Value Engineering

An Opportunity for Consulting Engineers to Redefine Their Role

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ABSTRACT

The motivation for this research stems from the authors experience as a resident engineer spanning two decades, the observation of significant value engineering opportunities persistently remaining available at construction stage and the belief that the engineer's role could be enhanced significantly if these were grasped.

At present clients are increasingly dissatisfied with the service they receive from design professionals. Contractors are no longer covering up the failures of engineers and are developing stronger ties with clients. This development risks alienating the consulting engineer who must deliver improved performance or risk becoming redundant.

Value engineering has potential to fill this gap and redefine the consultant's role. This research explores the opportunities it can bring to the engineer in meeting the changing needs of clients with particular emphasis on the critical design phase.

The methodology was to combine a wide-ranging and comprehensive survey with an in-depth case-study of a specific ACEI firm. This enabled the researcher to cross-check "macro" results against a "micro" environment. The research did not envisage evaluating the merits of different value engineering techniques however if successful, the research will bring the concept of value engineering into the main stream of the Irish construction industry.

The literature review did not uncover any studies concerning the adoption by consulting engineers of a value engineering role and this paper is unique in this regard.

The sample group comprised all consulting civil/structural engineering firms on the ACEI register. More than 97% of respondents held director positions with 70% having over 20 years experience. Given the 39.3% response rate the results are significant.

The findings hold much significance for consulting engineers: a widespread resistance to value engineering, the negative effect of competitive tendering, engineers own recognition of their ability to a better service, the concept of value engineering is poorly understood.

The recommendations include: the establishment of a Government taskforce to explore policy and legislative solutions to the problems the research has brought to light; pilot studies should be introduced to investigate the potential of value engineering in an Irish context; the negative effects of competitive fee tendering on the application of value engineering should be addressed; value engineering should be incorporated in relevant engineering syllabi.

KEYWORDS

Client satisfaction, Engineering consultant, Opportunity, Role, Value engineering,

DEDICATION

I dedicate this work to my Dad:

Dr. Brendan O'Farrell, (1931-2008)

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DECLARATION

I declare that, except where reference is made in the text, the contents of this dissertation are entirely my own work. I further declare that the contents, in whole or in part, have not been submitted to this or any other institution as an exercise for a degree. The author agrees that the library may lend or copy the dissertation upon request for study purposes, subject to the normal conditions of acknowledgement.

Author's Signature: 

Peter K O'Farrell.

Dated: 31st August 2010.

USED ACRONYMS / ABBREVIATIONS

ACEC	Association of Consulting Engineers of Canada
ACEI	Association of Consulting Engineers of Ireland
ARCOM	Association of Researchers in Construction Management
CRP	Client Requirement Processing
FIDIC	International Federation of Consulting Engineers
FAST	Function Analysis System Technique
GDP	Gross Domestic Product
GNP	Gross National Product
IEI	Institute of Engineers of Ireland (Now - Engineers Ireland)
IT	Information Technology
PPP	Public Private Partnership
QBS	Quality-Based Selection
QFD	Quality Function Deployment
RIBA	Royal Institute of British Architects
SAVE	Society of American Value Engineers
SBR	Dutch Building Research Institute
SMART	Simple Multi-Attribute Rating Technique
TRIZ	Theory of Inventive Problem Solving
TQM	Total Quality Management
UK	United Kingdom
US	United States
USGSA	US General Services Administration Public Buildings Service
VE	Value Engineering
WTO	World Trade Organisation

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CHAPTER 1 – Introduction

1 INTRODUCTION

'*Engineering consultancy consists of two disciplines, namely engineering and consultancy. In the current work climate it is no longer enough to be a good engineer*'. Clients require more than technical expertise and problem solving they expect customer service and value for money (Anderson, 2001: 34). Client satisfaction is a fundamental issue for construction participants who must constantly seek to improve their performance. However, despite industry challenges the case study firm does not have a formal approach to briefing or value engineering which if implemented could potentially improve their effectiveness and achieve increased levels of client satisfaction.

The firm selected to form the case study, hereafter called the *case study firm*, was founded in Dublin in the 1970's. Expanding over the years to include offices in Waterford and Galway and employing some 50 staff they are one of the leading engineering consultancies in the country. The services offered by the firm include Civil, Structural and Marine Engineering along with Environmental Services, Process and Project Management.

It is the opinion of Zimmerman and Hart (1982) that the best place for the value engineering effort is in the planning and design stages. The reason being that if changes can be found at these stages the major cost savings being realized by the client will not have to be shared with the contractor. Consulting engineers will find that value engineering enhances the capabilities of their firm to the benefit of present and future clients, providing an additional valuable service that gives them a competitive edge over firms who do not (Brahtz, 1978). As far back as 2004 FIDIC (International Federation of Consulting Engineers) identified price competition and low fees to be the number one threat facing the consulting engineering profession. They also found new infrastructure deficits, tendering practices and design-and-build were among the main forces of influence affecting consulting engineers worldwide.

"*One would think that any process that advocates economy would be readily adopted. This has not being the case for Value Engineering*" (Jergeas and Revay, 1999: PM12.2).

The purpose of this paper is to present the aim and objective of enhancing the role of the consulting engineering in the marketplace by better meeting the needs of their clients, through the provision of a value engineering service.

1.1 RESEARCH AIMS AND OBJECTIVES

The aim of the research is to investigate the opportunity for enhancing the role of the consulting engineer by introducing value engineering as an additional service for their clients. In order to achieve this aim the following objectives have been formulated:

Objective 1. *To critically analyse the existing body of literature relating to value engineering.*

Objective 2. *To explore the existing attitudes and perceptions to the value engineering concept, to seek an understanding of consulting engineer's opinions and to examine the factors that guide these opinions.*

Objective 3. *To examine and discover the reasons, where they exist, for resistance to the introduction of a value engineering service.*

Objective 4. *Explore the technical, cultural, and commercial feasibility of introducing a value engineering service.*

Objective 5. *Investigate the potential value engineering may have in constructing the brief.*

The hypothesis which shall be tested by research is as follows: *'If consulting engineers want to expand their role in the market place they should provide a value engineering service for their clients'.*

1.2 BACKGROUND TO THE RESEARCH

The current contraction in the construction industry '*is expected to be the most severe in thirty years.'* The value of construction output has dropped from €38.4b in 2007 to €19.9b in 2009 with a forecast of just €13b for 2011. In 2009 construction as a percentage of GDP across Europe averaged 12% (2005-2011) Irish construction output has declined in value terms from its high of 24.7% of GNP in 2006 to 14.5% last year (2009) and is expected to bottom in 2011 at 10% of GNP or lower. (DKM, 2009, p vi)

Many analysts have portrayed the construction industry to be uncompetitive and inefficient with up to 40% of the effort expended in developing capital works being wasted, adding no value to the client, depleting both the respect between, and the profit and reputation of professionals, contractors and clients alike and exacerbating the adversarial conditions so prevalent in the construction industry (Gallo et al. 2002).

Construction is a project-based industry with each project typically being unique. It has many problems with its structure and fragmented nature that have combined to inhibit its performance (Banwell, 1964, Latham, 1994, Egan 1998). The translation of client requirements into physical reality depends largely on the effective collaboration of teams of professionals and contractors frequently operating within conflicting and competing interests. Competitive pressures from both within and outside the industry are increasing pressure for the industry to re-examine and improve itself. Many countries have set up construction task forces to report and target radical improvements.

Poor design and documentation can be responsible for up to 12% of project costs (Tilley *et al.* 2000). The reduction in quality is in direct relation to reductions in design fees and there has also been a corresponding increase in project time, cost overruns disputes and delays. As a major stakeholder in the industry, '*it is essential that the engineering profession address this situation with a view to ensuring that the building and construction industry returns to a mindset of efficient performance'* (Gallo et al. 2002 p3).

It is acknowledged by many studying in the field of value engineering that projects, which undergo functional analysis and whole life costing studies, frequently see cost savings in the region of 10 – 30%. In the context of the construction industry that can amount to 10-25% of a country's total GDP. This is a major area where significant rationalisation can be achieved.

Poor quality construction was found, in a survey carried out by FIDIC in 2001, to be an area of general concern. The survey showed that poor quality arose as a result of the '*fundamental characteristics of project delivery by competitive tender…*[leading] *to poor project practice in virtually all areas (poor designer and contractor selection; poor project supervision; poor materials; poor workmanship)'* (FIDIC, 2002, p15).

ACEC (Association of Consulting Engineers of Canada) - believing quality-based selection (QBS) to be the best method for choosing an engineer - have established a special task force to develop and promote a coordinated strategy for the adoption of QBS by clients. '*Projects procured on a low bid basis may save an owner a small amount on up-front design costs but can lead to significantly higher construction costs … and higher operating and maintenance costs'* (ACEC, 2004 p 6).

1.3 STRUCTURE OF THE THESIS

Chapter 1. Introduces the rationale behind the research project, details the research aims and objectives, introducing the case study firm and the drivers behind the project within the construction industry.

Chapter 2. Describes the concept of value engineering, its basis, what it is and is not, outlining its history, its development and application.

Chapter 3. Discusses the current state of the construction industry and explores the application of value engineering during the construction phase, the design phase and the briefing phase.

Chapter 4. Explores both the impetus and the resistance to the application of value engineering from the differing perspectives of the engineering consultant and their client and considers the issue of client satisfaction from the perspective of the client and their consultant.

Chapter 5. Provides a summary of the key findings of the literature review indicating consensus and disparity.

Chapter 6. Describes briefly the differing types of methodologies available, the reason for those chosen, the rationale, limitations, and the validity of the chosen approach to research design and methods of analysis.

Chapter 7. Presents and analyses the primary research to which a dual approach was taken. The results of the industry (correlational/background) questionnaire, analysed and tabulated are presented first, followed by a commentary of the preliminary and the semi-structured case study interviews.

Chapter 8. Highlights the key findings of the research drawing conclusions and discussing both the research limitations and hypothesis being tested. Finally recommendations are offered for the industry and for further research.

Chapter 9. Presents the Bibliography.

Chapter 10. Contains the Appendices.

CHAPTER 2 – Value Engineering

2 VALUE ENGINEERING

2.1 HISTORY AND DEVELOPMENT

Value Engineering is a creative and disciplined process which according to Hegan (1993) seeks to offer the client a reliable opportunity for cost savings without detriment to quality or performance. The power of the value engineering technique is rooted in its objective and disciplined methodology. Understanding and applying the technique can see significant improvement in most projects.

The term, *engineering* is described by Watson (2005) as being derived from the Latin *ingeniousus* meaning to be skilled, the word Value being relative. Sperling, (2001:46) adds Value = Function / Cost and contends *'improving value means enhancing function, reducing cost, or both.'* Kelly and Male (1993) describe value engineering as a philosophy supported by technique rather than an absolute method or set of rules. A basic concept of value engineering is that each element of cost must add commensurate user function (Miles, 1961).

'The creation of value for the client is intertwined with the exploration and resolution of project functionality.' (Kelly and Male, 1993:84)

Value Engineering - which has been the subject of much study and consideration and has been defined in many ways - is an organised approach to identifying and eliminating unnecessary costs which urges a complete analysis of the use of a service or product rather than simply its engineering attributes (Watson, 2005). Value engineering also plays a significant role in pulling together a complete construction team making them more effective and more efficient - a benefit which cannot be overlooked (Boorman, 2009).

Acknowledged as the *'Father of value analysis'* by Fletcher and McClintock (2004:554) and Wixson (1999) Lawrence D. Miles conceived the concept to overcome a scarcity of materials during World War 2 while he was employed as an engineer with General Electric in the early 1940s (Davis, 2004). Value engineering is not cost reduction, reduction of quantities, cheaper materials or lower standards; nor is it quality control or a design review. It is the analysis of functionality focusing on the elimination or modification of elements that add cost without contributing to the functionality required (Jergeas and Revay, 1999).

'Value engineering is not simply about money…it's about value' (Kirk *et al.* 2002:5).

An understanding of function is the essential precursor to the uncovering of alternatives (Sperling, 2001). Dell'Isola (1982) maintains that traditional cost reduction methods have generally given little thought to functional consideration. Function analysis plays a very important part of value engineering by encouraging thought about why an item is necessary rather than just thinking about the item. It is function-orientated rather than item-orientated. The Function Analysis System Technique (FAST) which uses mapping to graphically represent and relate the identified functions to each other and indicate both the primary and subordinate positions (SAVE, 2007) was developed in the 1960s by Charles W. Bytheway an engineer with Sperry Univac (Unisys) (Wixson, 1999). Historically it has been argued that the only distinctive characteristic the various value methodology styles have from other management philosophies is the application of functional analysis (Male *et al.* 2007). FAST, claim Shen *et al.* (2004), is one of the most popular and essential techniques used in function analysis. There has been, according to Hunter and Kelly (2007), a mixed reaction in the approach to the use of the FAST technique in the UK. Some practitioners find the method both difficult to perform and time consuming while others consider it a vital and necessary part of any value engineering study.

Brown (2002) report that value engineering, introduced by Larry Miles publicly in 1947 is considered to be the first formalised design process technique for problem solving that requires specific steps. Davis (2004) adds that the key foundation of the value methodology was the development of a focus on function that was emphasised by the use of a two word active-verb and measurable-noun pairing to characterise the benefit, e.g. Support-Roof (SAVE, 2007). By carefully analysing the basic function of a component of process Larry Miles became adept at making beneficial changes by intent rather than by necessity. Over the years the process has evolved and improved into a systematic job-plan designed to separate and manage the distinct tasks of a value engineering study (Davis, 2004).

Cheah and Ting (2005) acknowledge the distinctions between value analysis, value engineering and value management, with value management being a style of management applied at corporate levels, while value analysis and value engineering apply tools and methods at the operational level. *'Value management is about getting the right project whilst value engineering is done to get the project right'* (Hammersley, 2002: 2). Fong and Shen (2000) point out that while some schools of thought distinguish value engineering from value management and value analysis SAVE International prefers to consider the terms synonymous. Schwarz and McConkey (1974) consider that whatever title is used for the methodology, value analysis, value engineering or value management they will use the same techniques and job plan to achieve similar aims.

Value analysis (the technique designed to improve value without sacrificing function) was introduced into construction by the US military around 1963 where its success lead it to be taken up by other agencies and departments (Cheah and Ting, 2005). Around the same time in the early 1960s Alphonse Dell'Isola is accredited with introducing the value engineering concept in to the American construction industry (Fong and Shen, 2000).

Two factors marked the birth of the term value engineering by the US navy in the 1950s, the first being a change in the contextual application of the technique from finished goods to conceptual design. The second resulted from an embargo on the hiring of *analysts* by the navy in the 1950s - the practitioners of value analysis were imaginatively hired under the then permitted designation engineer thereby creating the value engineers of today (SAVE, 2007) *'since their quota of analysts was full the navy hires engineers to carry out the programme'* (Fletcher and McClintock, 2004:554). Value engineering workshops/seminars were, according to Soffield *et al.* (1988), first initiated by the US Navy back in the 1950s.

