS1	Re-arranging building locations	4
2	AS2	Optimise landscaping	10
3	AS3	Optimise building orientation for solar efficiency	2
4	AS4	Optimise or minimise shading areas	9
5	AS5	Optimise parking spaces to 2.75 x 5.0 m in lieu of 2.75 x 5.5 m	10
6	AS6	Change car parking shading from tented fabric to PVC	8
7	AS7	Decrease number of building by increasing floors	1
8	AS8	Optimise number of basketball, volley ball fields and tennis courts on site	2

Table 6.1 Summary of Ideas from outcome of Value Engineering for Case Study 1 (Cont'd)…

Sr.No.	No. of Ideas	Description	Rank
9	AS9	Minimise bollards and floor light	9
10	AS10	Optimise number of children playgrounds	8
11	AS11	Reduce number of palm trees to 1.50 m from 2.30 m	8
12	AS12	Optimise number of pergolas and shaded areas	8
13	AS13	Use interlock tile lieu of clay tile finish for pergolas roads	8
14	CS1	Re-arrangement of walkways	8
15	CS2	Eliminate middle islands in the parking lots	5
16	CS3	Reduce road width to 7.2 m in lieu of 7.5 m	8
17	CS4	Delete kerbstone painting except for main roads	10
18	CS5	Change internal roads pavement to interlock pavement	10
19	CS6	Eliminate longitudinal parking spaces	2
20	CS7	Eliminate concrete pebbles walkways and replace interlock tiles	8
21	CS8	Eliminate road painting in parking areas	See CS9
22	CS9	Use different colours of interlock for marking	8
23	CS10	Delete interlock tiles walkway around the building except front side	4
24	CS11	Delete stone boulders	8
25	ES1	External lighting	10
26	MS1	Optimise number of chiller yards on site	8
27	MS2	Locate the chillers on top of roof	0
28	MS3	Minimise number of manholes	8
29	MS4	Use fibre glass manholes in service roads	6
30	MS5	Delete irrigation control room and integrate with existing RHD control systems	4
31	MS6	Re-routing of site utilities	6
32	CM1	Optimise number of service blocks	9

Table 6.1 Summary of Ideas from outcome of Value Engineering for Case Study 1 (Cont'd)…

Sr.No.	No. of Ideas	Description	Rank
Architectural Work Ideas			
33	A1	Simplify external features	See A2
34	A2	Eliminate the GRC from building elevation	4
35	A3	Change ceramic tiles from international to local manufacturers tiles	10
36	A4	Use steel handrails for balconies in-lieu of GRC	7
37	A5	Reduce the height of aluminium windows	8
38	A6	Change washbasin closets from international to local manufactures	10
39	A7	Redesign of roofing system	9
40	A8	Use two (2) steel pipes handrails in-lieu of three (3) pipes handrails	4
41	A9	Eliminate the bathtub except in master bathroom	10
42	A10	Change door specification	10
43	A11	Eliminate paper dispenser and soap dispenser	10
44	A12	Eliminate foldable sliding doors between dining and living room	9
45	A13	Change door in living room from double to single	8
46	A14	Change the hardware from stainless steel to aluminium	10
47	A15	Change solid entrance door to fire rated veneered	9
48	A16	Change garbage and electrical door to aluminium	10
49	A17	Reduce glass in main entrance	8
50	A18	Reduce glass in terrace sides	5
51	A19	Change internal bedroom cupboards from wood to aluminium door	5
52	A20	Change all service rooms doors from wood to hollow metal doors	9
53	A21	Reduce parapet height to 1.2 m	8
54	A22	Replace decorative ceramic border in bathroom with ceramic tiles	10
55	A23	Use gypsum tiles in lieu of gypsum board for corridor false ceiling	8
56	A24	Delete mirror shelves	10
57	A25	Use 30 cm CMU in lieu of 40 cm CMU exterior wall	4

Table 6.1 Summary of Ideas from outcome of Value Engineering for Case Study 1 (Cont'd)…

Sr.No.	No. of Ideas	Description	Rank
58	A26	Follow AIA for functional space requirements	0
59	A27	Use ceramic bathroom accessories in lieu of stainless steel	10
60	A28	Provide 1.8 m height access panels for utility shafts	8
61	A29	Use one garbage container in lieu of two (2) in ground floor	2
62	A30	Change internal wooden doors to hollow core in lieu of solid core door	2
63	A31	Rationalise external window size for corridors	4
64	A32	Reduce number of windows in the corridors	4
65	A33	Change porcelain floor tiles to ceramic as appropriate	10
66	A34	Revisit all internal finishes (tiles, ceramic, etc.)	10
67	A35	Use 4 mm plywood in lieu of MDF for interior doors	See A30
68	A36	Revisit lifts specifications / finishes	8
69	A37	Use insulated fluted blocks instead of solid concrete blocks	5
70	A38	Revisit the painting specifications	4
71	A39	Second floor lobby to match third floor	8
72	A40	Revisit the all the fittings and fixtures of doors and windows for less expensive	6
73	A41	Relocate bathroom next to external walls	2
74	A42	Enhance screen around buildings	7
75	A43	Use tented glazing	7
76	A44	Use 15cm CMU for interior partitions	6
77	A45	Use local bathroom fixtures in lieu of European fixtures	10
78	A46	Use dogleg type stairs in lieu of open stairs	2
79	A47	Revisit the design of service corridor to reduce A/C temperature to $27^{o}c$	8
80	A48	Use PVC window sections in lieu of aluminium	2
81	A49	Delete vanity counter for wash basins of category "B"	5
82	A50	Windows to open outward from top side instead of downside	2

Table 6.1 Summary of Ideas from outcome of Value Engineering for Case Study 1 (Cont'd)…

Sr.No.	No. of Ideas	Description	Rank
83	A51	Resize aluminium windows	8
84	A53	Remove from OTS	8
85	A54	Reduce height of ceramic tiles in garbage room	8
Mechanical Work Ideas			
86	M1	Revise zoning of air conditioning to reduce number of fan coil units	10
87	M2	Replace hard duct by flexible duct for branches	10
88	M3	Reduce number of electric water heaters by re-zoning	10
89	M4	Revisit alternative piping materials	9
90	M5	Utilise OTS to connect ground floor drainage	8
91	M6	Rationalise external manholes	9
92	M7	Use centralised exhaust system instead of window fans	8
93	M8	Use mild steel instead of stainless steel for fire hose cabinets body	10
94	M9	Use ABS floor drain body and cover instead of cast iron body and SS cover	7
95	M10	Revisit the drainage system routing internally and externally	4
96	M11	Use ERW pipes in lieu of seem less pipes	8
97	M12	Eliminate bathroom window and fix exhaust fans into wall	10
98	M13	Remove floor drains in bathroom with recessed showers basin	10
99	M14	Delete shower drain in the maid bathroom in F5 building	10
100	M15	Provide access panels and catwalks for shaft	7
101	M16	Replace bathtub with recessed shower	10
102	M17	Eliminate hand shower with recessed fixed shower head	2
103	M18	Remove cover from OTS shaft	0
104	M19	Delete AHU room in the roof level and provide room for controls	10
105	M20	Mechanical chiller HVAC, reduce the capacity of the chiller will reduce the size of the cable / transformers	8
106	M21	Use two (2) water heaters system for hot water	7
Electrical Work Ideas			
107	E1	Delete five (5) amp flexible outlet in kitchen	10
108	E2	Reduce one 4x18 w compact fluorescent in master bedroom	10

Table 6.1 Summary of Ideas from outcome of Value Engineering for Case Study 1 (Cont'd)…

Sr.No.	No. of Ideas	Description	Rank
109	E3	Reduce lift outlet in the shaft	5
110	E4	Reduce size of telephone room on roof	9
111	E5	Delete top roof lighting (flood lights)	6
112	E6	Reduce corridor lighting up to seven in each floor	8
113	E7	Reduce main entrance building light	8
114	E8	Reduce number of earth pits for lighting system	7
115	E9	Introduce central solar water heater system	See M21
116	E10	Revisit external light of the building	6
117	E11	Delete lighting for planter (halogen)	9
118	E12	Delete shaving sockets in bathrooms (to be studied with mirror light)	7
119	E13	Reduce 45 amp cooker sockets with 15 amp in the kitchen	9
120	E14	Reduce number of lights in the corridor	See E6
121	E15	Use digital PLC energy meter (to match RHD existing system)	10
122	E16	Use digital PLC water system	0
123	E17	Change and reduce number of landscape lighting to lighting pollard 3m decorative	9
124	E18	Use nominal wire to emergency light instead of fire resistant wire	8
125	E19	Increase transformer capacity from 1500 KVA to 2000 KVA to suit connected load	See M20
126	E20	Delete associated sockets of deleted FCU	8
127	E21	Delete double pole switches associated with water heaters deleted	9
128	E22	Delete electrical installation associated with deleted chillers	10
129	E23	Delete one transformer	9
Structural Work Ideas			
130	S1	All suspended slabs to change to an alternative pre-cast system	8
131	S2	Use isolated footing in lieu of raft foundation	8
132	S3	Use 5 cm blind concrete in lieu of 10 cm underneath of raft foundation	9
133	S4	Replace GGBS concrete by cement except for foundation	10
134	S5	Reduce concrete curing time from 7 days to 3 days and use curing compound after 3 days	10
135	S6	Remove corrosion inhibitor from concrete	10

Table 6.1 Summary of Ideas from outcome of Value Engineering for Case Study 1 (Cont'd)…

Sr.No.	No. of Ideas	Description	Rank
136	S7	Use protect and eliminate waterproofing of foundation	2
137	S8	Use one layer of 4 mm waterproofing membrane on roof in lieu of 2 layers (coordinate with roofing system)	10
138	S9	Reduce the design life of buildings from 50 to 35 years	0
139	S10	Delete polythene sheet 1000 gauge from roof waterproofing	10
140	S11	Minimise reinforcement of beams and columns as per design requirements	1
141	S12	Eliminate 5 cm blind below slab on grade	8
142	S13	Reduce floor to floor height to 3.2 m in lieu of 3.4 m	2
143	S14	Optimise number of columns and tie beams at the end bay of chiller yard	2
144	S15	Utilise flooring system	See S1
145	S16	Revisit expansion joints covering details	10
146	S17	Eliminate steel hooks from bottom reinforcement of slabs	2
147	S18	Use tapered roof insulation instead of foam concrete	5
148	S19	Utilise excavated material for backfill as appropriate	Done
Preliminaries Ideas			
149	G1	ADNOC / RHD to provide contractor's camp and office facilities	8
150	G2	Locate Contractor camp closer to site to reduce logistics	8

Case Study I

Table 6.2 Summary of Recommendations for Initial Cost Savings and Life Cycle Cost

Sr. No.	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
Architectural – External Work Ideas				
1	AS2	Optimise landscaping	325,600.00	564,593.00
2	AS4	Optimise or minimise shading areas	1,207,620.00	Nil
3	AS6	Change car parking shading from tented fabric to PVC	2,308,790.00	Nil
4	AS10	Optimise the number of children playgrounds	119,094.00	Nil
5	AS11	Reduce number of palm trees to 1.50 m from 2.30 m	245,200.00	299,965.00
6	AS12	Optimise number of pergolas and shaded areas	Included inAS4	Nil
7	AS13	Use interlock block in lieu of clay tile finish for pergolas roads	107,952.00	Nil
Structural – External Work Ideas				
8	CS1	Re-arrange walkways	1,440.00	Nil
9	CS4	Delete kerbstone painting except for main roads	14,000.00	Nil
10	CS5	Change internal roads pavement to interlock pavement	100,000.00	Nil
11	CS7	Eliminate concrete pebbles walkways and replace with interlock tiles	323,570.00	Nil
12	CS9	Use different colours of interlock for marking	17,600.00	Nil
13	CS11	Delete stone boulders	728,752.00	Nil
14	CM1	Optimise service block	1,307,838.00	799,971.00
		Sub-total External Work Ideas	**6,807,456.00**	**1,664,529.00**
Architectural Works Ideas				
15	A2	Eliminate GRC from building elevation	195,300.00	Nil
16	A3	Change ceramic tiles from international to local manufactures tiles	1,601,205.00	Nil
17	A4	Use steel handrails for balconies in lieu of GRC	494,700.00	Nil
18	A5	Reduce the height of the aluminium works	669,577.00	409,563.00

Case Study I

Table 6.2 Summary of Recommendations for Initial Cost Savings and Life Cycle Cost (Cont'd)…

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
19	A6	Change Washbasin closets from international to local manufactures	45,510.00	Nil
20	A9	Eliminate the bathtub except in master bathroom	450,684.00	Nil
21	A11	Eliminate paper dispenser and soap dispenser	372,792.00	Nil
22	A12	Eliminate foldable sliding doors between dining and living room	2,312,874.00	Nil
23	A13	Change door on living room from double to single	382,968.00	Nil
24	A15	Change solid entrance door to fire rated veneered	431,904.00	Nil
25	A20	Change all service room doors from wood to hollow metal doors	244,800.00	Nil
26	A21	Reduce parapet height to 1.2 m	683,424.00	Nil
27	A22	Replace decorative ceramic border in bathroom with ceramic tiles	229,086.00	Nil
28	A23	Use gypsum tiles in lieu of gypsum board for corridor false ceiling	86,544.00	Nil
29	A24	Delete mirror shelves	65,772.00	Nil
30	A27	Use ceramic bathroom accessories in lieu of stainless steel	23,616.00	Nil
31	A28	Provide 1.8 m height access panels for utility shafts - Extra	(230,842.00)	Nil
32	A31	Rationalise external window size for corridor	331,343.00	Nil
33	A36	Revisit lifts specifications / finishes	1,069,200.00	Nil
34	A39	Second floor lobby to match third floor	119,644.00	Nil
35	A45	Use local bathroom fixtures in lieu of European fixtures	Included in A3	Nil
36	A47	Revisit the design of service of corridor to reduce A/C temperature to 27^{o}c	See Mech.	Nil
37	A51	Resize aluminium windows	211,536.00	119,071.00
38	A53	Remove from OTS	121,500.00	Nil
39	A54	Reduce height of ceramic tiles in garbage room	66,700.00	Nil
Sub-total Architectural Works - Ideas			**9,979,837.00**	**528,634.00**

Case Study I

Table 6.2 Summary of Recommendations for Initial Cost Savings and Life Cycle Cost (Cont'd)…

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
Structural / Civil Works Ideas				
40	S1	All suspended slabs to change to an alternative pre-cast system- Extra	(-429,836.00)	Nil
41	S2	Use isolated footing in lieu of raft foundation	3,266,512.00	Nil
42	S3	Use 5 cm blinding concrete in lieu of 10 cm underneath of the raft foundation	517,446.00	Nil
43	S4	Replace GGBS concrete by cement except for foundation	1,251,250.00	Nil
44	S8	Use one layer 4 mm waterproofing membrane on roof in lieu of 2 layers	370,707.00	Nil
45	S10	Delete polyethylene sheet 1000 mm gauge from roof waterproofing	46,900.00	Nil
46	S12	Eliminate 5 cm blind concrete below slab on grade	354,042.00	Nil
47	S16	Revisit expansion joints covering details	43,920.00	Nil
Sub-total Structural / Civil Works - Ideas			**5,420,941.00**	**NIL**
Mechanical Work Ideas				
48	M1	Revise zoning of air conditioning to reduce number of fan coil units	350,726.00	Nil
49	M3	Reduce number of electric water heaters by re-zoning	236,640.00	Nil
50	M4	Revisit alternate piping materials	141,120.00	Nil
51	M5	Utilise OTS to connect ground floor drainage	278,980.00	Nil
52	M8	Use mild steel instead of stainless steel for fire hose cabinets body	243,000.00	Nil
53	M11	Use ERW pipes in lieu of seem less pipes	139,903.00	Nil
54	M20	Mechanical chiller HVAC, reduce the capacity of the chiller will reduce the size of the cable / transformers	4,660,923.00	Nil
Sub-total Mechanical Works ideas			**6,051,292.00**	**NIL**

Case Study I

Table 6.2 Summary of Recommendations for Initial Cost Savings and Life Cycle Cost (Cont'd)…

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
Electrical Work Ideas				
55	E1	Delete five (5) amp flexible outer in kitchen	77,760.00	96,786.00
56	E2	Reduce one 4x18 w compact fluorescent in master bedroom	420,552.00	102,896.00
57	E4	Reduce size of telephone room on roof	61,281.00	22,490.00
58	E6	Reduce corridor lighting up to seven in each floor	214,200.00	52,408.00
59	E7	Reduce main entrance building light	29,592.00	7,240.00
60	E10	Revisit external light of the building	70,144.00	38,249.00
61	E11	Delete lighting for planter (halogen)	46,500.00	57,877.00
62	E12	Delete shaving sockets in bathroom (to be studied with minor light)	106,920.00	26,160.00
63	E13	Replace 45 amp cooker sockets with 15 amp in the kitchen	63,180.00	38,646.00
64	E15	Use digital PLC energy meter (to match RHD existing system)-Extra	(729,000.00)	Nil
65	E17	Change and reduce number of landscape lighting to lighting pollard 3m decorative	425,625.00	529,763.00
66	E20	Delete associated sockets of deleted FCU	53,550.00	13,102.00
67	E21	Delete double pole switches associated with water heaters deleted	195,840.00	47,916.00
68	E22	Delete electrical installation associated with deleted chillers	646,300.00	883,495.00
69	E23	Delete one transformer	500,000.00	683,502.00
Sub-total Electrical Work Ideas			**2,182,444.00**	**2,600,531.00**
Total Value Engineering Potential Savings			**30,441,970.00**	**4,793,694.00**

6.6 Summary of Value Engineering Outcomes from Case Study 1

The Value Engineering data was extracted by the author for the Case Study 1 of the project entitled "Ruwais Housing Expansion – Phase III, Married Staff Accommodation and related facilities including Infrastructure", Western region, Abu Dhabi, United Arab Emirates.

Based on Value Engineering analysis, it concluded that a total potential Value Engineering savings in the initial cost was UAE Dirhams 30.44 million and life cycle cost savings was UAE Dirhams 4.79 million. The findings are summarised in Table 6.3.

Table 6.3 Summary of workshop results of Case Study 1

Description	Result
▪ Total No. of Ideas	150
▪ Ideas related to cost saving / performance	120
▪ Ideas related to performance improvement only	30
▪ Potential initial cost saving – UAE Dirhams	30,441,970.00
▪ Life cycle costing – UAE Dirhams	4,793,694.00
▪ Total initial and life cycle cost savings – UAE Dirhams	35,235,664.00

The outcome of the Value Engineering summary study was considered to be a success with a value of UAE Dirhams 30.44 million (US Dollars 8.27 million) a cost savings of 7% to the award value of the construction cost of UAE Dirhams 427.76 million (US Dollars 116.24 million). This was achieved without reducing the function or scope of works, however, the project was delayed for more than six (6) months due to the contractor's poor management. Life cycle cost analysis was performed to applicable elements, taking into consideration of the impact of energy costs, the replacement costs and impact on operations and maintenance, produced a UAE Dirhams 4.79 million (US Dollars 1.30 million) savings.

The savings were achieved on the basis of ideas from the disciplines of architectural, structural, electrical, mechanical and general, which are in Table 6.1.

The extensive details of the variations for the case studies are given in appendixes to this chapter for clarity (Refer to the note at the beginning of the appendix for the table numbering system used).

Initial cost savings and life cycle cost savings shown in Table 6.4 and Figure 6.6 is based on the cost estimate prior to the Value Engineering exercise.

Table 6.4 Summary of Value Engineering Outcome

Description	Construction Cost UAE Dirhams	Initial Cost Saving UAE Dirhams	Life Cycle Cost Savings UAE Dirhams
Cost	427,760,000.00	30,441,970.00	4,793,694.00
Percentage	92%	7%	1%

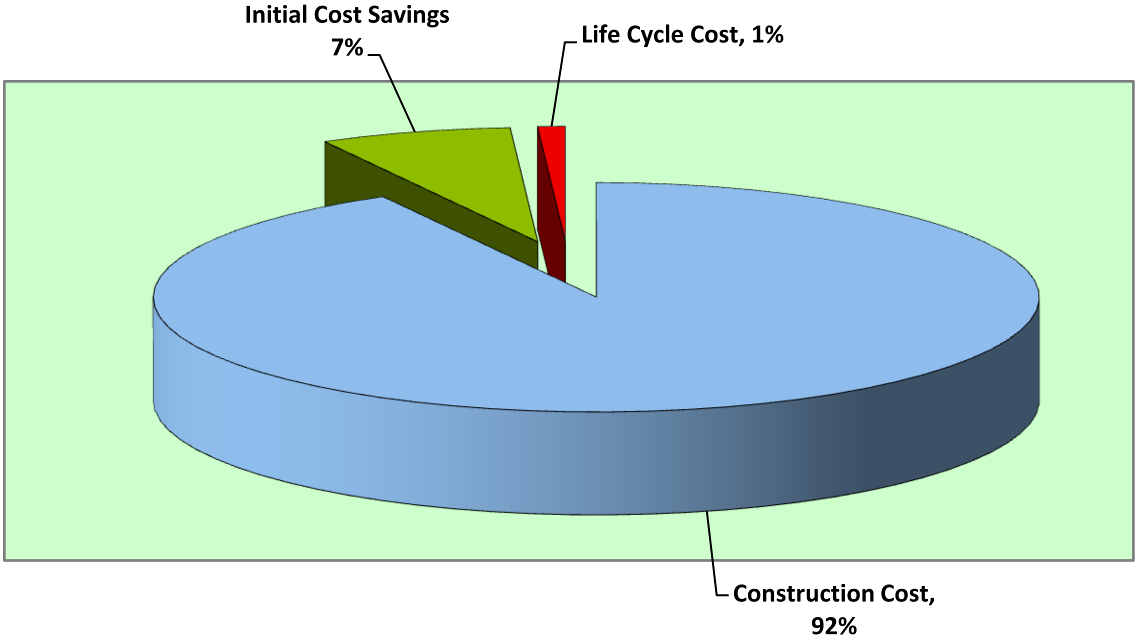


Figure 6.6 Value Engineering Summaries of the Predicted Potential Savings

Variations during Construction

Table 6.5, below is a summary of the variations relating to Case Study 1. For a summary of variations for Case Study 1, refer to Appendix “A” at the end.

Table 6.5 Summary of Variations in Case Study 1

Description	Amount UAE Dirhams
Original Agreement Price	427,670,000.00
Variation Savings (Refer Appendix)	(15, 237,490.09)
Percentage of Variations to Original Agreement Price	3.56%

For Case Study 1, the Value Engineering workshop was conducted during the detailed design of the project. End-user presence was not available during the Value Engineering workshop, and variations were raised during the construction stage because the recommended ideas generated by the Value Engineering process were too late to be incorporated in the final design. However, the timing of the Value Engineering influenced the performance of the project. The variations were required to enhance the quality and performance of the construction including the functionality of the project. However, the project duration had to be extended due to delays by the contractor.

Variations arose during the construction, from both changes resulting from the Value Engineering recommendations, design improvement, and end-user requirements, were resulted in a final net saving of 3.56% of the award value of the project, shown in Table 6.5.

6.6.1 Review of issues arising from Case Study 1

6.6.1.1 The Structure and Method of the Value Engineering Process

The Value Engineering workshop was carried out in forty (40) hours for a period of five (5) days implementing the following five (5) phases of Value Engineering:

- Information Phase
- Speculation Phase
- Evaluation (Analysis) Phase
- Development Phase
- Presentation Phase

In this Case Study 1, the Value Engineering study was conducted near the end of the detailed design stage by an external Value Engineering Facilitator. Due to the workshop being conducted at end of the detailed design stage, many opportunities for improvement were lost. There was a reluctance to propose significant changes to the design proposals and if fundamental changes arose, they were rejected due to the effect of major re-design on cost and time constraints. Thus, the changes that were finally proposed and accepted were those that could be included in the design without delaying the start of the project. Failure to commence construction at the time designated would have been unacceptable to the client due to the shortage of accommodation. The actual workshop was conducted in accordance with the recommendations of the SAVE international guidelines.

6.6.1.2 Timing and execution of the Value Engineering and workshop studies.

The tendering process to select a contractor was underway while the Value Engineering workshop was being conducted. The tender was based on the Pre-Value Engineering project cost estimate. Consequently, there was an urgency to commence and complete the project due to the clients need for the building to provide additional accommodation. The implementation of the recommended ideas by the Value Engineering team was limited to certain items requiring minimal modifications being carried out by the contractor during construction. It is to be noted that the timing of Value Engineering for this Case Study 1 was not conducted during the preliminary design stages suggested by Kelly et al. (2006), and even later than at the 55% - 60% of the preliminary design stage proposed by Seely (1996). The lateness in conducting Value Engineering contributed to a loss of potential benefits, as it required significant redesign and revisions to construction that may have provided additional savings.

6.6.1.3 Composition of the workshop team

In this Case study, the Value Engineering workshop was conducted by an external Value Engineering facilitator with an in-house multidisciplinary team of experienced professionals including civil engineers, structural engineers, electrical engineers, mechanical engineers, a quantity surveyor from the owner and the design consultant. The pre-workshop introduction meeting was conducted by Value Engineering co-ordinator to ensure all Value Engineering members understood the process of the workshop. The designer presented the scope of the project and different opinions were discussed. All Value Engineering team ideas were also recorded in order to evaluate a ranking used as a basis to prioritise the ideas. The basic costing of the construction alternatives was done by the client's quantity surveying department based on information supplied by the workshop team. This was done due to the commercial sensitivity of the costing data required.

6.6.1.4 Understanding of the Value Engineering process

Prior to start of Value Engineering workshop, the external Value Engineering specialist gave an introduction on the importance of Value Engineering and its benefits in order to explain the Value Engineering process in the design stage and also how this impacts on construction in terms of life cycle costing, reliability, operability environmental factors as recommended by Zimmerman and Hart (1982). The process of this Case Study 1 was carried out by Value Engineering Specialist as "Team Leader" who guided the Value Engineering team during each stage of the 40 hours workshop. All the team had a familiarity with Value Engineering, hence, the introduction by the external Value Engineering specialists was primarily to direct and focus the team on the procedure and outcomes.

Due to the late timing of the workshop (see 6.6.1.2 above), and the constraints imposed by the client, the range of alternatives available to the team were constrained. Hence, a degree of re-orientation was required. The workshop was not scheduled at the appropriate time by the project management team.

6.6.1.5 Value Engineering during the construction phase

At the time of the Value Engineering workshop, the project was at the tender stage. Therefore, in this Case Study-1, contractor's participation was not available, and no specialist construction advisor was on the team. The main Value Engineering recommendations were not incorporated during the design stage, but were issued, and then executed by the contractor during the construction stage. In spite of the Value Engineering recommendations, many further variations were encountered during the process of construction stages. In this project, no Value Engineering was conducted during the construction stage and it was further noted that the Value Engineering workshop recommendations were not audited and monitored during the construction stage. There were many additional variations encountered due to non involvement of the end-user during the design stage. The end-user was within the client organisation, however, the execution of design and construction was done by a separate department. As a direct consequence of the lack of early involvement by the end-user many additional variations arose during construction.

6.6.1.6 Performance measurement based on costs

In this Case Study, the performance of value Engineering measureable planned (SAVE Model) for the following:-

- Savings in construction cost
- Lower life cycle costs
- Improved operational performance
- Reduced maintenance costs
- Identification of risks and mitigation strategies

The cost information which was used as a basis for assessing 'value' was on a predicted cost estimate supplied to the Value Engineering workshop team. This was provided by the project consultant, based on an agreed project brief and preliminary design, which is normal practice in the United Arab Emirates.

Based on the Value Engineering workshop conducted to this Case Study 1, this predicted an outcome of a cost saving of 7% (of the initial predicted cost) and 1% on life cycle costing. Due to the limitations and timing of the Value Engineering process in this case study, it is not unreasonable to suppose that a higher percentage saving could have been predicted if the workshop team had been in a position to consider a wider range of design options.

There was no auditing of the Value Engineering aspects of the contract during the construction phase, consequently the pre-contract Value Engineering a predicted savings were assumed to have occurred.

However, the predicted saving remained in the range of 5% to 10% as identified in Chapter 3 Section 3.5.6. The cost of implementing the variations resulting from the modifications adopted on the Value Engineering recommendations and subsequent change required by the end-user, resulted in a reduction of the projected saving from 8% to a final 3.56% of the initial predicted cost of the project during construction due to variations.

6.6.1.7 The effect of environment and culture on Value Engineering

In this Case Study 1, the Value Engineering workshop evaluation indicates that the importance of environmental factors and culture was taken into consideration when Value Engineering workshop was conducted. This Case study 1 was conducted by external Value Engineering specialist who was familiar with the culture and environment of the United Arab Emirates. The workshop team selected were also familiar with the environment and culture, and had experience of working in the United Arab Emirates.

As a consequence there was no evidence of unplanned influence on the Value Engineering process on the team itself, in this case from an environmental perspective or in cultural aspects arising from the multi cultural make up of the team. The major influence was an external one from the client organisation.

The client organisation imposed conditions which the team had to adhere to namely:

- Maximum cost savings had to be achieved and there was no qualification of the requirement in terms of performance or function.

- It was required to start the construction immediately without delay due to urgent requirement for accommodation.

Also, the selected contractor was obligated to revise the planned construction operations to encompass the substantial variations resulting from the Value Engineering recommendations.

The final completion of the project was delayed by six months due to contractor's management deficiencies.

CASE STUDY No. 2

ADNOC GROUP COMPANIES HEADQUARTERS

6.7 Case Study 2

6.7.1 Project Description

The project of ADNOC Group of Companies Headquarters – Phase I and II, is located at a prime location on the 'Corniche' in the city of Abu Dhabi, United Arab Emirates. The project comprises of four (4) commercial towers with nine (9) levels of car parking including external works and services. This project has two (2) office towers of twenty (20) storeys in the middle, and two (2) twenty five (25) storey commercial towers at each end. The total built-up area for the four (4) towers is 129,329 square meters and for car parking is 77,022 square meters for 1500 spaces. The elevation of the four (4) ADNOC Group of companies towers are shown in Figure 6.7.

Figure 6.7 Typical elevation of ADNOC Group of Companies Headquarters

The project was designed for two (2) separate phases. The middle two (2) towers were awarded to a Japanese based international design consultant for the value of UAE Dirhams 21.85 million (US Dollars 5.94 million) with a design period of sixteen (16) months. The end two (2) towers were awarded to a UK based design consultant for a value of UAE Dirhams 7.46 million (US Dollars 2.03 million) with a design period of thirteen (13) months. Therefore, the total design award value was UAE Dirhams 29.31 million (US Dollars 7.96 million).

Upon completion of the design, the project was awarded for construction in two (2) phases by two (2) separate international contractors. The construction of the middle two (2) towers of twenty (20) storey buildings was awarded to international joint venture of German and UK based companies for the award value of UAE Dirhams 280.66 million (US Dollars 76.27 millions) and a construction duration of twenty eight (28) months. Upon completion of the middle two (2) towers, the construction of both end two (2) towers of twenty five (25) storeys buildings was awarded to a Joint Venture of South African and UAE based companies for the award value of UAE Dirhams of 252.88 million (US Dollars 68.72 million) and a project duration of forty seven (47) months. The total construction cost is UAE Dirhams 533.54 million (US Dollars 144.98 million).

6.7.2 Value Engineering Analysis for Case Study 2

The Value Engineering analysis described below was conducted for each of the two phases for this case study.

The Value Engineering team on this project conducted a five (5) day workshop following SAVE international job plan. The workshop was conducted in Abu Dhabi and its agenda was the similar to that for Case Study 1 (see Section 6.2.2).

The following schedule of activities was implemented during Value Engineering session:

Task	Schedule
Value Engineering study workshop	4 days
Develop Value Engineering recommendations	1/2 day
Review of Value Engineering recommendations	1/2 day
Final Value Engineering report (includes client's comments)	1 day
Value Engineering implementation	Throughout design and construction

The following design criteria were considered during the Value Engineering session for the Project:-

- Respect of the general planning spirit of surrounding housing facilities.
- Highest utilisation of existing services and utilities as appropriate.
- Meet design codes and housing standard requirements with respect to space utilisation, efficiency and functional requirements.
- Safety environmental and safety requirements.
- Meet safety and security requirements.

6.8 Value Engineering Workshop Methodology

Value Engineering 40 hour workshop was adopted, based on the SAVE International Methodology implemented same as Case Study 1.

The ideas generated during evaluation phase are presented in Table 6.6 for Phase I and Table 6.7 for Phase II. The recommended ideas are presented in Table 6.8 for Phase I and Table 6.9 for Phase II.

Case Study 2

ADNOC Group of Companies Headquarters – Phase I

Table 6.6 Summary of Ideas as an outcome of Value Engineering for Case Study 2

Sr.No	Idea No.	Description	Rank
Architectural External Work Ideas			
		Site Architectural Items	
1	SA1	Reduce the height of the perimeter fence wall	7
2	SA2	Delete entrance guard house and related facilities	9
3	SA3	Minimise the landscaping and revise the hard landscaping layout	10
4	SA4	Reduce the external light fixtures and down light from roof	9
5	SA5	Delete the asphalt road and replace with 80 mm thick interlock paving tiles for internal roads	8
Architectural External Work Ideas			
6	A1	Revise the lobby pool layout and reduce the sizes	8
7	A2	Reduce the thickness of gypsum board wall partitions	9
8	A3	Change the suspended ceiling tiles types and systems	9
9	A4	Add stone features to the elevator lobby	8
10	A5	Omit attendance fees for system and loose furniture	9
Mechanical Work Ideas			
11	M1	Delete 1 No. of chiller Unit	10
12	M2	Delete standby generator and control	9
13	M3	Delete auditorium sound system	7
14	M4	Delete open office sound masking system	8
15	M5	Change the sizes and manufacture for duct and pipe insulation	7
Electrical Work Ideas			
16	E1	Revision to electrical switch board	10
17	E2	Revise the cable route and resize the cables to main distribution board	9
18	E3	Change of light fixtures model and manufacture	7
19	E4	Reduce the capacity of transformers and LV panels	8

Case Study 2

ADNOC Group of Companies Headquarters – Phase I

Table 6.6 Summary of Ideas as an outcome of Value Engineering for Case Study 2 (Cont'd)…

Sr.No	Idea No.	Description	Rank
Structural Works Ideas			
20	S1	Change all ladders, railing canopies and supports from stainless steel to aluminium	9
21	S2	Change the building maintenance system rails and supports from stainless steel to galvanised steel	10
22	S3	Change the door frame from stainless steel to galvanised steel	10
23	S4	Change the windows and curtain wall frames from stainless steel to aluminium	10
General / Preliminaries			
24	G1	Delete the ADNOC list of vendors and sub-contractors from the agreement	9
25	G2	Revise the advance payment articles of agreement	8
26	G3	Provide the storage area within the site plot	10
27	G4	Revise the payment terms of the agreement	6
28	G5	Relax the project duration and reduce the liquidated damages allowed in the tender	10
29	G6	Reduce the client's site offices layout and other facilities	9
30	G7	Change the supplier of building management system	8

Case Study 2

ADNOC Group of Companies Headquarters – Phase II

Table 6.7 Summary of Ideas as an outcome of Value Engineering for Case Study 2

Sr.No	Idea No.	Description	Rank
Architectural Work Ideas			
1	SA1	Delete fountains and replace with granite paving and landscaping	7
2	SA2	Reduce the external light fixtures	9
3	SA3	Delete the asphalt and replace with 80mm paving tiles	8
4	SA4	Revise the layout hardscaping and landscaping areas	7
Architectural Work Ideas			
5	A1	Reduce the number of wash basins in female toilets from 3 Nos. to 2 Nos.	7
6	A2	Delete paving tiles and replace with gravel on top of water proofing insulation	9
7	A3	Reduce the thickness of external stone cladding from 50mm to 30 mm	8
8	A4	Delete rendering and terrazzo tiles and replace with rendering and epoxy coated floor painting for service areas and mechanical room floors	9
9	A5	Change the metal ceiling and replace with gypsum board ceilings for all the service areas	10
10	A6	Change the type of door handles from decorative to normal type handles	8
11	A7	Change the aluminium door to metal doors to service areas and fire escape doors	10
12	A8	Change the epoxy paint to emulsion paint for the internal walls and partitions	9
13	A9	Delete the terrazzo tiles and screw and replace with cement rendering for the carpet areas	10
Mechanical Work Ideas			
14	M1	Delete chiller plant manager form the scope of works	9
15	M2	Delete 1 No. chiller from chiller yard	10
16	M3	Reduce the sizes of A/C duct to accommodate above the ceiling with other services	9
17	M4	Resize the fan coil units and reduce the number of units	10

Case Study 2

ADNOC Group of Companies Headquarters – Phase II

Table 6.7 Summary of Ideas as an outcome of Value Engineering for Case Study 2 (Cont'd)…

Sr.No	Idea No.	Description	Rank
Electrical Work Ideas			
18	E1	Change swing card readers to proximity card readers	8
19	E2	Optimise the internal light fixtures and spot lights	9
20	E3	Reduce the size of the cable from substation to main distribution board.	9
21	E4	Change the cable route from sub-station to distribution boards to optimise the length of the cables	6
Structural Work Ideas			
22	S1	Change all ladders and all supports from stainless steel to aluminium	10
23	S2	Change the entrance space frame from stainless steel to aluminium	9
24	S3	Change all stainless steel door frames from stainless steel to aluminium	10
25	S4	Change the curtain wall supports and anchors from stainless steel to galvanised steel	9
General / Preliminaries Work Ideas			
26	G1	Delete the vendors and sub-contractors from the Agreement	10
27	G2	Change the space frame supplier and optimise the size of tubes	9
28	G3	Delete the company facilities and offices and use existing facilities	10
29	G4	Minimise the project site management staff to share both the towers	7

Case Study 2

ADNOC Group of Companies Headquarters – Phase I

Table 6.8 Summary of Recommendations for Initial Cost Savings and Life Cycle Cost (Cont'd)…

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
Architectural External Work Ideas				
1	SA1	Reduce the height of perimeter wall fence	540,000.00	Nil
2	SA2	Delete the entrance guard home and related facilities	967,000.00	Nil
3	SA3	Minimise the landscaping and revise the hardscape areas	750,000.00	1,600,000.00
4	SA4	Reduce the external light fixture and down light from roof	2,100,000.00	1,350,000.00
5	SA5	Delete the asphalt roads and replace with 80 mm thick interlock paving tiles for internal roads	375,000.00	650,000.00
Sub-total Architectural / External Work Ideas			**4,732,000.00**	**3,600,000.00**
Architectural Work Ideas				
6	A1	Revise the pool lay out and reduce the size	121,000.00	Nil
7	A2	Reduce the thickness of gypsum board wall partition	186,000.00	Nil
8	A3	Change the suspended ceiling tiles types and systems	550,000.00	Nil
9	A4	Add stone features to the elevator lobby - extra	(115,000.00)	450,000.00
10	A5	Omit attendance fees for system and loose furniture	1,738,000.00	Nil
Sub-total fees for Architectural Ideas			**2,480,000.00**	**450,000.00**
Structural / Civil Work Ideas				
11	S1	Change all ladders, railings canopies and supports from stainless steel to aluminium	1,730,000.00	Nil
12	S2	Change the building maintenance system rails and supports from stainless steel to aluminium	119,000.00	Nil
13	S3	Change the door frames from stainless steel to galvanised steel	754,000.00	Nil
14	S4	Change the windows and curtain wall for stainless steel to aluminium	3,430,000.00	Nil
Sub-total Structural / Civil Works			**6,033,000.00**	**Nil**

Case Study 2

ADNOC Group of Companies Headquarters – Phase I

Table 6.8 Summary of Recommendations for Initial Cost Savings and Life Cycle Cost (Cont'd)…

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
Mechanical Work Ideas				
15	M1	Delete 1 No. of chiller unit	738,000.00	Nil
16	M2	Delete standby generator and control	222,000.00	Nil
17	M3	Delete auditorium sound system	53,000.00	Nil
18	M4	Delete open office masking system	300,000.00	Nil
19	M5	Change the sizes and manufactures for duct and pipe insulation	400,000.00	725,000.00
Sub-total Mechanical Works			**1,713,000.00**	**725,000.00**
Electrical Work Ideas				
20	E1	Revision to electrical switch board	210,000.00	475,000.00
21	E2	Revise the cables route and resize the cables to main distribution boards.	350,000.00	Nil
22	E3	Change of light fixture model and manufacture	600,000.00	Nil
23	E4	Reduce capacity of transformers and LV Panel	850,000.00	200,000.00
Sub-total Electrical Works			**2,010,000.00**	**675,000.00**
General Work Ideas				
24	G1	Delete the ADNOC list of vendors and sub-contractors from the agreement	3,000,000.00	Nil
25	G2	Revise the advance payment articles of agreement	1,572,000.00	Nil
26	G3	Provide the storage area within the site plot	1,675,000.00	Nil
27	G4	Revise the payment terms of agreement - extra	(643,000.00)	Nil
28	G5	Relax the project duration and reduce the liquidated damages allowed in the tender.	4,000,000.00	Nil
29	G6	Reduce the client's site office layouts and other facilities	180,000.00	Nil

Case Study 2

ADNOC Group of Companies Headquarters – Phase I

Table 6.8 Summary of Recommendations for Initial Cost Savings and Life Cycle Cost (Cont'd)…

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
30	G7	Change the supplier of building management system	500,000.00	Nil
Sub-total General Items Ideas			**10,284,000.00**	**Nil**
Total Value Engineering Potential Savings			**27,252,000.00**	**5,450,000.00**

Case Study 2

ADNOC Group of Companies Headquarters – Phase II

Table 6.9 Summary of Recommendations for Initial Cost Savings and Life Cycle Cost

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
Architectural External Work Ideas				
1	SA1	Delete fountains and replace with granite paving and landscaping	1,972,000.00	452,000.00
2	SA2	Reduce the external light fixtures	1,120,000.00	952,000.00
3	SA3	Delete the asphalt and replace with 80mm paving tiles	975,000.00	Nil
4	SA4	Revise the layout hardscaping and landscaping areas	893,000.00	1,200,000.00
Sub-total Architectural External Works			**2,960,000.00**	**1,604,000.00**
Architectural Work Ideas				
5	A1	Reduce the number of wash basins in female toilets from 3 Nos. to 2 Nos.	128,000.00	58,000.00
6	A2	Delete paving tiles and replace with gravel on top of the water proofing insulation	290,000.00	65,000.00
7	A3	Reduce the thickness of external stone cladding from 50mm to 30mm	1,200,000.00	1,800,000.00

Case Study 2

ADNOC Group of Companies Headquarters – Phase II

Table 6.9 Summary of Recommendations for Initial Cost Savings and Life Cycle Cost (Cont'd)…

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
8	A4	Delete rendering and terrazzo tiles and replace with rendering and epoxy coated floor painting from service areas and mechanical room floors	575,000.00	Nil
9	A5	Change the metal ceiling and replace with gypsum board ceilings for all the service areas	850,000.00	Nil
10	A6	Change the type of door handles from decorative to normal type handles	460,000.00	120,000.00
11	A7	Change the aluminium door to metal doors to service areas and fire escape doors	656,000.00	Nil
12	A8	Change the epoxy wall painting to emulsion paint for the internal walls and partitions	328,000.00	Nil
13	A9	Delete the terrazzo tiles and screw and replace with cement rendering for the carpet areas	275,000.00	Nil
Sub-total Architectural Works Ideas			**4,762,000.00**	**2,043,000.00**
Mechanical Work Ideas				
14	M1	Delete chiller plant manager form the scope of works	1,800,000.00	Nil
15	M2	Delete 1 No. chiller from chiller yard	450,000.00	Nil
16	M3	Reduce the size of A/C duct to accommodate above ceiling with other services	1,750,000.00	Nil
17	M4	Resize the fan coil units and reduce the number of units	875,000.00	425,000.00
Sub-total Mechanical Work Ideas			**4,875,000.00**	**425,000.00**
Electrical Work Ideas				
18	E1	Change swing card readers to proximity card readers	645,000.00	Nil

Case Study 2

ADNOC Group of Companies Headquarters – Phase II

Table 6.9 Summary of Recommendations for Initial Cost Savings and Life Cycle Cost (Cont'd)…

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
19	E2	Optimise the internal light fixtures and spot lights	575,000.00	750,000.00
20	E3	Reduce the size of the cable from substation to main distribution board.	300,000.00	Nil
21	E4	Change the cable route from sub-station to Distribution Boards to optimise the length of the cables	950,000.00	Nil
Sub-total Electrical Work Ideas			**2,470,000.00**	**750,000.00**
Structural Work Ideas				
22	S1	Change all ladders and all supports from stainless steel to aluminium	1,750,000.00	Nil
23	S2	Change the entrance space frame from stainless steel to aluminium	950,000.00	Nil
24	S3	Change all stainless steel door frames from stainless steel to aluminium	375,000.00	Nil
25	S4	Change the curtain wall supports and anchors from stainless steel to galvanised steel	2,500,000.00	Nil
Sub-total Structural / Civil Work Ideas			**5,575,000.00**	**Nil**
General Ideas				
26	G1	Delete the vendors and sub-contractors from agreement	1,500,000.00	Nil
27	G2	Change the space frame supplier and optimise the size of tubes	975,000.00	Nil
28	G3	Delete the company facilities and offices and use existing facilities	350,000.00	Nil
29	G4	Minimise the project site management staff to share both the towers	1,450,000.00	Nil
Sub-total General Items			**4,275,000.00**	**Nil**
Total Value Engineering Potential Savings			**20,042,000.00**	**4,822,000.00**

6.9 Summary of Value Engineering Outcome from Case Study 2

The following data was extracted by the author from the contract documentation for the project and is presented in tabular form for ease of evaluation.

<u>Phase 1</u>

Table 6.10 Summary of Workshop results for Case Study 2, Phase 1

Description	Result
Total No. of ideas	30
Ideas related to cost saving / performance	22
Ideas related to performance improvement only	8
Potential initial cost saving – UAE Dirhams	27,252,000.00
Life cycle costing – UAE Dirhams	5,450,000.00

Table 6.11: Summary of Workshop Results Analysis by discipline for Case Study 2, Phase I

Discipline	Cost Savings UAE Dirhams	Life Cycle Costing UAE Dirhams
Architectural – External works - ideas	4,732,000.00	3,600,000.00
Architecture works – ideas	2,480,000.00	4,50,000.00
Mechanical works –ideas	1,713,000.00	725,000.00
Electrical works – ideas	2,010,000.00	675,000.00
Structural works – ideas	6,033,000.00	Nil
General ideas	10,284,000.00	Nil
Total	**27,252,000.00**	**5,450,000.00**

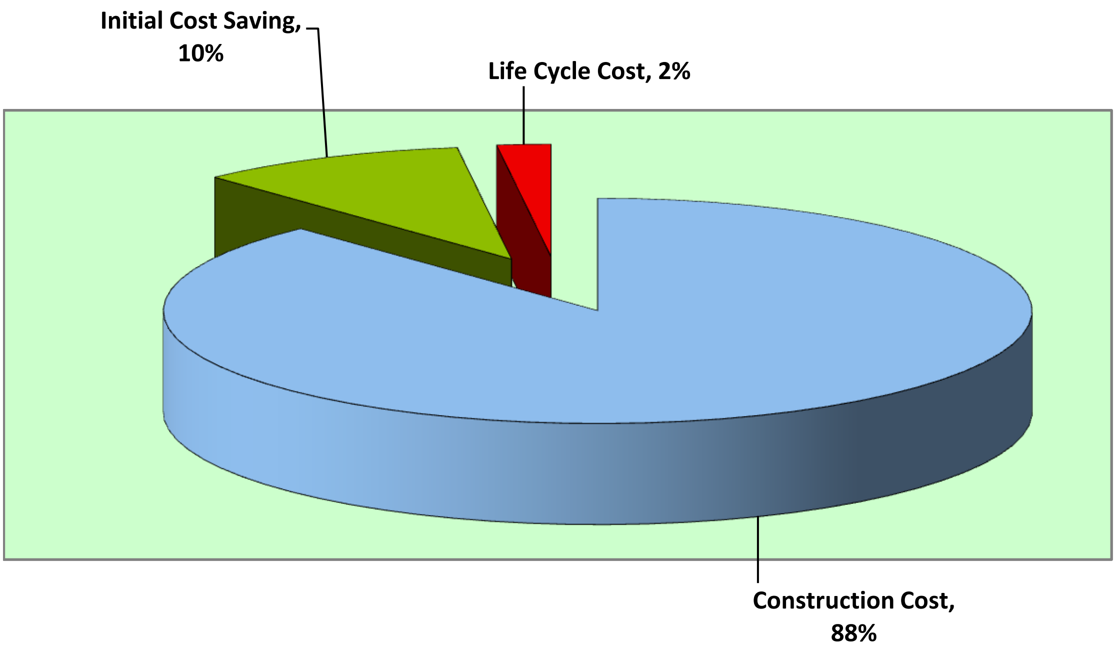


Figure 6.8 Value Engineering Predicted Potential Savings, Case Study 2, Phase 1

Table 6.12: Summary of Award Value and Potential Savings for Case Study 2, Phase I

Description	Construction Cost UAE Dirhams	Initial Cost Savings UAE Dirhams	Life Cycle Cost Savings UAE Dirhams
Cost	280,658,082.46	27,252,000.00	5,450,000.00
Percentage	88%	10%	2%

Tables 6.10 and 6.11 presents the summary of ideas recommend and includes initial predicted savings cost and life cycle cost for phase 1 covering site ideas, housing proposals, architectural, civil / structural, electrical and mechanical disciplines. Based on Value Engineering analysis, it concluded that a total Value Engineering potential savings in the initial cost savings was UAE Dirhams 27.252 million and life cycle cost savings was UAE Dirhams 5.45 million. This represents a 10% of potential savings on initial cost and a 2% potential saving on life cycle cost and overall 12% potential cost reduction on the award value in accordance with Table 6.12 and Figure 6.8.

Phase II

Table 6.13: Summary of Workshop Results Analysis by disciplines for Case Study 2, Phase II

Discipline	Cost Savings UAE Dirhams	Life Cycle Costing UAE Dirhams
Architectural – External works - ideas	2,960,000.00	1,604,000.00
Architecture works – ideas	4,762,000.00	2,043,000.00
Mechanical works –ideas	4,875,000.00	425,000.00
Electrical works – ideas	2,470,000.00	750,000.00
Structural works – ideas	5,575,000.00	Nil
General ideas	4,275,000.00	Nil
Total	**20,042,000.00**	**4,822,000.00**

Table 6.14 Summary of Workshop results for Case Study 2, Phase II

Description	Result
▪ Total No. of ideas	29
▪ Ideas related to cost saving / performance	25
▪ Ideas related to performance improvement only	4
▪ Potential initial cost saving – UAE Dirhams	20,042,000.00
▪ Life cycle costing – UAE Dirhams	4,822,000.00

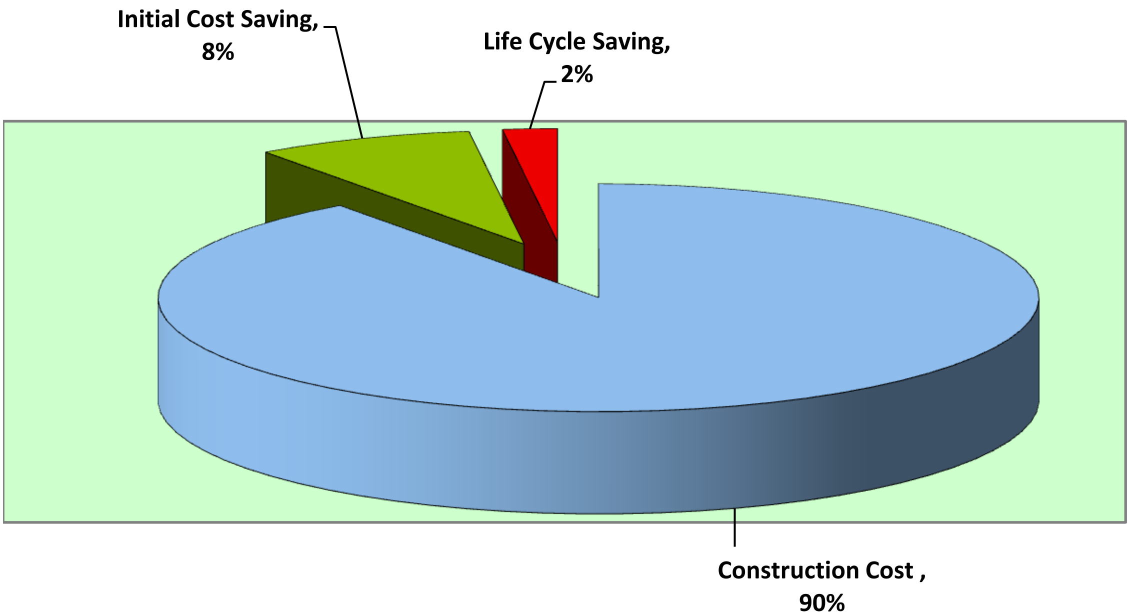


Figure 6.9 Value Engineering Predicted Potential Savings, Case Study 2, Phase II

Table 6.15: Summary of Award Value and Potential Savings for Case Study 2, Phase II

Description	Construction Cost UAE Dirhams	Initial Cost Savings UAE Dirhams	Life Cycle Cost Savings UAE Dirhams
Cost	252,880,000.00	20,042,000.00	4,822,000.00
Percentage	90%	8%	2%

Tables 6.13 and 6.14 presents proposed summary of recommendations Phase II for initial cost savings and life cycle cost. The summary of workshop results of Phase II is presented in Table 6.15 and Figure 6.9 shows that initial cost savings was UAE Dirhams 20.04 million, and life cycle cost savings was UAE Dirhams 4.82 million. This represents an 8% potential savings on initial cost and a 2% potential savings on life cycles cost and overall 10% reduction on the project award value.

Phase I and II

Table 6.16 Summary of Award Value and Potential Savings for Phase I and II

Discipline	Construction Cost UAE Dirhams	Initial Cost Savings UAE Dirhams	Life Cycle Cost Savings UAE Dirhams
Phase I	280,658,082.46	27,252,000.00	5,450,000.00
Phase II	252,880,000.00	20,042,000.00	4,822,000.00
Total Cost	**533,538,082.46**	**47, 294,000.00**	**10,272,000.00**
Percentage	**89%**	**9%**	**2%**

The outcome of Value Engineering study for Phase I and II is presented in Table 6.16 and provided an approximate net cost savings to the estimated to UAE Dirhams 47.29 million (US Dollars13.39 million). Life cycle cost analysis performed and the cost savings of UAE Dirhams 10.27 million (US Dollars 2.79 million) to applicable elements taking into consideration of the impact on energy costs, the replacements costs and impacts on operations and maintenance. This represents a 9% potential initial savings on cost and a 2% potential saving on life cycle cost giving on an overall 11% potential cost reduction on the project award value.

Case Study 2:

ADNOC Group of Companies Headquarters – Phase I and II.

The summary of variations for Case Study 2 is presented in the table below. For breakdown of variations refer to Appendix 2.

Table 6.17 Summary of variations during construction for Case Study 2

Description	Amount UAE Dirhams
Original Agreement Price – Phase I and II	533,538,082.46
Variation Savings for Phase I and II (Refer to Appendix B)	106,206,795.30
Percentage of Variations to Original Agreement Price	19.90%

Based on above, variations derived from Case Study 2, this study indicated that there was an additional cost and time impact on this project. This happened due to the non-availability of end-user presence during the Value Engineering workshop and also during late involvement in the construction stage. When the end-user was on board, many changes occurred in the facilities, requiring modifications to meet end-user requirements. As a result of late involvement, the project was delayed with attendant additional cost.

Variations arose during the construction stage resulting interior fit out changes based on the end-user requirements since the building designed for open space and design improvements were resulted in a final net increase of 19.90% is presented in the Table 6.17 of the award value of the project.

6.10 Review of issues arriving from Case Study 2

6.10.1 The Structure and Method of the Value Engineering Process

As with Case Study 1, the Value Engineering workshop was carried out in 40 hours over a period of five (5) days implementing the following five (5) phases of Value Engineering in accordance with SAVE International approach.

1. Information Phase
2. Speculation Phase
3. Evaluation (Analysis) Phase
4. Development Phase
5. Presentation Phase

In Case Study 2, the Value Engineering study was conducted during the preliminary design stage by the external Value Engineering facilitator. The recommended ideas were implemented during the finalisation of the designs. A detailed brief was provided to Value Engineering together with details of the submission of the project into Phase I and II. A separate Value Engineering process was undertaken for each of the two separate phases of the project. The structure and the process of the Value Engineering conducted in each of the two phases of this Case Study is closely based on the SAVE International Guidelines.

6.10.2 Timing and execution of the Value Engineering Workshop studies

The two Value Engineering workshops for Case Study 2 were conducted at the end of preliminary design stage for both Phase I and II of this project. The recommendations of the Value Engineering team were approved and incorporated in the project at the detailed design stage of each phase. The maximum benefits are thus theoretically possible since the Value Engineering studies were done at the recommended times, suggested by Kelly et al. (2006). It is to be noted that the timing of Value Engineering for this Case Study 2 was conducted at the 50% - 60% of the preliminary design stage as stated by Seely (1996).

6.10.3 Composition of the Workshop Team

In this Case study, Value Engineering was conducted by an external Value Engineering specialist. The Value Engineering team consisted of an in-house multidisciplinary team of experienced professionals in civil, structural, architectural, electrical, mechanical, also the owner's quantity surveyor, design consultants and end-user. The pre-workshop introduction meeting was conducted by a Value Engineering consultant to ensure all Value Engineering members understood the process of the 40 hours job plan. The designer presented the scope of the project and the different opinions of Value Engineering members were discussed. All Value Engineering team ideas were also recorded in order to evaluate a ranking to the ideas. The basic costing of the construction alternatives was done by the client's quantity surveying department based on information supplied by the workshop team. This was done due to the commercial sensitivity of the costing data required.

6.10.4 Understanding of the Value Engineering process

Prior to start of Value Engineering workshops, the external Value Engineering specialist gave an introduction as to the importance of Value Engineering and the potential benefits, in order for all the team members to understand the Value Engineering process at the design stage and, also, how it impacts on construction in terms of life cycle costing, reliability, operability environmental factors, Zimmerman and Hart (1982). The process of this Case Study 2 was carried out by the same Value Engineering Specialist as "Team Leader" who guided the Value Engineering team during each stage of 40 hours workshops for each of the two phases of the project. It was noted by the Value Engineering specialist that the Value Engineering workshop was conducted in time for Phases I and II.

6.10.5 Value Engineering during the Construction Phase

At the time of the Value Engineering workshop, the project was at the preliminary design stage. Therefore, in this Case Study 2, contractor's participation was not available, and no specialist construction advisor was appointed to the team. The Value Engineering recommendations were fully implemented during the design stage by the design consultant. In spite of Value Engineering recommendations, many variations were encountered during the construction stages. Many variations resulted from the non-involvement of the end-user during the design stage. The effect and number of these variations could have been generally reduced, since the end-user was within the client's organisation. However, the detailed design was done by a separate department. While the inclusion of this end-user in the valuation process may or may not have resulted in modified recommendations by the Value Engineering team, this could not be assessed. However, the resultant variations to accommodate the end-user (detailed in Appendix B), caused a significant increase in cost, and time extensions (see Table 6.17) to both the phases of this case study. In this project, there was no Value Engineering conducted during the construction stage and it was further noted that the recommendations of Value Engineering were not audited and monitored during the construction stage.

6.10.6 Performance measurement based on costs

In this Case Study 2, the performance of Value Engineering measureable planned (SAVE Model) for the following:-

- Savings in construction cost
- Lower life cycle costs
- Improved operational performance
- Reduced maintenance costs
- Identification of risks and mitigation strategies

The cost which was used as a basis for assessing 'value' was on a predicted cost estimate supplied to the Value Engineering workshop team. This was provided by the project consultant, based on an agreed project brief and preliminary design, which is normal practice in the United Arab Emirates.

Based on the Value Engineering workshop conducted on this Case Study 2, this predicted an outcome of an initial cost saving is 7% of the initial predicted cost and 1% on life cycle costing for Phase I and 8% of the initial predicted cost savings and 2% on life cycle savings for Phase II (see Tables 6.12 and 6.15).

This combined to give a cost savings of 9% on the initial predicted cost and 2% on life cycle costing for the total project of Phase I and II in accordance with Table 6.16.

6.10.7 The effect of Environment and Culture on Value Engineering

In this case study, both the Value Engineering workshops, (one for each tower), indicated that the importance of environmental factors and culture were taken into consideration when the workshops were being conducted. Case Study 2 was conducted by an external Value Engineering specialist who was familiar with the culture and environment of the United Arab Emirates. Also the workshop team selected was also familiar with, and had experience of working in the United Arab Emirates.

As a consequence there was no evidence of unplanned influence on the Value Engineering process team itself in this case, from an environmental perspective or cultural aspects using from the multicultural make-up of the team. The major influence was an external one from the client organisation.

The client organisation imposed conditions which the team had to adhere to namely:

- Cost savings had to be achieved without reducing the quality and performance or function.

- There were also questions about the client’s organisational culture with respect to Value Engineering. Although the end-user and designers were both from departments within the client’s organisation, end-user input into the Value Engineering process was not employed at a stage that provides maximum benefit.

CASE STUDY No. 3

RUWAIS HOUSING COMPLEX EXPANSION – PHASE III
NEW HOSPITAL AND RELATED FACILITIES INCLUDING INFRASTRUCTURE

6.11 Case Study 3

6.11.1 Project Description

The project of Ruwais Housing Complex Expansion - Phase III, new hospital and related external works and services including infrastructure works was located two hundred forty two (242) kilometres from Abu Dhabi, United Arab Emirates. The project comprised of a new hospital of fifty (50) beds with facilities with a total built-up area of 21,000 square metres and included functions of emergency units, radiology medical units, special services, physical therapy, maternity and neurology ward, laboratory and pharmacy, medical surgical ward, dental clinic and out-patient clinics.

The project was awarded to a design consultant specialist in hospital designs from Germany with the value of UAE Dirhams 5.70 million (US Dollars 1.55 million) for the period of twenty five (25) months. During the design period of twenty five (25) months in the preliminary design stages works, Value Engineering workshop was conducted to optimise the cost and to improve the design.

Upon completion of design, the project was awarded to UAE based construction contractor for the value of UAE Dirhams 373.30 million (US Dollars 101.44 million) for the duration of thirty (30) months.