Value engineering initially provided better value through the simplification of products by functional analysis providing cost savings and improved performance. It was through its later application to custom manufacturing that it evolved to consider customer expectations as values and thereby expand from being a solely retrospective technique to one concurrently assisting in design development (Thompson and Austin, 2001) the resulting competitive effect produced easily ascertainable savings. Sperling (2001) observes that a failure to understand the functional approach of value engineering can lead to a false conclusion that it is merely a cost cutting exercise. The benefit from a systematic functional inquiry of products or services often extends beyond their functional improvements by creating more effective communications and teamwork among the stakeholders (Cheah and Ting, 2005).

Experience in the US has clearly demonstrated the important role governmental agencies have in promoting the implementation of value engineering (Cheah and Ting, 2005). Many construction bureaus, government bodies and federal agencies now require value management studies to be carried out for most major projects.

The use of value engineering in the United States expanded widely in 1993 with the introduction of two bills making the process mandatory on all government programmes (Fong and Shen, 2000). In 1996 President Clinton signed into law an act obliging all executive agencies to establish value engineering procedures - the estimated savings for 1996 alone were forecast at $2.19B (Elias, 1998).

Dell'Isola (1982) advances typical value engineering savings as follows:

- In construction programmes to a value of €10million, savings typically range from 3 to 10 times the value engineering effort.
- In programmes from €10-75million, savings range from 5 to 15 times the effort.
- In programmes over €75million, savings range from 10 to 20 times the effort.

Value engineering initially dominating American thinking, diversified internationally from the 1960s onwards through the manufacturing arena in Japan, the United Kingdom, Australia and Canada. Differing perspectives developed during the 1980s and the 1990s with the introduction of value management into construction (Male *et al.* 2007). Value management is described by Kelly and Male (2004b: 2) as being *'the management of a process to obtain maximum value on a scale determined by the client'*. Value management is more prevalent in a European context and is considered to encapsulate a broader scope, commence deeper and be more strategically focused within the client organisation (Kelly and Male, 1993).

The thinking on value methodologies international is diverse with the various definitions, procedures and standards expressing localised and developing views and attitudes towards value engineering (Male *et al.* 2007). The SAVE International standard adopts the term value methodology to encompass the processes known as value analysis, value engineering, value management, value control, value improvement and value assurance. While not specifically including the emerging European-style value management, it is nevertheless an all embracing standard (Male *et al.* 2007).

Value management, introduced into Chinese manufacturing industries from 1978, has been identified in government surveys as being their second most famous management methodology. Its use has now however has declined sharply in the absence of support from the formally state owned companies in the recent transition to the market economy (Shen and Liu, 2004).

The North American engineer enjoying a higher status than his European counterpart is often the design team leader responsible for taking both the brief and preparing the cost plan. There is no chartered surveyor (Kelly and Male, 1993). The use of value management in the formation of the brief is considered to be a beneficial application of the method enabling the full participation of the client in a systematic identification and definition of their requirements within a 'common language' (Yu *et al.* 2005). Gallo et al. (2002) consider it is essential that the engineering profession now return to a mindset of providing more efficient performance.

The use of the Bill of Quantities (a key contract control document for over a century and the reason for the development of quantity surveying as a separate profession) is diminishing (Potts, 2004). Surveyors in Europe especially those in large private practice are expanding and diversifying from their traditional roles to a total process management service (Kelly and Male, 1993). Potts (2004) confirms this new development in the roles of quantity surveyors through research which indicates that changes in procurement methods are creating a strong need for quantity surveyors to embrace project management, critical path analysis and value analysis. The diversification of the construction industry into the total process management arena is putting new pressures on small to medium sized technically- based consulting firms and narrowing their role and position within the industry (Kelly and Male, 1993). Engineering consultants are finding their management and supervision roles increasingly under threat from surveyors and construction firms. This threat has been compounded by new procurement routes providing alternatives in the management of project design and construction (Kelly and Male, 1993).

Watson (2005) tells us that the concepts deployed in value engineering have influenced the development of Quality Function Deployment (QFD), The Toyota Production System and the Theory of Inventive Problem Solving (TRIZ). Zhang *et al*. (2009) contend that the TRIZ methodology developed by Soviet Union researchers could be a useful systematic tool for the generation of innovative ideas and solutions that go beyond traditional brainstorming technique of value engineering.

Short *et al.* (2007) contend that the role of modern value engineering is described as being a soft systems-based technique and directly comparable to value management and considered analogous to that of a therapist and client advisor concerned with understanding the design problem and improving project communication. Managing the value improving process requires considerable sensitivity towards a variety of issues and people (Phillips, 2009).

Historically, value engineering was applied late in the design process, however this was found to be too late to make any major design changes *'a great idea for adding value to a project is not so great when it requires the whole team to go back up and start over again'* (Kirk *et al.* 2002:6).

Short *et al.* (2007) also contend that the linear and strict application of the *Plan of Work for Design Team Operation* established by the RIBA in 1964 can be inappropriate and inflexible for the client, maintaining that the conceptual thinking is restricted to the very early stages of a project and the following design stages are effectively being unchallenged. In a separation from *management* of the *design process*, a specialist field of *design management* is emerging.

This is likely to remain outside of the increasingly prevalent umbrella of the design-build contractor to whom the traditional design team is inexorably becoming subordinate (Smith and Love, 2001). This may present an opportunity for engineering consultants who can expand their roles.

Male *et al.* (2007) concludes that at present value management is in its academic infancy and without an adequate theoretical underpinning its foundation of distinctive technique is not sufficient to claim professional status. Spekkink (2005), notes that throughout the world institutes and universities are in the process of developing applications to model and analyse the performance of buildings at any stage in the design process. Factors considered range from life cycle analysis to cost planning and value engineering. Improvement in project delivery requires a different way of thinking, a different attitude and even a change of culture in order to develop (Spekkink, 2005; Gallo et al. 2002).

'*One would think that any process that advocates economy would be readily adopted. This has not being the case for Value Engineering*' (Jergeas and Revay, 1999: PM12.2).

2.2 OVERVIEW

Research has shown a continuing decline in a construction industry that is considered to have become demonstrably wasteful, inefficient, ineffective, inequitable and adversarial (Gallo et al. (2002). An industry wide task force has identified 10 root causes of the construction industries decline as identified in table 2.2.1 below (Engineers Australia, 2004). As discussed the construction sector typically accounts for a large proportion of Gross National Product - the scale and effect of inefficiencies in the construction industry has therefore a major impact on a country's overall economy (Gallo et al. (2002).

Root Cause of Construction Industry Decline	
Inadequate project briefs	Inexperienced client project coordinators
Lack of integration	Poor appreciation of optimised design
Devalued professional ethics and standards	Lack of skilled and experienced people
Lowest bid selection strategy	Poor use of technology
Poor management processes	Lack of open communication

Table 2.2.1 developed from Engineers Australia, 2004.

Kee and Robbins (2004) contend that many of the proven cost management techniques available today such as Total Quality Management (TQM) and Just in Time have an inward focus, concentrating on a firm's operations without a specific consideration of the owners needs. Functional analysis on the other hand incorporates the customer's perspective and establishes the value they place on each function to determine precisely where cost reduction can be achieved. Dell'Isola, (1982) points out that traditional cost reduction efforts concentrate on making the same item, only cheaper. Functional analysis involves thinking why an item is necessary. Being function orientated rather than item orientated leads to a more creative solution for the users needs. Hussain (2002) agrees and suggests value engineering is not group-cost-cutting but rather a team based structured approach to accomplishing the functions required by the client. U.S. General Services Administration Public Buildings Service (USGSA, 1992) contend the objective of all value engineering proposals to be value improvement whether or not costs savings are realised.

The acknowledged foundation of the value engineering methodology and the key activity that distinguishes the methodology from other problem-solving or improvement practices is function analysis (SAVE, 2007). Function analysis, an essential feature of the value management methodology is considered to be a promising method of expressing client requirements by providing precise description of client requirements in a structured framework thereby enabling a clear definition and identification of client/user objectives and necessary functions (Shen *et al.* 2004). The technique of stating function using the verb-noun

abridgement forces conciseness, assists in reducing a problem to its fundamentals and ensures only one function is defined at a time. It also aids distinction between primary and secondary functions and leads to a broad level of disassociation from previous any solutions that is necessary for an effective study (Dell'Isola, 1982).

Mansour (1991) describes value engineering as the analysis of a product design, engineering concept or construction approach with a multi-disciplinary team through problem solving techniques based on a functional analysis approach in order to gain optimum value while maintaining or improving quality, safety, and maintainability *'an organised approach for identifying and eliminating unnecessary cost'* Watson (2005:167). As a general rule it is accepted that approximately 20% of a system will contain 80% of the cost. It follows therefore that there will be a small number of elements which contain the bulk of any unnecessary costs. Hence a nominal value engineering effort directed at these particular areas can achieve significant savings (Dell'Isola, 1982).

'Value engineering employs some of the most powerful problem solving techniques ever devised' (Wixson, 1999: 3).

Value engineering is a procedure that examines cost and function from every conceivable aspect. It is a fundamental approach that takes nothing for granted, investigating everything about a system or subsystem including the very existence of the item itself, subject to the restriction that the required function or performance must not be degraded (Brahtz, 1978). Watson (2005) describes value engineering as being the least expensive way to provide the desired functional performance. *'The overarching objective of a value study is to improve the value of the project'* (SAVE, 2007: 2).

Lack of support, lack of flexibility and lack of awareness and knowledge of value engineering in some regions are causes for its limited application (Cheah and Ting, 2005). Participants can take a negative and sometimes adversarial view of value engineering with engineers seeking to avoid the liability of design modifications by non-engineers and contractors believing the time and expense of developing value engineering proposals risk being an unrecoverable cost should the proposal be rejected. The result is that they only consider advancing proposals with a particularly large cost reduction potential thereby causing the large cumulative effect of smaller savings to be lost (Jergeas *et al.* 1999). Coffield *et al.* (1988) contend that the converted praise value engineering while others dismiss it as a buzzword or just the renewal of old ideas. The reason for this apparent conflict is primarily a lack of understanding. *'The lack of knowledge and awareness about value engineering is a major cause for its limited*

application' (Cheah and Ting, 2005:153). Fong (1999) claim value management to be one of today's most misunderstood management concepts.

Value engineering has been misconstrued by some as a cost cutting exercise, while cost is a factor, overall value occurs in reduced design ambiguity, conflicts, errors and omissions in addition to increased value (Moyer, 2003). The term value engineering is often misunderstood to mean devalue engineering (Tarricone, 1993). *'The starting point of value engineering should be value rather than cost'* (Cheah and Ting, 2005: 153). Few will disagree that the primary objective of value engineering is to obtain value for money by dissecting alternatives and comparing function, value and cost (Coffield *et al.* 1988). In the United States, to ensure the active involvement of the designers in the value engineering efforts, the design fee (which is based on the estimated contract amount) is generally not reduced in line with any reduction in the contract amount following the value engineering study (USGSA, 1992).

Brown (2002) has observed that value engineering studies frequently result in a 10% to 30% reduction in total costs for the project and they often have a profound effect on the ultimate design. Moyer (2003) concurs, noting that value engineering can see a 10% to 30% reduction in total costs when carried out in the early phase of design.

Researchers conservatively estimate that a value engineering investment during the design phase of a project will yield a five to twenty fold return, however a reward system is necessary in order to instigate the incentive required (Coffield *et al.* 1988). '*Value engineering is an extremely effective, but often misunderstood tool for the design of any project*'. The benefit of applying this methodology is beyond question and has, for example in US Highways and Transportation departments, saved taxpayers in the order of $1 billion in 2000 alone. Value engineering studies typically costs between 0.1% and 0.3% of the total project costs yet save 3% to 5% of total costs - a return on investment in the order of 16-30 to 1 (Fletcher and Mc Clintock, 2004: 553).

HM Treasury (2007c) reports that over a 30year life the typical maintenance costs are 5 times the construction costs and the total operational and staffing cost can be as high as 200 times the construction cost. Whole life cost can therefore be a better indicator of overall value than initial construction costs as a well-built facility can achieve significant savings in running costs. Value engineering endeavours to optimise the balance between the cost of a facilities construction and costs which occur over the projects useful life –that is to say its lifetime/operating cost (Jergaes and Cooke, 1997). Kirk *et al.* (2002) reason that, for example, the capital costs of a hospital facility represents just 5 percent of its total lifetime cost - the ongoing operating costs accounting for the rest. It is of great importance to understand where

day to day spending occurs. The lifetime of an item will mean different things in different situations. An owner may wish to retain an item for an extended period of time thereby incurring operational and even disposal costs or they may wish to end their involvement soon after commissioning whereby only the capital costs will be of relevance (Jergeas *et al.* 1999).

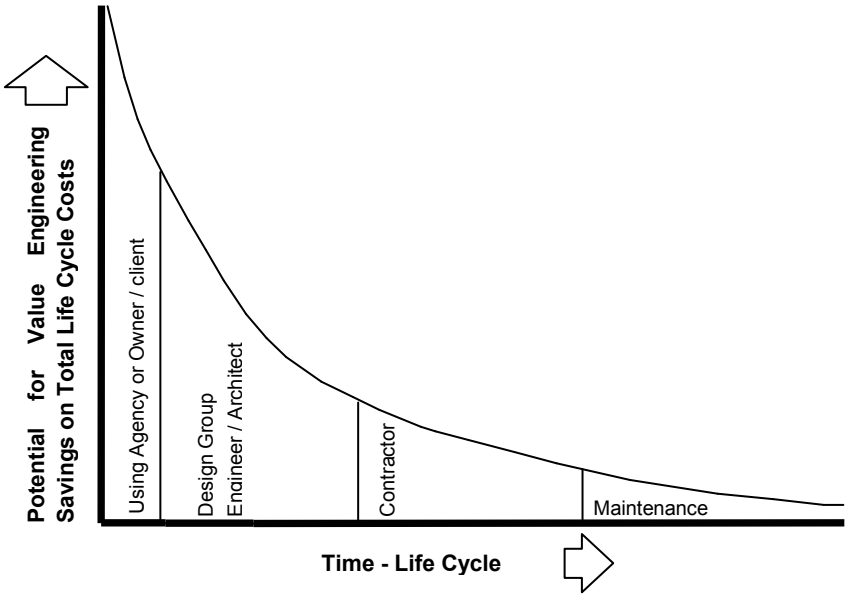

Figure 2.2.1 Adapted from (Dell'Isola, 1982)

As seen from figure 2.2.1, the most productive results of value engineering initiatives stem from studies conducted during the early stages of design when client and designer have complete control. It is at this point, before design development exceeds approximately 20% that value engineering is at its most effective (Coffield *et al.* 1988). Dell'Isola (1982: 60) contends that *'an initial study should be made no later than the 30% design phase'*. It is also necessary to relate potential saving, cost of study and the probability of implementing the recommended change when selecting the best time to perform a value engineering study (Davis, 2004). Dell'Isola (1982) cautions against value engineering studies being carried out on relatively complete designs as the exercise will, without adequate support, result in frustration and conflict.

There are 3 stages to a value study, figure 2.2.2. The preparatory pre-workshop stage, the workshop (using the 6 phase job plan) and the post workshop stage for implementation and follow up (SAVE, 2007).

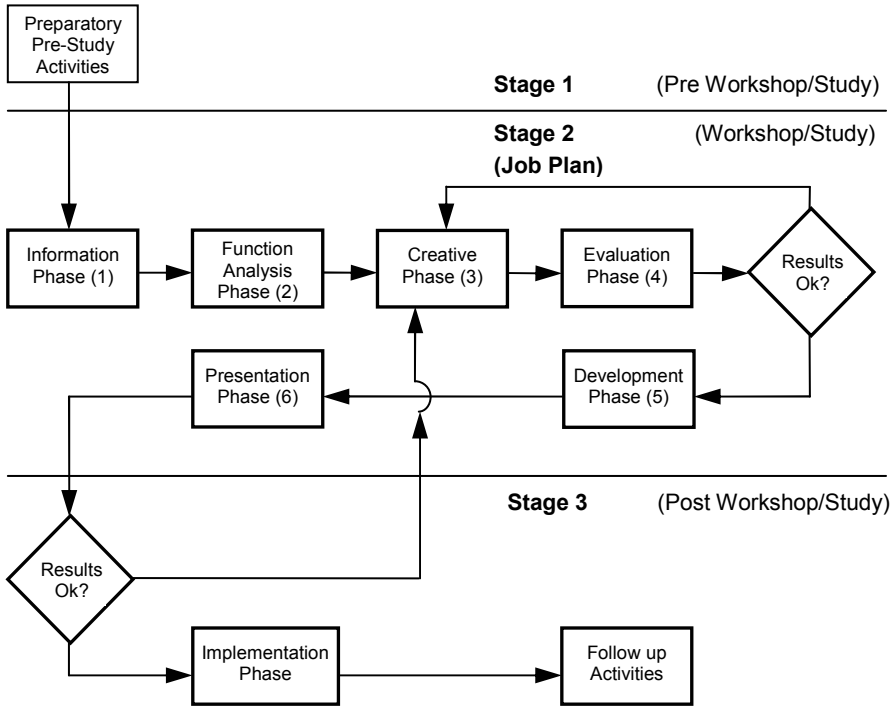

Figure 2.2.2 developed from, SAVE (2007)

Hunter and Kelly (2007) regard the main difference between UK and US value management studies as being in the management of the workshops. The UK studies typically use the project team in a one-day workshop compared to 3-5 days for the US studies where an independent team is the norm. While Kelly and Male (1993) adds that some value engineers exclude members of the original design team from the study as their presence may stifle a critical examination of the design, Barki and Hartwick (1994) conclude however that those who participate in the development process of a project are more likely to consider that project as being good, important and personally relevant.

A characteristic of value management in Hong Kong is the adoption of shortcuts to the process with the 40 hour American style workshop being uncommon, also there is generally some participation by the original design team in the studies and the inclusion of external expertise is considered to be beneficial (Fong and Shen, 2000). With the recent trend towards shorter workshops Phillips (2009) notes that they sometimes risk being conducted just to demonstrate process.

The 1994 Australian-New Zealand standard for value management is closely aligned with the UK and European-style, defining value management as being *'a structured and analytical group process which seeks to establish and improve value and where appropriate, value for money, in products, processes, services, organisations and systems'*. It is centred on a representative multi-disciplinary team employing workshop processes (Male *et al.* 2007:108).

A panel drawn from the design team together with a value management facilitator is considered by Kelly and Male (1993) to be more appropriate for UK projects than the independent value engineering team advocated in North America.

A value study must follow a systematic process - the Job Plan - which consists of six sequential phases as indicated in table 2.2.2 below (SAVE, 2007). The principles of the value engineering job plan, reflecting classical research techniques, are generally regarded to be sound (Kelly and Male, 1993).

The Job Plan sequential phases	Outline
Information phase	Project definition and goals
Function analysis phase	Function definition and analysis
Creative phase	Identification of alternatives
Evaluation phase	Structured evaluation of alternatives
Development phase	Development of alternative into proposals
Presentation phase	Report / Presentation of the opportunities

Table 2.2.2 developed from SAVE (2007)

Kelly and Male (1993) identify 4 formal value engineering approaches, the *Charette* meeting, the 40 hour study, the value engineering audit and the contractors change proposal, which can be varied to suit project particulars.

Many construction bureaus, government bodies and federal agencies now require that value management studies be carried out for major projects. The use of value management in the formation of the brief is considered to be a beneficial application of the method that enables the full participation of the client in the systematic identification and definition of their requirements, all within a common 'language' (Yu *et al.* 2005).

There are three primary routes by which an owner can benefit from value engineering as indicated in table 2.2.3 below:

Design Phase (Owner's Scope of Control)	**Bid Phase** (Owner's Scope of Control)	**Execution Phase** (Contractor's Scope of Control)
By utilising value engineering principles in the production of the projects design.	By terms, specifying the engagement of contractors and suppliers.	By providing incentives to the contractor through appropriate mechanisms within the contract.

Table 2.2.3 developed from Jergaes and Cooke, 1997.

Male *et al.* (2007) suggest that there is an indication that while value management has a strong theoretical base it is not driven by application. It is seen by some to lack a professional image

and be in decline due to a perceived ambiguity. Referring to Cheah and Ting's (2005) study they highlight the lack of support, contractual inflexibility and poor understanding of value engineering as a cause of its limited application in South East Asia. Male *et al.* (2007) conclude, that for value management to grow, it needs to be treated, designed and implemented as a professional service; it must become advice-laden and embrace more comprehensive skills; and finally it must be interventionist, challenging, and change-orientated. Crucially the value manager must accept liability for their professional advice. Fong and Shen (2000) concur noting that arguments centred on responsibility for design liability and the costs of redesign can further aggravate relationships.

> *'Ask yourself one question. If I could receive 10% of any saving I generated during the design and construction phase, could I turn out more economical designs, if the answer is yes, a formal value engineering program should be established and vigorously pursued'* (Dell'Isola, 1982: 11)

CHAPTER 3 –Value Engineering Application

3 VALUE ENGINEERING APPLICATION

3.1 CONSTRUCTION PHASE APPLICATION

There is a growing crisis in the design industry that is caused by errors, omissions and ambiguities in design. Contractors are not covering up the engineer's errors as they once did but are now actively identifying and pursuing them for additional profit. Architects and engineers are averaging 29 insurance claims per 100 firms per year and analysis indicates that 65% were the result of errors in the drawings and specifications (Brown, 2002). Despite their responsibility, engineering consultants frequently neglect the importance of design constructability leading to claims and delays (Chow and Ng, 2007). Due to a lack of experience in construction processes designers inevitably make decisions that hamper the work of contractors and stifle innovation on site (Prior and Szigeti, 2003). The informal system of construction management that is geared towards dealing with uncertainty and interdependence can create an endemic climate of self-perpetuating crisis (Koskela and Vrijhoef, 2001).

The peculiarities of construction, as a one-of-a kind production method, are shared by many other industries. However, the prevalent attributes of uncertainty and interdependence represent the main challenges to be overcome in the construction industry and are limiting factors to the application of innovative production techniques (Koskela and Vrijhoef, 2001).

Engineers can be concerned that contractor value engineering proposals may give the owners the impression they are not doing a good job and so often try to discredit the contractor pointing out flaws and pitfalls in the design (Jergeas *et al.* 1999).

Clients are becoming increasingly frustrated with the situation and more and more are turning to third party reviews, design-and-build contracting and other initiatives to circumvent the problem (Brown, 2002). New procurement processes are moving away from the traditional, prescriptive and fragmented approach to construction through design-and-build, prime contracting and public private partnership (PPP) (Prior and Szigeti, 2003). While many design management contractors utilise value engineering/management techniques to promote their outline designs to clients they do not extend these techniques into the detailed and later design stages, despite these stages representing the greatest opportunity for savings (Thompson and Austin, 2001).

Research has indicated that problems in construction are invariably deeply rooted but basic in nature and are the cause of considerable waste and inconvenience. While they are often not

even classified as being problems they consume managements time with fire-fighting (Koskela and Vrijhoef, 2001).

At execution phase, value engineering is primarily the domain of the contractor. In order for the client to benefit from the value engineering at this stage of the project the mechanism must have been defined within the contract (Jergeas and Cooke, 1997). Attempting to employ value engineering in the execution phase can lead contractors to focus on obtaining incentives to the detriment of other project objectives. Good communications will ensure owner's time is available to the project and not spent managing contractor behaviour (Jergeas *et al.* 1999).

Studies by Fong and Shen (2000) and Cheah and Ting (2005) have found that integrated project delivery methods such as design-and-build are more inducive to value engineering studies. Designers and contractors are effectively on the same team negating the confrontational attitude, which frequently develops and thereby overcoming one of the major obstacles to the successful application of value engineering.

A value engineering incentive clause is a contractual arrangement where the savings from value engineering are apportioned between the client, engineer and contractor (Jergeas *et al.* 1999). Although contractors are interested in value engineering as it offers opportunity to increase both profits margins and reputation (Acharya *et al.* 1995) the incentive must sufficiently exceed the margin already available in order for value engineering proposals to be worthwhile (Jergeas and Cooke, 1997). Ivory (2005) maintains that the complexity of construction projects can habitually render innovation an unwelcome disturbance to ongoing management efforts.

While Brahtz (1978: 25) maintains that *'the principles of incentive contracting should be used whenever feasible…* [it] *provides contractors with a means to share in any cost saving proposals they submit after contract award…the intent being to encourage contractors to be alert for cost saving ideas during construction'* An interesting side effect on incentive contracting is its ability to inspire better and more economical design decisions by consultants (whose work will be subjected to the scrutiny of contractors) (Dell'Isola, 1982).

As contractors now do little of the actual site work learning experiences and innovative solutions to construction problems are not being absorbed or retained but are dispersed with the subcontractors who have little incentive to reapply them on future projects (Koskela and Vrijhoef, 2001). Brahtz (1978) contends that while there is typically no incentive for the contractors to reduce the cost of the project there is clearly considerable motivation for them to increase it.

With 80% of construction costs established when the outline design has been formulated, undetected design errors or omissions inevitably lead to serious difficulties, delays and claims when construction begins (Chow and Ng, 2007). A value engineering study that reviews criteria before engaging a design-and-build firm is a very cost effective way to obtain the greatest value and realise 100 percent of the value engineering saving (Mitten, 1997).

Contractor requests for changes once a contract has been signed are generally proffered without a saving for the client thereby resulting in a general reluctance on the owner's part to accept them (Jergeas *et al.* 1999). Although the benefits of a contractor's value engineering initiatives through improved/innovative methods, equipment etc. accrue to the contractor not the owner, the owner may benefit indirectly through lower initial bid costs (Jergeas and Cooke, 1997).

The new Irish Pubic Works Construction Contract provides for and sets out entitlements for the contractor to submit value engineering proposals. The contractor is not reimbursed for work done on proposals and is therefore highly unlikely to propose changes unless they are to receive significant monetary benefit (Department of Finance, 2007). As proposals may not be accepted or often even considered, contractors can consider the cost, time and effort expended in developing value engineered proposals to be an unrecoverable risk. It is a major obstacle to the wider implementation of value engineering (Jergeas *et al.* 1999).

A contractor who can use a superior technique to their reduce execution cost is not obliged to share any savings with the owner however the implementation of new techniques will frequently require the owner's approval. With sufficient incentive owners may encourage contractors to search out and develop alternatives and through the contract may share in any savings (Jergeas and Cooke, 1997).

The risk of delays as a result of the time taken for an evaluation of contractor-initiated value engineering proposals can be a major disincentive (Kelly and Male, 1993). Engineers must approve contractor initiated value engineering change proposals and when these proposals impact on design, conflict can develop between the contractor and the engineer if they are rejected (Jergeas *et al.* 1999). A client confronted with pulling a project back in line with the established budgets may find that the combined alterations recommended by the consultants and the contractor yield the worst of all possible outcomes for the viability and marketability of the project (Reynolds Smith, 1995). Watson (2005) contends that costs should be managed where they occur and believe the 'myth' that engineering objectivity is impaired by a robust financial consideration of design does not hold true but is countered by instances of cost-based decisions being taken without proper consideration of the engineering consequence.

Large construction firms diversifying their service base are now offering complete design, management and construction processes directly to clients. The diversification of the construction industry into the total process management arena is putting new pressures on small to medium sized technically based consulting firms and narrowing their role and position within the industry (Kelly and Male, 1993). With advances in information technology and the continued use of partnering and design-and- build some main contractors foresee a possibility of consultants merging with contractors (Potts, 2004).

3.2 DESIGN PHASE APPLICATION

In traditional design methods each discipline generates and reviews their own requirements establishing and modifying their criteria and on occasion modifying the criteria and standards of the client. While this may encourage economical decisions by each discipline individually and is not without its merit, the decisions of individual disciplines can have a significant effect costs in other areas. It is these cumulative costs, generally the result of the architect/engineers decisions that have the greatest impact on the total cost of a facility. An architect or engineer in an attempt to optimise costs in their area may adversely affect the cost areas of all other disciplines (Brahtz, 1978). The separation of design from the rest of the construction process is indicative of the fundamental problems afflicting the construction industry (Egan, 1998).

Dell'Isola (1982) contends that as the two groups having the greatest cost impact on a given project are the client/owner/agencies and the designers it follows that if significant cost savings are to be realised the greatest effort should be directed to these two areas. If a value engineering benefit is to be fully realised Jergeas and Revay (1999) contend, it must be made from day one of the design process and not limited to process of constructability at a later stage. Value engineering, reports (Hussain, 2002), not only reduces cost it also improves constructability and helps to build team relationships. Watson (2005) contends that the management of the design-cost to total product-cost-leverage must not only engage the design engineers, but must be lead by them for the full benefits to be realised. It should not become solely an accounting function.