6.11.2 Value Engineering Analysis

The aim of Value Engineering team on this project included a five (5) days workshop following SAVE international job plan. The workshop was conducted in Abu Dhabi and its agenda was similar to that for Case Study 2.

Value Engineering schedule for activities for implementation as follows:

Task	Schedule
Value Engineering study workshop	4 days
Develop Value Engineering recommendations	1/2 day
Review of Value Engineering recommendations	1/2 day
Final Value Engineering report (includes client's comments)	1 day
Value Engineering implementation	Throughout design and construction

The Value Engineering study workshop was organised in three different parts as was indicated in Figure 6.4 (see Section 6.3.1). Table 6.18 presents a summary of the ideas generated by the Value Engineering workshop. The last phase of the Value Engineering study was the presentation of recommendation which is presented in Table 6.19.

The recommendations based on Table 6.19 rationalises the development of each proposal and a summary of cost savings were presented at this time, so that the owner / design team could initiate an evaluation on the Value Engineering report. The summary of recommended ideas for initial cost saving and life cycle cost are presented in Table 6.19.

The design criteria for the project included the followings:

- Respect of general planning spirit of surrounding housing facilities
- Highest utilisation of existing services and utilities as appropriate
- Meet design codes and housing standard requirements with respect to space utilisation efficiency and functional requirements
- Safety environmental and safety requirements
- Meet safety and security requirements

Case Study 3

Table 6.18 Summary of ideas from outcome of Value Engineering for Case Study 3

Sr. No	Idea No.	Description	Rank
Architectural Civil Work Ideas			
1	A1	Reduce No. of offices in the administration department	8
2	A2	External panel of skylight glazing to be 10 mm in lieu of 31 mm	9
3	A3	Add prayer room for women	3
4	A4	Split secretary room	4
5	A5	Delete enclosed office allocated for the support officer in basement store	7
6	A6	Double door to be provided for dish / kitchen 02b/37	8
7	A7	Delete one door from corridor H-I/9-10	10
8	A8	Reduce width of service corridor in the basement to 2.2 m	2
9	A9	Delete block wall between chillers and freezers in kitchen	6
10	A10	Delete the second door and block wall in the toilet in order to provide space for wash area and WC instead of 2 whenever applicable	8
11	A11	Optimise the design of toilets and showers in basement by shifting the wall (i.e. reduce size of staff toilet / changing)	4
12	A12	Reduce the area of glazing in court yard	9
13	A13	Internal block work thickness to be reduced to 150 mm	10
14	A14	Eliminate 250 mm block work and replace with 200 mm block work	7
15	A15	Bathroom door to be open inside	3
16	A16	Main entrance to be segmented in lieu of curved glass	3
17	A17	Urinal to change to WC use in pharmacy department	4
18	A18	Cancel urinal in the gate house	6
19	A19	Reduce size at gate house to a single room and service	8
20	A20	Delete canopy in gate house	9
21	A21	Use epoxy flooring for service corridor in lieu of Linoleum	10
22	A22	Use ceramic tiles in lieu of porcelain in all areas except kitchen, medical waste and bed processing area	9
23	A23	Use epoxy in lieu of porcelain in the services staircase	8
24	A24	Use cast in situ concrete tile for the external walkway	7
25	A25	Simplify the entrance floor pattern	8
26	A26	Use porcelain in lieu of granite in main spine and main entrance	7
27	A27	Use rectangular airlock in lieu of revolving door	9

Case Study 3

Table 6.18 Summary of ideas from outcome of Value Engineering for Case Study 3 (Cont'd)…

Sr. No	Idea No.	Description	Rank
28	A28	Roofing tiles to be replaced at side of main entrance and walkway with gravel	6
29	A29	Delete the louver and supporting system above the chillers	10
30	A30	Spandrel panel and limestone in the basement to be replaced with plaster and paint.	6
31	A31	Delete the louvers in north elevation	7
32	A32	Delete the spandrel panel in the courtyard and replace with plaster and paint	8
33	A33	Delete the spandrel in main spine walkway	4
34	A34	Delete limestone in the services block elevation and replace with plaster and paint	9
35	A35	Delete false ceiling in basement except corridor and kitchen and staff bathroom	7
36	A36	Garbage computer room to be enclosed with block wall in addition to provision of A/C	8
37	A37	Remove false ceiling in the service rooms and patient rooms	7
38	A38	Change the handrail material in the main spine from glass to stainless steel	6
39	A39	Study minimising the use of sound insulation in the flooring	9
40	A40	Internal gypsum board partition to be change to 150 mm block work plaster	10
41	A41	Delete ceramic behind mirror and cupboards	8
42	A42	Delete the cherry wood mirror frame	7
43	A43	Delete the soft plants landscape for the above floor of the basement	8
44	A44	Canopy to be aluminium in lieu of glass in the main entrance	9
45	A45	Canopy vertical tension cables are not required structurally and to be deleted	7
46	A46	Liquid applied water proofing membrane shall be used in wet areas	8
47	A47	Provide 2x2 meter patient room in lieu of the multi-purpose room in wards and nurse office / doctor.	2
48	A48	Clarify the need for the multipurpose room in wards and nurse office/doctor	3
49	A49	Delete protection guard rail inside the patient room	7

Case Study 3

Table 6.18 Summary of ideas from outcome of Value Engineering for Case Study 3 (Cont'd)…

Sr. No	Idea No.	Description	Rank
50	A50	Usage of gypsum board partition in the emergency to be restudied (especially in the corridor) and replace with block work	8
51	A51	Mosque dome to be changed to GRP panel	7
52	A52	Wooden floor to be changed to rubber in the gym	8
53	A53	Floor tile in the operation room to be linoleums	7
54	A54	Delete louver in all elevations	9
55	A55	Delete louvers from corners and around external staircase	6
56	A56	Revise spine sky light design by deleting sunshade and propose an alternative	7
57	A57	Revise the steel enclosure design in the mechanical roof by deleting the central part and providing aluminium cladding	9
58	A58	Revise the false ceiling to be gypsum tiles in operation theatre	3
59	A59	Parapet finish to be steel structure and aluminium cladding instead of exposed concrete	8
60	A60	Revise bath room layout to minimise usage to shaft	4
61	A61	Delete the hand dryer and replace it with tissue dispenser except in public toilet	7
62	A62	Revise the roof system slopes on roof to be reduced as per detail	9
63	A63	Door frame to be GI in lieu of stainless steel	8
64	A64	Aluminium finish to be powder coated in lieu of polyvinyl indene	9
65	A65	Chiller yard floor finish to be changed from interlock tiles to gravel	7
66	A66	Washbasin in patient's room to be ceramic in lieu of corian	8
67	A67	Stainless steel to be changed to GI door frames	3
68	A68	All stainless steel doors (at entrance) to be frameless glass	2
69	A69	Change in all porcelain tiles from international to local brands	6

Case Study 3

Table 6.18 Summary of ideas from outcome of Value Engineering for Case Study 3 (Cont'd)…

Sr. No	Idea No.	Description	Rank
Structural Work Ideas			
70	S1	Road from Etisalat tower to Hospital may not required, (profile is very difficult) verify the constructability	10
71	S2	Reduce 2% roof slopes to 1% maximum (foam concrete quantity will be reduced)	9
72	S3	Cavities in excavation can be filled by backfilling except by top 250 mm can be PC concrete	7
73	S4	Aggregates shall be from RAK Emirates	3
74	S5	Reinforcement steel to be mentioned from Qatar and Emirates	2
75	S6	Use local ceramic material from RAK Emirates	1
76	S7	General notes on drawing Item 2.12 indicate that maximum area of concrete poured at once to be $100m^2$. This item can be changed to $1000m^2$	3
77	S8	Footing under retaining wall to be modified	2
78	S9	Reduce blinding thickness under footings from 75 to 50 mm	8
79	S10	Ground slab and waterproofing underneath it shall be changed to slab on grade and polythene sheet underneath in addition to the beam	7
Mechanical Work Ideas			
80	M1	Replace water sprinklers fire fighting with clean agent in medical records	8
81	M2	Conceal all the pipes for the fighting in slabs in patient rooms and delete false ceiling	9
82	M3	Chillers shall have screw compressors	7
83	M4	Consider utilising fresh air for cooling during mild weather using enthalpy sensor	8
Electrical Work Ideas			
84	E1	All external cables running on roof, landscape and inside service blocks are LSF cable, to be changed to PVC normal type	7
85	E2	Size of cable ducts (external) are 6 inch upvc, change to 4 inch upvc	8
86	E3	Cancel all Type EX2 spike light and 120 No. of landscape lighting	7

Case Study 3

Table 6.18 Summary of ideas from outcome of Value Engineering for Case Study 3 (Cont'd)…

Sr. No	Idea No.	Description	Rank
87	E4	Generator room is congested, to be relocated near the chiller yard	3
88	E5	Change Type Ex1 light (metal handle 1x150w) for car-shed lighting to 1x23w PL Type fluorescent light	9
89	E6	Change Type S1(recessed halogen spot light 50w) to down light 2x18w PL Type fluorescent in corridor	3
90	E7	Delete F9Type 1x50w TS long light in the main corridor in ground floor	7
91	E8	Change light fixture F7Type in 1st Floor (indirect light) to be flood light	9
92	E9	Change lighting fixture Type F1 4x14w to be 4x18w F2	3
93	E10	Change lighting fixture Type F3 2x24w to be 4x18w F2	2
94	E11	Delete the crimp cable management software for voice and data network	10
External Work Ideas			
95	EX1	Delete water features	8
96	EX2	Change the fence to chain link fence	9
97	EX3	Remove fabric tensile	2

Case Study 3

Table 6.19 Summary of recommendations for initial Cost Savings and Life Cycle Cost

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
Architectural Civil Work Ideas				
1	A1	Reduce No. of offices in the administration department	134,400.00	Nil
2	A2	External panel of skylight glazing to be 10 mm in lieu of 31 mm **-Extra**	(664,400.00)	120,000.00
3	A5	Delete enclosed office allocated for the support officer in basement store.	26,632.00	Nil
4	A6	Double door to be provided for dish / kitchen 02b/37 **-Extra**	(2,400.00)	Nil
5	A7	Delete one door from corridor H-I/ 9-10	5,243.75	Nil
6	A9	Delete block wall between chillers and freezers in kitchen	2,668.00	Nil
7	A10	Delete the second door and block wall in the toilet in order to provide space for wash area and WC instead of 2 whenever applicable	51,836.00	Nil
8	A12	Reduce the area of glazing in court yard	523,202.00	425,000.00
9	A13	Internal block work thickness to be reduced to 150 mm	22,875.00	
10	A14	Eliminate 250 mm block work and replace with 200 mm block work	475,605.00	Nil
11	A18	Cancel urinal in the gate house	2,000.00	Nil
12	A19	Reduce size at gate house to a single room and services	105,600.00	Nil
13	A20	Delete canopy in gate house – **Extra**	(67,645.00)	Nil
14	A21	Use epoxy flooring for service corridor in lieu of Linoleum	145,600.00	Nil
15	A22	Use ceramic tiles in lieu of porcelain in all areas except kitchen, medical waste and bed processing area	1,151,260.00	Nil
16	A23	Use epoxy in lieu of porcelain in the services staircase	38,525.00	Nil
17	A24	Use cast in-situ of concrete tile for the external walkway – **Extra**	(154,468.00)	84,000.00
18	A25	Simplify the entrance floor pattern	Included in A24	Nil

Case Study 3

Table 6.19 Summary of recommendations for initial Cost Savings and Life Cycle Cost (Cont'd)…

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
19	A26	Use porcelain in lieu of granite in main spine and main entrance	829,480.00	Nil
20	A27	Use rectangular airlock in lieu of revolving door	125,800.00	Nil
21	A28	Roofing tiles to be replaced at side of main entrance and walkway with gravel	2,400.00	Nil
22	A29	Delete the louver and supporting system above the chillers	99,350.00	Nil
23	A30	Spandrel panel and limestone in the basement to be replaced with plaster and paint.	19,060.00	Nil
24	A31	Delete the louvers in north elevation	Included in A54	Nil
25	A32	Delete the spandrel panel in the courtyard and replace it with plaster and paint	Included in A12	Nil
26	A34	Delete limestone in the services block elevation and replace with plaster	228,000.00	Nil
27	A35	Delete false ceiling in basement except corridor and kitchen and staff bathroom	170,000.00	Nil
28	A36	Garbage computer room to be enclosed with block wall in addition to provision of A/C	31,471.00	Nil
29	A37	Remove false ceiling in the service rooms and patient rooms	154,575.00	Nil
30	A38	Change the handrail material in the main spine from glass to stainless steel - **Extra**	(64,470.00)	50,000.00
31	A39	Study minimising the use of sound insulation in the flooring	483,600.00	Nil
32	A40	Internal gypsum board partition to change to 150 mm block work plaster	196,475.00	Nil
33	A41	Delete ceramic behind mirror and cupboards	11,620.00	Nil
34	A42	Delete the cherry wood mirror frame	7,260.00	Nil
35	A43	Delete the soft plants landscape for the above floor of the basement	7,752.00	Nil
36	A44	Canopy to be aluminium in lieu of glass in the main entrance	32,000.00	Nil

Case Study 3

Table 6.19 Summary of recommendations for initial Cost Savings and Life Cycle Cost (Cont'd)…

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
37	A45	Canopy vertical tension cables are not required structurally and to be deleted	12,000.00	Nil
38	A46	Liquid applied water proofing membrane shall be used in wet areas only	59,455.00	Nil
39	A49	Delete protection guard rail inside the patient room	17,550.00	Nil
40	A50	Usage of gypsum board partition in the emergency to be restudied (especially in the corridor) and replace with block work	Included in A40	Nil
41	A51	Mosque dome to be changed to GRP panel	5,600.00	Nil
42	A52	Wooden floor to be changed to rubber in the gym	8,910.00	Nil
43	A53	Floor tile in the operation room to be linoleums - **Extra**	(1,320.00)	Nil
44	A54	Delete louver in all elevations	587,100.00	Nil
45	A55	Delete louvers from corners and around external staircase	Included in A54	Nil
46	A56	Revise spine sky light design by deleting sunshade and propose an alternative	87,000.00	Nil
47	A57	Revise the steel enclosure design in the mechanical roof by deleting the central part and providing aluminium cladding	207,900.00	Nil
48	A59	Parapet finish to be steel structure and aluminium cladding instead of exposed concrete	75,750.00	Nil
49	A61	Delete the hand dryer and replace it with tissue dispenser except in public toilet.	24,150.00	Nil
50	A62	Revise the roof system slopes on roof to be reduced as per the details	288,750.00	Nil

Case Study 3

Table 6.19 Summary of recommendations for initial Cost Savings and Life Cycle Cost (Cont'd)…

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
51	A63	Door frame to be GI in lieu of stainless steel	27,500.00	Nil
52	A64	Aluminium finish to be powder coated in lieu of polyvinyl indene.	106,150.00	Nil
53	A65	Chiller yard floor finish to be changed from interlock tiles to gravel	59,200.00	Nil
54	A66	Washbasin in patient's room to be ceramic in lieu of corian	77,600.00	Nil
55	A69	Change in all porcelain tiles from international to local brands	410,568.00	Nil
Sub-total Architectural Work Ideas			**6,184,761.75**	**2,309,000.00**
Structural / Civil Work Ideas				
56	S1	Road from Etisalat tower to hospital may not required (profile is very difficult) please verify the constructability	1,380,700.00	Nil
57	S2	Reduce 2% roof slopes to 1% maximum (foam concrete quantity will be reduced)	82,500.00	Nil
58	S3	Cavities in excavation can be filled by backfilling except by top 250 mm can be PC concrete	495,070.00	Nil
59	S9	Reduce blinding thickness under footings from 75 to 50 mm	585,918.00	Nil
60	S10	Ground slab and waterproofing underneath it shall be changed to slab on grade and polythene sheet underneath in addition to the beam	6,019.00	Nil
Sub-total Structural / Civil Works			**2,550,207.00**	**Nil**
Mechanical Work Ideas				
61	M1	Replace water sprinklers fire fighting with clean agent in medical records - **Extra**	(15,800.00)	25,000.00
62	M2	Conceal all the pipes for the fighting in slabs in patient rooms and delete false ceiling	6,000.00	Nil

Case Study 3

Table 6.19 Summary of recommendations for initial Cost Savings and Life Cycle Cost (Cont'd)…

Sr. No	Idea No.	Description	Initial Cost Savings (UAE Dirhams)	Life Cycle Cost Savings (UAE Dirhams)
63	M3	Chillers shall have screw compressors - **Extra**	(258,000.00)	Nil
64	M4	Consider utilising fresh air for cooling during mild weather using enthalpy sensor	(471,000.00)	660,000.00
Sub-total Mechanical Work Ideas			**(738,800.00)**	**685,000.00**
Electrical Work Ideas				
65	E1	All external cables running on roof, landscape and inside service blocks are LSF cable, to be changed to PVC normal Type	58,263.00	175,000.00
66	E2	Size of cable ducts (external) are 6 inch upvc. Change to 4 inch upvc	10,125.00	Nil
67	E3	Cancel all Type EX 2 spike light and 120 Nos. of landscape lighting	240,000.00	56,000.00
68	E5	Change Type Ex1 light (metal handle 1x150w) for car-shed lighting to 1x23w PL Type fluorescent light	70,000.00	Nil
Electrical Work Ideas				
69	E7	Delete F9Type 1x50w TS long light in the main corridor in ground floor	15,500.00	Nil
70	E8	Change light fixture F7Type in 1st Floor (indirect light) to be flood light	78,400.00	156,000.00
71	E11	Delete the crimp cable management software for voice and data network	200,000.00	Nil
Sub-total Electrical Work Ideas			**672,288.00**	**387,000.00**
External Work Ideas				
72	EX1	Delete water features	117,988.00	1,560,000.00
73	EX2	Change the fence to chain link fence	529,700.00	Nil
Sub-total External Work Ideas			**647,688.40**	**1,560,000.00**
Medical Equipments				
74		Optimise medical equipments	10,000,000.00	Nil
Sub-total Medical Equipments			**10,000,000.00**	**Nil**
Total Value Engineering Potential Savings			**29,316,145.00**	**4,941,000.00**

6.12 Presentation of cost data for Case Study 3

The data was extracted by the author from the contract documentation for this project and is presented for this project in tabular form for ease of evaluation.

Figure 6.10 Front view of Ruwais Housing Expansion Phase III, new hospital, western region of Abu Dhabi, United Arab Emirates.

Case Study 3 is project titled "construction of new hospital including infrastructure, western region, Abu Dhabi, United Arab Emirates" as shown in Figure 6.10. This includes ideas arrived in disciplines covering architectural, structural, electrical, mechanical and general, and also shown together with rate of ranking obtained for individual items.

Table 6.20: Summary of Workshop Results for Case Study 3

Discipline	Cost Savings (UAE Dirhams)	Life Cycle Costing (UAE Dirhams)
Architectural proposal	6,184, 761.00	2,309,000.00
Mechanical proposal	(738,800.00)	685,000.00
Electrical proposal	672,288.00	387,000.00
Structural proposal	2,550,207.00	Nil
External proposal	647,688.00	1,560,000.00
Medical equipment	10,000,000.00	Nil
Total	**19,316,145.00**	**4,941,000.00**

Table 6.21 Summary of Workshop Results for Case Study 3

Description	Result
Total number of ideas	97
Ideas related to cost saving / performance	75
Ideas related to performance improvement only	22
Potential initial cost saving	UAE Dirhams19,316,145.00
Life cycle costing	UAE Dirhams 4,941,000.00
Award value of construction	UAE Dirhams 280,658,082.46

Table 6.21 presents summary of workshop results of Value Engineering while Table 6.22 presents proposed summary of initial cost savings and life cycle cost savings. Based on Value Engineering analysis, it concluded that a total Value Engineering potential savings in the initial cost was UAE Dirhams 19.31 million and life cycle cost savings was UAE Dirhams 4.94 million.

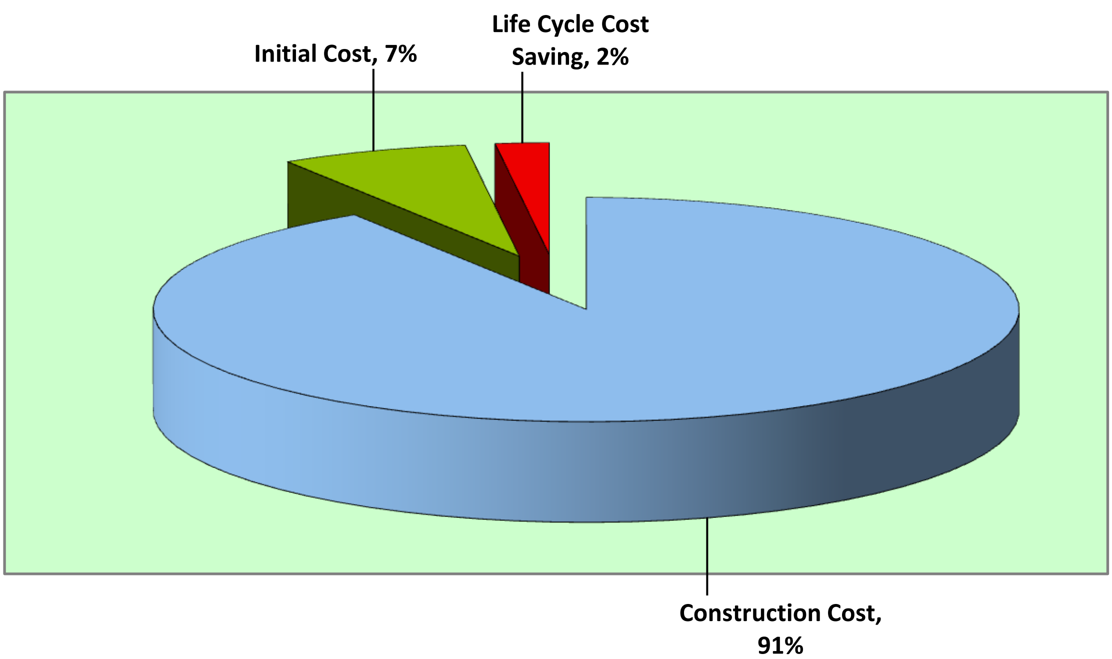


Figure 6.11 Shows Value Engineering Potential Savings for Case Study 3

Table 6.22 Shows the Potential Cost Savings for Case Study 3

Description	Construction Cost UAE Dirhams	Initial Cost (AED) UAE Dirhams	Life Cycle Cost (AED) UAE Dirhams
Cost	280,658,082.46	19,316,145.00	4,941,000.00
Percentage	91%	7%	2%

The variation orders summary related to Case Study 3 that occurred during construction are presented in the Table 6.23 below. The detailed variations related to Case Study 3 are presented in Appendix 3.

Table 6.23 Summary of Variations during Construction for Case Study 3

Description	Amount UAE Dirhams
Original agreement price	280,658,082.46
Variations during construction	2,904,057.80
Percentage of variations to original agreement price	1.03%

The final cost outcome of the Value Engineering study was a success and approximately 7% was potential initial cost savings and estimated construction cost reduced to 91% of total project cost (see Table 6.22 and Figure 6.11). This was achieved without reducing the function or scope of the work and still met the project schedule. Life cycle cost analysis performed to applicable elements taking into consideration of the impact energy costs, the replacement costs and impact on operations and maintenance and found projected life cycle costing savings of 2% of the total estimated cost of the project.

During the Value Engineering workshop, there was no contractor's representative involved and further indicated that Value Engineering recommendations agreed in the outcome of Value Engineering workshop was not fully implemented by the designer. As a result, this caused delay during the construction.

Variations arose during the construction resulting from changes in end-user requirements and design improvements resulted in a final net increase of 1.24% (Table 6.23) of the award value of the project.

6.13 Review of issues arising from Case Study 3

6.13.1 The Structure and Method of the Value Engineering Process

The Value Engineering workshop was carried out in 40 hours for a period of five (5) days for implementing the following five (5) phases of Value Engineering in accordance with SAVE International approach:

- Information Phase
- Speculation Phase
- Evaluation (Analysis) Phase
- Development Phase
- Presentation Phase

6.13.2 Timing and execution of the Value Engineering and Workshop Studies

The Value Engineering workshop for Case Study 3 was conducted at the end of the detailed design stage. The recommended Value Engineering ideas were partially incorporated into the design and the remaining recommended ideas were implemented by the contractor upon award, and during construction. However, all the Value Engineering recommendations were not incorporated. Due to the lateness of being able to provide detailed designs, some of the recommendations would have an unacceptable impact on the construction process, and were consequently not implemented. It is to be noted that the timing of Value Engineering for Case Study 3 was not conducted at 50% - 60% of the preliminary design stage as suggested by Seely (1996). The late timing of conducting Value Engineering resulted in a loss of benefits at both the design and construction stages.

6.13.3 Composition of the Workshop Team

In Case Study 3, Value Engineering was conducted by an internal Value Engineering team. The Value Engineering team consisted of internal Value Engineering co-ordinator, in-house multidisciplinary team of experienced professionals in civil, structural, architectural, electrical, and mechanical, the owner’s quantity surveyor, design consultants and end-user. The pre-workshop introduction meeting was conducted by Value Engineering co-ordinator to ensure all Value Engineering members understood the process of the job plan. The designer presented the scope of the project and differences in opinions were discussed and the Value Engineering team ideas were also recorded in order to evaluate a ranking used as a basis to prioritise the ideas. The basic costing of the construction alternatives was done by the clients' quantity surveying department based on information supplied by the workshop team. This was done due to the commercial sensitivity of the costing data required.

6.13.4 Understanding of the Value Engineering Process

Prior to start of Value Engineering workshop, the internal Value Engineering specialist gave an introduction to the importance and benefits of Value Engineering in order that the team understand the Value Engineering process at the design stage and also its importance to construction in terms of life cycle costing, reliability, operability environmental factors, Zimmerman and Hart (1982). The process of Case Study 3 was carried out by a Value Engineering specialist as "Team Leader" who guided Value Engineering team during each stage of 40 hours workshop. It was noted by the Value Engineering specialist that the Value Engineering process was initially overlooked by senior management. Also, the workshop was not conducted at the recommended time for achieving the full benefits of the process.

The lateness in conducting the workshop limited the effectiveness of the process as it was not feasible to implement some recommendations due to the amount of re-design required, and consequent project delay implications.

6.13.5 Value Engineering during the Construction Phase

At the time of Value Engineering workshop, the project had not yet reached the tender stage. Therefore, in Case Study 3, contractor's participation was not available. However, the Value Engineering recommendations were not completely implemented during the design stage, the remainder being executed during the construction stage by the contractor. As a result of this, construction work was delayed. In spite of the Value Engineering recommendations, many variations were encountered during the process of construction stages. In this project, Value Engineering was not conducted during the construction stage; also the Value Engineering workshop recommendations were not audited and monitored during the construction stage.

6.13.6 Performance Measurement based on costs

In Case Study 3, the performance of value Engineering measureable planned (SAVE Model) for the following:-

- Savings in construction cost
- Lower life cycle costs
- Improved operational performance
- Reduced maintenance costs
- Identification of risks and mitigation strategies

The cost which was used as a basis for assessing ‘value’ was on a predicted cost estimate supplied to the Value Engineering workshop team. This was provided by the project consultant, based on an agreed project brief and preliminary design, which is normal practice in the United Arab Emirates.

Based on Value Engineering workshop conducted to this Case Study, the predicted initial cost saving was 7% of the total construction cost and 4% of life cycle cost were achievable. At the time of Value Engineering, the project had a predicted cost estimate provided by the consultant which is normally the case for major projects in the United Arab Emirates.

6.13.7 The Effect of Environment and Culture on Value Engineering

In Case Study 3, the importance of environmental factors and culture were addressed and also potential supply problems due to the high volume of other construction projects at that time. In Case Study 3, Value Engineering was carried out internally. The team was selected internally and conducted Value Engineering workshop. Although the project required some changes during construction as recommendations made during Value Engineering in the design stage were not fully implemented. Value Engineering was viewed as a cost-cutting exercise instead of being treated as benefiting the project in terms of reducing the unnecessary cost and enhances improvement in performance of the project.

This project incurred substantial delays totalling 980 days. These delays can be grouped under the following 3 headings:

- Change in the economic climate in the Emirates. When the project started the construction industry was operating in a buoyant market. This resulted in a shortage of manpower and a heavy demand for materials. This resulted in delays due to poor productivity as a result of reduced manpower and poor supervision. Also, delays in supply of materials as lead times for ordering increased. While the Value Engineering team made some allowance, it proved to be an underestimate.

  Part way through the project, there was an economic crisis. While this was initially felt in Dubai, the impact was soon felt in Abu Dhabi. The contractor employed on this project had a heavy commitment in Dubai. When his many projects in Dubai were suspended, he suffered serious cash flow problems. This resulted in delayed payments to staff and workers, which caused a large turnover in staff, a reduction in productivity due to inexperienced supervision, and a failure in commitment to the project.

- As the end-user was another department in the clients' organisation, it would have been possible to involve the end-user in the Value Engineering process at an earlier stage. An opportunity for an improved outcome was thus lost.

  Also the design team were not familiar with cultural issues affecting the hospital. In the Emirate culture, it is necessary to separate men and women resulting in greater duplications of facilities that would be expected in a western hospital. It is therefore required substantial changes in pre-installations for medical equipment, furniture and fittings. These were issued as variation orders during construction.

- The late stage at which the Value Engineering was conducted (see 6.13.2) resulted in the issue of variations from an early stage of construction. This resulted in disruptions to the contractor's programme, but the contractor would be expected to absorb much of this delay by re-programming. To date there has been no final settlement of time extension to be granted.

6.14 Summary of Final Cost Savings for Case Studies 1, 2, and 3

These are summarised in Table 6.24, where the predicted savings are given as the sum of the initial and life cycle cost savings e.g. in case 7% + 1% = 8%.

Table 6.24 Summary of final Cost Savings for Case Studies 1, 2 and 3

Case Study	Value Engineering Saving	Variations during construction	Outcome
1	(7+1) = 8%	3.56%	Savings
2	(9+2) = 11%	19.90%	Extra
3	(7+2) = 9%	1.03%	Extra

The percentage saving is based upon the award value and the estimated Value Engineering savings based on estimated prior to award.

In all case studies the Value Engineering workshop was based on the SAVE International model and was conducted using experienced professionals. The process was well documented and an external Value Engineering consultant was used in case studies one and two and an internal specialist in Case Study 2.

The Value Engineering workshops for case studies one and three were conducted after detailed design was complete. This as much later than what was accepted to be the time to provide the most productive result. Case Study 3 was conducted at the end of the preliminary design stage, which is later than most specialist advice approximately 50% to 60% of the preliminary design stage as stated by Seely (1996).

This was a major factor in reducing the savings achieved. The consequential loss of savings was of the order of 3%, comparing Case Study 1 with Case Study 2 (11% - 8%) and 2% comparing case Study 3 and Case Study 2. It is accepted that this is not wholly attributable to delay in executing the Value Engineering process, but from the data, it was a very significant one.
There was no extension of the Value Engineering process into the construction stage, or an auditing of the implementation of individual recommendations made by Value Engineering team.

The culture and environment of the United Arab Emirates had an impact in all case studies. Designers were not fully aware of the impact of cultural norms on architectural issues and end-user involvement was very restricted. Lack of appreciations of these issues resulted in major variations being issued during the construction stages of all case study projects.

The seven research issues referred in Chapter 3 Section 3.5 examined in each of the three case studies are re-examined in Chapter 7 in conjunction with the data from Chapter 5, the questionnaires and semi structured interviews.