According to Zimmerman and Hart (1982) the biggest drawbacks currently being experienced in using value sharing incentive clauses with the contractor are the delays experienced by the contractors in receiving the approval of their proposals. In many cases potential savings that could result from value engineering are being eaten up by having to reschedule construction activities and unless the savings are substantial for the contractor they are usually not willing to take the risk. In fact *'Many leading practitioners are increasingly trying to eliminate the*

need for retrospective value engineering studies by ensuring that the philosophy is integrated into the initial design process' (Green, 1992 p 2). The design stage represents the best opportunity to optimise the value of a facility to its users (HM Treasury, 2007a). The primary method of obtaining value engineering is that which allows the design team to brainstorm and pursue alternatives. This process requires additional design time and costs and the concept will not work if there is a mindset or restriction to award the design work to the lowest bidder (Jergeas and Revay, 1999).

It is the opinion of Zimmerman and Hart (1982), Dell'Isola (1982) and Davis (2004) that the best place for the value engineering effort is in the early planning and design stages. The reason being that if changes can be found at these stages the major cost savings being realised by the client will not have to be shared with the contractor. SAVE (2007), clarify that while value methodology can be applied at any stage the greatest benefits are achieved with its use in the conceptual stage before major design resources have been committed. Repeated application at various stages can further refine the benefits but there will be increasing implementation costs, in fact HM Treasury (2007a) maintain that after the final design stage further design changes should not be allowed as they can be very expensive leading to wasted time, materials and a loss of direction. A parallel finding by Jergeas and Revay (1999) is that (in design development) decisions are frequently locked into design relationships that can become so complex that the cost of subsequent changes would be prohibitive. Reynolds Smith (1995) however maintain that value engineering while preferably a fundamental part of the design process is unfortunately most often sought only when cost estimates exceed approved budgets.

Brown (2002: CSC.10.1) maintains that *'[w]hen done in the early stages of design the Value Engineering studies often result in a 10% to 30% reduction in total costs although larger savings for significant design improvements are common.'* Acharya *et al.* (1995) concurs, stating the savings obtained by using value engineering range from 5-30% of original total costs. Dell'Isola (1982) adds that results from studies on numerous construction projects indicate a 5-20% reduction in costs to be a reasonable expectation of a formal value engineering programme.

The cost expended during the design phase of a project is typically the smallest yet according to Brahtz (1978) this is where the client and the designer can make the greatest impact on overall costs. As seen in figure 3.2.1 below the concept/design phase represents the greatest opportunity for return on a value engineering investment.

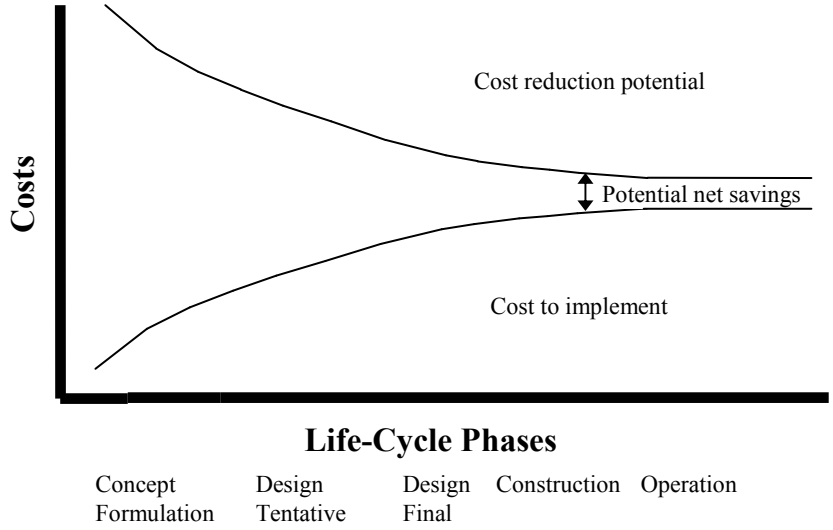

Figure 3.2.1 Adapted from Brahtz, 1978: 100.

Two factors control the correct time to apply a value engineering study: the first being the objective of obtaining maximum return from the value engineering effort, the second being a consideration of the ease/difficulty with which the study may be applied (Davis, 2004). Projects that show the greatest results are those where the value engineering studies were conducted at the early design stage, and most effectively when design development has reached around 20%. Once the design has been completed it typically becomes extremely difficult to realise savings on account of redesign costs, project delays and conflict (Coffield *et al,* 1988). Fletcher and McClintock (2004) maintain the optimum time to apply a value engineering study as being the 25% and 35% design stage. Hegan (1993) surmises that value engineering should be carried out early in the design stage, at 30%, and 70% of completion if appropriate, and advocates a 3 stage process as follows:

Stage 1 Preparation (Value Engineering Manager)

- Project familiarisation.
- Data preparation.
- Project modelling.

Stage 2 Workshop & Study Report (VE Study Team)

Information Stage:

- Briefing on clients needs, constraints, and design philosophy etc.
- Objectives of value engineering study to be identified.
- Function analysis.
- Selection of areas for detailed study.

Speculative Stage:

- Ideas session open to creative, unusual and other responses to ensure the widest scope of ideas are generated.

Analytical Stage:

- Discussion and analysis of all the ideas and a short listing of alternative solutions for consideration.

Proposal Stage:

- Developing sketches, calculations and estimates.
- Presentation to the client of the principal proposals.
- Action plan to schedule the development of the agreed proposals.

Stage 3 Follow up

Post Study Stage (Value Engineering Manager / VE Study Team)

- Preparation of summary value engineering report.
- Proposal implementation.
- Monitoring of Action Plan.

The technique of value engineering is distinctive in the emphasis it gives to the concept of function analysis with most definitions being built around the word function, such analysis is typically retrospective and is therefore, to a degree contrary to the established recognition that the maximum benefits are to be gained the earlier it is introduced. While the earlier value engineering is applied the more difficult it becomes to define the problem, it is considered preferable to get it correct at the beginning rather than to embark on a process of correcting poor design. The decisions that have the greatest impact are those taken at the start (Green, 1992). It is important that senior management be aware the earlier a value study is preformed the greater the potential benefit will be to their client (SAVE, 2007).

From the array of traditional problem solving techniques to the rapidly expanding new generation of methodologies and approaches to problem solving Smith *et al.* (1998) identified 3 techniques with the potential to make a contribution to the client briefing process.

- SMART methodology - A value management framework basis for design decision making.
- Expert Choice – An analytic hierarchy process with qualitative consideration ranking.
- Strategising – Neural network techniques as a basis to choose between alternatives.

The study concluded that while the techniques provided valuable insights there remained a challenge in interpreting the findings of any analysis into real and significant grounds by

which the design team could guide their decisions, the findings derived did not indicate how the designer should include the result into the design. It was suggested that a bridging technique is required to aid in this conversion process (Smith *et al.* 1998). SMART value management, based on the *Simple Multi-Attribute Rating Technique* was developed to link value management and value engineering methodologies. This is carried out in two stages VM1 and VM2 the former being an exercise in definition and understanding and the latter measuring and evaluating lower-order objectives creating a weighted value hierarchy by consensus (Green, 1992).

Shen et al. (2004) are of the opinion that while the SMART approach, developed by Stuart Green, is concerned primarily with the structure of decision making rather that the decisions themselves, it reveals underlying conflicts and inconsistencies allowing for their resolution and according to Green (1992) provides a framework on which the client and the design team can think and communicate. Yu et al. (2005) explored the Charette job plan, a method evolved from value engineering and found it held effective potential but needed to be broadened using a functional hierarchy and considers the SMART methodology developed by Green (1994) to be a beneficial framework for facilitating thought and communication. The Charette job plan focuses on the functions of key elements and identified spaces (an exercise typically carried out by a value engineer after the brief formation) but needs to be broadened to include other client requirements issues (Green, 1992).

As indicated in Figure 3.2.2 the project mission statement should explain concisely why the client undertakes a project. It should advance an identification of the functional objectives necessary to achieve the mission and the performance specifications necessary to meet the criteria of the functional objectives (Shen *et al.* 2004). A survey by Kometa *et al.* (1994) ranked project definition and formulation as the highest client attribute affecting the performance of their consultants.

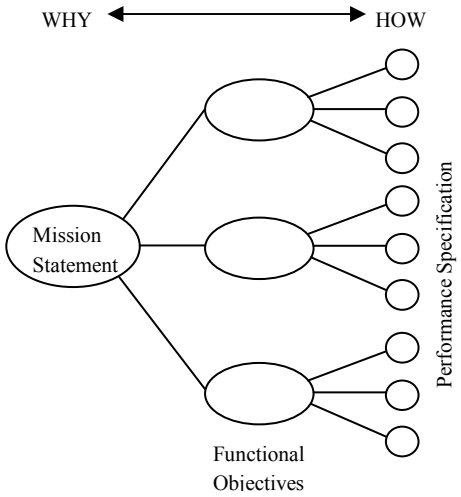

Figure 3.2.2: The hierarchy of functions adapted from Shen et al. 2004

It is indicated by the research of many government bodies that value engineering can help client and project teams focus more efficiently on both the needs and objectives of the project and may be the solution to improving the briefing performance (Yu *et al.* 2006b).

It is important in the exploration of 'function' to explicitly determine the client needs and wants (Kelly and Male, 1993). Studies have shown that poor early phase development can lead to conceptual changes during the implementation phase. In order to improve projects the high degree of uncertainty that is prevalent in the early phase must be explicitly addressed (Kolltveit and Gronhaug, 2004). Designers can not make decisions for the owner but they can assist the client in reaching informed decisions (Kirk *et al.* 2002). Kolltveit and Gronhaug (2004) however point out that the culture and conservatism of the construction industry presently inhibits active involvement in the vulnerable early developmental project phases.

Value management in the early stages will provide the opportunity to clearly and explicitly establish the project task: *reason for the projects existence*, project needs: *primary functions required by the client,* and project wants: *embellishments - the site of much unnecessary cost* (Kelly and Male, 1993). As a project will always reflect a value perspective Kelly and Male (2004b) argue that it is better if a project is developed on the basis of established client value criteria rather than an interpretation of the client's values by the design team which would otherwise be the case.

3.3 BRIEFING PHASE APPLICATION

The brief is the formation of a major resource commitment for the client. The ability to influence cost is at its maximum during this stage of a projects life. It is crucial therefore to success that all options are fully and critically examined, justified and properly documented in a formal and defined manner (Yu *et al.* 2005). Yu *et al.* (2008) contends that despite the considerable degree of research and the development of briefing guides over the past two decades current briefing practices remain inadequate. The limitations can shift the focus away from client requirements resulting in inadequate solutions. Kamara *et al.* (2000b) maintain that many briefs are currently generated from design rather than from client objectives and that to avoid a shift in focus from the client to the designer construction design problems must be resolved in a context where the client requirements are distinctly separated from other project requirements. The solution must not define the problem before a thorough understanding of client requirements have being reached. Current techniques identify what should be done but fail to explain how to integrate this knowledge into the design (Shen *et al.* 2004). While many initiatives have been taken to improve project briefing the process remains inadequate according to much of the research (Shen *et al.* 2004).

Research has suggested there are no widely adopted techniques to manage brief development and little attention appears to be paid to the issue or the extent to which it may advance project performance (Othman *et al.* 2005).

A systematic approach is needed, maintain Shen *et al.* (2004). The complex problem of the briefing process indicates that an integration of the value management, FAST and functional performance specification techniques is appropriate to both systematically identify client requirements and develop a precise understanding and definition of these requirements to the benefit of all stake holders in the project.

The construction industry reports of Banwell (1964), Latham (1994) and the Construction Industry Review Committee (2001) signals a continuance of inadequate briefing, and suggests there is an entrenched resistance to the application of sufficient resources to the briefing process (Shen and Chung, 2006; Yu *et al.* 2005; Shen *et al.* 2002; Barrett and Stanley, 1999).

Briefing is a complex, dynamic and iterative task requiring a shared understanding and commitment together with close coordination and communication from and among clients, users, the design team and other stakeholders (Barrett and Stanley 1999; Shen *et al.* 2004; Yu *et al.* 2005; Yu *et al*.2006b). Brief development has a considerable impact on project cost, duration, quality, value and risk (Othman *et al.* 2005). *'The briefing process is critical to the successful delivery of construction projects…it is the first and most important step in the design process'* (Shen *et al.* 2004, p 213).

In traditional briefing it is through the slow iterative process of presenting successive schemes each going one step closer to achieving the client's goals that the client's value system is eventually established (Kelly and Male 2004a). The project brief is a topical issue is the construction industry and while it is the subject of much research (Yu *et al.* 2005) there remains little improvement in client briefing techniques (Smith *et al.* 1998). *'Building problems are extremely complex and ill-defined, starting in uncertainty and trying to end up with certainty'* (Fong, 1998b: 6). To overcome the problem Barrett and Stanley (1999) advocate the following 5 key improvement areas:

1. Empowering the client
2. Managing the project dynamics
3. Appropriate user involvement
4. Appropriate team building
5. Appropriate visualization techniques

> *'All value engineering authors agree that the maximum cost reduction potential occurs early in the briefing/design process' (Kelly and Male, 1993:16).*

Existing briefing techniques have been described as being of little real assistance to clients and designers and are considered inadequate by many researchers (Smith *et al.* 1998; Barrett and Stanley 1999; Shen *et al.* 2004) in fact Barrett and Stanley (1999) and Newman, (1996) contend that most of the problems in construction projects can be traced back to failures in the briefing process claiming that while briefing processes are acknowledged to be critical to successful construction, the clients needs, despite good practice advice for over 30 years, continue to be unmet. The brief in many cases is an event rather than a process and results in projects that while being efficient, regularly fail to be effective in meeting the client's needs. The brief becomes a cage for the client - handing ownership of the project to the design team. *'On many civil engineering projects one third of the design is completed by the time pencil meets paper'* (Sturts and Griffis, 2005b: 622).

> *'The briefing process is critical to the satisfaction of clients as well as the successful delivery of construction projects….a good project brief protects clients from a major source of delays and cost overruns'* (Yu *et al.* 2005).

Client briefing is the single most important element of the project. It is the foundation of design, a formative stage where owners and users of a project still have a significant impact on the decisions that will dictate the nature and form of the project (Smith *et al.* 1998). Yu *et al.* (2005) describe the brief as being the formal documentation of client requirements that forms the basis of design from an early stage of a construction project. Not only are engineering consultants required to observe the client's brief they should assist the client in identifying and developing their necessary objectives and requirements (Chow and Ng, 2007). *'The client finds it hard to imagine how they will operate within the building ... the briefing process must support the client through the journey from uncertainty to certainty'* (Barrett and Stanley, 1999 p15). The exploration of client's needs aims to achieve an accurate definition of the project that is not only cost effective but is more valuable to both the client and the users (Smith *et al.* 1998).

Leadership is a primary client role and it must begin with the clear and developed brief that is so essential to good design. It is at this stage that most optimisation can be achieved, as it is said: *'The million pound mistake is made on day one'* (HM Treasury, 2007a: 7).

While initiatives have been taken to improve project briefing, according to much of the research, the process remains inadequate (Shen *et al.* 2004). Many of the initiatives have

developed from the realisation, (generated by research) that problems in the briefing process are caused by a lack of focus on client needs. The software and techniques that have being developed to managing briefing-information typically adopted from manufacturing, often simply computerises the existing practices without a re-engineering of the process to prioritise the client's perspective (Kamara *et al.* 2000b). Kolltveit and Gronhaug (2004) maintain that despite the dramatic value generation improvement that can be achieved through improving the early project phases the subject has received only limited research attention.

Key variables that have a major impact on the briefing process

Variables	Keywords
Projects:	*Physical, Separate, Temporary, Change*
Stakeholder management:	*Interests, Balance, Responsibility, Relationships,*
Change Management:	*Teamwork, Collaboration, Communication, Techniques*
Risk & Conflict Management:	*Uncertainty, Problem Solving, Flexibility, Resolution*
Evaluation:	*Success, Failure, Experience, Learning*
Team & Team Dynamics:	*Focus, Interaction, Individualism, Collectivism*
Client Representation:	*Adequacy, Needs, Groups, Distortion*
Organisation:	*Difference, Aims, Criteria, Influence*
Decision Making:	*Problem, Situation, Limits, Methods*
Communication:	*Enable, Encouraged, Effective, Active*
Culture & Ethics:	*Uncertainty, Power, Dilemmas, Division*
Key Indicators/Success Factors:	*Time, Cost, Quality, Involvement*

Table 3.3.1 developed from Yu *et al.* (2005).

Yu *et al.* (2006b) consider there to be two schools of thought regarding project briefing - one sees the brief as an entity that should be frozen after a critical period, the other considers the brief to be an evolving activity developing from an initial global brief (Yu *et al.* 2006a). It is generally accepted that there are two distinct stages to briefing: strategic briefing (*the business solution*, identifying the clients needs, requirements and objective) and project briefing (which focuses on delivering *the technical solution*, the construction response to the business requirement). The completed brief should therefore be a full statement of the client's functional and operational requirements (Yu *et al.* 2006b).

Yu *et al.* (2008) contend that there are three layers in the decision making process: corporate, departmental and individual. The problem of senior managers trying to make decisions on detail at the early stage when strategic decisions are required should be avoided.

'Success has always been the ultimate goal of every activity of a project, and construction project briefing is no exception…successful briefing is where the needs and requirements of

the client and stakeholders are identified, understood, defined, represented and communicated accurately and effectively to the project team' (Yu *et al.* 2006a, p 1179).

Factors Critical for Successful Briefing (ranked in descending order)	
1. Open and effective communication.	6. Experience of writer (of brief)
2. Clear and precise briefing documents	7. Team commitment
3. Clear intention and objectives of client	8. Identification of client requirements
4. Clear project goal and objectives	9. Agreement of brief by all relevant parties
5. Understanding of client requirements	10. Sufficient consultation from stakeholders

Table 3.3.2 developed from, Yu *et al.* (2006a)

The expression of the client's requirements involves by necessity some form of processing as the clients requirements are typically expressed in non-design/construction terms which therefore requires a translation. Client Requirement Processing (CRP) involves the presentation of the client's requirements in a format that enhances an understanding of the clients' needs and desires. It has been defined as the translation and analysis of explicit and implicit client requirements into a solution presented through a neutral design specification thereby allowing the various professionals and their client understand them in the same way (Kamara *et al.* 2000a).

A neglected but vitally important area is the development of effective methodologies to enhance the understanding of client requirements. An effective mechanism for processing client requirements will contribute positively to the project (Kamara *et al.* 2000a). *'Designers speak different languages to users yet they must understand the business language of their clients to allow for meaningful communication of needs'* (Yu *et al.* 2006a, p 1179). A new way of looking at the issue comes from the Dutch Building Research Board who recommended that the brief start out as the client's aspirations in terms of a global brief that is not expressed in construction terms but instead focuses on functional needs – briefing as a process (Barrett and Stanley, 1999). The performance based building approach focuses on the ends rather than the means and in this context that the design stage is very important as it is when significant decisions are made that will determine the project. *'Performance requirements should be expressed in solution-independent terms'* (Spekkink, 2005).

According to Spekkink (2005 p 3) design practitioners appear to be largely unaware of the concept of performance-based design (a client oriented way of thinking and working) and its potential impact on the profession. The performance concept has two key characteristics: the functional concept on the demand side and the solution concept on the supply side. The study

of performance specification at present primarily lies in the realm of academia, and the work of institutions and government bodies.

The management of client and user involvement in the design process is a relatively new topic, although the building industry is recognised as not been very user orientated several countries have engaged in major programmes aimed at structurally changing the industry the common goal being to create a more customer focused industry. The Dutch Building Research Institute (SBR) has identified a framework for a new system of briefing in which briefing and design are carried out in a controlled, parallel but separate process. The methodology is depicted in figure 3.3.3 below (Spekkink, 2005).

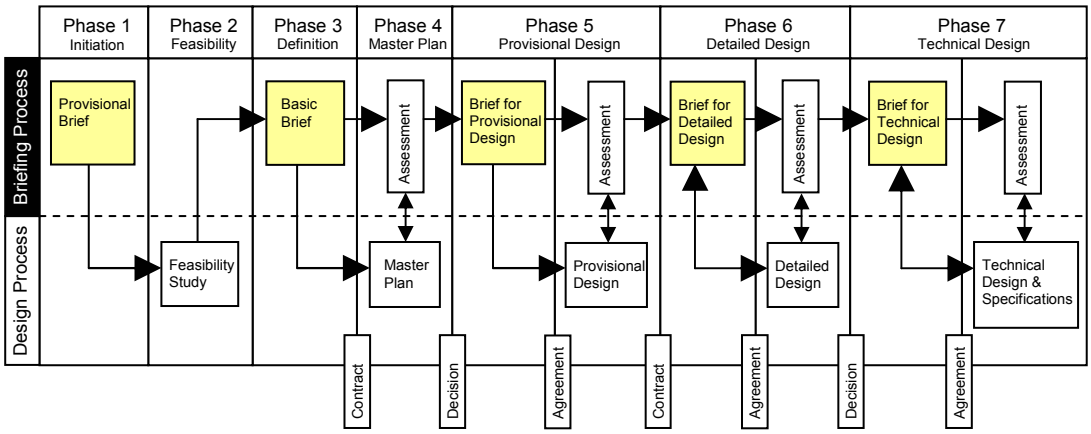

Figure 3.3.3 Parallel briefing and design process
(Adapted from, Spekkink, SBR 1992/2005, Barrett and Stanley, 1999)

There are very clear parallels between the functional briefing process as advocated and those in design stage value engineering (Barrett and Stanley, 1999). Yu *et al.* (2006b) contend that the body of research and growing legislation for the use of value engineering on major projects suggest that value management may be the solution for improving the performance of the briefing process. Surveys indicate that a guided briefing workshop can improve communication and result in solutions constructed from a number of views that are considered superior to that proposed by any individual (Yu *et al.* 2008). *'The translation of user requirements into performance requirements is specialist work that has to be done by Architects or Consulting Engineers'* (Spekkink, 2005).

The World Trade Organisations (WTO) 1997 agreement on technical barriers to trade state that wherever appropriate technical regulations shall be based on performance rather than prescriptive characteristics. Both the Australian and the New Zealand regulatory systems set the building code objectives to be achieved without prescribing definitive construction method and performance based contracting is mandatory in the United States (Prior and Szigeti, 2003). Yu *et al.* (2005); Kamara *et al.* (2000a&b); Barrett and Stanley (1999) and Mac Pherson *et al.*

(1992) contend that the current briefing techniques offer no real improvement to briefing practice being too general and implicit they provide little assistance to either the client or the designers.

Client requirements represent the base of a framework incorporating site requirements, environmental requirements, regulatory requirements and design requirements - all of which underpin the formation of the project's construction requirements (Kamara *et al.* 2000a). Othman *et al.* (2005) concluded that there is a need for a brief-development management system that incorporates both value management and risk management. Kamara *et al.* (2000b) consider improvements to the construction process may be achieved by bringing a renewed focus on the client's requirements. According to Barrett and Stanley, (1999) part of the secret to success lies in the recognition that improvement over time will be non-linear. Accepting that dips in performance will be followed by rapid a improvement leads to a more positive outlook on the periodic setbacks as they occur, leading to a continuous improvement process as confidence grows.

The successful implementation of advanced briefing depends on the clients support and the recognition that the additional resources necessary will be justified. The many recognised benefits achieved by the effective and efficient representation of the client requirements will generate a more precise and defined project brief (Shen *et al.* 2004). Yu *et al.* (2008) add that the project brief should not be for the sole use of the design team, it should serve as a reference document for, and available to, all project parties. According to Shen *et al.* (2004) and Yu *et al.* (2005) current problems on the general briefing framework include:

- Insufficient consideration given to obtaining the input of all relevant stakeholders
- Insufficient time allocation for project briefing
- Client perspectives not adequately considered
- Communication problems between those involved/who should be involved in briefing
- Poor change management
- Decision making limited to conflict resolution
- Briefing stage can be poorly defined and often in conjunction with preliminary design
- Inadequate information management that is often fragmented and unprocessed

Research findings reveal that due to commercial pressures many construction clients restrict the time allowed for briefing and design in order to shorten lead-in time to construction. The resultant lack of definition and understanding considerably increases project risk (Shen and Chung, 2006). With clients often viewing the brief as an event rather than a process there is little effort made to use briefing guides, work to an established or any framework, or to

improve the briefing process. Research findings imply that client requirements are not being identified properly resulting in inappropriate decisions being made (Shen and Chung, 2006).

'The purpose of commissioning a new project is to achieve the objective of the client. These objectives direct the specific requirements of the project which in turn direct the design tasks' (Shen *et al.* 2004, P 216). If construction participants want to improve their briefing performance they should concentrate on empowering the client, managing project dynamics, engage appropriate user involvement, and develop team building and visualization techniques (Barrett and Stanley, 1999).

Othman *et al.* (2005) consider that for success briefing, roles should be both understood and managed. The client for their part must provide the design team with the information necessary to realise their needs and should incorporate the views of the projects users in the briefing process. Design firms in turn must avoid unilateral behaviour and should where necessary enable the client to understand the design. To this end Shen *et al.* (2004) advocates a hierarchical structure to identify and represent the client requirements within a structured job plan for the briefing process, a process enabled by the techniques of value engineering.

CHAPTER 4 – The Need for and Resistance to Value Engineering

4 IMPETUS & RESISTANCE TO VALUE ENGINEERING

4.1 THE CONSULTING ENGINEERS PERSPECTIVE

There is a clear difference in how clients and their engineers' rate distinct service features that indicate consultants may not be listening adequately to their clients. A clear disparity exists between what the client expects and what the consulting engineer believes they expect. A gap exists also between what the client expects and in what they feel has been delivered by their consulting engineer in terms of service quality (Samson and Parke, 1994). Many owners are unfortunately of the belief that designers perform value engineering as part of their normal design work (Davis, 2004). Engineering firms consider themselves to be professionals providing a complete service for their fee and already believe that they provide their clients with economical designs (Jergeas *et al.* 1999). Jergeas and Cooke (1997) acknowledge that inherent in the design phase of all projects is the attempt to provide a considered design that meets or exceeds the owner's specification, while not formalised, it can nevertheless be a form of value engineering.

'It is extraordinary that whenever questions of briefing are discussed amongst construction professionals the first thing they do is blame the client.' (Barrett and Stanley, 1999 p28) Engineers Australia (2004) contends that rather than being cooperative the client consultant relationship has become more contractual and adversarial. The problem faced by the construction industry into the future will be more organisational and cultural rather than technical (Smith and Love, 2001).

The introduction of value engineering is often met with resistance and a lack of understanding. Consulting engineers with their extensive background, experience, qualifications and technical discipline can consider their design to be satisfactory and not warranting additional *unnecessary and costly* scrutiny. They often consider value engineering to be *a waste of time* and a criticism of their technical capabilities (Mansour, 1991). When faced with deadlines, value engineering can have a low priority (Kelly and Male, 1993). Time expended on value engineering by the design firm is often viewed negatively, expending unrecoverable costs and reducing their profit particularly where the design fee is calculated on the total project cost (Jergeas and Cooke, 1997). Engineering firms typically find their clients unreceptive to the concept of introducing value engineering incentive clauses in client/engineer relationships (Jergeas *et al.* 1999).

Designers frequently consider value engineering as an unwelcome disturbance to the design process. The additional burden of reviewing value engineering proposals, time wasted,

interrupted work and re-design is often believed to be more costly than any anticipated savings (Kelly and Male, 1993). As engineers perceive their clients as being risk averse and preferring of a tried and trusted design basis there is little incentive for them to develop innovative value engineering proposals without securing additional compensation (Jergeas *et al.* 1999). The very nature of value engineering, its dynamism and search for change are perceived as being conflict laden with the potential to undermine rather than be complementary to professional practices (Fong and Shen, 2000).

'Value engineering', Mansour and Hulshizer (1997) report, generates very little interest for project designers and for the most part is taken as an imposition and received as an affliction by those responsible for implementing it. Therefore *'[w]hen the suggestion of value engineering for their task is thrust upon them, many designers consider it a potential threat that could fly in the face of their efforts, questions their virtues and challenges their expertise*' (Mansour and Hulshizer, 1997: VE&C.02.1). Sturts and Griffis (2005a) contend that many engineers feel their role is being undervalued and that they have lost a sense of professional distinction, the design team interpreting value engineering as a critique of their design judgement (Kelly and Male, 1993). Miles (1967) contends that in order for value engineering to develop it is necessary to understand and minimise or end the embarrassment that can be perceived by professionals who's designs are questioned by any value engineering efforts.

With growing competition successful engineering firms are differentiated by their ability to provide their clients with an efficiency of service and not by their technical abilities, '*[e]ngineers are some of the smartest people on earth*', but engineering firms, being dominated by the engineer's perspective, can resist the risk of change (Cayes, 1998: 31-32). Engineers typically dominate engineering firms and the thought of venturing into a new area can be daunting, egos are delicate and change can be frightening. With a culture of doing things the old way change can sometimes feel like professional suicide (Cayes, 1998).

As the market has become more flexible and dynamic, an unwillingness to fully address the client's needs is becoming increasingly more disadvantageous to design firms (Prior and Szigeti, 2003). While engineers may possess the logical, mathematical and spatial intelligence suitable for technical advancement they typically are not well suited for business (Cayes, 1998). *'If an engineering firm cannot meet all of the customers' expectations, the client will look for support elsewhere. By using the Internet or a phone book a client can find another engineer in minutes'* (Anderson, 2001: 34). The idea that the service expectations of the clients of consulting engineers may possibly be set too high is at variance with almost every other industry where the customer's needs and desires drive and set the level of quality to be attained (Samson and Parke, 1994).