6.15 References

1. *Changing patterns–UK Framework for Sustainable Consumption and Production*, DEFRA (2003), retrieved from www.defra.gov.uk/environment/business/scp.
2. El-Sayegh, S.M. (2007), *Risk assessment and allocation in the UAE construction Industry*, International Journal of Project Management, Vol.26, pp 431-438
3. Kelly, J., Morledge, R., and Wilkinson, S. (2006), *Best value in construction*, Blackwell Science Limited, United Kingdom.
4. Nadem, A.B.A.T. (2009), *Understanding and Preventing Construction Conflict, claims and Disputes, A critical in-depth study into their causes and recommendations to control in the United Arab Emirates*, PhD Thesis, University of Glamergon.
5. Seely, I.H. (1996), *Building Economics – appraisal and Control of building Design and Efficiency*, Macmillan Press Ltd, U.K.
6. Stephen, J.K. and Alponse, J.D.I. (1995), *Life Cycle Costing for design professionals*, McGraw Hill, U.S.A.
7. Zaneldin, E.K. (2006), *Construction claims in United Arab Emirates: Types, causes, and frequency*, International Journal of Project Management, Vol. 24, pp 453-459.
8. Zimmerman, L.W. and Hart, G.D. (1982), *Value Engineering: A practical approach for Owners, Designers and Contractors*, Van Nostrand Reinhold Company, New York.

CHAPTER 7

DISCUSSIONS OF FINDINGS

7.1 Introduction

This chapter discusses findings of questionnaires survey one (1), semi structured interviews based on Questionnaires two (2) and three (3), and the three (3) case studies and their relationships. The objective being to gain a greater understanding of how Value Engineering is currently perceived and implemented in the United Arab Emirates.

The findings are first discussed under the seven research data collection issues identified in Chapter 3 Section 3.5 and subsequently related to the research objectives. These findings are then used to address the hypotheses stated in Chapter 1 (end of Section 1.6). The final section of chapter proposes a model for improvement based on the following findings. Table 7.1 identifies the source data for each of the seven issues.

Table 7.1 Data Sources for the Research Issues (Note: Q1 = Questionnaire 1 etc.)

Sr. No.	Issue	Data Source					
		Q1	Semi Structured Interviews		Case Study 1	Case Study 2	Case Study 3
			Q2	Q 3			
1.	Structure and method of Value Engineering process.		•		•	•	•
2.	Timing and execution of the Value Engineering workshop studies	•	•		•	•	•
3.	Composition of the workshop team		•		•	•	•
4.	Understanding of the Value Engineering process	•	•		•	•	•
5.	Value Engineering during the construction phase	•	•		•	•	•
6.	Performance Measurement based on costs	•		•	•	•	•
7.	The effect of Environment and culture on Value Engineering		•		•	•	•

7.2 Discussion of Data Collected

The data collected from the three (3) sources stated in Section 7.1 are now used to address each of the seven ‘issues’ identified in the literature review in Chapter 3 Section 3.5, and compared to the findings of other researches.

7.2.1 Structure and Method of the Value Engineering Process

From the structured interview results (Section 5.3.5.1), it was found that the use of external Value Engineering consultants is widespread. It was also reported that some large companies use staff experienced in Value Engineering to manage the process and run the workshops. Also, in most case studies an external Value Engineering specialist was appointed as a team leader to manage the process for the project, where not, Value Engineering specialists from the client organisation were used.

The Value Engineering process was reported as being embodied in company documentation in all but one, in the structured interview results in Section 5.3.5.1. In the exception, the Value Engineering consultant was required to provide this documentation for the project.

Value Engineering workshops were used in all three case studies reviewed. All workshops were also employed the stages recommended by the SAVE International approach although there were some minor differences in the format used. All the case studies used an agenda based approach as well as by two reported by respondents in the structured interview. The remaining four respondents in the structured interviews reported the use of the open discussion format for their workshops.

All respondents in the structured interviews agreed that the cost consultant and project management consultant be involved in advising on the potential benefits from changes and corresponding costs.

For the case studies the costs and cost / benefit evaluation was conducted by the clients’ own quantity surveyors. This was done due to the commercial sensitivity and confidentiality of the costing database.

From the structured interview and case studies, it is evident from above that the Value Engineering process is well structured in the United Arab Emirates and that documentary procedures are in place with a structured system to evaluate benefits and costs at the workshop stage. This indicates that there is a wide acceptance of the Value Engineering process amongst stakeholders in the United Arab Emirates, as was found by Al-Yousefi et al. (1999). However, the process does not include a framework for measurement and performance of the outcome of the process as advocated by Lin (2003) or extending the process into the project construction phase as advocated by Kelly, Male and Graham (2004).

7.2.2 Timing and Execution of the Value Engineering and Workshop

From the Questionnaire 1 (Section 5.2.5.1), there was strong agreement (83%) that the most productive time to implement Value Engineering is by the end of the preliminary design stage. Moreover, 69% of respondents considered its extended use into the construction stage was desirable. From the structured interview (Section 5.3.5.2) there were some variation, all six (6) respondents considered that the process be applied by the end of the preliminary stage of design, but also that benefits can result from applying Value Engineering at the feasibility and conceptual design stages.

Workshops were usually employed over five (5) days, (Section 7.2.1), all six (6) respondents in the semi structured interviews were in favour of a time allocation not less than the standard 40 hours recommended by SAVE International. For smaller projects two, eight hour day workshops were deemed appropriate.

Advance information provision was reported by all respondents in the structured interview while one (1) respondent favoured documentation that targeted at individuals. In all of the case studies full documentation was supplied to each member of the Value Engineering team.

In the case studies advance preparation consisted of prescribed requirements (Section 6.4.1) with full project documentation distributed to the all Value Engineering team. The findings of the case studies reveal that while it is recognised that the Value Engineering process is more effective when undertaken by the end of the preliminary stage of design, this does not always occur. In two of the case studies Value Engineering was instigated after the detailed design was completed.

This was well beyond the 50% to 60% preliminary design completion stage recommended by Seely (1996), and this resulted in some of the recommendations not being implemented. This lateness in undertaking the Value Engineering workshop was evidenced in all case studies and resulted in disruption to the projects and a reduction in potential benefits.

Whilst there is no universal agreement between researches on the optimum timing for conducting the Value Engineering, all caution that late execution will result in loss of benefits from the process e.g. Roe (2009), Siterman (2009), Seely (1996), Carter (1991 / 1992), Kelly and Male (1988), and Fery and Brandon (1984).

7.2.3 Composition of the Workshop Team

There were typically 8-12 people reported to be attending workshops, by respondents of the semi structured interview, Section 5.3.3. The clients, architects, designers and quantity surveyors were reported as attending by all respondents. In the case studies a similar make up of workshop membership was reported, however, in none of case studies was a contractor's representative present, the project management specialist was expected to provide a construction perspective.

If there is limited contractors' representation in the workshops the question arises as to how specific construction and "buildability factors'' are fully addressed.

There is usually more than one construction method possible and a particular contractor would evaluate the best for him based on a variety of factors. The project management specialist on the workshop team could therefore only give advice based on his assumed construction method, which may not be the optimum solution decided upon by the appointed contractor.

7.2.4 Understanding of the Value Engineering Process

Questionnaire one (1) revealed a widespread awareness of Value Engineering and its use, amongst their professional groups, however the majority, 91%, reported that for the United Arab Emirates the prime motivation from its application was considered to be reduction in costs.

From the structured interviews, the Value Engineering specialists recognise the importance of the timing of the workshops, but they report that in the Emirates, workshops are regularly conducted after the completion of the preliminary design. Seely (1996), recommended conducting the workshops no later than the 50% to 60% stage of the preliminary design.

In Case Studies 1 (section 6.6.1.4) an external Value Engineering specialist was appointed as team leader to preside over the workshop and reported that the workshop was conducted at the end of the detailed design stage. In Case Study 2 (section 6.10.4), a Value Engineering specialist was appointed as team leader and reported that the workshops were conducted at the preliminary design stage for both phases of the project. In Case Study 3 (Section 6.13.4) a Value Engineering specialist was appointed as a team leader, and reported that the Value Engineering was initially overlooked by both senior management of the client and contractor.

The above results indicate that there is a lack of appreciation of the time sensitivity of Value Engineering, in particular that the workshop be conducted within the preliminary design stage. There is a tendency for Value Engineering to be viewed as being predominantly an issue for the design aspects of the project, but not appreciate that the timing of the workshops in the preliminary design stage is essential in order to provide the greatest potential benefits. Also, the findings of the Value Engineering process can impact on all aspects of the project, not just design.

7.2.5 Value Engineering during the Construction Phase

Value Engineering during the construction phase questionnaire 1 indicates that a large proportion of construction professionals consider that Value Engineering is done at both the design and construction stage (69%).

However, Value Engineering specialists in Questionnaire 2 and 3 states that this process terminate prior to the start of the construction. They also recognise that further benefits could be gained if Value Engineering also extended into the construction stage. This agrees with Fist (1988), Kelley et al. (2004) and also Waddle (2008).

In the case studies Value Engineering was not conducted into the construction stage. However, the lateness of the Value Engineering process had an effect on construction operations, this meant many recommendations proved to be too disruptive and costly to implement.

7.2.6 Performance Measurement based on Costs

Questionnaire 1 indicates that construction professionals identify cost as the most important measure of the successful implementation of Value Engineering. This is not unsurprising as Value Engineering is promoted on this basis. Whether the key factor of maintaining or improving function as well was appreciated, was not clear.

From the survey of Value Engineering specialists in Questionnaire 2 and 3 the expected cost saving expected range from 7% to 16%. This proved to be an evaluation on projected savings based on the workshop reports. It was also evident that there was little hard evidence to support these quoted figures as no auditing of outcomes for individual proposals adopted in the projects.

Table 7.2 Value Engineering projected savings in the case studies

Case study	Project saving Value Engineering	Change in project cost estimate
1	8%	-3.29%
2	11%	+19.90%
3	9%	+1.03%
Mean	10%	

Table 7.2 indicates an average saving in initial project cost estimate of 10% which is in the range anticipated by Value Engineering specialist in the Emirates.

In all the case studies many variations were encountered. These variations subsequently resulted in increased costs which reduced or exceeded the savings achieved through Value Engineering.

In Case Studies 2 and 3 the major variations were needed to meet end-user requirements, that were not included in the Value Engineering teams brief. The end-user was not represented on the Value Engineering workshop team. In case study 1 the lateness of the Value Engineering process required design change recommendation to be issued, as variations, to the contractor during the construction phase, thus reducing the potential savings gained from the Value Engineering process from 8% to 3.29%.

This is an interesting finding as it indicates that the technical proposals emanating from the Value Engineering workshop provide predicted cost savings that are in the range predicted by Seely (1996), who predicts expected savings of 5% to 10%, while other authors are less specific as to an actual percentage saving to be expected.

It can therefore be reasonably inferred that the workshops themselves are well structured and have the necessary management and technical expertise in place.

From the evidence of the case studies in particular, the potential savings resulting from the actual workshops are being reduced by other factors.

7.2.7 The Effect of Environment and Culture in Value Engineering

The environment and culture in the United Arab Emirates presents Value Engineering with special considerations that need to be addressed.

- There are specific technical design issues to be addressed as a result of the harsh climatic environment. This means that the design specification is specific to this geographic area.

- Local authority requirements, legal and statutory requirements are also specific to the area and need to be understood if delays are to be avoided.

- The Emirates have a multicultural construction industry whilst, clients are likely to be United Arab Emirates nationals, hence there are accepted cultural norms to be observed. A strong hierarchical structure exists where status and trust are important issues, and the obligatory, 'Local partner' is an important link with the client's organisation.

- Value Engineering workshops are likely to have specialists from a range of ethnic backgrounds, but the workshops are usually conducted in English. This establishes an accurate common basis for communication. English is widely understood in the Emirates, so companies from non-English speaking backgrounds are expected to conform.

- Design particularly of domestic buildings and commercial and state offices is strongly influenced by cultural factors. This can influence room size, separate provision for the men and women, position and size of windows etc., if these factors are not appreciated then much abortive design work may result. It is important that the Value Engineering consultant advisor is aware of these factors so as to guide the workshop team effectively.

The findings of this research do not concur with the assertion by SAVE International. Paget (2008) stated that cultural risks were insignificant in the United Arab Emirates. The multicultural nature of the Workshop Team, however, was not found to be an issue.

Sustainability is an aspect of construction that is rapidly developing in the United Arab Emirates. The Pearl Rating System of 'Estidama' (i.e. sustainability) in design and construction and operations is being controlled by the Urban Planning Council. To receive planning approval, the project has to achieve the regulatory requirements and certification. As sustainability is now an integral part of the design process and also the construction process is an issue that has to address by the Value Engineering team. Hence, it has to be included in the Value Engineering process.

Sustainability issues may have to be addressed in the tender submission and may prove a factor in the selection of the winning bid. After a contract is awarded it may well be possible to improve the sustainability of the project. A Value Engineering based review at this stage would have available details of both design and construction and method of construction and is thus well placed to consider overall project sustainability.

It is possible that benefits could result to all stakeholders in the project, as the revoking of Estidama certification during construction would well incur substantial cost and time penalties.

Using Value Engineering at this stage could well reduce the risk of the above event.

7.3 Appraisal of findings in relation to the Research Objectives

Each of the research objectives (Chapter 1, Section 1.6) are examined below and their achievement assessed.

- To evaluate current practices involved in Value Engineering of building projects in the United Arab Emirates.
  - The data summary of 7.2 confirms that an insight into the practices and application of Value Engineering has been achieved.

- To evaluate the measurement of Value Engineering outcomes in the current practices in the United Arab Emirates.
  - It was found (Section 7.2.6) that the measurement of outcomes in the United Arab Emirates is largely cost based and this reflects the clients stated principle requirements. However, the costs predicted on completion of the Value Engineering workshop stage are not verified by subsequent measurements on whether the Value Engineering recommendation has been implemented, and if the benefits of predicted savings accrued.

- To identify potential areas for improvement in the application of Value Engineering in the United Arab Emirates.

As a result of findings detailed in Section 7.2, the following areas have been identified.

- Senior management of both the client and design team need to be provided with a detailed brief to the Value Engineering team and time table the workshop not later than 50% to 60% completion stage of the preliminary design stage.

- Monitoring and auditing of Value Engineering recommendations needs to occur at the design, construction and operation stage of the project to provide feedback on successful implementation and function.

- Value Engineering should be extended into the construction period in order to potentially gain improvements during the constructions stage.

- Value Engineers need to develop cultural and environment awareness. Also the early involvement of a client's representative and (when known) the end-user is important in reducing the incidence of costly variations during the construction stage of the project.

- Increased representation on the workshop group from a specialist in the construction aspects of the project.

7.4 Proposed Model for Improving the Effectiveness of Value Engineering in the United Arab Emirates

7.4.1 Identification of Improvement Factors

The Value Engineering process is conducted almost exclusively in the design stage with no evidence of extending this concept through to the later project stages. Researchers, notably by, Neap and Seran (2009), Fist (1988), and Sneden (1988) recommend its extension into these later project stages. There is certainly a case to conduct further Value Engineering workshops when significant changes and variations to design occur. Evidence from the case studies reveals that significant variations are not uncommon in major building projects in the United Arab Emirates.

For the above reasons, improvement recommendations target both the design and construction stages. The improvement factors are detailed below under sub-headings for the design and construction stages of the project. However, they would need to be integrated into the overall Value Engineering procedures for the project.

7.4.1.1 Improvements of Value Engineering during Design Stage

Item 1. Integrate Value Engineering into the project programme.

The literature review demonstrated strong support for conducting key Value Engineering activities at specific stages in the project. If not done at the appropriate stage, it is likely to result in a failure to meet client expectations in terms of overall project cost saving. Therefore, it is important that a decision be made, when the project programme is formulated, when these activities are to occur. By integrating Value Engineering into the project programme target dates and all project task interdependencies are established. This will make the process easier to manage and control.

Item 2. Conducted a Value Engineering workshop by the end of the preliminary design stage.

There was wide agreement between Value Engineers in the Emirates that the use of workshops is appropriate and, that the SAVE International recommendation of a workshop of five day duration is commonly employed and found to be appropriate. For smaller less complex projects, time could be justifiably reduced from the 40 hour model of SAVE International. There were some differences amongst researchers as to what should be the exact timing. This research indicated that current Value Engineering practitioners in the Emirates consider the end of the preliminary design stage, Seely (1996), proposed no later than the 50% to 60% completion period. It is therefore inappropriate to be too presumptive on precise timing.

Evidence from the case studies indicates that Value Engineering workshops are being conducted too late, sometimes into the detailed design stages. This resulted in both delays and failure to implement the Value Engineering recommendations.

Item 3. Established Involvement of end-user and construction specialist.

The reason for this recommendation is that the client brief may not contain information pertinent to these two parties.

End-User: If the end-user is identified at the time of the Value Engineering workshop it would be prudent to identify their 'wants' and 'needs'. This would be communicated via the client's organisation to acquire the necessary sanctions. Evidence from Case Study 2 demonstrated the major time delays, cost increase from including end-user requirements at a late stage of the project.

Construction specialist: The construction specialist has the expertise to translate the design into a physical reality. There are construction aspects that overlap with design, so 'buildability' can be an issue that designers may not fully consider. In the case studies the construction input was supplied by a project management specialist. If the contractor for the project is not appointed at the preliminary design stage, as is usual, then a further Value Engineering review with the appointed contractor may be beneficial. However, this was not evident in any of the case studies.

Item 4. Culture and Environment.

Section 7.2.7 highlighted four issues where culture impacts on Value Engineering in the United Arab Emirates, therefore, the Value Engineering facilitator and constituent designers need to have an understanding of these issues. In terms of client relationships it is the 'local partner' that is important in information exchange with the client as well as interfacing with local regulatory authorities.

Item 5. Development of Management Awareness and Commitment.

Value Management is an integral part of the Project Management process, hence the whole project team need to have an understanding of its purpose. It is considered important to the client, otherwise the client would not have made it as project requirement. Company procedures and training should therefore reflect this importance.

Comments in Item 1 (above) also suggest that increased awareness of the criticality of some issues is necessary.

Item 6. Implement 'Estidama' the new regulations to achieve certification on sustainability.

Recent legislation in the United Arab Emirates merits special consideration of sustainability by the Value Engineering team and needs to be an agenda item in workshops.

The prime reason for inclusion as a separate issue for consideration is the recent (2010) Estidama regulations. Compliance and certification under these regulations is mandatory. The risk of failing to achieve certification, or having certification removed during the project for it to merit consideration as a separate environmental issue.

7.4.1.2 Improvements of Value Engineering during Construction Stage

Item 1. Conducting a Value Engineering workshop after the award of the construction.

It was noted in Item 3 of Section 7.5.1.1 that the contractors' expertise can be employed to the overall benefit of the project. This is an opportunity to reduce project risk by reviewing the compatibility of the design and construction aspects of the project. It is consistent with current thinking in project management that at this stage the contractor is one of the 'stakeholders' in the project. Hence, it is as much in the contractor's interest as that of the client and design teams, to ensure the commercial and technical success of the project. This concurs with the recommendations of Neap and Seran (2009) for contractor's involvement.

Item 2. Monitoring and Auditing Value Engineering benefits.

Value Engineering represents an investment by the client, who requests, and ultimately pays for, its incorporation into the project. It is a logical conclusion, therefore, there needs to be a 'feed-back' system to authenticate claimed benefits are achieved. This can only be done by implementing a structured audit based on monitoring outcomes.

There is currently no evidence from either questionnaires or case studies that this is being undertaken.

Item 3. Controlling Variation and Change Orders.

When a variation or change order is issued there is a possibility that the change made may invalidate an assumption or precondition that the Value Engineering team had based their review upon.

By monitoring variation and change orders, potential conflicts could be identified and the client advised. In this way project cost estimate can be reviewed and updated and hence, improve the financial management and control of the project.

Item 4. Verifying Value Engineering recommendations adopted are achievable.

This is similar to Item 2 of this section but focuses on the technical outcome of the Value Engineering process being achieved. Again this provides a feedback of information in the Value Engineering process.

Item 5. Cultivate Company's Culture and Environment to maximise the benefits of Value Engineering.

While Value Engineering is seen primarily as a tool for design engineers, if the contractors' involvement is desired then the contractor's organisation will need to have an understanding and appreciation of what contribution is expected from them.

Item 6. Ensure the new regulations of certification on sustainability (Estidama) are achieved.

The Estidama regulations apply to the construction phase as well as the design stage. It will be necessary for the contractor to consider sustainability, in line with Estidama as well as the designers. Hence, it is considered that as the construction process necessarily involves the compatibility of both, in terms of sustainability, that Value Engineering would provide a suitable mechanism for this to occur.

Failure to comply poses a significant risk to all stakeholders, hence they need to co-operate on this issue.

7.4.2 Implementation and relevance of the recommendations

The recommendations for improvement, detailed in Sections 7.4.1.1 and 7.4.1.2, were developed in the particular context of building construction in the United Arab Emirates. They identify specific issues where the effectiveness of Value Engineering has been impaired and hence indicate pitfalls to be avoided. They also indicate areas that have the potential to improve the Value Engineering outcomes for such projects.

These findings are therefore relevant to all stakeholders in such projects. In particular they are relevant to:-

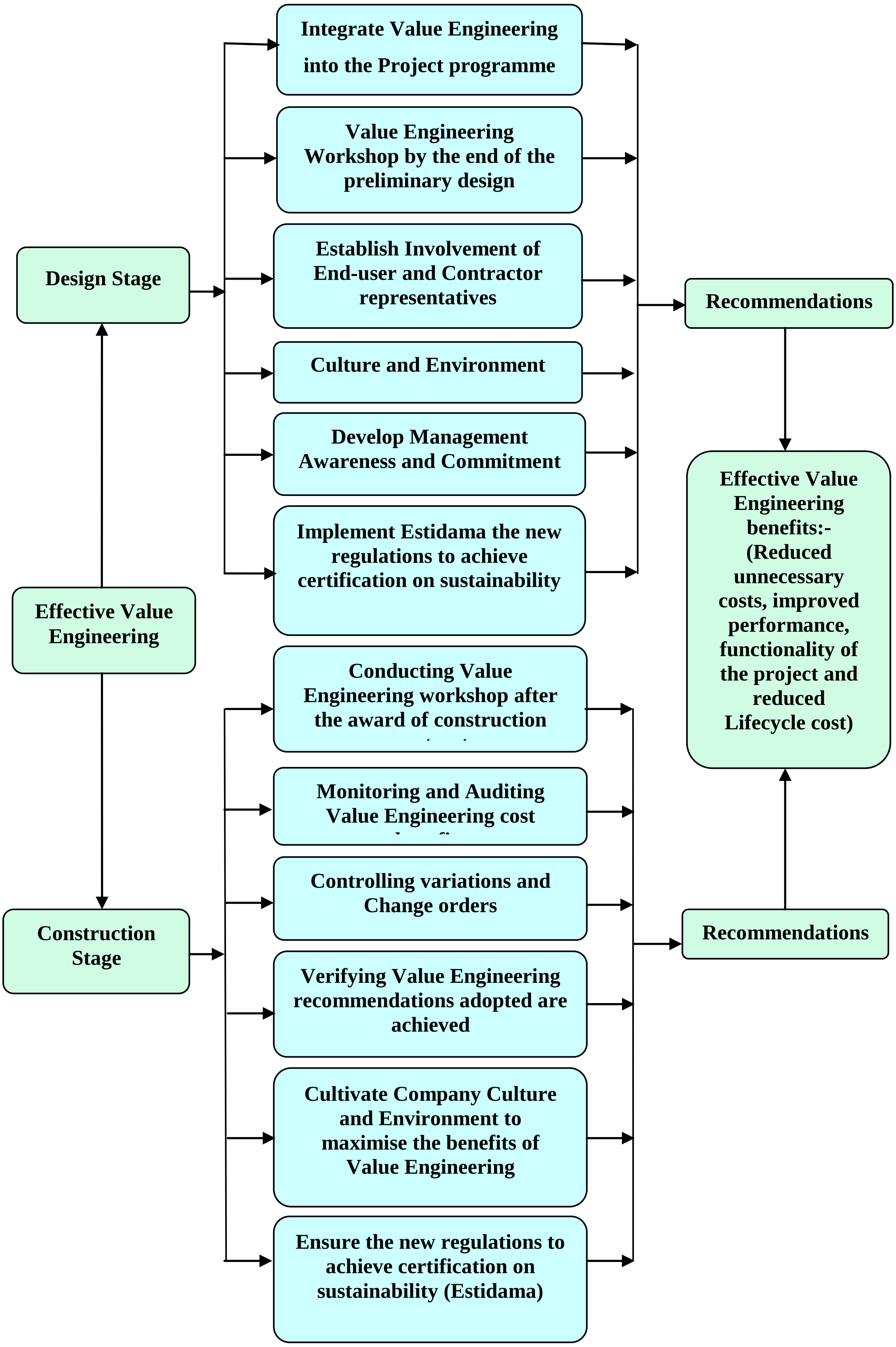
1. Value Engineers - For consideration when developing a client's or Company's Value Engineering procedures and those implementing the procedures.

2. Project Managers – Tasked with co-ordinating and integrating the Value Engineering process with the overall project objectives.

3. Clients – To provide confidence that a well structural and efficiently implemented Value Engineering process can deliver tangible benefits.

4. Contractors – As an efficient Value Engineering process can reduce variations and hence assist in implementing their construction programs more efficiently.

Figure 7.1 – Proposed Model for Improving the Effectiveness of Value Engineering



7.4.3 Proposed Improvement Model

The recommendations for improvement listed in Section 7.4.1.1 and 7.4.1.2 have been presented as a model schematic in Figure 7.1.

The model highlights specific issues for consideration and potential pitfalls to be avoided when developing or implementing the Value Engineering process in the context of United Arab Emirates building construction projects.

The recommendations are grouped under the design and construction stages.

7.5 Validation of the Proposed Model

The validation of the model was achieved by providing details of the proposed model to senior managers and specialists with experience of Value Engineering on projects in the United Arab Emirates.

The questionnaire issued is given in Appendix B together with the detailed responses.

Respondents were classified by the industrial sector they were employed and also whether they were Emirati nationals or not. The responses from Emirati nationals were included under the industrial sector they were employed and, also shown separately.

A total of 72 responses were achieved with the following breakdown:-

Value Engineers	6 Nos.
Project Managers	25 Nos.
Contractors	21 Nos.
Clients	20 Nos.
Total	**72 Nos.**

A total of fourteen (14) Emirati nationals contributed, of these twelve (12) were a client, one (1) was project manager and one (1) was construction company senior manager.

7.5.1.1 Results of the Validation for the Design Stage

Issue 1. Integrate Value Engineering in the project programme.

This received strong support, with 90.3% of all respondents in agreement and 62.5% of these being strongly in favour. 92.9% of the Emirati respondents agreed with 50% expressing ‘strong approval’. Four disagreed out of the total of 72, of these four one did provide a comment. There seemed to be confusion between the project programme and the construction programme.

Influence on proposal – consider clarifying project programme statement in the model.

Issue 2. Value Engineering workshop by the end of preliminary Design Stage.

This received similar strong support to Issue 1, with 93.1% of all respondents agreeing, 59.7% of them strongly agreed. One project manager, disagreed, but no reason was given. The response from Emirati respondents was 100% and 50% respectively for ‘agree’ and ‘agree strongly’.

Influence on proposal – no change to this issue in the model.

Issue 3. Establish involvement of End-user and Contractor.

There was a high overall agreement, but 76.4% respondents who strongly agreed reduce to 31.9%. The figure for overall agreement for Emirati’s was noticeably less in the agreement with 50% agreeing, but only 21.4% strongly agreeing.

From the data, three of the five respondents who disagreed were project managers and five were clients. The reason cited by one respondent was contractors would not be appointed when the Value Engineering at the design stage was being done.

Influence on proposal – Considering a specialist from project management team or project manager from client’s representative.

Issue 4. Culture and Environment.

This had the joint / second lowest agreement of all the model issues at 76.4% with 38.9% strongly agreeing. For the Emirati respondents this issue seemed more pertinent with 92.9% agreeing and 35.7% agreeing strongly.

Examination of the results show that no respondents disagreed but 17 of all 72 respondents (23.6%) entered a 'not sure response'.

<u>Influence on proposal</u> – revise the issue wording to clarify.

Issue 5. Develop Management awareness and commitment.

This issue received the strongest support of all issues presented, with 98.6% agreeing and 48.6% in strong agreement. There was a similar result from Emirati respondents at 92.5% and 28.6% respectively.

<u>Influence on proposal</u> – no change to the issue in the model.

Issue 6. Implement "Estidama", the new regulations to achieve certification on sustainability.

These received overall support with 86.1% agreeing and 70.8% of all respondents agreeing strongly. The Emirati respondents however registered their joint lowest support on any of the issues in the model, with figure of 70.80% and 57.10% respectively but none disagreed. Examination of the results shows that the agreement figures quoted above has the second largest number of 'not sure' entries (8 out of 72) for all respondents.

This is not totally unsurprising as the 'Estidama' regulations have been in operation only since 2010. It may be that some respondents working on long duration projects may not yet be familiar with the new 'Estidama' requirements.

What was surprising was that the only two respondents that disagreed were clients. However, lack of awareness due to the reason cited above may well be a factor, in not realising that these regulations are mandatory.

<u>Influence on proposal</u> – revise wording of the issue in the model.

7.5.1.2 Results of the validation for the construction stage

Issue 1. Conduct a Value Engineering workshop after the award of the construction.

This received the lowest agreement of all issues in the model, with 72.2% agreeing and only 30.6% in strong agreement. Emirati's, as a group, were more supportive with 78.6% agreeing and 42.9% in strong agreement.

The project managers were the least in favour, with 8 out of the 25 expressions of disagreement coming from this respondent category. Comments received indicate that they perceive Value Engineering as being exclusively a component related to design.

<u>Influence on proposal</u> – revise in the following Section 7.5.2, responses to the validation process.

Issue 2. Monitor and auditing Value Engineering cost benefits.

This received an agreement, from all respondents, of 83.3% in agreement and 31.9% in strong agreement. Again, as for Issue 1 above, Emirati respondents were similarly supportive with 85.7% agreeing, but only 21.4% strongly agreeing.

From the data it was seen that the Value Engineers and client categories were fully supportive, but the contractors and project managers registered disagreement, (5 registered disagreement, 1 strongly)

<u>Influence on proposal</u> – review in the following Section 7.5.2.

Issue 3. Controlling Variation and Change Orders.

There was strong support for this issue with 86.1% agreeing, 44.4% strongly from all respondents. Support was given by Emirati respondents with 78.6% and 50% respectively. From the data, one project manager and one contractor disagreed.

<u>Influence on proposal</u> – no change to this issue.

Issue 4. Verifying Value Engineering recommendations adopted are achieved.

Only one respondent registered non-agreement. The overall agreement was 91.7% and 54.2% strong agreement, amongst all categories. Similar returns were received from Emirati respondents with figures of 92.3% and 61.5% respectively.

Influence on proposal – no change to this issue.

Issue 5. Cultivate a Company Culture and Environment to maximise the benefits of Value Engineering.

Two respondents out of the 72 registered disagreed, but there were the highest number of 'not sure' returns of 15, which lowered the agreement percentages to 76.4% and 38.9% for all categories. Emirati respondents returned a similar response with 76.9% agreeing, but only 15.4% in strong agreement.