Client satisfaction is according to Cheng *et al.* (2006) one of the major determinants of project success and therefore a fundamental issue for construction participants who must seek to constantly improve their performance in order to survive in the market place. Studies indicate that 65% of construction consultant's new business comes from existing clients and of the remaining 35%, 61% comes by recommendation or referral (Barrett and Stanley, 1999). Cheng *et al.* (2006) assert that developing a new client is up to 5 times more expensive than maintaining an existing one. Firms could double their profits by simply retaining 5% more of their clients. Clients now evaluate potential consultants both in terms of value-for-money and service, in addition, to their engineering capabilities (Anderson, 2001).

It follows therefore, according to Sturts and Griffis (2005a: 57), that the current fee based selection method has reduced the profession to a technical level where the '*Engineers are no longer the creative and inventive professional service provides they once were*' they are now being forced to create a design as efficiently as possible in order to maintain profit under competitively low fees, rather than to design a solution that is as efficient as possible for their client. Gallo et al. (2002) add that the quality of design and documentation within the construction industry has worsened in a direct relationship to the reduction in design fees and there has been a corresponding and similar decline in construction efficiency with increased project delays, costs and disputes. Hoxley (2000) contends conversely that while earlier studies show a decline in the checking and reviewing of designs with a corresponding reduction in the investigation of alternatives. Professional firms have, as a result of competitive fee tendering become more efficient - not allowing the lower fees to compromise their professionalism. There is nevertheless, according to Sturts and Griffis (2005a), an opportunity for engineers to change their approach. In the past, marketing engineering services were viewed as unprofessional, however today the need is being recognised and marketing strategies are becoming a major part of the engineer's job.

Sturts and Griffis (2005b) contend that many engineers lament the commoditisation of their services and have trouble quantifying their value to potential clients. Engineering design has become standardised and it is this very standardisation that leads potential clients to perceive their services simply as another commodity, a commodity that the engineer prices and their clients expect to negotiate. More detailed discussion needs to take place between the client and engineering consultant in order to define the needs and service qualities important to the client and to establish how the firm will match their service delivery to that expectation (Samson and Parke, 1994). Mansour and Hulshizer (1997) contend that almost always the beneficiaries of value engineering will be the owner and/or the contractor, rarely if ever will there be a realisable financial or prestige gain for the originating design team. In the United States

according to Sturts and Griffis (2005b) quality-based selection makes fee based bidding illegal by federal mandate in many states.

While the conceptual and design phases have been shown by Jergeas and Cooke (1997) to present the most beneficial opportunity of achieving gain from value engineering, the process can be considered as questioning the designer's original plans and reasoning, and can result in the designer defending the original design against a perceived critical reproach.

The perceived assault of value engineering can create an enemy to discredit leading to a culture of distrust, evasiveness and protectionism (Mansour and Hulshizer, 1997). *'To deny the reality of the value engineering phobia potential is to deny human nature'* (Mansour and Hulshizer, 1997:328). The engineer's analytical mind can create a barrier to acceptance of non-tangible undertakings that must be overcome with measures to make them more recognisable and demonstrable (Robinson et al. 2004). Perceived criticism can create a confrontational atmosphere between the designer and the value engineering team resulting in designers becoming reluctant to participate in value engineering efforts (Jergeas and Cooke, 1997). To overcome this value engineering phobia it is considered necessary to plan ahead, introducing value engineering to the project at is initiation, establishing goals, budgets and schedules conveying value engineering to be a beneficial contribution which is to be encouraged and valued whilst recognising the importance of the design team's position (Mansour and Hulshizer, 1997).

> '*Engineers have been planning and building cities since human beings began creating them. Though there have been advances and changes in engineering methodology, today's practices are based on ancient traditions'* (Sturts and Griffis, 2005a: 58).

Today's construction industry is characterised by the need to accommodate change (Smith and Love, 2001). With clients continuing to force change, consultants must re-examine the services they provide and meet the clients changing social and economic demands, adding value to the building product and the clients business (Smith and Love, 2001). *'Clients consider value for money as the most important aspect when procuring an external consultant.'* (Cheng *et al.* 2006: 580) Engineering firms need to qualify themselves, creativity is subjective; popularity, notoriety and image increase prices while the standardisation typified by current engineering practice forces prices lower. The client should be clear why he is being asked to pay more (Sturts and Griffis, 2005b). Research indicates that clients do recognise the benefits of value added services and are willing to pay extra for it (Kirk *et al.* 2002). A re-skilling of the industry its organisations and individuals may be essential to achieve the necessary improvements in value that clients are demanding (Phillips, 2009: 28). A more

favourable perception of consulting engineering services is to be obtained through a value rather than quality orientation. If consulting engineering firms communicate the notion that the money, time and effort spent on projects are not necessarily negative it can increase client perception of value and thereby satisfaction (Lapierre *et al.* 1999). Engineering however firms typically find their clients unreceptive to the introduction of value engineering incentive clauses in client/engineer relationships (Jergeas *et al.* 1999).

Smedlund (2008) tells us that innovation in professional services occurs in the delivery, therefore according to Brahtz (1978) consulting engineers will find that value engineering enhances the capabilities of their firm to the benefit of both present and future clients, providing additional valuable services gives them a competitive edge over the firms who do not, the result potentially being more business and more revenue. Implementing a value engineering programme incurs an investment and the programme will provide a return in the form of cost savings. The return on these savings will have to be enough to provide for the satisfactory economic stimulus to the firm (Brahtz, 1978). A designer hired solely under a competitive fee-based procurement process is unlikely to spend enough time to make the design as efficient as possible (Sturts and Griffis (2005a)), while according to Kirk *et al.* (2002:5) the design process should not stop with the first workable idea *'[t]he current pricing method does not incentivise engineers to improve or optimise the design'* (Sturts and Griffis 2005a: 57). Conflict can originate in the owner's perception of an engineering firm's desire to increase their margin by maximising their fee. Owners unfamiliar with value engineering objectives can view contractor developed value engineers proposals as a failure on the engineers part, believing such savings should have been part of the original design (Jergeas *et al.* 1999).

Mansour and Hulshizer (1997) contend that there can be a view among engineers that when the value engineering savings roll in, they do so to the clients' and contractors' bank accounts, not those of the engineer whose budgets and targets are missed by the additional work load. Male *et al.* (2007) contend the most serious impediment to value engineering is considered to be the lack of time available to implement it and the continuing efforts to further constrict and *tick-box* the process. Shen and Liu (2004) agree, reporting a significant barrier to the application of value management in construction as being its perception as time consuming and interruptive. The success of a service delivered is, according to Smedlund (2008), heavily reliant on the client's input. The usual strategy in service innovation is the use of a pilot client to develop the service prior to its wider implementation (Smedlund, 2008).

In an integrated value engineering study design team members will form part of and contribute to the process. Through this participation and involvement the lead designer gains an insight

into the process thereby instilling a will to engage and support, rather than resist, the study's recommendations. The designer will be reflected positively through association with the recommendations in a way that will further endorse the findings and themselves (Mansour, 1991). Smedlund (2008) suggests that high-potential services create a future competitive advantage not only for the service provider but also for the client and notes the typical implementation strategy for new innovations in the service industry as being the initial implementation with a pilot client prior to developing the service further with others. So if consultants want to develop their competencies and their market reputations they must find (or tailor) clients that are willing to allow them to develop and try out new service innovations (Ivory, 2005).

While there is reluctance on the part of professionals and clients to undertake value engineering studies (Fletcher and McClintock, 2004), *'designers always express criticism regarding value management'* (Fong and Shen, 2000:325), the cost of doing nothing could be startling. Halder and Mehrabian (2008) inform us that some major universities in the U.S. recently considered dropping Civil Engineering from their engineering programme. The reason given for this decision was the misconception that civil engineering was fully developed and there were no major research challenges remaining. University engineering courses are no longer well supported and student numbers are falling (Engineers Australia, 2004).

4.2 THE CLIENT PERSPECTIVE

The client is responsible for commissioning and paying for the design and construction of a facility or construction service. While they may or may not be the direct end user they should nevertheless represent the interest of users and other persons affected by the acquisition, use and operation of the facility being commissioned. They can be considered as the body incorporating the interests of the buyer of construction services, prospective users and other groups (Kamara *et al.* 2000a).

Chinyio *et al.* (1998) in their survey of client needs found that respondents rated building functionality as being their most predominant need ahead of timely construction and value for money.

Up to 40% of the cost of developing and managing capital projects has been shown to bring no value to the end user. Elements conservatively or overly designed for their function increase costs by up to 15% and poor quality design and documentation can contribute up to a further 12% of the tender costs. There is therefore considerable scope for improvement within the industry (Gallo et al. (2002)).

'Clients believe consulting engineers are significantly lacking in performance' (Samson and Parke, 1994).

The general philosophy of many clients is that where architects and engineers fail to consider value engineering in their selection of methods and materials they are simply not doing their job (Jergeas and Revay, 1999). Indeed, according to Bibby *et al.* (2006), clients are increasingly adopting design-and-build type procurement routes in favour of more traditional contracts in order to reduce the risks associated with their construction projects. As a result, contractors are now being expected to accept an increasing responsibility for the control of design – a process they have little experience in managing. Design-and-build projects now account for 35% of all construction work (Sturts and Griffis (2005a)). High level construction industry reports *Constructing the Team* (Latham, 1994), Egan's report, *Rethinking Construction* (DETR, 1998) and *Modernising Construction* (NAO, 2001) recommend that clients move away from traditional procurement methods to adopt more collaborative approaches and partnering alliances, as well as adopting continuous improvement and whole-life costing (Potts, 2004). Rwelamila and Edries (2007) contend that civil engineering consultants are not sufficiently knowledgeable of the theory and practice of the range of procurement methods available to adequately assist clients with appropriate selection.

A thorough understanding of client requirements, the primary source of information for a construction project, plays a vital role in satisfying the client and in the project being successful (Kamara *et al.* 2000a). Clients' needs are frequently lost in the organisational rivalry borne from the conflict of today's adversarial relationships (Smith and Love, 2001). Clients tend to associate risk more to the purchase of services than they do to the purchase of goods (Mills and Moshavi, 1998). Without an adequate understanding of the wishes of the client it is possible for the preferences of the designer to be substituted for that of the client (Kamara *et al.* 2000a). The supremacy of the client's needs are only now being realised by many constructional professionals. Clients are becoming the driving force in the increasing development of alternative procurement methods (Smith and Love, 2001).

How a client perceives a service provider's performance and how the service provider considers how they themselves have preformed on a project can differ markedly (Cheng *et al.* 2006). Clients frequently assume the qualification of all engineers competing for fee based work to be equal and only the price therefore is important without questioning *'how much is an engineers solution worth'* and conversely what is the cost (Sturts and Griffis, 2005a:61). The culture of construction professionals historically was paternal in nature with professionals deciding the best product of design and construction and clients accepted what was given. Time, cost and quality are now the industry drivers (Smith and Love, 2001).

Irrespective of how distinguished, fast or cost effectively a construction project is developed it will remain poor value for a construction client if it fails to meet their strategic objectives (Green, 1992).

Clients have little interest in the hierarchical divide among professionals in the construction industry where it is obviously does not realise their needs. Client needs now are creating pressure for the reorientation of design and construction services, a trend that the modern client advisor must be aware of (Smith and Love, 2001). Clients regard innovative and alternative solutions highly believing them to provide opportunities for cost and time reduction. To be innovative the engineering consultant must examine all possible solutions. Studies show that to be considered excellent in this regard consultants should carefully review about 92% of design elements - a level that experts suggest can realise an 18% cost and time reduction (Chow and Ng, 2007). The client needs professionals who can provide guidance and assistance with strategic needs analysis, a technique which attempts to understand the client's reason for requiring new facilities, the technique should not automatically accept that a build solution is the answer. Design consultants can play a valuable role in the project initiation stage (Smith and Love, 2001).

'[I]f a product does not fulfil a user's need then it has no value, regardless of its price' (Elias, 1998:385).

Sturts and Griffis (2005a) contend that the firm which sets themselves apart by innovating new types of project support services will acquire a client willing to pay a higher price and can position themselves as an industry leader.

4.3 ACHIEVING CLIENT SATISFACTION

Client satisfaction, subjective and difficult to measure, is born of the comparison between expected and realised project outcomes set in a framework of the client's own experiences and background (Cheng *et al.* 2006). It is identified by Tang *et al.* (2003) as a function not only of output but also of perception and expectations, they found that taking a proactive attitude to attaining a high level of service in the first instance to be much more valued by clients than achieving the same result later with the more time-consuming reactive measures: *'one person's view of a successful project can be quite different from that of another'*, Phillips (2009:29). Clients are the highest project authority and can remove obstacles to value engineering (Jergeas *et al.* 1999). The valid determination of project value is the client/user's measure, not that of the designer or service/product provider (Elias, 1998).

The construction industry often fails to regard the constructed asset as being a resource to support the client's business (Prior and Szigeti, 2003).

Studies show that the strategic decisions taken by a client can have an impact on their own satisfaction levels (Cheng *et al.* 2006). '*Consultants seldom attempt to uncover the expectations of their clients'* (Ng, 2005:519). Kamara *et al.* (2000a) point out that a constructed facility is but a means to the end of satisfying the business needs of a client, it is not an end in itself.

Kometa *et al.* (1994) argue that a client's ability to organise and manage a project's objectives can have a significant effect on the project outcome. There has been little self-examination by clients into the impact of their own performance on achieving the project objectives. Jergeas *et al.* (1999) for example note that where value engineering improvements are identified by the engineer these are typically considered by the owner to be part of the professional service necessary in providing an economical design to their requirements and are therefore considered to be included in the engineer's fee.

> Kometa *et al.* (1994:433): *'Despite numerous efforts to understand construction clients and their priorities, evidence abounds to suggest that they are largely misunderstood and dissatisfied with the performance of their consultants and contractor.'.*

In their study of client satisfaction Cheng *et al.* (2006) identified overall quality of service, problem solving, delivering value for money and effective communications as the key high-priority areas in which the consultant typically underperforms. Smith *et al.* (1998) believe it is essential therefore that appropriate techniques and processes are used by the design team that generate a clear definition of the project thus achieving greater satisfaction amongst the participants. Client satisfaction contend Kamara *et al.* (2000a), as a goal of a value engineering study, requires an effective understanding and identification of the client requirements and is according to Cheng *et al.* (2006) a fundamental issue in the determination of perceived project success, constant improvement is essential for the survival of consultants. With the sole purpose of any constructed asset being to fulfil a need, why should clients put up with the fact that the maxim *the customer is always right* does not apply to construction output? By changing the focus to client/user requirements the quality and value of the customer's asset will increase (Prior and Szigeti, 2003).