Influence on proposal – consider re-phrasing the statement.

Issue 6. Ensure the new regulations to achieve certification on sustainability (Estidama).

The results for all categories are 76.4% agree and of these 54.2% strongly agree. Emirati respondents registered figures of 78.6% and 64% respectively, indicating greater awareness of the regulations.

The comments made for issue 6 in Section 7.5.1.1 the use of 'Estidama' in the design stage are considered to apply. However compliance has to be verified during construction. The Estidama regulations requires: *"a Pearl Qualified Professional (PQP) to be a member of the design team who facilitates the Pearl Rating System for both Design and Construction stages",* Pearl Building Rating System, (2010). Therefore, some consideration is required for any variations and amendments.

Influence on proposal – consider re-wording the issue in the model.

7.5.2 Response of the validation process

The validation process has provided a high degree of agreement for the improvements in the management and control of the Value Engineering process in the United Arab Emirates. Also the responses from Emirati respondents and the combined responses of all categories of respondents do not exhibit any major differences. Although a case could be made that Emirati's consider cultural influences as being more significant to the Value Engineering process than the other respondents and are more aware of current legislation.

The following section examines revisions to the model in the light of the validation process conducted.

7.5.2.1 Changes to the Model

These are considered below, based on the findings of Section 7.5.1.1 and 7.5.1.2 where no changes has been indicated that issue will not be considered further.

Design Stage – Issue1

Clarify that it is the Value Engineering process that needs to be integrated into the project programme. This may be done by ensuring that this is done prior to earlier design or construction. Hence move its position in the model to be an activity prior to either of these operations.

Design Stage – Issue 3

Concerns were raised that no contractor would be appointed at this stage. The prime findings of the research were that construction expertise that can enhance the Value Engineering outcome. This could well be done by a project manager from client's representative with experience of construction issues or an experienced construction manager for project management consultant, hence replace contractor by construction expertise.

Design Stage – Issue 4

Clarify the statement by re-stating as:-
"Ensure Cultural Environmental issues specific to the United Arab Emirates are considered".

Design Stage – Issue 6

Clarify the statement by re-stating as:-

"Ensure current sustainability issues are addressed and mandatory regulations and clarification requirements (Estidama)".

Construction Stage – Issue 1

There seems to be a misconception that Value Engineering is exclusively a design issue. It has been demonstrated in this thesis that potential benefits can accrue to the project if it extends into the construction phase. Hence revise the statement in the model to:-

"Conduct a Value Engineering review after the contract award when the contractors' construction methodology is established".

Construction Stage – Issue 2

While there was some disagreement it was widely supported. The potential benefits identified in this thesis merits its inclusion. Hence, the issue remains unchanged in the Model.

Construction Stage – Issue 5

Due to the 'not sure' responses the wording of this issue is revised to:-

"Cultivate a company culture and environment that enables the Value Engineering process to operate effectively".

Construction Stage – Issue 6

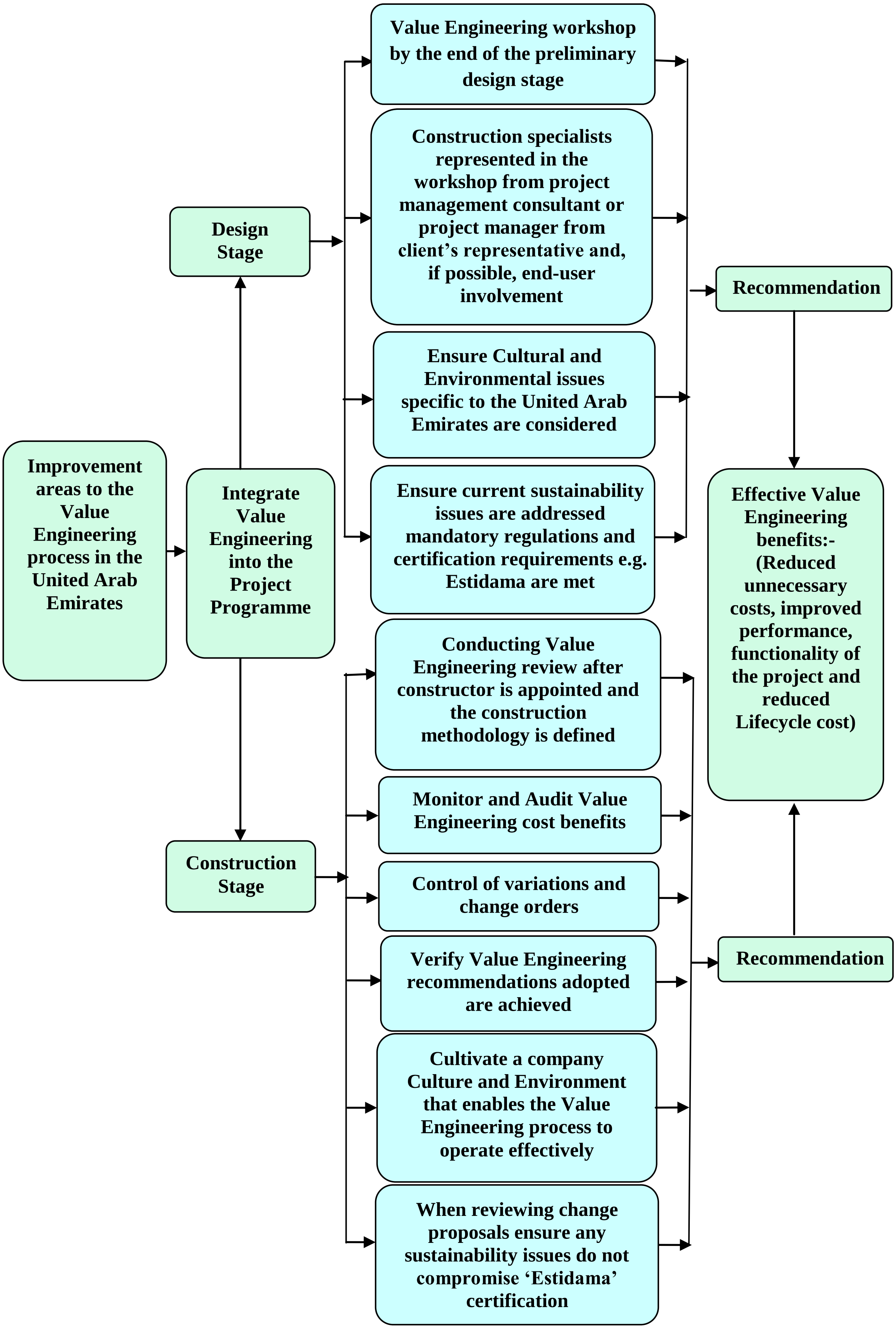
As with Issue 6 at the design stage, rewording is necessary to clarify the issue. The wording is revised to:-.

"When reviewing any change proposal ensure that any sustainability issues do not compromise Estidama Certification".

7.6 The proposed revised Model based on the response

The first model developed in Figure 7.1 was subsequently revised in light of the validation process. This proposed model is revised and improved is shown in Figure 7.2.

Figure 7.2 – Revised Model for Improving the Effectiveness of Value Engineering



7.7 Summary of findings

On the basis of the data collected, it was possible to identify a series of improvement factors and hence to develop a model for improving the Value Engineering process applied in the United Arab Emirates.

This model was then issued to clients, value engineers and contractors and project managers who had agreed to review and comment on the above information. On the basis of the comments from the independent reviewers, some additional modified statements were incorporated and the layout changed to improve the proposed model.

The research provided evidence that, currently, savings of 8% to 11% of project cost are being achieved by the current application of Value Engineering procedures in the United Arab Emirates. This compares well with the concept being predicted by some researchers. According to Siterman (2009), *"experienced value engineers can optimise various systems of a project with reduced capital budget and less operating expenses"*. Siterman further highlighted that the capital saving of 20% can be achieved with Value Engineering applications together with reduction of total energy requirement to the projects. However, some of the potential benefits of this process can be lost due to a *"lack of integration into the overall Project Management process"*, Siterman (2009).

The two major improvements issues that were identified in the design stage were:

- Integrate Value Engineering into the project programme.
- Conduct a Value Engineering workshop by the end of the preliminary design stage.

When workshops were conducted outside this stage of design difficulties were experienced in projects and potential benefits from the process were lost. By programming the Value Engineering process into the project at an early stage this problem could be alleviated.

During the construction stage the two key issues for improvement are to:

- Monitor and audit the Value Engineering (projected) cost savings.
- Verify the Value Engineering recommendations adopted are achieved.

Both these aspects provide a ‘feedback’ mechanism for improvement. They can also evaluate wider ‘outcomes’ in terms of ‘value’. This ‘plan-do-check’ process is advocated by Dallas (2006).

Of necessity, the ‘benefit’ issue in this thesis has been restricted to cost savings. The basic consumption made was that competent design teams are appointed and ‘Value’ targets have been defined in the clients brief and verified by ‘Value’ analysis within the overall Value Management process for the specialist and technical areas contributing to the project.

7.8 Benefits of applying the model

The model developed identifies specific improvement issues to be addressed when planning and implementing the Value Engineering process for building projects in the United Arab Emirates.

It has been shown in the case studies that the actual Value Engineering operation predicts savings varied among 8% for Case Study 1, 11% for Case Study 2 and 9% for Case Study 3 based on the initial project cost i.e. an average of about 9%.

The cost of the improvements suggested in refining the existing procedures would be primarily compared to the potential cost savings that could be achieved.

Deficiencies were identified in the case studies that could have been avoided if the recommendations of the proposed model had been implemented. For example, the difference in saving between the projects where the Value Engineering was conducted by the end of preliminary design stage and those where it was conducted later was of the order 2% to 3% (ref. Section 6.1.4). This is a considerable saving on project cost on just one of the factors identified. It is possible that the highest saving (i.e. 11%)

recorded in case study could have been greater had the model been fully implemented. Hence, tangible benefits can be achieved in applying the model as proposed by author. The assertion by Value Engineering specialists in questionnaire 3 of cost savings of the order 7% to 16% then seems realistic.

7.9 References

1. Al-Yousefi, A.S., Al Khuwaiter, A., Al Oshaish, S. and Shublaq, E. (1999), *Value Engineering in Saudi Arabia*, SAVE International Conference, pp 9-17.
2. Carter (1991/1992), *A study of Value Management and Quantity Surveying practice*, Surveyors Publications, London.
3. Dallas, M.F. (2006), *Value and Risk Management A Guide to Best Practice,* Lackwell Publishing Ltd, U.K.
4. Estidama Pearl Building Rating System (2010), *Design and Construction*, *Version 1.0*, Abu Dhabi Urban Planning Council.
5. Fist, E.R. (1988), *Construction Project Administration*, 3rd Edition, Willy, New York.
6. Ferry, D. and Brandon, P. (1984), *Cost planning of buildings,* 5th edition, Granada, London.
7. Kelly, J. and Male, S. (1988), *A study of Value Management and Quantity Surveying practice*, Surveyors Publications, London.
8. Kelly, J., Male S. and Graham D. (2004), *Value Management of construction projects,* Blackwell Publishing, United Kingdom.
9. Lin, G. (2003), *Developing a performance measurement framework for Value management Studies*, *Delivering Value today and Tomorrow*, pp 1-8 (downloaded from internet).
10. Neap, H.S., Seran, A. (2009), *Owner's Factor in Value –Based Project Management in Construction*, Journal of Business Ethics, Mar, page no. 99.
11. Paget, S. (2008), *Value Engineering and sustainability*, Annual Conference Paper and Presentation Abstracts, Save International.
12. Roe, B. (2009), *Value Engineering for Sustainable Data Centres*, Built Environment, Nov-Dec 2009.

13. Siterman, E. (2009), *A “perfect storm” boosts Value Engineering in Dubai*, Construction Week (online) available from 07 April 2012, www.constructionweekonline.com.
14. Seely, I.H. (1996), *Building Economics – appraisal and Control of building Design and Efficiency*, Macmillan Press Ltd, U.K.
15. Sneden, J.A. (1988), *A Value Engineering Incentive*, The Chartered Quantity Surveyor.
16. Waddle, T. W. (2008), *The Contractor’s Role in building Cost reduction After Design (Bringing a Project into Budget)*, The International Journal of Cost Engineering, February, pp 14-23.

CHAPTER 8

SUMMARY AND RECOMMENDATIONS

This chapter summarises the main research findings, to demonstrate how the research has met its objectives and addressed the hypotheses. It also sets out the recommendations for the improvement in the implementation and effectiveness of Value Engineering in the United Arab Emirates.

8.1 Summary

The research set out to examine how Value Engineering is being implemented in the United Arab Emirates and whether there are possibilities to improve the effectiveness in which it is currently being implemented. It has considered existing literature relating to effective Value Engineering implementation both internationally and especially to the United Arab Emirates. It has presented the methodology that underpins the research and the methods used in the process of data collection and evaluation. It has examined the perceptions and expectations that construction professionals in the United Arab Emirates have with respect to Value Engineering. It has also evaluated the implementation process and achieved outcomes of applying Value Engineering to construction projects in the United Arab Emirates using case studies. Finally, it has presented an improvement model which identifies key issues that need to be addressed in order to achieve improvements in the application of Value Engineering to building projects in the United Arab Emirates.

8.2 Objectives

This section addresses how, and to what extent, the research has met its objectives.

8.2.1 To gain an insight into current practices in Value Engineering on Building Projects in the United Arab Emirates

Current practices in the United Arab Emirates are based on widely accepted principles of Value Engineering methodology established by SAVE International. The SAVE International format is widely used, based used a forty (40) hour ‘workshop’ approach.

The Value Engineering Team is usually guided through the Value Engineering process by a ‘team leader’, who is usually an external consultant, but larger companies may use a suitably qualified and experienced staff member.

The Value Engineering procedures to be followed are usually embodied in company documentation, except where Value Engineering consultants are employed to manage the whole process.

There is no universal agreement on the optimum time that Value Engineering workshops should be conducted, with expert opinion varying from between 10% to 60% of the preliminary design stage. The findings of this research indicate that a failure to conduct the Value Engineering workshops by the end of the preliminary design stage results in a loss of potential benefits. Value Engineering is not programmed to extend into the construction stage of projects. The focus of the process is very much on design aspects with limited input on the constructability aspects of projects.

8.2.2 Evidence to identify cost benefits that are currently being achieved

Because Value Engineering in the United Arab Emirates is focused almost exclusively on the design stage of building construction projects, caution is required in addressing cost benefits. It is widely accepted that Value Engineering can result in a reduction in project costs, whilst maintaining functionality, of the order of 5% to 10%. This research indicates that, projected average savings of 8% to 11% are achieved based on three (3) case studies in the United Arab Emirates at the design stage.

However, the case studies indicate that much of these potential savings are being lost due to the lateness of implementing the Value Engineering during the preliminary design stage. This delay results in both additional design costs and time delays. Also some recommendations may have to be cancelled as the cost of late inclusion becomes prohibitive. Currently there is no auditing of the outcome of the Value Engineering process conducted at the post-design stage, so in most cases the projected cost savings predicted by Value Engineering cannot be verified.

8.3 Identify areas of improvement

Based on the literature review, seven (7) issues were identified as being essential for successful implementation of Value Engineering. Data collection from construction projects and personnel in the United Arab Emirates was focused on these issues in order to identify the potential for improvement.

The resulting key findings were:-

- The Value Engineering review does not consistently occur at the stage recommended to provide the maximum potential benefits to the project.

- The non-involvement of the project end-user or a construction specialist in Value Engineering workshops. This can result in additional cost and loss of time as a consequence of subsequent variations to the works.

- The culture and environment in the United Arab Emirates can have a significant effect on project outcomes and needs specific consideration by the Value Engineering team. A poor appreciation of these factors by the Value Engineering team can lead to inappropriate designs that can be costly to correct at later stages of the project.

- There is often a lack of understanding at senior management level in both client and contracting organisations of the Value Engineering process and its objectives.

- Value Engineering workshops are not conducted during the construction phase of projects. Hence, there is a lost opportunity to gain further cost efficiencies.

- The project's Value Engineering benefits to the contract is not audited to authenticate claimed benefits.

- The Value Engineering team needs to be aware of current regulations of sustainability introduced by Abu Dhabi Urban Planning Council. The recent government certification scheme on sustainability (Estidama) is of particular relevance for building design in the United Arab Emirates. The main objective is to achieve significant environmental, social, economic and cultural benefits while ensuring that the costs of development are optimised.

8.4 A model for improving the effectiveness of Value Engineering in the United Arab Emirates

A detailed study of the data identified specific areas where improvements could be potentially achieved, which resulted in the identification of specific targeted recommendations. These improvement recommendations apply to the design stage and also propose extending Value Engineering into the construction stage. A further recommendation is that the project programme incorporates Value Engineering as a specific activity.

The identified improvement recommendations for the design stages are:-

1. Conduct Value Engineering workshop by the end of the preliminary design.

2. Establish involvement of end-user and who has experience in construction from project management consultant or client's representative.

3. Specific consideration of the culture and environment in United Arab Emirates.

4. Develop management awareness and commitment.

5. Implement the new regulations to achieve certification on sustainability (Estidama).

The identified improvement recommendations for the construction stages are:-

1. Conducting Value Engineering review after the award of construction.
2. Monitoring and auditing Value Engineering cost benefits.
3. Controlling variations and change orders.
4. Verifying Value Engineering recommendations adopted are achieved.

5. Cultivate company culture and environment to maximise the benefits of Value Engineering.
6. Ensure the new regulations to achieve certification on sustainability (Estidama).

The identified improvement into the design consultant agreement is to:-

1. Include Value Engineering in the overall project programme.

The above improvement recommendations were incorporated into an improvement model. This model was then validated by independent construction practitioners with experience of Value Engineering in the construction projects in the United Arab Emirates.

8.5 Implementation responsibilities

For the model for improvement to be effective, responsibilities will have to be taken by all the project stakeholders.

While all stakeholders bear some responsibility it is the Project Managers that have the prime responsibility for co-ordination and implementation. The following suggested allocation is based upon the standard roles and responsibilities of stakeholders in construction projects. They may need to be revised to conform to the roles and responsibilities allocated in a specific project.

Clients :	Contribute to an effective briefing of the Value Engineering team include an 'End-user' input when possible. Be aware the subsequent variations reduce predicted benefits.
Project Managers:	Ensure Value Engineering Workshops are programmed into the preliminary design activity. Liaise with the client to supply the necessary design brief. Appoint an experienced Value Engineering team leader. Establish a monitoring process for Value Engineering outcomes and variations

Design Consultant: Work in a pro-active way with the Value Engineering team's recommendations.
Limit variations as far as possible.

Value Engineer : Ensure construction expertise is included in the team.
Be conversant with current sustainability regulations.
Have cultural awareness.

Contractor : Be proactive in Value Engineering reviews.
Provide information required for verifying outcomes.
Develop a company culture to support Value Engineering.

8.6 Examination of the validity of hypotheses

1. **'Value Engineering is currently being effectively implemented'**
   Many of the necessary structures and methods for Value Engineering are already in place in the United Arab Emirates. Client organisations are aware of the potential benefits advocated for the approach. There is also an expectation that cost savings will result. However, some deficiencies have been identified which can improve effectiveness of implementation.

2. **'Value Engineering currently provides tangible and measurable benefits'**
   Examination of the detailed proposed technical changes in the case studies do indicate some tangible and measurable benefits. However, from the client perspective of overall cost saving, the issue is less transparent. No evidence was found of a structured measured evaluation of predicted and achieved savings up to the completion of the project construction stage. Therefore, the predicted savings made during the Value Engineering workshops were not subsequently verified.

3. **'Current practice in the application of Value Engineering can be improved'**
   From hypothesis 1 and 2 above it is evident that improvement is possible. Much of the Value Engineering process is well structured, so it is primarily a matter of addressing specific inconsistencies that have been identified in this research. This has been incorporated in an improvement 'model'.

8.7 Originality and application of the research findings

8.7.1 Originality

This research has provided substantive evidence of the processes and output, based on cost, for Value Engineering on building projects in the United Arab Emirates. Such detailed critical evaluation has not previously undertaken and published. Further, the research provides a 'Model for improvement' that can be used to enhance existing established Value Engineering procedures by addressing the identified improvement factors specified in the model.

In validating the final model the process compared responses between Emirates nationals and expatriate professionals employed in the construction industry in the United Arab Emirates. This comparison has not been previously published.

8.7.2 Outcomes of the Research Findings

The evidence provided indicates that implementing the recommendations for improvement in the model developed will enhance the management and application of Value Engineering in the United Arab Emirates. Further, on the evidence of the case studies substantial cost benefits can potentially result from implementing the recommendations.

8.8 Limitations in the Research

The issue of value analysis and cost effectiveness proved too difficult to quantify in detail due to the technical complexity of the projects used in the case studies. It was decided early in this research that the business prospective of the management of the Value Engineering process would be the prime focus of the research. The decision was therefore made to view successful implementation as providing the client with an overall project cost saving in the range predicted by Value Engineering theory.

It therefore assumes that competent design teams are appointed and 'Value' targets for specific elements of technical, functional, sustainability and aesthetic etc. components of the design have been addressed in an appropriate way. This assumption was vindicated by verifying that the technical aspect of Value Engineering in the United Arab Emirates are producing cost reductions comparable with those claimed internationally, namely of the order 5% to 10%.

Due to the limited number of Value Engineering specialists with the necessary experience of working on building projects in the United Arab Emirates it was only possible to obtain the contribution of six (6) specialists to this research. This meant that the contribution of the questionnaires 2 and 3 with the associated structured interview was not as large as was desired. However, it is felt the insight provided by these specialists compensated for the reduced number. In fact there was significant agreement between the six respondents which gave the researcher confidence in the final outcome of this data set. The validation of the model also compensated to the above limitation to some extent.

8.9 Recommendations for Further Research

Areas and topics in which the author would recommend research in relation to Value Engineering in the United Arab Emirates:-

- Policy makers / managers:
    - The management and delivery of an effective project brief for Value Engineering.
    - A procedure to track predicted Value Engineering outcomes over the life of a project.

- Professionals:
  - Benchmarking of Value Engineering performance.
  - The Impact of environmental and sustainability regulations in the United Arab Emirates.
- Value Engineering:
  - The management and timing of Value Engineering conducted during the construction stage and their contract implications
- Contracting:
  - Evaluation of the benefits of a Contractors’ proactive approach to Value Engineering

CHAPTER 9

CONCLUSIONS

9.1 Conclusions

While client awareness of the potential benefits of Value Engineering and a sound underlying methodology and system has been identified as being present in the United Arab Emirates, there are areas for improvement in its current application.

From the case studies it was shown that, at the Value Engineering stage, savings in the range of 8% to 11% are achieved. This compares favourably with the 5% to 10% range predicted by researchers internationally. However, in the case studies, these anticipated savings were reduced to a maximum of 5% during project implementation, and some cases no net benefits resulted. This reduction in potential benefit has been shown to primarily result from deficiencies in the management and control of the Value Engineering process within the context of the overall project.

Addressing the following seven issues were identified as having the potential to effect improvements:

- The Value Engineering review does not consistently occur at the stage recommended to provide the maximum potential benefits to the project. This often resulted cost increases a delay due to the requirement for variations to be issued at the detailed design and construction stages of the project.

- The non-involvement of the project end-user or a construction specialist in Value Engineering workshops. This can result in additional cost and loss of time as a consequence of subsequent variations to the works.

- The culture and environment in the United Arab Emirates can have a significant effect on project outcomes and needs specific consideration of these factors by the Value Engineering team. A poor appreciation of these factors by the Value Engineering team can lead to in appropriate designs that can be costly to correct at later stages of the project.

- There is often a lack of understanding at senior management level in both client and contracting organisations of the Value Engineering process and objectives.

- Value Engineering workshops are not conducted during the construction phase of projects. Hence, there is a lost opportunity to gain additional cost effectiveness.

- Project's Value Engineering benefits to the contract is not audited to authenticate claimed benefits.

- The Value Engineering team needs to be aware of current regulations of sustainability introduced by Abu Dhabi Urban Planning Council. The recent government certification scheme on sustainability (Estidama) is of particular relevance for building design in the United Arab Emirates. The main objective is to achieve significant environmental, social, economic and cultural benefits while ensuring that the costs of development are optimised.

The above issues were addressed to develop, and validate, a model for the improvement in Value Engineering implementation in the United Arab Emirates. This model proposes improvements at both the design and construction stages of the projects.

It is recommended that the final model proposed is to be considered when the Value Engineering processes in the United Arab Emirates are being planned and implemented, in particular by client, design consultant and project management organisations. Also, contractors need to be encouraged to be proactive during the construction stage.

Clients and project management organisations are in a position to ensure that the issues raised in this research are addressed in the project stakeholder's interests and ensure these issues are incorporated in the context of the overall project management and control system for building projects in the United Arab Emirates.

BIBLIOGRAPHY

- Abdullah, A. (2003), *Intelligent Selection of Demolition Technique*. Ph.D Thesis, Loughborough University, Berkshire.
- Abu Dhabi Urban Planning Council (2007), *Plan Abu Dhabi 2030, Urban Structure Framework Plan*, Abu Dhabi, United Arab Emirates.
- Abu Dhabi Urban Planning Council (2010), *The Pearl Rating System for Estidama, Building Rating System Design and Construction version 1.0*, Abu Dhabi, United Arab Emirates.
- Alasuutari, P. (1998), *An Invitation to social research*, Sage Publication, London.
- Alder, N.J. (1991), *International dimensions of Organisational Behaviour* (2nd edition), Published by PWS-Kent, Boston MA, United Kingdom.
- Al Duaij, J., Awaida T., and Kollarayam, A. E. (2007), *Performing Value Analysis on Construction Project Variation Orders*, Cost Engineering International Journal, June pp 23-27.
- Al-Hammadi, A. (2010), *Middle East Business Intelligence (MEED)*, Page no 6, William Gibbons, U.K.
- Al-Yousefi, A.S., Al Khuwaiter, A., Al Oshaish, S. and Shublaq, E. (1999), *Value Engineering in Saudi Arabia*, SAVE International Conference, pp 9-17.
- Al-Zammy, Y., Hoddell S.E.J, Savage B.M. (2002). *"Understanding the difficulties of implementing quality management in Yemen"*, The TQM magazine, Vol 14, No. 4, pp 240-247.
- Amanda, S. (1993), *Approaches to Organisational Culture and Ethics*, Journal of Business Ethics, Jan 1993, Vol. 12.1.
- Amaratunga, D and Baldry, D., Sarshar, M. and Newton, R. (2002), *Quantitative and Qualitative Research in the Built Environment: Application of 'Mixed' Research Approaches*, Work Study, vol.551 pp 17-31.
- Ashworth.A and Hogg.K. (2000),*Added value in design and construction*, Pearson Publication Ltd., United Kingdom.
- Assafm, S. et al. (2000),*Value Engineering*, College of Environmental Design, (KFUPM), Dhahran, Kingdom of Saudi Arabia.
- Avison, D., Baskerville, R. and Myers, M. (2001), *Controlling action research project*, Information Technology and People, Vol.14 pp 28 – 45.

- Benesh, G.C. (2008), *Culture Shock, A Survival Guide to Customs and Etiquette, United Arab Emirates*, Marshall Cavendish.
- Blaxter, L., Hughes C. and Tight M. (2006), *How to research,* 3rd edition, Open University Press, England.
- Brain, R.N. and William C.M. (1995). *Value Management in Construction, A Practical Guide,* United Kingdom.
- Brian, R.N., and William C.M. (1995), *Value Engineering in Saudi Arabia,* SAVE International Conference, pp 9-17.
- Brown, A. (1995), *Organisational Culture.* Esser: Pearson Education Limited.
- *Building Works Regulations and the Executive By Law (1994)*, Department of Municipalities and Agriculture, Abu Dhabi Municipality.
- Burns, R.B. (2000), *Introduction to research,* Sage Publication, Thousand Oaks, California, United States.
- Carter (1991/1992), *A study of Value Management and Quantity Surveying practice*, Surveyors Publications, London.
- *Changing patterns–UK Framework for Sustainable Consumption and Production*, DEFRA 2003, retrieved from www.defra.gov.uk/environment/business/scp.
- Charles, Y.J., Cheah, C. Y. J., and Ting, S. K. (2004), *Appraisal of Value Engineering in construction in Southeast Asia*, International Journal of Project Management, February Vol. 23, issue 2, pp 151-158.
- Cheah, C.Y.J and Ting S.K. (2005), *Appraisal of Value Engineering in Construction in Southeast Asia.* International Journal of Project Management, Vol. 23, pp 151-158.
- Cladwell-Shaw, M. and Chan, A. (1992), *Value Management – A Gateway to a more competitive Construction Industry*, *The Building Economist*, June, Volume 31, pp 7 -11.
- Colacchia, G.V. (1995), *Estimating for Value Engineering*, SAVE International proceedings.
- Columnist, G. (2009), *Value Engineering in Dubai,* (online) available from 06 April 2012, www.constructionweekonline.com.
- Connaughton, J.N. and Green, S.D. (1996) *Value Management in Construction – a Client's Guide,* SP29 CIRIA, London.
- Cook, B. and William, P. (1998), *Construction planning, programming and control,* Mcmillan London, United Kingdom.

- Creswell, J. (1994), *Research Design: Qualitative and Quantitative Approaches*, Sage Publication, Thousand Oaks, California.
- Dallas, M.F. (2006), *Value and Risk Management A Guide to Best Practice*, Lackwell Publishing Ltd, U.K.
- Darke, P., Shanks, G. and Broadbent, M. (1998), *Successfully Competing Case Study Research: Combining Rigour, Relevance and Pragmatism*, Information system Journal, Vol. 8, pp 273-289.
- Dasgupta, R. and Mujumdar, K.J. (2000), *Value Engineering Management in an Industry – A case study of GGL* , SAVE International Conference proceedings, pp 40- 43.
- Dell' Isola, A.J. (1973), *Value Engineering in the Construction Industry*, Construction Publishing, Washington.
- Dell'Isola, A.J. (1982), *Value Engineering in the Construction Industry*, 3rd Edition, Van Nostard Reinhold, New York.
- Denscombe, M. (2003), *The good research Guide- for small-scale social research project*, 2nd edition, Open University Press, Maidenhead, Philadelphia.
- Dubai Chamber of Commerce (2009), *LEED FACTS, Project Profile, Dubai Chamber of Commerce and Industry Headquarters*, LEED Existing Certification Award.
- Easterby-Smith, M., Thorpe, R. and Lowe, A. (2001), *Management Research: An Introduction*, Sage Publication, London.
- Egan, J. (1998), *the Egan Report: Rethinking Construction,* DOE London.
- El-Alfy, A.E.D. (2010), Designing *of sustainable building through Value Engineering*, Journal of Building Appraisal, Vol.6, pp 69-79.
- El-Sayegh, S.M. (2007), *Risk assessment and allocation in the UAE construction Industry*, International Journal of Project Management, Vol.26, pp 431-438.
- Zaneldin, E.K. (2006) *Construction claims in United Arab Emirates: Types, causes, and frequency*, International Journal of Project Management, Vol. 24, pp 453-459.
- Estidama Pearl Building Rating System (2010), *Design and Construction, Version 1.0*, Abu Dhabi Urban Planning Council.
- EunHong, Kim, William G. Wells Jr., Michael R. Duffey (2003), *A model for effective implementation of Earned Value Management methodology*, International Journal of Project Management, July, Volume 21, pp 375-382.

- Evans, S. (2009), *Middle East Business Intelligence (MEED),* Page no 33, William Gibbons, U.K.
- Fairservice, I. (2007), *Dubai: Gateway to the Gulf*, Motivate Publishing, U.A.E.
- Fellows, R. and Liu, A. (2003), *Research method for construction,* 2nd edition, Blackwell Publishing, Oxford, United Kingdom.
- Ferry, D. and Brandon, P. (1984), *Cost planning of buildings,* 5th edition, Granada, London.
- Fink (2006), *How to Conduct Surveys: A step-by-step guide,* London: Sage.
- Fist, E.R. (1988), *Construction Project Administration*, 3rd Edition, Willy, New York.
- Foreman, C. and Roberts, J., (2010), *Meed, Middle East Business since 1957*, Volume 54 No. 24. pp 6 – 22 William Gibbons, U.K.
- Foreman, C. K. (2009), *Middle East Business Intelligence (MEED),* page no. 28, William Gibbons, U.K.
- Foster, M. (1972), *An Introduction to the Theory and Practice of Action Research in Work Organisation*, Human Relations, vol.25, pp 529-556.
- Gallier, R. (1992), *Information System Research: Issues, Methods and Practical Guidelines,* Blackwell Scientific, Oxford.
- Ganah, A.M. (2003), *Computer Visualisation Support for Billability*, PhD thesis, Loughborough University.
- George, G.M. (2003), *The implementation of project management in the building construction field in the United Arab Emirates*, PhD Thesis, University of Glamorgan.
- Ghosh, A. K. (2008), *Success of Value Engineering Applications in Organisations in the competitive world,* SAVE International 2008 Annual Conference.
- Gill, J. and Johnson,P. (2002), *Research Method for Managers*: 3rd Edition, Sage Publication, London.
- Glenn, J.C. and Gordon T.J. (2003), *Futures Research Methodology*, ACUNU Millennium Project.
- Glover, N. (1992), *Value management Applied to Organisational Effectiveness*, International Conference of the Society of American Value Engineers (SAVE), pp 158-168.
- Goetsh, D.L., Davies S.B. (2003), *Introduction to total quality management for production, processing and services,* Upper Saddle River: Simon & Schuster.

- Gongbo, L., Developing a performance measurement framework for Value management Studies.
- Gordon, W. and Langmaid, R. (1998), *Qualitative Market Research: A Practitioner's and Buyer's Guide*, Gower, Aldershot.
- Gordon, W.J. (1961) *Synetics: The development of creative Capacity,* Harper, New York.
- Graham, M.P. (2000), *The Strategic Phase of Privately Financed Infrastructure Project*, PhD Thesis, University of Leeds.
- Green, S.D. (1990). *The Essentials of Value Engineering Chartered Builder Journal*, United Kingdom.
- Green, S.D., Popper, P.A. (1990), V*alue Engineering : The search for Unnecessary Cost*, Occasional paper no.39, Chartered Institute of Building, Ascot.
- Greenwood, M. (1997), *Discovering the individuals risk behaviour profile.* ARCOM 13th Annual Conference, 15-17 September 1997, Cambridge, UK.
- Geography of U.A.E., *US library of Congress*, online retrieved from www.countrystudies.com.
- Handy, C. (1993), *Understanding Organisation*, 4th edition, Benguin Group Publishers, U.K.
- Hassanein, A.A.G. and HalaM.f.Afify, H. (2007) Contractors' Perceptions of Construction Risks – A Case Study of Power Station Projects in Egypt, Cost *Engineering, Vol.49/No.5,* May, pp 25-34.
- Hodgetts, R.M., Luthans, F. (1991), *International Management*, 3rd edition, McGraw Hill, New York, U.S.A.
- Hofstede, G. (2003), *Cultures and organisations. Software of the mind: Intellectual cooperation and its importance for survival.* Second edition, London: Profile books.
- Hofstede, G. (1980). *"Culture's consequences: International differences in work-related values"*, Sage, Beverly Hills, CA.
- Hofstede, G., Hofstede, G.J. (2005), *"Cultures and organisations: Software of the mind",* Sage, Beverly Hills, CA.
- Hughes, J.A., Randall, D. And Shapiro, D. (1992), *Faltering from Ethnography to Design*, Proceeding of CSCW 92. ACM 1992 Conference on Computer-Supported Cooperative Work: Sharing Perspective, New York: ACM Press, pp 115-123.

- Humford, E. (2001), *Advice for an Action Researcher, Information Technology and People*, Vol.14, pp 12-27.
- Hayden and Parsole (1996), *Value Engineering in the Construction Industry*, 3rd Edition, Van Nostard Reinhold, New York.
- Jacob, A. (2010), "*UAE professionals thinking green, but not doing*", retrieved on 02 February 2012, http://www.khaleejtimes.com.
- Jeyakumar, R. (1999), *Value Engineering Application in the U.A.E., Dissertation thesis submitted for M.Sc. in Engineering Project Management to School of Built Environment*, University of Glamorgan.
- Jing, X.U. and Ling F.J.Y. (2005), *Constructing a framework for building relationships and trust in project organisation*: two case studies of building Projects in China, Construction Management and Economics, September, pp 685-696.
- Johnson, G. and Scholes, K. (1999), *Exploring Corporate Strategy: Text and Cases*, 5th edn. Prentice Hall Europe, Hemel Hempstead.
- Johnson, W.J., Leach, M.P. and Liu A.H. (1999), *Theory Testing using Case Studies in Business-to-Business Research*. Industrial Marketing Management, Vol.28 pp 201-213.
- Johnson, B. and Turner, L.A. (2003), *Data Collection Strategies in Mixed Methods Research. In: A. Tashakkori and C. Teddlie (Eds.) Handbook of Mixed Methods in Social and Behavioural Research*, Thousand Oaks. CA.: Sage.
- Jugdev, K., Mathur, G. and Fung, T.S. (2007), project management assets and their relationship with the project management capability of the firm, *International Journal of Project Management* Vol. 25, pp 560-568.
- Kagioglou, K., Cooper, R., Aoud, G., and Sexton M, (1998), *Rethinking Construction: The Generic Design and Construction process Protocol, Engineering, Construction and Architectural Management*. Vol 7 pp 141-153.
- Kamaruzzaman, S. N., Egbu C.O., Zawawi, E.M.A, Ali, A.S., Che-Ani, A. I. (2011), "*The effect of indoor environmental quality on occupants' perception of performance: A case study of refurbished historic buildings in Malaysia*", Energy and Buildings, 43, pp 407–413.
- Kasi, M. (2009), *Function Approach to Transportation Projects, A Value Engineering Guide*, Alfred Basesch & Company.

- Kelly, J., Male S. and Graham D. (2004),*Value Management of construction projects*, Blackwell Publishing, United Kingdom.
- Kelly, J. and Male, S. (1988), *A study of Value Management and Quantity Surveying practice*, Surveyors Publications, London.
- Kelly, J. and Male, S. (1992), *Value Management: Enhancing Value or Cutting Costs*, The QS Bulletin.
- Kelly, J., Morledge, R., and Wilkinson, S. (2006), *Best value in construction*, Blackwell Science Limited, United Kingdom.
- Kelly, J..and Male, S. (1999), *the implementation of value management in the public sector: A value for money approach, SAVE International Conference Proceedings,* pp 333-339.
- Kelly, W. (1986), *You and Value What Not,* Vest, Vest Walla, Walla, Washington state, USA.
- Kelly, J., Male.S and Graham.D. (2004), *Value Management of construction projects*, Blackwell Publishing, United Kingdom.
- Kelly, J., Male, S. (1993), V*alue management in design and construction: The economic management of projects*. E & F N Spon, London.
- Kim, E., Wells (Jr), W. G. and Duffey M. R. (2003), *A model for effective implementation of Earned Value Management methodology*, International Journal of Project Management, July, Volume 21, pp 375-382.
- Kirk, S. J., and Spreckelmeyer, F. K. (1993), *Enhancing value in design decisions*. S J Kink, Detroit, USA.
- Klien, H.K. and Myers, M.D. (1999), *A set of Principles for conducting and evaluating interpretive field studies in information systems*, MIS Quarterly , Vol.23. pp 67-94.
- Kondo, Y. (2002), *The line-up of leadership,* The TQM magazine, Vol. 14, No.6, pp 339-344.
- Krishnan, K. (1996), *Application of Value Engineering to enhance Personal finances, SAVE International conference Proceedings,* pp 132-138.
- Lang, G. And Heiss G. (1984), *A Practical Guide to Research Methods*, University Press American. Lanham.
- Latham, M. (1994), Constructing the Team, Final report of Government Industry Review of Procurement and Contractual Arrangements in the UK Construction Industry, HMSO, London.

- Laudon, K.C. and Laudon, J.P. (2002), *Management Information System: Managing the Digital Firm*, 7th Edition, Prentice Hall, New Jersey.
- Laurent, A. (1983), *The Cultural diversity of Western Conceptions of Management*, 13, 75-96 International Studies of Management and Organisation Published by Penguin Group, U.K.
- Leedy, P.D. and Ormorod, J.E. (2001), *Practical Research Planning and Design*, 7th edition, Prentice – Hall, New Jersey.
- Lee, S. Y. and Guerin, D.A. (2010), '*Indoor environmental quality differences between office types in LEED-certified buildings in the US*', Building and Environment, 45, pp 1104-1112.
- Lin, G. (2003), *Developing a performance measurement framework for Value management Studies, Delivering Value today and Tomorrow*, pp 1-8 (downloaded from internet).
- Lin, G.B., Shen, Q.P., and Fan, S.S. (2004), *A Framework for Performance Measurement of Value management Studies in construction*, Proceeding of the 3rd International Conference on Construction and Real Estate Management, China Architecture & Building Press, Hongkong, pp 307-311.
- Langdridge, D. (2004), *Introduction to Research Methods and Data Analysis in Psychology*. Harlow: Prentice Hall.
- Luke, A. (2009), *Forming Features, What strategies are formworks companies implementing,* i*n order to counteract the Economic slowdown*? Construction week investigates, Construction Week, May 2-8, pp 27-28.
- Macedo, M.C., Dobrow, P.V. and O'Rourke, J.J. (1978), *Value Management for Construction,* Wiley Interscience, New York.
- Male, S., Kelly J. (2005), *Reappraising value methodologies in Construction for Achieving best value*, Value solutions Ltd, pp 1-14 (downloaded from internet).
- Male, S., Kelly, J. Grongqvist, M. and Graham, D. (2007), *Managing value as a management style for projects*, International Journal of project Management, Vol.25, pp 107-114.
- Mangoub, Y. (1999), *Architecture of the United Arab Emirates,* Retrieved on 24 July 2012, from the Architecture of the United Arab Emirates. http//victorian.fortunecity.com.
- Maree, K. (2009), *Middle East Business Intelligence (MEED),* Page no 18, William Gibbons, U.K.

- Martin, S.J. (1998), *Constructively Measuring Value Programs Effectiveness, SAVE International Conference Proceedings*, pp 239-248.
- Martin, M. (1999), Midle East Buisiness Intelligence MEED magazine 'supplement', pp 8-9, William Gibbans, U.K.
- McGeorge, D. and Palmer, A. (1997), *Construction Management New Directions*, Blackwell Science, U.K.
- Melville, S. and Goddard, W. (1996), *Research Methodology: An Introduction for Science and Engineering Students*, Creda Press, Cape Town.
- Michelle C. and Albert C. (1992), *Value management – A Gateway to a more competitive Construction Industry,* The Building Economist, June 1992, Volume 31, PP 7-11, United Kingdom.
- Miles, F. and Bytheway (1992), *Techniques of value analysis and engineering, 2nd edition,* New York McGraw- Hill.
- Miles, J.C., Moore, C.J., Kotb, A.S.M. and Jaberisan,H.A. (2000), *End User Evaluation of Engineering Knowledge Based Systems,* Civil Engineering and Environmental Systems, VOL.17 pp 293-317.
- Miles, L.D. (1972), *Techniques of Value Analysis and Engineering*, 2nd Edition, McGraw-Hill, New York.
- Mohamed, F.S. (2006), *Integrating Knowledge Management Processes into Site management Practices*, PhD thesis, Loughborough University.
- Molly, K.K. (2007), *Six steps for Successful Change Order Management*, Cost Engineering, Vol. 49/No.4, April, pp 12-19.
- Moore, D. (2000), *How to do Research*, Library Association Publishing Ltd., London.
- Morgan, B.J.T. (1984), *Element of Simulation*, Chapman and Hall, London.
- Mudge, A.E. (1971), *Value Engineering – A Systematic Approach,* McGraw – Hill, New York.
- Mukhopadhyaya, A.K. (2009), *Value Engineering Mastermind, from concept to Value Engineering Certification*. SAGE Publication, California.
- Mullins, L.J. (1993), *Management and Organisational behaviour* (2nd Ed.), Published by PWS-Kent, Boston MA. U.K.
- Myers, M.D., (1999), *Investigation Information System with Ethnographic Research,* Communication of the AIS. Vol.2 pp 1-20.

- Nadem, A.B.A.T. (2009), *Understanding and Preventing Construction Conflict, claims and Disputes, A critical in-depth study into their causes and recommendations to control in the United Arab Emirates,* PhD Thesis, University of Glamergon.
- Nalewaik, A. (2007), *Construction Audit – An Essential Project Controls Function*, *Cost Engineering*, October, pp 20-26.
- Naoum, S.G. (1998), *Dissertation Research and Writing for Construction Students*, Elserier Butterworth Heinemann.
- Neap, H.S., Seran, A. (2009), *Owner's Factor in Value –Based Project Management in Construction*, Journal of Business Ethics, Mar, page no. 99.
- Neuman, W.L. (2006), *Social Research Methods: Qualitative and Quantitative Approaches:* 6th edition, Pearson Education, Boston, United States.
- Nolan, V. (1987), *The Innovator's Handbook,* Sphere Books, London.
- Norton (1992), *A Value Engineering Case Study*, Chartered Quantity Surveyor, September, page no. 7.
- Norton, B.R. and McElliot, W.C. (1995), *Value Management in Construction: A Practical Guide*, Macmillan Press Ltd., London, United Kingdom.
- Nutakor, G. (2007), *Assessing Final Cost of Construction at Bid Time*, International Journal of Cost Engineering, June,Vol.49/No.6, pp 15-21.
- O'Leary, Z. (2004), *The essential guide to doing research,* sage publication, Thousand Oaks, California, United States.
- Otto, B. K., (2007), "*Sustainable Office Design: Unlocking Performance and Productivity*", Morgan Lovell - Inspiring office transformation, retrieved on 02 February 2011 from http://www.morganlovell.co.uk/useful-info/white-papers.
- Paget, S. (2008), *Value Engineering and sustainability*, Annual Conference Paper and Presentation Abstracts, Save International.
- Palmer, A. (1990), *A Critique of Value Management*, Technical Information Service No. 124, Ascot.
- Paul, R. (1997), Value Engineering and the Texas Prison System Expansion, *Cost Engineering,* January, Vol.39, pp 7-8.
- Payne, J. and Beardsall, D. (2005), *Application of Value Management to the Understanding and Improvement of knowledge Management, Delivering Value Today and Tomorrow*, pp 1- 8.

- Powell, A. (2009), *The (un) Balancing Act: The impact of culture on women engineering students gendered and professional identities.* P.H.D. Thesis, Loughborough University, UK.
- Proto, A. K. (2009), *Middle East Business Intelligence (MEED)*, pp 40-41, William Gibbons, U.K.
- Punch, F.K. (1998), *Introduction to social research: Quantitative and Qualitative approaches*, Sage publications, United Kingdom.
- Punch, F.K. (1999), *Developing effective research proposals*, 2nd edition, Sage publications, United Kingdom.
- Qie, W.H and Yang, M. (2007), *Theory and Practice of Project Value Management*, Beijing, China Machine Press, page no. 89 and pp 124-143.
- Qiping, S. and Jacky, K. H. Chung, a group decision support system for value management studies in the construction industry, International Journal of Project Management, Vol. 20,2002, pp 247-252.
- Robert, P. (1997), *Value Engineering and the Texas Prison System Expansion*, Cost Engineering, January, Vol.39, 1997, pp 7-8.
- Robson, C. (2002), *Real World Research*, Oxford: Blackwell Publishing Company.
- Roe, B. (2009), *Value Engineering for Sustainable Data Centres*, Built Environment, Nov-Dec.
- Salama, M, and Habib, A.P. (2009), *Investigating the cases of variation within the Construction Projects in U.A.E.* In: Dainty, ARJ (Ed) procs 25th Annual ARCOM Conference, 7-9 September, Nottingham, UK, Association of Researchers in Construction Management, pp 949-957.
- Samarrai, H., Souwed, A. M. (2006), *Emirates and GCC Society*, University Book House, Al Ain U.A.E.
- Sameh, M., El-Sayegh (2008), *Risk assessment and allocation in the United Arab Emirates construction Industry*, International Journal of Project Management,Vol.26, pp 431-438.
- Seely, I.H. (1996), *Building Economics – appraisal and Control of building Design and Efficiency*, Macmillan Press Ltd, U.K.
- Seraphim, D. (2005), *Implementing TQM principles in a construction company in the U.A.E.*, PhD Thesis, University of Glamorgan.

- Shen, Q.P., and Chung, J.K.H. (2002), "*A group decision support system for value management studies in the construction industry*". *International Journal of Project Management*, 20, pp 247-252.
- Shen, Q.P., Lin G.B., Kelly, J., and Sun, M., (2005), "*Measuring the Processes and Outcomes of Value Management Studies in Construction*". Proceeding of the 7th International Value Management Conference – Why Re-Invent the wheel, Hong Kong Institute of Value Management, 2-3 June, Hong Kong.
- Siterman, E. (2009), *A "perfect storm" boosts Value Engineering in Dubai*, Construction Week (online) available from 07 April 2012, www.constructionweekonline.com.
- Smircich, L. (1983), *Concepts of Culture and Organisational Analysis. Administrative Science Quarterly*, 28 (3): pp 339-358.
- Smith, T.R. (1995), *Value Engineering and Full – service Appraisal: New Dimensions for Old Technology,* The Appraisal Journal, pp 418-424.
- Sneden, J.A. (1988), *A Value Engineering Incentive*, The Chartered Quantity Surveyor.
- Stephen, J.K. and Alponse, J.D.I. (1995), *Life Cycle Costing for design professionals*, McGraw Hill, U.S.A.
- Stewart, J. (2009), *Abu Dhabi's genuine property demand will fuel construction, Construction Week,* March 14-20, pp10.
- Stringer, R.A. (1995), *Value Engineering a Nation- South Africa: A Case Study*, SAVE proceedings, pp 309-314.
- Sustainability Report (2009), Parsons Corporation, Pasadena, U.S.A.
- The CTBUH 8th World Congress (2008), *Tall and Green; Typology for a Sustainable Urban Future. The Council on Tall Buildings and Urban Habitat (CTBUH)*, 3-5 March, Dubai, United Arab Emirates.
- Urban Street Design Manual (2009), *Plan Abu Dhabi 2030, Next Generation Planning,* Abu Dhabi Urban Planning Council, Abu Dhabi.
- Urban Structure Framework Plan (2007*), Plan Abu Dhabi 2030, Abu Dhabi Urban Planning Council*, Abu Dhabi.
- US Green Building Council (2007), *New Construction & Major Renovation Reference Guide*, Third edition.
- Value Methodolgy Standard and Body of knowledge (2007), *Save International. Value Standard, 2007 edition.*

- Waddle, T. W. (2008), *The Contractor's Role in building Cost reduction After Design (Bringing a Project into Budget),* The International Journal of Cost Engineering, February, pp 14-23.
- Wajcman, J. (1998), *Managing Lime a Man: Women and Men in Corporate Management,* Cambridge; Polity Press.
- Wajcman, J. and Martin, B. (2002), *Narratives of identity in modern management: The corrosion of the identity difference?* Sociology, page no. 36.
- Wilen, J. (2008), *Sustainable building and green buildings,* United Arab Emirates.
- Willemyns, M., Hosie, P. and Lehaney, B. (2011), *Communication and Social Identity Dynamic in UAE Organisation, International Review of Business Research Papers,* Vol. 7, March 2011, pp 245-256.
- Woodhead, (2005), *Paired Comparison: why tools and techniques with the value methodology,* Save International, San Diego, California, June 26-29th.
- Woodhead, R.M. and Garnett, A.J. (2006), *Value Engineering and theories of the firm "45th Annual Conference of the Society of American Value Engineering International (SAVE International),* Savannah, Georgia, June 5-7th.
- Yeo, K.T. and Qiu, F. (2003), *The Value of management flexibility – a real option approach to investment evaluation,* International Journal of Project Management Vol. 21, pp 243 – 250.
- Yin, R. K. (2003), *Case study research: Design and methods* (3rd edition.).Thousand Oaks, CA:Sage.
- Zaneldin, E.K. (2006), *Construction claims in United Arab Emirates: Types, causes, and frequency,* International Journal of Project Management, Vol. 24, pp 453-459.
- Zimmerman, L.W. and Hart, G.D. (1982), *Value Engineering: A practical approach for Owners, Designers and Contractors,* Van Nostrand Reinhold Company, New York.

APPENDIX - A

CASE STUDY No. 1 – VARIATION ORDERS

RUWAIS HOUSING COMPLEX EXPANSION – PHASE III

MARRIED ACCOMMODATION AND

RELATED FACILITIES INCLUDING INFRASTRUCTURE

Case Study 1

Ruwais Housing Complex Expansion – Phase III
Married Accommodation And Related Facilities Including Infrastructure

Table A.1 - Variation order No. 1

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	1	1	Optimising number of children's play grounds.	(37,873.29)	Nil
2	2	1	Reducing number of palm trees from 230 to 150	(241,040.00)	Nil
3	3	1	Using interlock block in lieu of clay tile finish for pergolas roads	(13,494.24)	Nil
4	4	1	Deletion of stone boulders	(658,947.40)	Nil
5	5	1	Using steel handrails for balconies in lieu of GRC	92,958.80	Nil
6	6	2	Deletion of soap dispenser and change of paper dispenser to paper holder	(485,108.40)	Nil
7	7	1	Elimination of foldable sliding doors between dining and living room	(2,310,502.32)	Nil
8	8	0	Changing door in living room from double to single	(372,504.00)	Nil
9	9	0	Changing solid entrance door to fire rated veneered door	(265,926.00)	Nil
10	10	1	Removing windows from OTS and replacing with block work, plaster and paint	(257,068.00)	Nil
11	11	1	Using one layer 4mm water proofing membrane on roof in lieu of two layers	(166,495.00)	Nil
12	12	0	Deletion of 1000 gauge polythene sheet from water proofing	(46,900.00)	Nil
13	13	1	Elimination 5cm thick blinding concrete below slab on grade	(325,533.00)	Nil
14	14	0	Changing car park shading from tented fabric to PVC	(906,000.00)	Nil
15	15	2	Using mild steel instead of stainless steel for fire hose cabinets body	(169,800.00)	Nil

Case Study 1

Ruwais Housing Complex Expansion – Phase III
Married Accommodation And Related Facilities Including Infrastructure

Table A.1 - Variation order No. 1 (Cont'd…)

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
16	16	0	Using ERW pipes in lieu of seamless pipes	0.00	Nil
17	17	1	Optimising or minimising shading areas	(480,000.00)	Nil
18	18	0	Reducing parapet height	(618,659.48)	Nil
19	19	1	Deletion of double pole switches associated with heaters deleted	(106,920.00)	Nil
20	20	0	Deletion of mirror shelf wherever vanity is provided	0.00	Nil
21	21	1	Reducing number of water heaters by re-zoning	(158,202.72)	Nil
22	22	1	Using alternative piping materials for water piping	(147,018.02)	Nil
23	23	0	Utilising OTS to connect ground floor drainage	0.00	Nil
24	24	0	Deletion of 5amp flexible outlet in kitchen	(38,880.00)	Nil
25	25	0	Reducing one number 4X18W compact fluorescent in master bedroom	(420,552.00)	Nil
26	26	1	Reducing size of telephone room in roof	(6,731.20)	Nil
27	27	1	Reducing number of corridor lights to seven in each floor	(316,200.00)	Nil
28	28	1	Reducing number of main entrance building light	(161,028.00)	Nil
29	29	0	Deletion of planter lighting	(46,500.00)	Nil
30	30	0	Deletion of shaving sockets in bathrooms	(106,920.00)	Nil
31	31	0	Replacing 45amp cooker socket with 15amp in the kitchen	(97,200.00)	Nil
32	32	0	Replacing GGBS concrete with OPC concrete except for foundation	(116,148.00)	Nil

Case Study 1

Ruwais Housing Complex Expansion – Phase III
Married Accommodation And Related Facilities Including Infrastructure

Table A.1 - Variation order No. 1 (Cont'd…)

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
33	45	1	Using ceramic bathroom accessories in lieu of stainless steel	(209,932.80)	Nil
34	48	0	Provision of 1.8m height access panel for utility shafts	151,648.44	Nil
35	63	0	Reduction in number of landscape lighting	(714,435.00)	Nil
36	87	1	Optimising landscaping and Re-arranging walkways	(1,366,541.57)	Nil
Total Cost Impact and Time Impact				**(11,124,453.20)**	**Nil**

Case Study 1

Ruwais Housing Complex Expansion – Phase III
Married Accommodation And Related Facilities Including Infrastructure

Table A.2 - Variation Order No. 2

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	35	1	Deletion of 70 watt flood light (Type L17) on top of roof in all buildings	(66,825.00)	Nil
2	36	0	Change of concrete mix design from 20 mm to 10mm aggregate (maximum size) for columns and walls in all buildings	0.00	Nil
3	37	0	Deletion of pay phones in all buildings	0.00	Nil
4	38	1	Power supply for air cooled chillers in service blocks S1, S2 and S3 and deletion of one chiller	(61,275.00)	Nil
5	39	0	Reducing kitchen window height from 1300 mm to 1200mm	(365,566.00)	Nil
6	40	0	Waiving the lowest limit of C_3A content in Ordinary Portland Cement	(79,987.50)	Nil
7	41	0	Reducing width of inverted beam IB-7 from 200 mm to 150 mm in Building type F4	0.00	Nil
8	64	0	Change of Constant Air Regulator to Volume Control Damper in all buildings	0.00	Nil
9	75	0	Change in water heater capacity from 80 litres to 50 litres in typical floors of Building type F4	(2,357,099.14)	Nil
Total Cost Impact and Time Impact				**(2,930,752.64)**	**Nil**

Case Study 1

Ruwais Housing Complex Expansion – Phase III
Married Accommodation And Related Facilities Including Infrastructure

Table A.3 - Variation order No. 3

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	33	0	CAT ladder deletion at F4 Building top roof and Service Blocks	(162,232.00)	Nil
2	34	0	Deletion and change of L10 light fixture	(129,685.00)	Nil
3	42	0	Change of door type for Garbage Room	3,891.18	Nil
4	43	1	Change design of slab on garden	(15,126.82)	Nil
5	44	0	Deletion of decorative ceramic boarders in bathrooms (Change is only for Phase-I Buildings)	(21,798.48)	Nil
6	46	0	Change of chemical content of black sand used for mortar	0.00	Nil
7	47	1	Supply and installation of wooden cupboard and related items in the master bed rooms of F5 type building	523,640.00	Nil
8	49	0	Deletion of wooden door in family hall in Buildings F4 and F5 types	(465,791.67)	Nil
9	50	0	Replacement of dry stream pit gravel 300 mm deep with red sand	(12,471.24)	Nil
10	51	0	Change of GRP lamination to epoxy coating to internal face of sewerage manholes	(93,644.34)	Nil
11	52	0	Change of ductile iron manhole cover finish from epoxy paint to bitumen paint	(29,984.00)	Nil
12	53	0	Change of concrete slump from 125±25 and 150±25 to 175±25	0.00	Nil
13	54	0	Change of walkway pavement from pebble wash to interlock tiles	0.00	Nil

Case Study 1

Ruwais Housing Complex Expansion – Phase III
Married Accommodation And Related Facilities Including Infrastructure

Table A.3 - Variation order No. 3 (Cont'd….)

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
14	55	0	Change of first floor beam CB1 depth from 800 mm to 470 mm	(395.00)	Nil
15	56	0	Change of first floor beam B4 depth at grid F from 1050 mm to 880 mm	3,991.15	Nil
16	57	0	Change of 2nd floor typical beam B4 width from 200 mm to 150 mm (F5 type building)	(944.02)	Nil
17	58	0	Change of reinforced concrete wall WI width from 800 mm to 55 0mm	0.00	Nil
18	59	0	Change of forth floor beams B2b and B2c width from 200 mm to 150 mm (F4 type building)	(4,355.00)	Nil
19	60	0	Change of beams IB7 and IB9 width from 200 mm to 150 mm	(1,352.30)	Nil
20	61	0	Changes to trench layout in service blocks S1, S2, S3 and S4	(1,839.79)	Nil
21	62	0	Change of top roof beams B4, B5 and CB3 depth from 3,430 mm to 600 mm	1,669.80	Nil
22	65	0	Change of external light poles for light types A,B and C from aluminium to galvanised iron	(8,537.60)	Nil
23	66	0	Change of transformer room trench covers from galvanised iron grating to galvanised iron chequer plate	(70,902.94)	Nil
24	67	0	Change of substations types S1, S2 and S3 trench cover from 100 mm to 75 mm	(11,820.00)	Nil

Case Study 1

Ruwais Housing Complex Expansion – Phase III
Married Accommodation And Related Facilities Including Infrastructure

Table A.3 - Variation order No. 3 (Cont'd….)

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
25	68	0	Changes to the false ceiling height in corridors, family hall and kitchen and deletion of bulkhead in family hall of F4 and F5 type buildings	(306,546.00)	Nil
26	69	0	Change of stair case windows from openable to fixed	(2,288.00)	Nil
27	70	0	Change of potable water service connection fitting from ductile iron flanges to galvanised iron flanges	0.00	Nil
28	71	0	Change of face plate from metal to PVC for all 15A single pole switch socket outlet above false ceiling	(15,669.25)	Nil
29	72	0	Changes to the water meter cabinet	0.00	Nil
30	73	0	Changes to the spring hangers for pipes in pump room	(2,730.00)	Nil
31	74	0	Change of electrical room size and space in ground floor - F5 type building	(15,383.56)	Nil
32	76	0	Deletion of access doors from all shafts and deletion of platform and ladder from AC ducts (J2,K) in F4 type buildings	0.00	Nil
33	77	0	Supply and installation of wheel stoppers at car parks	52,433.10	Nil
34	78	0	80mm thick interlock paved access for diesel filling station at service blocks S1, S2 and S3	13,106.93	Nil
31	74	0	Change of electrical room size and space in ground floor - F5 type building	(15,383.56)	Nil

Case Study 1

Ruwais Housing Complex Expansion – Phase III
Married Accommodation And Related Facilities Including Infrastructure

Table A.3 - Variation order No. 3 (Cont'd….)