'A first step in the process of satisfying the client is the precise determination of his or her requirements' (Kamara *et al.* 2000a, p17).

Kamara *et al.* (2000a, p17) set out the first steps in the process of satisfying the client's requirements as being:

- Precisely defining requirements without ambiguity;
- The statement of requirements in a solution neutral format;
- Clearly identifying the client's perspectives and priorities;
- Ensuring there is, at all stages, traceability to original intentions.

Clients consistently find it difficult or impossible to be clear about their requirements. What constitutes a good outcome is frequently redefined and often not apparent until the project is complete, as a result a startling 71% of projects are not deemed [by the clients] to have been a success (Stoughton, 2009). It is believed that the application of value engineering during the development of the brief enables a more complete understanding of the project and can result in a refining of the project by the client (Kelly and Male, 1993).

Poor customer focus throughout the construction industry has led to a perception that constructed assets often offer poor fitness for purpose and poor value for money especially when compared to other consumer goods (Prior and Szigeti, 2003). Drawings and specifications are but an end product, it is in the quality of the design where the real value lies (Sturts and Griffis, 2005b). Client requirements (comprised of objectives, needs, wishes and expectations in respect of these requirements) should be expressed with respect to function, attributes or other special features in satisfying the needs of the facility, business, and the client (Kamara *et al.* 2000a). In order to better match the constructed asset to the needs of the client, construction professionals need to ask the right questions from the start to achieve more of the right answers (Prior and Szigeti, 2003).

A major goal of engineering firms is winning future business through relationship building and client satisfaction (Jergeas *et al.* 1999), nevertheless *'[c]lient satisfaction has remained an elusive issue for a majority of construction professionals'* (Cheng *et al.* 2006: 567). According to Lapierre *et al.* (1999) research has shown the quality of service provided by consulting engineers is assessed by their clients mostly through measures of competence, reliability and communication.

For designers with fee arrangements fixed to the final project cost, the redesign required by value/cost studies presents a dilemma that can lead to a *roll over and play dead* scenario typically resulting in a reduction in quality (Reynolds Smith, 1995:420). On the other hand, for an engineering firm contracted on a fixed fee basis Jergeas *et al.* (1999) contend conversely

that while any time spent on value engineering will reduce the firm's margin, a desire to win repeat business may increase efforts to produce a more economical design.

Clients view service/technical quality as a normal and expected standard when they engage professional engineers it therefore does not play a large part in a positive evaluation (Lapierre *et al.* 1999). Clients are increasingly demanding greater leadership, responsibility and accountability from their designers. There are growing expectations of designers to understand the client's business needs. Clients want to be involved in decision-making, to ensure their priorities are met, a common language and an explicit decision-making process are required (Kirk *et al.* 2002).

One of the most difficult challenges facing the construction industry is the need to refocus on client requirements and away from the less favourable traditional prescriptive input (Prior and Szigeti, 2003). Previous research has found unfortunately that UK construction professionals tend not to listen to their clients, even to the extent of levelling blame at them (Short *et al.* 2007) if important functions required by clients are not being met by the existing arrangements firms should view this positively as an opportunity for the introduction of innovative services and solutions (Ho and Cheng, 1999).

CHAPTER 5 – Summary of Key Findings

5 SUMMARY OF KEY FINDINGS

5.1 SUMMARY OF KEY FINDINGS

Value engineering, more about value than money, is not cost cutting but a means of enhancing functionality. While it has being proven through decades of application to have significant benefits the literature review strongly supports the view that its application is consistently being resisted particularly where there is a choice in its use.

There has been some study/conjecture into the cause of this resistance but little research has been carried out on the basis or reasoning behind it, and none found on a reflection by designers for their resistance.

A clear consensus exists throughout the literature that the earlier value engineering is applied the more effective and beneficial it will be, yet its application is left to the latter stages of a project.

While those with the greatest influence have been found to be the client and the designer, the separation of the design and construction process contributes to the industry's inherent problems. While increasingly recommended to move away from traditional procurement methods, clients trying to reduce their risk have become the driving force behind alternative procurement arrangements. There is nevertheless a considerable consensus to suggest that the root of construction problems lies in a lack of project definition.

There appears to be a persistent absence of a systematic approach to the identification of client objectives and a resistance to the application of sufficient resources in this area. A renewed focus on client requirement through a managed brief development is considered necessary.

A review of the literature suggests that although there have been some initiatives put forward on the briefing process many project failures can still be traced back to the project brief. Very clear similarities exist between the application of value engineering in the design stage and the parallel briefing and design processes being advocated in the most recent research, indicating that value engineering may be a solution to improving briefing performance.

Research shows that clients typically find little fault in their engineer's technical ability, to the extent that they no longer rate it as an important element in their choice of service provider. However they are increasingly dissatisfied with the service they receive in regard to quality of service, effectiveness of communication and delivered value for money. There is little

correlation found in the research between these views and the effect competitive fee tendering may have on them.

Construction problems are becoming more organisational and cultural rather than technical, and the review highlights a tendency towards an increasingly adversarial relationship between the client and the engineer.

A view repeatedly occurring in the literature and of considerable concern for the engineer is that of clients regarding value engineering proposals by others as representing a failure on the part of their engineers.

A clear disparity exists between what clients expect and what their consultants believe they expect. Clients believe consultants perform or should perform value engineering as part of their normal design work, while consultants for their part are adamant that they already provide clients with economical designs. Anecdotal evidence suggests however that their designs could be further refined if they were able to share in the resultant savings.

Value engineering is frequently applied too late to make major design changes. With outline design responsible for up to 80% of construction cost, the concept/design phase (before major design resources have been committed) represents the greatest opportunity for a return on a value engineering investment.100% of value engineering saving can be realised by clients only where it is identified before engaging contractors.

The traditional design team is at risk of becoming subordinate to the design-and-build process. Contractors are putting pressure on consulting firms through their diversification into total construction process management, a process becoming more prevalent as a result of unsatisfied clients. Many engineers feel their role and professional distinction is being undervalued.

Contractor incentive is typically to increase rather than reduce project costs and studies indicate engineers may discredit contractor value engineering proposals to preserve their own reputation. Value engineering, generating little interest for designers, is frequently received as an unwelcome imposition.

In Europe the role of the consulting engineer is diminishing, surveyors, undertaking project management, expanding and diversifying, are narrowing the position of the engineer. Studies indicate that in the US where there are no quantity surveyors, engineers enjoy a higher status

than their European counterparts and are responsible for taking the brief and preparing the cost plan. In Europe the application of value engineering is increasingly being fitted into the quantity surveyor's role.

The lack of awareness of value engineering is a major cause for its limitation. Many of the current construction management techniques are inward focused with little consideration of client perspective. The additional demand of value engineering is in conflict with the award of design work to the lowest bidder. Innovation is frequently considered a disturbance to both the design process and the execution phase (where project complexity and the disturbance of innovation can limit its application) and the cost of developing value engineering proposals can be considered to be an unrecoverable risk.

The earlier value engineering is applied the more difficult it is to define the problem. Conversely if value engineering is left until the design is complete change can be prohibitive. Consultants should provide assistance with client's strategic needs analysis and not automatically accept a build solution to be appropriate. An emerging field of design-management is developing to separately challenge the design process. Value engineering has been shown to help the client and project team's focus more effectively on projects avoiding late conceptual changes, its integration may be critical to brief formation. The valid criterion of success must be client satisfaction.

CHAPTER 6 – Research Design and Methods of Analysis

6 METHODOLOGY

6.1 INTRODUCTION

To ensure the research objectives can be met and the findings validated it is necessary to make sure the correct methodology is used when undertaking research. This chapter explains the research design and methodology used and compares the different research types and approaches considered.

The research follows on from a research proposal which was initially framed around the subject and commenced with a very comprehensive review and critical appraisal of the available literature. Material was sourced from relevant textbooks, academic and trade journals, research reports, government publications and conference proceedings. In order to satisfy validity and reliability issues, material was extensively and systematically sourced, mainly from primary sources and over a considerable period of time.

Qualitative research has been described by Creswell (1998) as being exploratory and attitudinal, seeking to explain, to understand, to explore and to evaluate opinion or perception. The emergent/developmental nature of this type of research, being the primary research strategy employed, is considered more suitable for the aims and nature of the research intended than the harder, testing and more conformational nature of quantitative methods. In addition the size of the target sample group may be too small to satisfy the requirements of quantitative analysis (Fong and Wan, 2000).

By means of an extensive background survey and an in depth case study of an Association of Consulting Engineers of Ireland (ACEI) member firm, the research sought to carry out a qualitative assessment of what opportunity value engineering can bring to the role of the consulting engineer.

The research does not intend to offer an examination of the relative merits or otherwise of any particular value engineering technique, of which there are many.

Figure 6.1 diagrams the research methodology undertaken.

Research Methodology

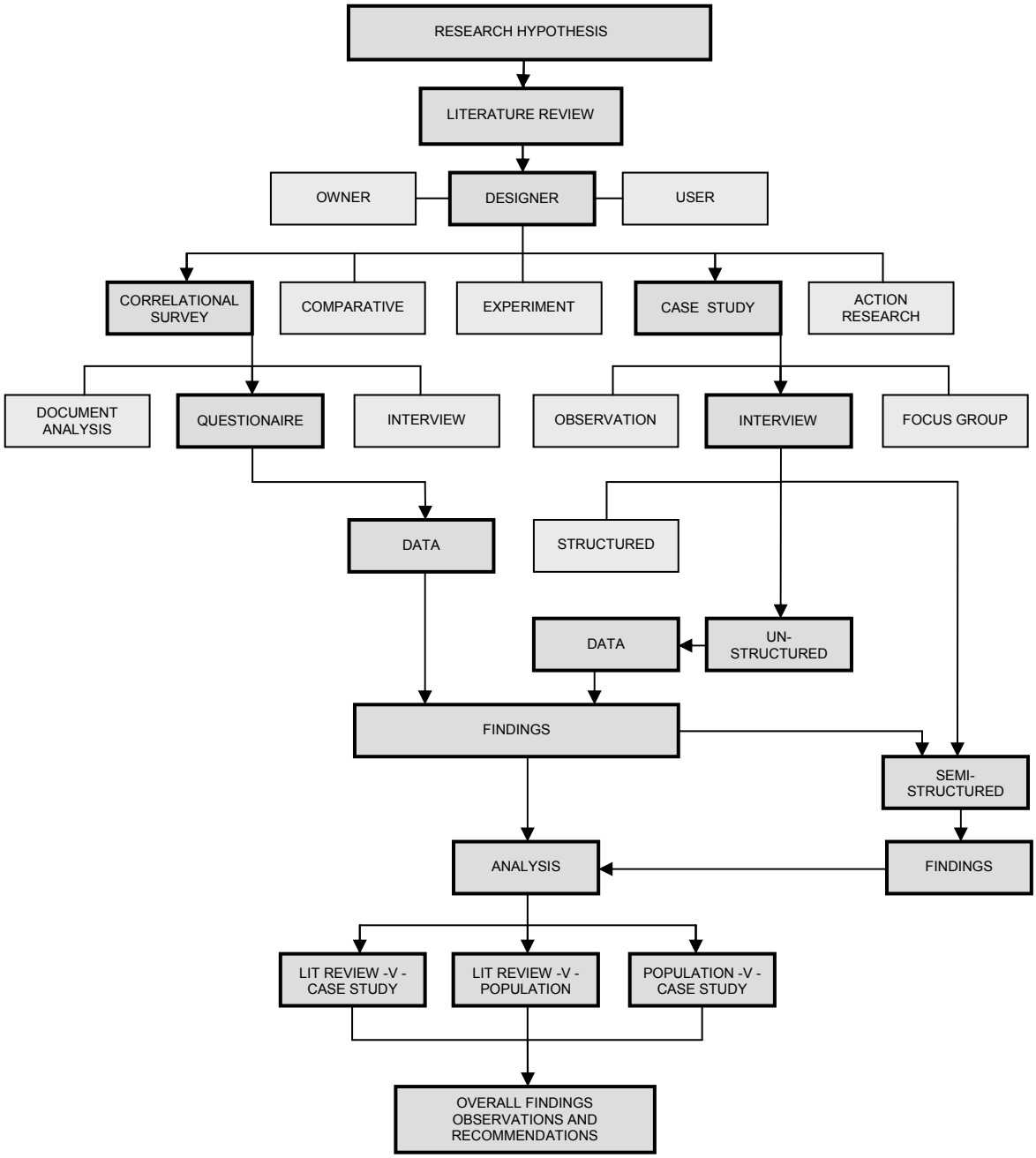

Figure 6.1

6.2 METHODOLOGY

The exploratory research is used to establish the current/emergent thinking, attitude and perception of the body of engineering consultants to the value engineering concept and subjectively evaluate and examine the need for, and potential benefits of, introducing a value engineering service. According to Gerring (2007) we must not think of cross-case and single-case evidence as just being complementary, researchers should engage in both styles.

The dual study strategy was adopted to provide an in-depth examination of the current thinking. Case study research is considered to be the exploration of a *bounded system* (Crestwell, 1998) where the context of the case involves situating the case within its setting (Stake, 1995). The collaborative iteration between the researcher and the subject both facilitated and enabled the data collection that explores how a value engineering service may enhance the engineering consultant's role. This case-study approach is set against, and incorporates, the wider background survey that utilised a comprehensive questionnaire as the research instrument. The author was in a unique position to achieve a greater cooperation and insight than might otherwise have been the case given he has been employed for over twenty years in the consulting engineering firm selected to form the case study.

An interpretative approach (which according to Mason (2002: 56), '*not only sees people as a primary data source but seeks their perceptions…the insider view, rather than imposing an outsider view*') is adopted as the best platform from which to explore the issue. According to Gerring (2007), case studies may offer advantages over other methods of an exploratory nature and can provide insight into the intention, reasoning and information processing procedures of decisional behaviour, reading more fully into how the subjects arrive at their opinions.

The data was collected by a series of individual interviews over two stages, with the researcher being the instrument of data collection.

Stage One involved the use of loosely structured, exploratory interviews to establish a baseline of initial perceptive attitude to the value engineering concept and the extent of its use within the ACEI member firm The survey questionnaire was introduced at the end of stage one, two weeks were allowed for the participants to reflect and return the completed questionnaire before the stage two interviews.

In Stage Two individual semi-structured interviews introduced the data collected by the background/cross-case study of ACEI member firms and considered in detail the respondent's questionnaire. '*Cross case studies …help to select cases and explain the significance of those cases. The more one knows about the population the more one knows about the case and vice versa*' (Gerring, 2007: 13).

The dual approach and the representative nature of the case goes further than just collecting existing stagnant data. It generates a more considered/dynamic and a potentially more useful form of data, providing a meaningful and valuable analysis for a broader understanding of how the issue may be received by the engineering consultants and a wider population.