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
32	76	0	Deletion of access doors from all shafts and deletion of platform and ladder from AC ducts (J2,K) in F4 type buildings	0.00	Nil
33	77	0	Supply and installation of wheel stoppers at car parks	52,433.10	Nil
34	78	0	80mm thick interlock paved access for diesel filling station at service blocks S1, S2 and S3	13,106.93	Nil
35	80	0	Change of foundation for road signs	3,424.74	Nil
36	81	0	Deletion of RCC folded beams in roof of chiller yard of service blocks 1,2 and 3	(288,720.00)	Nil
37	82	0	Access for gas filling at buildings F5/7, F5/6, F5/5, and F4/1	11,332.00	Nil
38	83	0	Change of kitchen light fixture L3 from 4X18W recessed mounted fluorescent luminaries IP55	0.00	Nil
39	84	0	Deletion of garbage chute booster pump and water tank	0.00	Nil
40	85	0	Changes to the garbage chute sound dampening system	0.00	Nil
41	86	0	Change of fire extinguisher cabinet from stainless steel to mild steel	0.00	Nil
42	88	0	Irrigation system tie-ins from existing potable water line	0.00	Nil
43	89	0	Sweet sand works	(24,394.50)	Nil

Case Study 1

Ruwais Housing Complex Expansion – Phase III
Married Accommodation And Related Facilities Including Infrastructure

Table A.3 - Variation order No. 3 (Cont'd….)

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
44	90	0	Change of manufactures for 1C PVC insulated wires	(1,496.00)	Nil
45	91	0	Change of fire alarm back box with break glass	(1,925.00)	Nil
46	92	0	Change of kitchen socket outlets from weather proof to non weatherproof	(105,740.64)	Nil
Total Cost Impact and Time Impact				**(1,182,284.25)**	**Nil**

Table A. 4 - Summary of Revised Agreement Price including Variation Orders

Description	Variations (UAE Dirhams)	Contract value (UAE Dirhams)
Original Agreement Price		**427,670,000.00**
Variation Orders		
VARIATION ORDER NO. 1	(11,124,453.20)	
VARIATION ORDER NO. 2	(2,930,752.64)	
VARIATION ORDER NO. 3	(1,182,284.25)	**(15,237,490.09)**
Revised Agreement Price (After VO Nos. 1, 2 and 3)		**412,432,509.91**

APPENDIX – B

CASE STUDY No. 2 – VARIATION ORDERS

ADNOC GROUP OF COMPANIES HEADQUARTERS

PHASE I & II

Case Study 2

ADNOC Group of Companies Headquarter – Phase I

Table B.1 - Variation Order No. 1

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	1	0	Mechanical and electrical statutory changes – revision 3	4,677,583.61	Nil
2	2	0	Architectural changes revision 3	8,823.97	Nil
3	3	0	Mechanical and electrical changes – revision 4	(17,381.65)	Nil
4	4	0	Architectural changes – revision 4	4,015.92	Nil
5	9	0	Building Management System	198,095.15	Nil
6	10	0	Revision to pile caps Type PC4	(212,032.94)	Nil
7	27	0	Deletion of partitions, doors, hardwares and associated finishes from level 2 to 18	(4,273,716.41)	Nil
Total Additional Cost and Time Impact				**385,387.65**	**Nil**

Table B.2 - Variation Order No. 2

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	24	0	Re-design of pilling works to car parking	4,264,488.69	180
2	25	0	Re-design of pile caps ground beams and associated works	3,409,235.12	Nil
3	26	0	Re-design of super structure for parking garbage and precast option	3,620,985.00	Nil
Total Additional Cost and Time Impact				**11,294,708.81**	**180**

Case Study 2

ADNOC Group of Companies Headquarter – Phase I

Table B.3 - Variation Order No. 3

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	5	0	Removal of demolition materials	46,158.80	Nil
2	6	0	Additional excavation and backfilling	Rejected	Nil
3	7	0	Revised waterproofing	Rejected	Nil
4	8	0	Changes of waterproofing primer	Rejected	Nil
5	11	0	Additional works to ADNOC	55,939.45	Nil
6	12	0	New site survey	21,999.78	Nil
7	13	0	Revision to duct installation	Rejected	Nil
8	14	0	Additional works to ADNOC office	2,499.98	Nil
9	15	0	Additional works to ADNOC office	321.55	Nil
10	16	0	Additional works to ADNOC site office	6,455.28	Nil
11	17	0	Additional works to building model	4,111.07	Nil
12	18	0	Water display equipment	86,495.39	Nil
13	20C	0	Revision of granite works – Value Engineering	4,290.93	Nil
14	21	0	As-built drawings format – CDROM	(5,999.94)	Nil
15	22	0	Additional items to ADNOC office	Rejected	Nil
16	23	0	Additional sets of contract drawings	14,217.00	Nil
17	28	0	Provision of additional drawings and diskettes for end-user	1,077.77	Nil
18	29	0	Re-design of MEP sleeves by NORR	50,824.49	Nil
19	30	0	Revision to electrical works due to deletion of partition	74,803.71	Nil
20	31	0	Revision in mechanical work due to re-design of services	128,381.83	Nil
21	32	0	Revision of girder beams in level 5 and level 11	12,269.22	Nil
22	33	0	Revision of paint finish to sprinklers	Cancelled	Nil

Case Study 2

ADNOC Group of Companies Headquarter – Phase I

Table B.3 - Variation Order No. 3 (Cont'd…)

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
23	34	0	Investigate boring adjacent to test piles	Rejected	Nil
24	35	0	Additional boreholes at car park	Rejected	Nil
25	36	0	Additional requirement in security system	Cancelled	Nil
26	37	0	Additional storage cabinet for site office	472.22	Nil
27	38	0	Electric extension board for site office	200.00	Nil
28	39	0	Repositioning of building	14,297.84	Nil
29	42	0	Extension of storm water discharging to painting area	29,535.55	Nil
30	43	0	Breaking of existing beams and slabs at car park area	Rejected	Nil
31	44	0	Increasing the height of partitions in wash rooms	Rejected	Nil
32	47	0	Lighting to store room	Rejected	Nil
33	49	0	Revision – Stone vanity top	(208,704.97)	Nil
34	52	0	Deletion of inergen system in computer room at level 9	(54,125.82)	Nil
35	53	0	Deletion of over flow pipe form roof mounted water tanks	(65,361.32)	Nil
36	54	0	Deletion of inergen system in computer room at level 5	(164,811.26)	Nil
37	55	0	Providing one additional direct line to account's office	611.11	Nil
Total Additional Cost and Time Impact				**63,311.43**	**NIL**

Case Study 2

ADNOC Group of Companies Headquarter – Phase I

Table B.4 - Variation Order No. 4

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	19	0	Changes to continue beams at composite columns	11,642,70	Nil
2	40	0	Revision to fire escape staircase	(378,852.63)	Nil
3	41	0	Revision to tea room sink	(7,701.63)	Nil
5	46B	0	Reception desk at ground floor	85,244.48	Nil
6	48	0	Revision to floor slab due to service penetration	5,109.63	Nil
7	50	0	Additional container toilet mock-up	35,544.47	Nil
8	51	0	Telephone and data cable system with consideration points as per revised design due to space planning by end-user	965,643.97	Nil
9	56	0	Reinforcement to ground beam at Area "G"	3,058.27	Nil
10	57	0	Insulation added to partitions in mechanical room	Nil	Nil
11	58	0	Revision to banking facilities	(41,683.77)	Nil
12	60B	0	Islamic Pattern – extruded aluminium grill	442,090.51	Nil
13	61	0	Relocation of partitions in room D34 at 19th floor	(15,250.25)	Nil
14	62	0	Increase in height of elevator machine room	Nil	Nil
15	63	0	Revision of storm drainage piping in ceiling void at mezzanine roof.	6,238.66	Nil
16	64	0	Deletion of storm drainage piping in ceiling voids at penthouse roof.	(422.24)	Nil
17	65	0	Epoxy resin flooring to electrical room at ground level.	107,367.81	Nil
18	66	0	Revision to civil and MEP works due to space planning	363,761.53	Nil

Case Study 2

ADNOC Group of Companies Headquarter – Phase I

Table B.4 - Variation Order No. 4 (Cont'd)

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
19	67	0	Modification in roof beams to accommodate Building Maintenance System	Nil	Nil
20	68	0	Additional stone cladding to mechanical penthouse wall	44,375.04	Nil
21	69	0	Notches to curved stone cladding of circular columns	Nil	Nil
22	72	0	Block work columns in lieu of steel channels	(14,102.98)	Nil
23	73	0	Modification of prayer room at mezzanine level	2,432.13	Nil
24	74A	0	Eggrate grill for light fixture in toilets, ground floor to 18th floor	37,814.76	Nil
25	75	0	Increase height of ground floor slab at area 'F'	8,867.50	Nil
26	76	0	Deletion of external works along Cornice side	(2,679,205.01)	Nil
28	78	0	Grouting for concrete core holes at car park	488.44	Nil
29	79	0	Service connection charges to WED	888.88	Nil
Total Omissions and Time Impact				**(1,020,009.53)**	**Nil**

Table B.5 - Variation Order No. 5

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	98A	0	Leaving the existing site hoarding, project signboards, site offices and associated services	499,339.17	Nil
Total Additional Cost and Time Impact				**499,339.17**	**Nil**

Case Study 2

ADNOC Group of Companies Headquarter – Phase I

Table B.6 - Variation Order No. 6

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	45	0	Revision to boundary wall and addition of bollard and chain	(110,256.09)	Nil
2	59	0	Revision to expansion joint details between new towers and car park	91,569.33	Nil
3	70A	0	Stone skirting and vinyl wall finish to 19th floor toilets	17,266.92	Nil
4	71	0	Reduce the size of the metal grating at ground level	(10,111.01)	Nil
5	77	0	Extension to storm water discharging to planting area	(29,535.55)	Nil
6	80	0	Additional precast concrete wheel stops for parking stall	48,746.16	Nil
7	81	0	Lowering of ceiling heights in area E and F in ground floor	(6,350.10)	Nil
8	82	0	Revised ceiling layout in level 19	(15,552.37)	Nil
9	83A	0	Block work surrounds and access panel to bus duct in car parking due to Statutory Authority requirements	Nil	Nil
10	84A	0	Electrical rooms to penthouse due to Statutory Authority requirements	Nil	Nil
11	85	0	Chiller trench between towers and parking garage	143,420.43	Nil
12	86A	0	Revision to GSM room finishes in level 20 due to Statutory Authority requirements	Nil	Nil
13	87A	0	Revision to Fire rated doors due to Statutory Authority requirements	Nil	Nil
14	88A	0	Moving of door, extra steps and hand rail in room GF-G03 due to Statutory Authority requirements	Nil	Nil

Case Study 2

ADNOC Group of Companies Headquarter – Phase I

Table B.6 - Variation Order No. 6 (Cont'd….)

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
15	89A	0	Revision to chiller pump room due to Statutory Authority requirements	Nil	Nil
16	90A	0	Additional manholes and covers due to Statutory Authority requirement.	Nil	Nil
17	91A	0	Water meter manhole due to Statutory Authority requirements	Nil	Nil
18	92A	0	Split units for transformer room in area 'G" due to Statutory Authority requirements	Nil	Nil
19	93A	0	Addition of fire extinguishers and deletion of inert gas system in area "G" due to Statutory Authority requirements	Nil	Nil
20	94	0	Storm drainage arrangement for roof, area G2 and A4	12,730.84	Nil
21	96A	0	Varying method of constructing core partitions	Nil	Nil
22	97	0	Addition of paper lower dispensers at Level 19	14,917.04	Nil
23	99	0	Roof top communication tower and mast	1,777.82	Nil
24	101	0	Change of CMU wall unit to reinforced concrete	Nil	Nil
25	104	0	Absence of Quality Assurance Manager	(110,575.67)	Nil
26	105	0	Delivery of skywalk structural steel in three pieces in lieu of one piece	(23,000.00)	Nil
27	106	0	Reduction in height of pile cut off level	(12,757.81)	Nil
28	107	0	Supply and install additional doors	8,297.32	Nil
29	108	0	Reduce thickness at ground floor slab	(7,944.40)	Nil

Case Study 2

ADNOC Group of Companies Headquarter – Phase I

Table B.6 - Variation Order No. 6 (Cont'd….)

Sr No.	CTN No.	Rev No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
30	109	0	Counters to area F in ground floor	14,549.27	Nil
31	110	0	Supply and install sink counter	4,193.39	Nil
32	111	0	Wall paper lining in 19th floor at both towers	4,289.96	Nil
33	112	0	Change in Fire Extinguisher system to car park, pump room and area G, F and F2	Nil	Nil
34	113	0	Change in size of earth bars in floors 1 -19	(3,589.10)	Nil
35	114	0	Absence of Geotechnical Engineer	Nil	Nil
36	115	0	Grouting to drainage pipes passing through grade beams under the car parking	Nil	Nil
37	116	0	Internal finishes to elevator	(31,255.24)	Nil
38	117	0	Deletion of smoke tinted plastic on 19th floor ZADCO	(1,142.69)	Nil
Total Omissions and Time Impact				**(5,023.52)**	**Nil**

Case Study 2

ADNOC Group of Companies Headquarter – Phase I

Table B.7 - Variation Order No. 7

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	*	0	Security and electricity	304,797.16	Nil
2	95	0	Additional screen windows and curtain wall	Nil	Nil
3	100	0	Compression strength testing of cast in site concrete	(27,777.00)	Nil
4	102B	0	Cost associated with additional work carried out in drawing office	61,679.70	Nil
5	103A	0	Reduction of slab thickness at ZADCO 5th Floor	(7,606.63)	Nil
6	118	0	Deletion of BMU Counter Balance System	(60,000.00)	Nil
7	119	0	Replacement of ingress security system of the clinic door	Nil	Nil
8	120	0	Changing card reader at the car park entrance	(25,541.10)	Nil
9	121	0	Replacement of automatic rolling shutters with manually operated	(3,117.20)	Nil
10	122	0	Deletion of lights from AHU's (Labour Cost Only)	(1,320.00)	Nil
11	123	0	Deletion of gypsum board enclosure around A/C ducts	(26,700.00)	Nil
12	124	0	Temperature monitoring of mass concrete	(10,186.00)	Nil
13	125	0	Omit water flow meter	(50,530.20)	Nil
14	*	0	Claim no.1	1,875,525.72	Nil
15	*	0	Claim no.2	839,050.98	Nil
16	*	0	Counter Claim by ADNOC	(542,915.34)	Nil
17	*	0	Disputed elements of progress	(2,461,000.00)	Nil
Total Omissions and Time Impact				**(134,349.95)**	**Nil**

Case Study 2

ADNOC Group of Companies Headquarter – Phase I

Table B.8 – Summary of Revised Agreement Price including Variation Orders

Sr No.	Description	Cost Impact (UAE Dirhams)	Time Impact Days
1	Variation Order No. 1	385,387.65	Nil
2	Variation Order No. 2	11,294,708.81	180
3	Variation Order No. 3	63,311.43	Nil
4	Variation Order No. 4	(1,020,009.53)	Nil
5	Variation Order No. 5	499,339.17	Nil
6	Variation Order No. 6	(5,023.52)	Nil
7	Variation Order No. 7	(134,349.95)	Nil
Total Variation Orders No. 01 to 07		**11,083,344.06**	**180**

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.9 - Variation Order No. 1

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	1	1	Demolition of existing structures from 2^{nd} floor level to pile cap bottom level, which is under the foot prints of the two new towers and reconstruction of the same as original.	Nil	180
			Preliminaries: Recurring cost for extended period	5,292,396.00	Nil
			Demolition: Breakout and remove the structures, including partial in piles, blinding piles, ground slabs, walls, suspended slabs, hollow core precast slabs, beams, columns etc, remove and replace existing louvers, handrails, doors and frames, construct temporary plinths for water tanks, walls and partitions for temporary plant room and demolition of the same.	7,922,255.59	Nil
			Reconstruction Works Rebuild the demolished structures including blinding, substructure waterproofing, pile caps, ground slabs, walls, suspended slabs, columns, beams, reinforcement, finishes and core testing etc.	2,594,832,83	Nil
			MEP Works Remove services installations from existing pump room; store them in yard / use in temporary pump room. New services installations to temporary pump room rerouting existing services to temporary pump room, reinstallation of all services to as original to rebuilt pump room and commissioning handover to End-User.	2,995,338.13	Nil
Total Additional Cost and Time Impact				**18,804,822.55**	**180**

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.10 - Variation Order No. 2

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	1	1	Extension of the key milestone date for the re-opening of ZADCO Clinic from December 28, 2001 to May 06, 2002	Nil	130
Total Additional Cost and Time Impact				**Nil**	**130**

Table B.11 - Variation Order No. 3

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	1	1	Incorporate certain changes in the agreement	Nil	Nil
Total Additional Cost and Time Impact				**Nil**	**Nil**

Table B.12 - Variation Order No. 4

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	2	0	Strengthening of existing car park columns, repairs to columns, re-sizing of columns, surface rendering of columns, hydro demolition of concrete topping / beam and corbel repair works.	418,942.73	Nil
Total Additional Cost and Time Impact				**418,942.73**	**Nil**

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.13 -Variation Order No. 5

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
01	01	01	Revision of project site office scope of works	Nil	Nil
02	02	01	Adjustment to freight elevator door and frame size	Nil	Nil
03	03	01	Change to static from dynamic analysis of structure	Nil	Nil
04	08	01	Change of DID system by Etisalat	Nil	Nil
05	09	02	Updated structural steel specification No. 05100	Nil	Nil
06	10	01	Conversion of clinic entrance door to a fixed panel	Nil	Nil
07	12	01	Base plate fabrication improvement at 6th floor	Nil	Nil
08	13	01	Change to chlorination sterilisation system for drinking water to microspore system	Nil	Nil
09	14	00	Replace the partial demolition of pile caps with full demolition at the footprint of the towers	Nil	Nil
10	16	01	To use PFC steel sections instead of similar RSC steel sections	Nil	Nil
11	19	00	Replacement of precast concrete panels with cast in-situ wall construction at staircase no.2 between line A1-A2/AA-AB	Nil	Nil
12	22	01	Change of shop weld of 21st floor column end plates to site weld	Nil	Nil
Total Additional Cost and Time Impact				Nil	Nil

Table B.14 - Variation Order No. 6

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	1	1	Extension of the intermediate key milestone date for the re-opening of ZADCO Clinic from 6th May 2002 to 29th July 2002	Nil	85
Total Additional Cost and Time Impact				**Nil**	**85**

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.15 - Variation Order No. 7

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	1	1	Extension of the key milestone date for the re-opening of existing car park (one entrance) from 13th September 2002 to 11th March 2003	Nil	180
Total Additional Time and Cost Time Impact				**Nil**	**180**

Table B.16 - Variation Order No. 8

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	1	1	Extension of the completion dates of control milestones 2.3 and 2.6	Nil	Nil
Total Additional Cost and Time Impact				Nil	Nil

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.17 - Variation Order No. 9

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	17	0	Rerouting of sewer gridlines A7-A10	(2,498.79)	Nil
2	21	1	Increase to ventilation capacity of existing diesel generation room and alterations to diesel tank room	469,528.15	Nil
3	13	1	ADNOC increase tariff	949,491.60	Nil
4	07	0	Change of mesh type behind tiles	0.00	Nil
5	26	0	K-bracing in car park	59,533.70	Nil
6	08	0	Fire pump set: Ul listing	(22,696.94)	Nil
7	28	0	Relocation of access door of ZADCO building	8,745.97	Nil
8	06	1	Heat resistant flexible cable	(675.06)	Nil
9	23	0	Strengthening of beams BR1, BR2, BR3 in car park ramp area A & B and diagonal beam strengthening B3-14, B4-14 and B5-14 in Area A	342,438.21	Nil
10	32	0	Revised design of parking ramps from level 4 to level 6 (total of 10 ramps in both towers)	521,016.00	Nil
11	20	0	Architectural modification of the slopes of all ramps from 2nd floor to 6th floor (total of 10 ramps in both towers)	82,527.07	Nil
12	33	0	6th Floor additional reinforcement, area AA, B and F, Chiller base design upgrade and associated roof slab reinforcement	159,265.04	Nil
13	29	0	Re-routing of existing water main pipe line feeding site	15,376.78	Nil
14	25	0	Additional structural steel to openings through existing precast concrete slab	47,786.68	Nil
15	05	0	Variation bearing capacity for transformer / switchgear building	8,045.14	Nil

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.17 - Variation Order No. 9 (Cont'd)…

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
16	19	0	Deviation of specification of Building Management System and additional central controllers	0.00	Nil
17	11	0	Supply of bus bars 1P55 instead of bus bar IP67	(28,297.47)	Nil
18	04	0	Steel column base plates strengthening of towers H and J	69,570.75	Nil
19	10	0	New beam PB3-100 on gird AD/13-A14 in Car park area F, 3rd floor to 6th floors	54,321.92	Nil
20	18	0	Supply of FP200 cables in lieu of MICC cables for fire alarm system	(248,203.33)	Nil
Total Additional Cost and Time Impact				**2,483,645.42**	**Nil**

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.18 - Variation Order No. 10

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	03	0	Delete granite cladding with aluminium frame and replace with glazed curtain wall system to façade for Towers H and J from ground level to 22nd floor and revision to the windows size at level 23 to 26	814,869.63	Nil
2	03	0	Revision of intermediate major milestone No. 3.4, substantial completion of cladding/curtain wall	Nil	297
3	03	0	Revision of key milestone No.3.5 – completion date	Nil	218
Total Additional Cost and Time Impact				**814,869.63**	**218**

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.19 - Variation Order No. 11

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	30	0	Deletion of water filtration system and GRP water tank in underground pump room	(454,010.28)	Nil
2	24	0	Deletion of bus coupler cubicle (without breaker) in 11KV switchgear	(16,643.57)	Nil
3	43	0	Area K substation: Overall dimension and raft size and car park transformer room changes	23,603.83	Nil
4	22	0	Deletion of elevator shaft lights fixture type 23 at mezzanine level, fixture H and J	(585.04)	Nil
5	39	0	Storm water drainage at mezzanine level area ‘G’	19,096.77	Nil
6	40	0	Installed hollow and solid blocks are non-compliance with the project specifications	(35,419.42)	Nil
7	36	0	Towers H and J 500mm thick wall-core wall 2 horizontal reinforcement for 500 mm thick wall as T12-175 instead of T12-200 from 10th floor to the top of core wall 2 in both towers	2,882.12	Nil
8	27	0	Car Park area A and B cracks on columns grid A4, 2/AD 8 at 4th and 5th floor only, and 17.8/AD. 8 at 4th floors	14,810.32	Nil
9	12	0	Towers H and J, 7th floor, composite slab reinforcement	1,384.16	Nil
10	41	0	Format overhead door closer 6350 -04 (SSS finish) instead of 6350-08 (PAA finish)	100,980.50	Nil
11	38	0	Zone 7 – floor level to electrical room	9,904.04	Nil
12	37	0	Removal of ZADCO smokers room	5,039.21	Nil
13	35	1	RFI/0755-Tower J-mezzanine floor LV switchgear room layout	39,459.22	Nil
14	42	0	The application of fire bond protective spray on to beams coated in ML-6 material	102,916.00	Nil
Total Additional Cost and Time Impact				**(186,582.14)**	**Nil**

Table B.20 - Variation Order No. 12

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	*	0	To allow interim payments for Task 1 works	Nil	Nil
Total Additional Cost and Time Impact				**Nil**	Nil

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.21 - Variation Order No. 13 – Package A - MEP Works

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	31	1	TASK -1 related to mechanical works	21,583,002.36	Nil
2	44	0	Integrity testing of computer rooms	56,628.00	Nil
3	45	0	Extended Warranties on MEP equipments	462,220.00	Nil
4	46	0	Upgrading the current rating of bus bars BBH8 and BBJ8	272,178.87	Nil
5	47	0	Additional card reader provisions and IT requirements	272,178.87	Nil
6	48	0	Revisions to layout of floor trunking	618,277.23	Nil
7	49	0	Revisions to specifications of light fixtures type 2, 2E, 11 and 11E	476,311.22	Nil
8	50	0	Switch controls in partition walls	1,124,462.96	Nil
9	51	1	Additional CCTV camera requirements for Computer / PABX Rooms.	541,375.97	Nil
10	52	0	Power telephone / data outlets in partitions	912,902.51	Nil
11	53	0	MEP variations in garbage rooms	88,672.37	Nil
12	54	0	MEP variations in prayer hall area due to enlargements and changes	131,335.64	Nil
13	55	0	MEP changes in janitor and store rooms ceiling	48,966.85	Nil
14	56	0	Structured cabling	3,184,078.73	Nil
15	60	0	Deviations from specifications of exit lights	(5,500.00)	Nil
16	65	0	Stainless steel and PPR piping in lieu of copper piping	(77,213.60)	Nil
17	73	0	Removal of installed Task -II cove light and install new type cove light	273,898.02	Nil

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.21 - Variation Order No. 13 - Package A - MEP Works (Cont'd…)

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
18	82	0	Deletion of BMS monitoring for water meter	Nil	Nil
19	91	0	Removal of reinstallation of MEP works at car park due to installation of additional steel beams	Nil	Nil
20	92	0	Repairing of leaking header pipe of domestic water pump of GASCO tower	453.20	Nil
21	93	0	Change in location of planter drain and rain water pipes at 1st floor area	10,328.30	Nil
22	94	0	Relocation of 5th floor storm water drain pipe	6,307.25	Nil
23	95	0	Roof drain over stair case 2 on level 6	1,903.70	Nil
24	96	0	Repair work to existing sprinkler system of 1st floor car park	3,194.40	Nil
25	97	0	Additional rain water outlet to Area G roof	5,281.02	Nil
26	102	0	Installation of new breaching inlet as existing one cannot be utilised	Nil	Nil
27	103	0	Shifting of electrical and telephone outlets, switches and thermostats after completion of work	14,593.69	Nil
28	107	0	Modification to 6th floor air intake louvers	80,230.04	Nil
29	108	1	Tapping from new main water supply pipes for cornice side irrigation system	63,429.87	Nil
30	113	0	Stainless steel plate behind breaching inlet	Nil	Nil
31	114	0	Change of air-conditioning jet nozzles in the entrance lobby	40,159.44	Nil
32	116	1	Cost saving for PVC coated stainless steel cable tie	(58,863.35)	Nil
33	118	0	Additional works related to relocated chillers	5,712.20	Nil
34	123	0	Cost savings for use of non-specified flexible ducts	(70,406.88)	Nil
35	124	0	Deletion of aluminium cladding to AHU room	(175,120.88)	Nil
Total Additional Cost and Time Impact				**30,077,661.86**	**218**

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.21 - Variation Order No. 13 - Package A - Civil Works (Cont'd…)

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	14	02	Interior fit out work to 7th to 25th floor of towers H and J including gypsum and folding partitions, doors and ironmongery, carpentry and joinery work, raised floors, floor & wall, ceiling finishes and management toilets	16,118,339.53	218
2	57	0	Modifications to ground floor access door of service lift body	7,888.65	Nil
3	58	0	Upgrading of Tower J lift machine room door to 1 hour fire rating and sound proof	5,848.69	Nil
4	59	0	Sealing of internal granite areas by applying double coat sealer	145,368.68	Nil
5	61	0	Delete stainless steel paving strip between carpet and stone finish at service lobby	(2,454.17)	Nil
6	62	0	2 hour fire rated partition inside service lift shaft	383,511.24	Nil
7	63	0	Enclosure to exposed bus bars at Tower J level 1 generator room roof	5,619.74	Nil
8	64	0	Repair cracks and re-level existing car park slabs prior to application of traffic coating	27,421.23	Nil
9	66	0	Additional block wall partitions and ladders to passenger lift pit	22,987.62	Nil
10	67	0	Replacement of aluminium spandrel panel for glazed curtain wall panels at elevation 6 of Tower H and J	96,013.74	Nil
11	68	1	Acoustic insulation of drainage risers	20,025.67	Nil
12	69	0	Change ground floor external column cladding from granite to stainless steel	(89,058.52)	Nil
13	70	0	Additional work instructed for main entrance lobby after agreement of VO #14	231,821.45	Nil
14	71	0	Additional work instructed for external works after agreement of VO # 14	137,198.32	Nil
15	72	0	Door hardware for security screen at 6th floor of Towers H and J	6,898.52	Nil

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.21 - Variation Order No. 13 - Package A - Civil Works (Cont'd….)

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
16	74	0	Fire escape door to car park store rooms at level 2 to 5	24,177.60	Nil
17	75	0	Modifications to gypsum wall partitions at Grid AJ-AH / A2 of tower H, 24th floor	1,256.81	Nil
18	76	0	Additional works to HV room doors at Area G and K as per ADDC comments	7,193.36	Nil
19	77	0	Additional work instructed to main entrance lobby after agreement of VO#14	121,199.19	Nil
20	79	0	Additional steel plate strengthening to beams 9 and 15 of level 8	Nil	Nil
21	80	0	Closure of service shaft at level 8 to penthouse of towers H and J	31,826.00	Nil
22	83	0	Protection barrier for the riser pipes in car park area of level 2 to 5	5,412.00	Nil
23	84	0	Modifications to floor beams of service elevators (S1 and S2) machine room	Nil	Nil
24	85	0	Overhead dummy panels to service lobby store room and disabled toilet timber doors of towers H and J	Nil	Nil
25	86	0	Change of double swing door to single door with opposite fixed leaf using additional base rail lock and head stop angle	19,060.80	Nil
26	87	0	Repair of carpentry work due to FF & E subcontractors changes	Nil	Nil
27	88	0	Additional irrigation work to car park level 5 and 6 to increase the pressure at control valves	5,922.40	Nil
28	89	1	Additional carpentry work which was not included in TASK I	161,372.86	Nil
29	90	2	Additional walk ways to relocated chillers	12,453.70	Nil
30	99	0	Modifications to airflow turrets at roof of Tower H and J	159,901.20	Nil

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.21 - Variation Order No. 13 - Package A – Civil Works (Cont'd….)

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
31	100	0	Remove traffic island at area K	4,012.58	Nil
32	101	0	Changes of frameless glass door handles	80,678.32	Nil
33	104	0	Cost savings on timber door for non UL listing	(11,000.00)	Nil
34	105	0	Cement board closure to exposed spandrel panels	60,798.32	Nil
35	110	0	Substitution of shrub type Acalypha to Bougain villa	Nil	Nil
36	111	0	Install and remove the demountable partition work mock-up	Nil	Nil
37	117	0	Additional works to external granite steps on the landscaping area	Nil	Nil
38	120	0	Use of JR steel in lieu of JO	(50,000.00)	Nil
39	121	0	BMU system change from 16m telescopic boom to 5m telescopic boom with mobile units	(20,000.00)	Nil
40	122	0	Cost saving for not producing status 'A' drawing	(45,441.00)	Nil
41	125	0	Cost saving for cancellation of spare quality of paint	(23,624.77)	Nil
Total Additional Cost and Time Impact				**17,662,159.96**	**218**

Table B.21 - Variation Order No. 13 – Preliminaries

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	106	0	Cost of preliminaries related to time extension from 9th June 2004 to 30th June 2005 (extension of time was given for VO #10 and 14, 218 + 168 days respectively)	15,986,544.15	386
Total Additional Cost and Time Impact				**15,986,544.15**	**386**

Table B.22 – Summary of Variation Order No. 13

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	*	0	MEP works (Package – A)	30,077,661.86	218
2	*	0	Civil works (Package – B)	17,662,159.96	
3	*	0	Cost of preliminaries related to time extension from 9th June 2004 to 30th June 2005 (extension of time given with VO No. 10 and 14, (218 + 168 days respectively)	15,986,544.15	386
Total Additional Cost and Time Impact				**63,726,365.97**	**386**

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.23 - Variation Order No. 14

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	09	0	Redesign of walls, floors and ceiling of entrance lobbies of both Towers H and J and two additional planter units with water feature and information desks.	1,811,297.90	138
2	15	0	Supply and installation of custom made chandeliers to entrance lobby to match chandeliers of existing ZADCO / GASCO towers lobby	1,510,820.16	Nil
3	16	0	Re-design of Cornish side external soft and hard landscaping, granite paving, water fountain and related works	5,194,020.97	168
Total Additional Cost and Time Impact				**8,876,139.03**	**168**

Table B.24 - Variation Order No. 15

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	78	0	Construction of block work with plaster, water proofing, screed and related mechanical work etc. in accordance with the revised layout and deletion of base scope finishes and MEP works in 26th floor of Tower H and J	(82,073.14)	Nil
Total Omissions and Time Impact				**(82,073.14)**	**Nil**

Table B.25 - Variation Order No. 16

Sr No.	CTN No.	Rev. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	81	0	Changes due to ADDC comments on LV design drawings	Nil	Nil
2	96	0	Relocation of sprinkler and wet riser system breaching inlets	Nil	Nil
3	109	0	Modification to the chilled water pipe route below 7th floor	Nil	Nil
4	112	1	Fixing type change for façade and gypsum works	Nil	Nil
5	115	2	Change of glass thickness in the main entrance screen	Nil	Nil
6	119	1	Water pump modifications to reduce high pressure	167,347.93	Nil
7	126	0	Reimbursement of cost for expenses after issuance	99,973.26	Nil
8	127	0	Al Habtoor Marble preliminaries cost claim	Nil	Nil
Total Additional Cost and Time Impact				**267,321.19**	**Nil**

Case Study 2

ADNOC Group of Companies Headquarter – Phase II

Table B.26 - Summary of Variation Orders No. 1 to 16

Sr. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	Variation Order No.1	18,804,822.55	180
2	Variation Order No.2	Nil	130
3	Variation Order No.3	Nil	Nil
4	Variation Order No.4	418,942.73	Nil
5	Variation Order No.5	Nil	Nil
6	Variation Order No.6	Nil	85
7	Variation Order No.7	Nil	180
8	Variation Order No.8	Nil	Nil
9	Variation Order No.9	2,483,645.42	Nil
10	Variation Order No.10	814,869.63	218
11	Variation Order No.11	(186,582.14)	Nil
12	Variation Order No.12	Nil	Nil
13	Variation Order No.13	63,726,365.97	386
14	Variation Order No.14	8,876,139.03	168
15	Variation Order No.15	(82,073.14)	Nil
16	Variation Order No.16	267,321.19	Nil
	Total Variation Orders Nos. 1 to 16	**95,123,451.24**	**386**

Table B.27 - Summary of Variation Orders for Phase I and II

Sr. No.	Description	Agreement Price (UAE Dirhams)	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	Variation Order Nos. 01 to 07 – Phase I	280,658,082.46	11,083,344.06	180
2	Variation Order Nos. 01 to 16 – Phase II	252,880,000.00	95,123,451.24	386
Total Additional Cost and Time Impact		**533,538,082.46**	**106,206,795.30**	**566**

APPENDIX – C

CASE STUDY No. 3 -VARIATION ORDERS

NEW HOSPITAL AND RELATED

FACILITIES INCLUDING INFRASTRUCTURE

Case Study 3

Ruwais Housing Complex Expansion – Phase III
New Hospital and Related Facilities Including Infrastructure

Table C.1 - Variation Order No. 1

Sr. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	Deletion of corrosion inhibitor (MCI) from concrete	(30,086.00)	Nil
2	Change in the collector system of water filteration system	0.00	Nil
3	Shifting the building in the same plot	178,276.96	Nil
4	Protection board 6mm thick for horizontal surface of foundation in lieu of 50mm thick screed and geo-textile layer	0.00	Nil
5	Deletion of slab on grade (SOG) under pocket gardens	(122,151.78)	Nil
6	Change of 25mm polystyrene board to 4mm thick henkel bitu board for vertical extended protection of EPDM membrane	0.00	Nil
7	Providing serving and cleaning persons to serve the COMPANY personnel in Ruwais site offices	218,697.60	Nil
8	Deletion of main spine trench in Building No. 7 (main spine building)	306,453.22	Nil
9	Deletion of test link junction boxes for lightning protection system	(3,992.45)	Nil
10	Deletion of light fixture type (H3) 1X70 watt metal Halide lamp, down light	(10,140.00)	Nil
11	Reducing number of Type G1 lights from 12 to 8 in ground floor of Block No. 5 (Entrance Hall)	(8,196.00)	Nil
12	Deletion of roof slab over liquid oxygen tank	(16,099.37)	Nil
13	Deletion of leak detection system for the chilled water pipes	(94,380.00)	Nil
14	Deletion of automatic gate barriers at gate houses Nos. 9 and 15; and additions of bollards at axis 9.1/5.9 (between building #5 and gate house #9)	(349,071.90)	Nil
15	Changing of concrete durability limit for superstructure concrete	0.00	Nil
16	Deletion of wash basin from building no. 6 (Laboratory/Administration) first floor room no. 06F/23	(6,389.00)	Nil

Case Study 3

Ruwais Housing Complex Expansion – Phase III
New Hospital and Related Facilities Including Infrastructure

Table C.2 - Variation Order No. 1 (Cont'd…)

Sr. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
17	Change of pre-cast column and slab to cast in-situ concrete in ablution building	11,434.28	Nil
18	Change of light fixture 4X18W standard flourescent lamp recessed type (F13) to 2X36W surface mounted light fitting type (F6) in Builidng No. 2 (medical surgical ward)	(3,276.00)	Nil
19	Change of light fixture from decorative water feature light fitting to low height bollard type in desert strip main entrance in front of Block No. 5 (Entrance Hall)	(7,488.00)	Nil
20	Construction of roof slab for staircases nos. 11 and 4	34,325.00	Nil
21	Changing face plate of wiring accessories from polycarbonate to stainless steel	169,493.08	Nil
22	Change of precast roof beams to cast in-situ beam in Building No. 11 (Power Plant)	(56,475.37)	Nil
23	Changes to the structural design of all buildings due to design deficiencies	3,775,576.90	Nil
Total Estimated Cost and Time Impact		**3,986,511.17**	**Nil**

Case Study 3

Ruwais Housing Complex Expansion – Phase III
New Hospital and Related Facilities Including Infrastructure

Table C.3 - Variation Order No. 2

Sr. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	Deletion of 141 Nos. Car park shades and changing fabric material from Teflo (PTFE) to PVC for remaining shades	(4,139,888.60)	Nil
2	Change of wash basin mixers from ordinary mixer to infrared sensor	902,436.48	Nil
3	Change of operation theatre wall cladding from anti laser reflected ceramic tiles to HPL (High Pressure Laminated) cladding panels	727,118.42	Nil
4	Additional culvert with (4) numbers of 400 mm diameter GRP pipe underneath the main road	180,695.67	Nil
5	Provision of space for dental vacuum and dental compressor equipment	275,998.80	Nil
6	Change of walkway material from asphalt finish to 60 mm thick red interlocking pavers (as per existing layout in Ruwais) on both sides of hospital main roads	(486,510.96)	Nil
7	Additional venetian blinds for doors and windows in the operation theatres and isolation rooms	81,748.00	Nil
8	Construction of additional under ground vehicle maintenance pit	28,067.26	Nil
9	Additional 3 numbers of self contained and non-maintained 3 Hrs. 1 x 18 w emergency luminair inside each operation room as per HAAD (Health Authority Abu Dhabi) requirements	10,062.00	Nil
10	Additional differential pressure guages for all the rooms and areas to monitor positive and negative pressure as per HAAD (Health Authority Abu Dhabi) requirements	36,277.63	Nil
11	Modifications at EDP and EDP Supervisor rooms as per IS and T Department	95,798.18	Nil

Case Study 3

Ruwais Housing Complex Expansion – Phase III
New Hospital and Related Facilities Including Infrastructure

Table C.4 - Variation Order No. 2 (Cont'd…)

Sr. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
12	Installation of additional soil drainage points for each building as per medical equipment drainage plans and end-user requirements	333,170.39	Nil
13	Changing the roof slab at the loading platform in building No. 2 from steel structure slab to reinforced concrete slab	Nil	Nil
14	Change of storm water pipes from GRP pipe to UPVC pipe for external areas	273,963.36	Nil
15	Additional electrical services provided as per medical equipments	521,059.74	Nil
16	Deletion of Bed Head Units for some of the rooms, Added one (1) number N2O and one (1) number AGSS with Bed Head Unit for LDR rooms. Deletion of Bed Head Unit except the gases and add only medical gas wall outlet unit for Phlebotomy, Special Clinic and paediatric. Deletion of Bed Head Unit and add one medical gas wall outlet unit with gases for special clinic (13G/45)	(237,190.30)	Nil
17	Additional (2) numbers IV pole, (1) number monitor, (1) number drawer, (1) number MAC, (1) number N20 and (1) number AGSS for Caesarean Operation Room Surgical Pendant	17,998.20	Nil
18	Additional (2) numbers IV pole, (1) number monitor arm, medical gases (1) number N20, (1) number AGSS and the column shall be horizontally and vertically adjusted for Endoscopy Pendent for Endoscopy Room 1 and Endoscopy Room 2	48,039.20	Nil

Case Study 3

Ruwais Housing Complex Expansion – Phase III
New Hospital and Related Facilities Including Infrastructure

Table C.5 - Variation Order No. 2 (Cont'd…)

Sr. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
19	Additional (2) numbers IV pole (monitor side), (1) number monitor arm (monitor side) and (1) number LV outlets in wet side for ceiling mounted column type CCU-I for three (3) ICU Rooms and ICU isolation room	75,288.40	Nil
20	Additional (1) number IV pole, (1) number monitor arm and 1 number shelf and (1) number LV outlets for ceiling mounted column type CCU-R at Recovery for major operation theatre (4 Numbers) and Pendant for C section recovery 1 and 2	46,721.40	Nil
21	Additional (2) numbers IV pole, (1) number monitor arm, (1) drawer and (1) number oxygen for ceiling mounted column type CCU - A and CCU - S at Operation room 1, Operation Room 2 and monitor operation room for Surgical Pendent and Operation room 1, Operation room 2 and minor Operation room for anaesthesia Pendant with Telescopic Lifter	72,359.10	Nil
22	Additional MGS (1) number of MA7, removal of (1) number MA 4, additional (1) number LV point for Plast room and Procedure room pendent	2,490.40	Nil
23	Deletion of kerbstone paint finish	(74,490.00)	Nil
24	Change of north elevation external wall finish between axis 2.1 to 5.1 from curtain wall and stone cladding to plaster with epoxy paint system and original openings shall be finished with aluminium frame and fixed glass due to future extension for Building No. 12	(321,820.11)	Nil
25	Supplying, installing, testing and commissioning of all services for MRI room and the attached rooms	577,763.60	Nil

Case Study 3

Ruwais Housing Complex Expansion – Phase III
New Hospital and Related Facilities Including Infrastructure

Table C.5 - Variation Order No. 2 (Cont'd…)

Sr. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
25	Supplying, installing, testing and commissioning of all services for MRI room and the attached rooms	577,763.60	Nil
26	Deletion of wash basins in Block No. 6, First Floor Administraction offices. Deletion of folded movable partition in the meeting room in Block No. 6. Deletion of partition between rooms No. 06G / 03 and 06G / 04 in the pharmacy area. Additional concealed curtain for windows curtains and Fire fighting cylinders in the Medical Record Room nearby to the bathroom and related works	(42,124.65)	Nil
27	Change of steel door frame material thickness from 2.0 mm to 1.5 mm	(16,581.84)	Nil
Total Estimated Cost and Time Impact		**(1,011,550.23)**	**Nil**

Case Study 3

Ruwais Housing Complex Expansion – Phase III
New Hospital and Related Facilities Including Infrastructure

Table C.6 - Variation Order No. 3

Sr. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	Change of pavement from asphalt to 80 mm thick heavy duty interlocking tiles	(9,821.88)	Nil
2	Deletion of soft landscaping (Irrigation, sweet soil and all the related works to remain as per agreement scope of works)	(1,790,850.07)	Nil
3	Modification of light fittings in central main spine corridor	(88,262.22)	Nil
4	Addition of a 'U' turn at hospital road	34,906.96	Nil
5	End-user requirement Pre installation required for equipments and medical cabinets MEP modification X-ray room modifications MRI room modification Sterile store 03F/ 03 modifications Mammography (04G/30.1) modifications Fluoroscopy (04/26) modifications CT Room (04G/29) Pharmacy and lab changes	1,473,210.27	Nil
6	Change of lighting fixture inside procedure room from surgical light to ceiling mount examination light	12,887.00	Nil
7	Enlarge the existing manhole 1b with proper benching to absorb the 18LT / sec discharged sewage from hospital as per RHD requirements	14,829.20	Nil
8	Addition of master key control system	126,637.50	Nil
9	Additional telephone and data cabling infrastructure works (IS & T comments and recommendation)	64,422.86	Nil
10	Additional Dado trunking in room No. 06F/26 with all required outlets and change of floor finish from linoleum flooring to ceramic tiles in room No 06F/22	25,698.50	Nil
11	Change of sprinkler type for logistic corridors from upright to pendant exposed type and provide additional upright sprinklers with pipe extension to garbage room and work shop	61,588.93	Nil

Case Study 3

Ruwais Housing Complex Expansion – Phase III
New Hospital and Related Facilities Including Infrastructure

Table C.7 - Variation Order No. 3 (Cont'd…)

Sr. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
12	Provide the separation for the fuel day tanks from the generator set	13,179.68	Nil
13	Change of height of the windows in the scrub rooms from 1.65 m to 1.40 m and remove the examination lights in dental rooms (2 nos.) and handed over to end-user as a spare parts	35,222.00	Nil
14	Change of socket outlet fed from UPS inside MDF, MDT & IDT rooms from 13A to 16A & 32A 3 pin industrial socket as per IS & T requirement	33,469.00	Nil
15	Additional handrail for Block 13 Staircase	90,294.31	Nil
16	Deletion of mixers in Administration Offices Block No. 06 first floor in some rooms	0.00	Nil
17	Additional (2) Nos. of venetian blinds to the doors in LDR rooms and Doctor's names display insertions	41,261.00	Nil
	Total Estimated Cost and Time Impact	**138,673.04**	**Nil**

Case Study 3

Ruwais Housing Complex Expansion – Phase III
New Hospital and Related Facilities Including Infrastructure

Table C.8 - Variation Order No. 4

Sr. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
1	Increase the illumination level by adding light fixtures for all entrances and Block No. 05	17,946.00	Nil
2	Deletion of base course and road base from station 0+075 to 0+180 and deletion of sub base from station 0+075 to 0+213	(539,173.20)	Nil
3	Removal of dry wall partition and steel frame of room No. 03F/ 02 and refax the same once the CSSD machines access to it's room	5,944.30	Nil
4	Change of patient bath door width of Block 01 at ground floor from 1.00 m (Door No. 01G / 05 01) to 1.5 m (similar to Door No. 01F / 05 01)	4,705.60	Nil
5	Change of 13 A wall mounted socket outlets fed from UPS from non - standard type to standard type for required areas	44,214.57	Nil
6	Relocation of (3) Nos. of ceiling lights in digital X - Ray room No. 04G / 25	1,044.00	Nil
7	Provide external hospital name signage with the title of "RUWAIS HOSPITAL" in English and Arabic	33,833.28	Nil
8	Additional 4 Nos. of external directional traffic sign boards	19,465.94	Nil
9	Supply, install, testing and commissioning of (6) Nos. of fire hydrants with all necessary piping, fittings and valves, etc including tie - in to RHD (Ruwais Housing Division) portable water net work	0.00	Nil
10	Decorative split units for MDF, MDT, IDT and PABX rooms	149,146.23	Nil
11	Supply and install stainless steel double bowl sink complete with mixers including water and drainage connection (all stainless steel material) in room No. 2B - 30	31,483.60	Nil

Case Study 3

Ruwais Housing Complex Expansion – Phase III
New Hospital and Related Facilities Including Infrastructure

Table C.9 - Variation Order No. 4 (Cont'd…)

Sr. No.	Description	Cost Impact (UAE Dirhams)	Time Impact (Days)
12	Modifications as per HAAD (Health Authority Abu Dhabi)	21,813.50	Nil
12.1	Provide 01 No. straight curtain and 1 No. " L" shape curtain as per site condition for bath tub inside the isolation room or decontamination room in the emergency department		Nil
12.2	Provide each emergency shower 1 No. floor drain in the lab		Nil
12.3	Elbow mixers shall replace the existing Deck Mounted ordinary type mixer in the laboratory and isolation room		Nil
12.4	Provide hand washing sink in the dirty area where dirty linen will be received		Nil
12.5	Aspiration to be provided at dental laboratory		Nil
12.6	Provide additional security glass for reception counter		Nil
12.7	Provide additional sinks and mixers for histology and cytology labs		Nil
12.8	Hand wash sinks shall be provided in each lab section		Nil
Total Estimated Cost and Time Impact		**(209,576.18)**	**Nil**

Case Study 3

Ruwais Housing Complex Expansion – Phase III
New Hospital and Related Facilities Including Infrastructure

Table C.10 - Summary of Revised Agreement Price including Variation Orders

Sr No.	Description	Cost Impact (UAE Dirhams)	Time Impact Days
1	Variation Order No. 1	**3,986,511.17**	**Nil**
2	Variation Order No. 2	**(1,011,550.23)**	**Nil**
3	Variation Order No. 3	**138,673.04**	**Nil**
4	Variation Order No. 4	**(209,576.18)**	**Nil**
Total Variation Orders No. 01 to 04		**2,904,057.80**	**Nil**

APPENDIX - D

QUESTIONNAIRE SURVEY FOR VALIDATION OF THE PROPOSED MODEL

Questionnaire Survey for Validation of the proposed Model for improving the Effectiveness of Value Engineering

Yes No

Name: Do you wish to remain anonymous?

Industrial sector employed: Client ☐ Project Management Consultant ☐ Value Engineering Specialist ☐ Contractor ☐ Cost Consultant ☐

Nationality: Emirati ☐ Others ☐

	Item for comment	Strongly agree		Not sure	Strongly disagree		Comment
		1	2	3	4	5	
Design Issue	Integrate Value Engineering into the project strategy and programme during design stage						
	Conduct Value Engineering Workshop by the end of the preliminary design stage						
	Establish involvement of end-user and contractor representatives						
	Culture and environment of the United Arab Emirates						
	Develop management awareness and commitment in Value Engineering						
	Implement new regulations on Estidama (sustainability), in order to protect the environmental, economic, social and cultural to consider sustainable urbanisation on the Value Engineering workshop						

<table>
<tr><td colspan="2" rowspan="2">Item for comment</td><td colspan="2">Strongly agree</td><td>Not sure</td><td colspan="2">Strongly disagree</td><td rowspan="2">Comment</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td rowspan="6">Construction Issue</td><td>Conducting Value Engineering review after the award of the construction contract</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Monitoring and auditing Value Engineering cost benefits</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Controlling the variations and change orders</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Verifying the Value Engineering recommendations are implemented and achieved</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Cultivate company culture and environment to maximise the benefits of Value Engineering</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Implement new regulations on Estidama (sustainability), in order to protect the environmental, economic, social and cultural to create sustainable urbanisation on the Value Engineering workshop</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

APPENDIX - E

QUESTIONNAIRE SURVEY ANALYSIS FOR IMPROVING THE PROPOSED MODEL

Model Validation: **Results:** **Stage I:** **DESIGN**

IMPROVEMENT FACTOR	RESPONDENT FACTOR	AGREMENT RATING					No. of Replys
		1	2	3	4	5	Σ
1 Integrate Value Engineering into Project Programme.	Value Engineers	5	0	0	0	1	6
	Project Managers	17	6	1	1	0	25
	Contractors	12	7	1	0	1	21
	Clients	11	7	1	1	0	20
	All Categories	45	20	3	2	2	72
	Emirati Nationals	7	6	1	0	0	14
2 Value Engineering to be done by the end of the preliminary design stage.	Value Engineers	6	0	0	0	0	6
	Project Managers	16	7	1	1	0	25
	Contractors	11	9	1	0	0	21
	Clients	10	8	1	1	0	20
	All Categories	43	24	3	2	0	72
	Emirati Nationals	7	7	0	0	0	14
3 Establish Involvement of end-user and contractor.	Value Engineers	0	4	1	1	0	6
	Project Managers	11	8	3	0	3	25
	Contractors	7	13	1	0	0	21
	Clients	5	7	3	3	2	20
	All Categories	23	32	8	4	5	72
	Emirati Nationals	3	4	3	3	1	14

Expressed as a %

IMPROVEMENT FACTOR	RESPONDENT FACTOR	AGREMENT RATING					All Respondents			Emirati only	
		1	2	3	4	5					
1 Integrate Value Engineering into Project Programme.	Value Engineers	83.3	0.0	0.0	0.0	16.7	AGREE	65	90.3%	13	92.86%
	Project Managers	68.0	24.0	4.0	4.0	0.0					
	Contractors	57.1	33.3	4.8	0.0	4.8	STRONGLY AGREE	45	62.5%	7	50.00%
	Clients	55.0	35.0	5.0	5.0	0.0					
	All Categories	62.5	27.8	4.2	2.8	2.8					
	Emirati Nationals	50.0	42.9	7.1	0.0	0.0					
2 Value Engineering to be done by the end of the preliminary design stage.	Value Engineers	100.0	0.0	0.0	0.0	0.0	AGREE	67	93.1%	14	100.00%
	Project Managers	64.0	28.0	4.0	4.0	0.0					
	Contractors	52.4	42.9	4.8	0.0	0.0	STRONGLY AGREE	43	59.7%	7	50.00%
	Clients	50.0	40.0	5.0	5.0	0.0					
	All Categories	59.7	33.3	4.2	2.8	0.0					
	Emirati Nationals	50.0	50.0	0.0	0.0	0.0					
3 Establish Involvement of end-user and contractor.	Value Engineers	0.0	66.7	16.7	16.7	0.0	AGREE	55	76.4%	7	50.00%
	Project Managers	44.0	32.0	12.0	0.0	12.0					
	Contractors	33.3	61.9	4.8	0.0	0.0	STRONGLY AGREE	23	31.9%	3	21.43%
	Clients	25.0	35.0	15.0	15.0	10.0					
	All Categories	31.9	44.4	11.1	5.6	6.9					
	Emirati Nationals	21.4	28.6	21.4	21.4	7.1					

Model Validation: **Results:** **Stage I:** **DESIGN (Cont'd)**

IMPROVEMENT FACTOR	RESPONDENT FACTOR	AGREMENT RATING					No. of Replys
		1	2	3	4	5	Σ
4 Culture in the United Arab Emirates	Value Engineers	3	1	2	0	0	6
	Project Managers	7	11	7	0	0	25
	Contractors	8	9	4	0	0	21
	Clients	10	6	4	0	0	20
	All Categories	28	27	17	0	0	72
	Emirati Nationals	5	8	1	0	0	14
5 Develop management awareness and commitment	Value Engineers	4	2	0	0	0	6
	Project Managers	12	12	1	0	0	25
	Contractors	9	12	0	0	0	21
	Clients	10	10	0	0	0	20
	All Categories	35	36	1	0	0	72
	Emirati Nationals	4	9	1	0	0	14
6 Implement new certification on sustainability (Estidama)	Value Engineers	5	1	0	0	0	6
	Project Managers	17	6	2	0	0	25
	Contractors	15	2	4	0	0	21
	Clients	14	2	2	1	1	20
	All Categories	51	11	8	1	1	72
	Emirati Nationals	8	3	3	0	0	14

Expressed as a %

IMPROVEMENT FACTOR	RESPONDENT FACTOR	AGREMENT RATING 1	2	3	4	5	All Respondents			Emirati only	
4 Culture in the United Arab Emirates	Value Engineers	50.0	16.7	33.3	0.0	0.0	AGREE	55	76.4%	13	92.86%
	Project Managers	28.0	44.0	28.0	0.0	0.0					
	Contractors	38.1	42.9	19.0	0.0	0.0	STRONGLY AGREE	28	38.9%	5	35.71%
	Clients	50.0	30.0	20.0	0.0	0.0					
	All Categories	38.9	37.5	23.6	0.0	0.0					
	Emirati Nationals	35.7	57.1	7.1	0.0	0.0					
5 Develop management awareness and commitment	Value Engineers	66.7	33.3	0.0	0.0	0.0	AGREE	71	98.6%	13	92.86%
	Project Managers	48.0	48.0	4.0	0.0	0.0					
	Contractors	42.9	57.1	0.0	0.0	0.0	STRONGLY AGREE	35	48.6%	4	28.57%
	Clients	50.0	50.0	0.0	0.0	0.0					
	All Categories	48.6	50.0	1.4	0.0	0.0					
	Emirati Nationals	28.6	64.3	7.1	0.0	0.0					
6 Implement new certification on sustainability (Estidama)	Value Engineers	83.3	16.7	0.0	0.0	0.0	AGREE	62	86.1%	11	78.57%
	Project Managers	68.0	24.0	8.0	0.0	0.0					
	Contractors	71.4	9.5	19.0	0.0	0.0	STRONGLY AGREE	51	70.8%	8	57.14%
	Clients	70.0	10.0	10.0	5.0	5.0					
	All Categories	70.8	15.3	11.1	1.4	1.4					
	Emirati Nationals	57.1	21.4	21.4	0.0	0.0					

Model Validation: **Results:** **Stage 2:** **Construction**

IMPROVEMENT FACTOR	RESPONDENT FACTOR	AGREMENT RATING					No. of Replys
		1	2	3	4	5	Σ
1 Conduct Value Engineering review after award of construction contract	Value Engineers	3	1	0	2	0	6
	Project Managers	3	12	2	6	2	25
	Contractors	8	10	1	1	1	21
	Clients	8	7	1	2	2	20
	All Categories	22	30	4	11	5	72
	Emirati Nationals	6	5	0	3	0	14
2 Monitor & auditing Value Engineering cost	Value Engineers	3	3	0	0	0	6
	Project Managers	6	14	2	2	1	25
	Contractors	6	9	4	2	0	21
	Clients	8	11	1	0	0	20
	All Categories	23	37	7	4	1	72
	Emirati Nationals	3	9	1	1	0	14
3 Controlling variations and change orders	Value Engineers	6	0	0	0	0	6
	Project Managers	8	14	2	0	1	25
	Contractors	9	9	2	1	0	21
	Clients	9	7	3	0	1	20
	All Categories	32	30	7	1	2	72
	Emirati Nationals	7	4	3	0	0	14

Expressed as a %

IMPROVEMENT FACTOR	RESPONDENT FACTOR	AGREMENT RATING					All Respondents			Emirati only	
		1	2	3	4	5					
1 Conduct Value Engineering review after award of construction contract	Value Engineers	50.0	16.7	0.0	33.3	0.0	AGREE	52	72.2%	11	78.57%
	Project Managers	12.0	48.0	8.0	24.0	8.0					
	Contractors	38.1	47.6	4.8	4.8	4.8	STRONGLY AGREE	22	30.6%	6	42.86%
	Clients	40.0	35.0	5.0	10.0	10.0					
	All Categories	30.6	41.7	5.6	15.3	6.9					
	Emirati Nationals	42.9	35.7	0.0	21.4	0.0					
2 Monitor & auditing Value Engineering cost	Value Engineers	50.0	50.0	0.0	0.0	0.0	AGREE	60	83.3%	12	85.71%
	Project Managers	24.0	56.0	8.0	8.0	4.0					
	Contractors	28.6	42.9	19.0	9.5	0.0	STRONGLY AGREE	23	31.9%	3	21.43%
	Clients	40.0	55.0	5.0	0.0	0.0					
	All Categories	31.9	51.4	9.7	5.6	1.4					
	Emirati Nationals	21.4	64.3	7.1	7.1	0.0					
3 Controlling variations and change orders	Value Engineers	100.0	0.0	0.0	0.0	0.0	AGREE	62	86.1%	11	78.57%
	Project Managers	32.0	56.0	8.0	0.0	4.0					
	Contractors	42.9	42.9	9.5	4.8	0.0	STRONGLY AGREE	32	44.4%	7	50.00%
	Clients	45.0	35.0	15.0	0.0	5.0					
	All Categories	44.4	41.7	9.7	1.4	2.8					
	Emirati Nationals	50.0	28.6	21.4	0.0	0.0					

Model Validation: **Results:** **Stage 2:** **Construction (Cont'd)**

IMPROVEMENT FACTOR	RESPONDENT FACTOR	AGREMENT RATING					No. of Replys
		1	2	3	4	5	Σ
4 Verifying Value Engineering recommendations adopted are achieved	Value Engineers	5	0	1	0	0	6
	Project Managers	8	14	2	0	1	25
	Contractors	12	8	1	0	0	21
	Clients	14	5	1	0	0	20
	All Categories	39	27	5	0	1	72
	Emirati Nationals	8	4	1	0	0	13
5 Cultivate Company culture and environment to maximize benefits of Value Engineering	Value Engineers	1	2	3	0	0	6
	Project Managers	7	11	6	0	1	25
	Contractors	15	2	3	1	0	21
	Clients	5	12	3	0	0	20
	All Categories	28	27	15	1	1	72
	Emirati Nationals	2	8	3	0	0	13
6 Ensure the new regs. To achieve certification on sustainability (Estidama)	Value Engineers	4	2	0	0	0	6
	Project Managers	8	10	5	1	1	25
	Contractors	14	3	3	0	1	21
	Clients	13	1	3	3	0	20
	All Categories	39	16	11	4	2	72
	Emirati Nationals	9	2	3	0	0	14

Expressed as a %

IMPROVEMENT FACTOR		RESPONDENT FACTOR	AGREMENT RATING					All Respondents			Emirati only	
			1	2	3	4	5					
4	Verifying Value Engineering recommendations adopted are achieved	Value Engineers	83.3	0.0	16.7	0.0	0.0	AGREE	66	91.7%	12	92.31%
		Project Managers	32.0	56.0	8.0	0.0	4.0					
		Contractors	57.1	38.1	4.8	0.0	0.0	STRONGLY AGREE	39	54.2%	8	61.54%
		Clients	70.0	25.0	5.0	0.0	0.0					
		All Categories	54.2	37.5	6.9	0.0	1.4					
		Emirati Nationals	61.5	30.8	7.7	0.0	0.0					
5	Cultivate Company culture and environment to maximize benefits of Value Engineering	Value Engineers	16.7	33.3	50.0	0.0	0.0	AGREE	55	76.4%	10	76.92%
		Project Managers	28.0	44.0	24.0	0.0	4.0					
		Contractors	71.4	9.5	14.3	4.8	0.0	STRONGLY AGREE	28	38.9%	2	15.38%
		Clients	25.0	60.0	15.0	0.0	0.0					
		All Categories	38.9	37.5	20.8	1.4	1.4					
		Emirati Nationals	15.4	61.5	23.1	0.0	0.0					
6	Ensure the new regs. To achieve certification on sustainability (Estidama)	Value Engineers	66.7	33.3	0.0	0.0	0.0	AGREE	55	76.4%	11	78.57%
		Project Managers	32.0	40.0	20.0	4.0	4.0					
		Contractors	66.7	14.3	14.3	0.0	4.8	STRONGLY AGREE	39	54.2%	9	64.29%
		Clients	65.0	5.0	15.0	15.0	0.0					
		All Categories	54.2	22.2	15.3	5.6	2.8					
		Emirati Nationals	64.3	14.3	21.4	0.0	0.0					