6.3 QUESTIONNAIRE DESIGN

The questionnaire, which was individually coded for tracking, was specifically designed for this study. It uses only closed form questions with responses requested on a five-point Likert scale, by ranking or by a checklist of certain statements. The core content of the questionnaire was informed by an extensive literature review undertaken on the subject. While closed form questions can introduce a degree of bias they were considered more appropriate for the background study due to both the difficulty in interpretation and analysis of free-responses and the unknown variable of the respondents' level of knowledge on the subject. It was felt that the questionnaire responses could be probed more effectively and in greater detail through the subsequent case study interviews. The questionnaire commenced with a definition of value engineering and was divided into 23 multi-part questions.

Pilot Study

The questionnaire was piloted with experienced construction professionals and academics to ensure all questions were clear and precise. The individuals were asked to complete the questionnaire, discuss any problems they encountered and suggest any modifications they felt would make the questionnaire more user-friendly. Their comments, focusing on the content, clarity and formatting of the questionnaire, were addressed where appropriate and the questionnaire was revised accordingly.

Amendments included the number of questions, which were reduced, as the questionnaire was considered to be too long, it was also felt appropriate to alter the order of presentation in areas to minimise the possibility of bias. As it was felt that the third and fourth levels of the original six level Likert rating scale could be construed as being similar this was changed to a five point Likert scale to give a more unambiguous result, a longer scale was considered too unwieldy and not a realistic option in this case.

In order to better focus the response it was suggested that the questionnaire be limited to the respondents experience in the Irish construction industry. It was further suggested the respondents be asked to indicate their current position, experience, and time with the firm being surveyed.

Nature of Sample, Sample Selection and Questionnaire Administration

Based on an abstract of the research submitted to them in March 2010 the Association of Researchers in Construction Management (ARCOM) considered the subject to be '*an interesting concept of the consultant engineer engaging in value engineering as a new role [which] should provide some useful insights from industry*' and '*an interesting area that does require further empirical research*'.

The sampling frame chosen for the background study is the register of the Association of Consulting Engineers of Ireland (ACEI), which lists, as of 31st January 2010, a total of 188 member firms. The ACEI register is broken down by company name, region, activity and the number of employees. The regional offices of individual firms are registered separately.

The sample-group comprises of all the consulting civil/ structural engineering firms on the register (including the firm selected for the case study). Only the head office of each of the firms was included, and this formed the background study sample-group. Data collection for the background study sample-group was in the form of multi-part questionnaire; data collection for the case study utilised both the questionnaire and individual interviews with directors of the case study firm. The names of all firms and the directors remain confidential in the results. An examination of the register as of 31st January 2010 revels the following:

Directory of ACEI Registered Member Companies (January 2010)	
All employees	188 registered offices of 104 firms (80 Civil & Structural - the sample-group)
6-20 employees	46 registered offices of 35 firms
21-50 employees	21 registered offices of 12 firms
50+ employees	83 registered offices of 22 firms
6+ employees	150 registered offices of 69 firms

Table 6.3.1 developed from ACEI, 2010.

The initial sample proposed, the entire population of engineering consultants in Ireland, was considered beyond the resources available. While not encompassing all member firms the 80 firms finally selected represent the total population of civil and structural engineering consultants (head offices) on the directory of ACEI registered member companies and as such can be considered to be a highly significant and a complete population grouping.

Each firm was contacted by telephone in order to confirm their cooperation prior to sending out the questionnaires. The author explained the purpose of the study, the reason the firm had been selected. The identity of a senior director in the firm to whom the questionnaire could be addressed was obtained/confirmed.

The questionnaire was accompanied by a detailed cover letter addressed to a senior director. A stamped addressed envelope was included in all survey packs. The questionnaires were posted out in the first week of February 2010. To elicit a higher return rate all non-replying firms were contacted by telephone/e-mail at the end of March 2010 and advised that their participation would be both valued and appreciated. Of the 84 questionnaires distributed (80 postal and 4 case study), 33 valid relies were received which represents a response rate of 39.3%. All respondents had more than 5 years experience with (70%) having over 20 years

experience. More than 97% of the respondents held director positions, with 55% of the respondents being the firms Managing Director (Table 6.2.2). This indicates that the respondents were both credible and capable of answering the questions effectively (Chow and Ng, 2007). 88% of the respondents indicated a desire for a copy of the completed research, this may be indicative of an elevated engagement with the study.

Characteristics of respondents		Number	Percentage
Experience	Over 20 years	23	70%
	15 - 20 years	3	9%
	10 - 15 years	4	12%
	5 - 10 years	3	9%
	0 - 5 years	0	0%
Time in Firm	Over 20 years	13	40%
	15 - 20 years	5	16%
	10 - 15 years	6	18%
	5 - 10 years	7	21%
	0 - 5 years	2	6%
Position Held	Managing Director	18	55%
	Director	8	24%
	Associate Director	6	18%
	Senior Engineer	1	3%
	Other	0	0%

Table 6.3.2

The questionnaire, sample cover letter and the survey sample are included at the rear of the dissertation in Chapter 11, Appendix A and B.

Rationale of the Research Questionnaire

The research is conceptualised as focus on an exploration of the cultural behaviour of engineering consultancy firms around the subject of value engineering. As the issue is emergent in nature the questions posed are naturally qualitative. They have primarily been selected from issues, surfacing in the literature review, that indicate scope for further contextual examination and exploration.

The first section of the questionnaire, questions 1-3, seek the respondent's opinion on a range of statements. The second section, questions 4-6, seeks to capture their knowledge and experience on a range of topics. In the third section, question 7, opinion is sought, while questions 8-22 collect background information and opinion. The last section, question 23, requests respondent details.

Table 6.3.3 sets out the objective of each question/statement, the reasoning behind the chosen format, the response type sought/permitted and how the response was to be analysed.

Table 6.3.3

Item	Objective	Reason for chosen format	Question/Statement	Response Type	How response will be analysed
1	Examine attitude, literature indicates clients are typically unsatisfied	Challenge perception	**Q1** *Clients are completely satisfied with the service they receive from the construction industry*	Likert Item	By weighting & Comparison
2	To seek opinion, to expand on trends emerging in the literature	Simplicity	**Q1** *Value engineering is typically a contractor lead initiative*	Likert Item	
3	To seek opinion, to expand on trends emerging in the literature	Simplicity	**Q1** *Clients are increasingly turning to design and build options for their developments*	Likert Item	By weighting & Comparison
4	Explore attitude	Challenge	**Q1** *The quantity surveyor is increasingly undertaking the role of project management, an important part of the engineering consultant's domain*	Likert Item	By weighting & Comparison
5	Explore attitude	Simple inquiry	**Q1** *The quantity surveyor is increasingly providing clients with a value engineering service*	Likert Item	By weighting
6	Explore attitude	Simplicity	**Q1** *The engineering consultant should exercise ownership of the role of value engineering*	Likert Item	By weighting
7	Seek opinion of finding surfacing in the literature review	Challenge	**Q1** *A firm receiving 10% of any saving generated during the design and construction phase could most likely produce more economical designs*	Likert Item	By weighting & Comparison
8	Explore opinion	Simplicity	**Q2** *Engineering objectivity can be impaired through the robust financial considerations of design*	Likert Item	By weighting & Comparison
9	Explore opinion	Simplicity	**Q2** *The engineer's traditional roles are increasingly under threat from the expanding services of quantity surveying firms*	Likert Item	By weighting
10	Explore opinion	Challenge	**Q2** *The engineer's traditional roles are increasingly under threat from alternative procurement methods (Design & Build etc.)*	Likert Item	By weighting & Comparison
11	Explore attitude	Challenge	**Q2** *The traditional design team is at risk of becoming a subordinate to the design and build contractor*	Likert Item	By weighting
12	Explore attitude	Challenge	**Q2** *Engineers are rooted in tradition and resist new construction methods and techniques*	Likert Item	By weighting
13	To seek opinion, to expand on trends emerging in the literature	Simplicity	**Q2** *The role of the engineering consultant is diminishing*	Likert Item	By weighting & Comparison
14	Seek opinion of finding surfacing in the literature review	Clarity	**Q2** *Cost savings which result from contractor initiated value engineering can initially leave the client with the impression that the engineer has failed to find the most economical design solution*	Likert Item	By weighting & Comparison
15	Explore the literature suggestion that the application of VE is inhibited by competitive tendering	Clarity	**Q3** *Competitive fee tendering for engineering services has a significant bearing on the time allocated to the consideration of alternative design options*	Likert Item	By weighting & Comparison

Table 6.3.3

Item	Objective	Reason for chosen format	Question/Statement	Response Type	How response will be analysed
16	Explore the literature suggestion that the application of VE is inhibited by competitive tendering	Clarity	**Q3** *The competitive tendering process for selecting consulting engineers contributes overall to lower project construction costs*	Likert Item	By weighting & Comparison
17	Explore the literature suggestion that the application of VE is inhibited by competitive tendering	Clarity	**Q3** *Engineers are being forced to work as efficiently as possible rather than designing solutions which are as efficient as possible*	Likert Item	By weighting & Comparison
18	To seek opinion, to expand on trends emerging in the literature	Clarity	**Q3** *Performance specifications should focus on functional needs and be expressed in solution independent terms*	Likert Item	By weighting
19	Explore attitude	Simplicity	**Q3** *A fundamental aim of an engineering consultant is to provide client satisfaction*	Likert Item	By weighting
20	Explore attitude	Challenge	**Q3** *The client is always right*	Likert Item	By weighting & Comparison
	To gather additional information	Clarity	**Q4** *How knowledgeable is your firm with each of the following procurement methods ?*		
21	Inquiry	Simplicity	*Traditional*	Forced Choice	By weighting
22	Inquiry	Simplicity	*Design and Build*	Forced Choice	By weighting
23	Inquiry	Simplicity	*Construction Management*	Forced Choice	By weighting
24	Inquiry	Simplicity	*Management Contracting*	Forced Choice	By weighting
25	Inquiry	Simplicity	*Public Private Partnership PPP*	Forced Choice	By weighting
	To gather additional information	Clarity	**Q5** *How do you rate your experience of the following procurement methods ?*		
26	Inquiry	Simplicity	*Traditional*	Rating	By weighting
27	Inquiry	Simplicity	*Design and Build*	Rating	By weighting
28	Inquiry	Simplicity	*Construction Management*	Rating	By weighting
29	Inquiry	Simplicity	*Management Contracting*	Rating	By weighting
30	Inquiry	Simplicity	*Public Private Partnership PPP*	Rating	By weighting
	To gather additional information	Clarity	**Q6** *What level of knowledge has your firm with each of the following ?*		
31	Inquiry	Simplicity	*The principles of functional analysis*	Forced Choice	By weighting
32	Inquiry	Simplicity	*The application/methods of functional analysis*	Forced Choice	By weighting

Table 6.3.3

Item	Objective	Reason for chosen format	Question/Statement	Response Type	How response will be analysed
33	Inquiry	Simplicity	*The principles of value engineering*	Forced Choice	By weighting
34	Inquiry	Simplicity	*The application/methods of value engineering*	Forced Choice	By weighting
	Explore Opinion	Clarity	**Q7** *Please rate in your opinion how well positioned the following stakeholders are to implement value engineering*		
35	Inquiry	Simplicity	*Client*	Rating	By weighting
35	Inquiry	Simplicity	*Architect*	Rating	By weighting
37	Inquiry	Simplicity	*Quantity Surveyor*	Rating	By weighting
38	Inquiry	Simplicity	*Engineering Conslt.*	Rating	By weighting
39	Inquiry	Simplicity	*Other Specialist*	Rating	By weighting
40	To gather additional information	Clarity	**Q8** *Does your firm provide a value engineering service ?*	Yes/No	By weighting
41	To gather additional information	Clarity	**Q9** *Does your firm hold value engineering workshops ?*	Yes/No	By weighting
42	To gather additional information	Clarity	**Q10** *Would you consider attending training on the subject of value engineering ?*	Yes/No	By weighting
43	To gather additional information	Clarity	**Q11** *Has your firm been involved in a value engineering workshop run by others ?*	Yes/No	By weighting
44	To gather additional information	Clarity	**Q12** *Do you believe value engineering can provide any real benefits ?*	Yes/No	By weighting
45	Explore attitude	Challenge	**Q13** *Does your firm believe the competitive tendering process for consulting engineers is beneficial to the client in terms of design quality ?*	Yes/No	By weighting
	To gather additional information	Clarity	**Q14** *Does your firm employ any staff trained in the following ?*		
46	Inquiry	Simplicity	*Value engineer*	Selection	By weighting
47	Inquiry	Simplicity	*Quantity Surveyor*	Selection	By weighting
48	Inquiry	Simplicity	*Architect*	Selection	By weighting
49	Inquiry	Simplicity	*Planner*	Selection	By weighting
50	Inquiry	Simplicity	*Other Specialist*	Selection	By weighting
51	To seek opinion, to expand on trends emerging in the literature	Clarity	**Q15** *Value engineering can provide greater definition of, and a more systematic identification, of client requirements than traditional briefing methods*	Likert Item	By weighting & Comparison
52	Exploritory	Clarity	**Q16** *Which of the following stages in your opinion, is most appropriate for the implementation of value engineering concept's ?*		
	Inquiry	Simplicity	*Client / conceptual*	Selection	By weighting
	Inquiry	Simplicity	*Briefing stage*	Selection	By weighting
	Inquiry	Simplicity	*Preliminary design*	Selection	By weighting
	Inquiry	Simplicity	*Design stage*	Selection	By weighting
	Inquiry	Simplicity	*Construction*	Selection	By weighting

Table 6.3.3

Item	Objective	Reason for chosen format	Question/Statement	Response Type	How response will be analysed
	Inquiry	Simplicity	*Don't know*	Selection	By weighting
53	Explore the literature suggestion that the application of VE is inhibited by competitive tendering	Clarity	**Q17** Do you agree with the selection of consulting engineers by the competitive tendering process ?	Yes/No	By weighting
54	Explore Opinion	Clarity	***Q18*** *Should the civil/structural engineering syllabus contain a value engineering module?*	Yes/No	By weighting
55	To gather additional information	Clarity	**Q19** *Have of your staff received specific training in briefing methods and procedures ?*	Yes/No	By weighting
	To gather additional information	Clarity	**Q20** *Does your firm have a partnering arrangement with any of the following ?*		
56	Inquiry	Simplicity	*Value engineer*	Selection	By weighting & Comparison
57	Inquiry	Simplicity	*Quantity Surveyor*	Selection	By weighting & Comparison
58	Inquiry	Simplicity	*Architect*	Selection	By weighting & Comparison
59	Inquiry	Simplicity	*Planner*	Selection	By weighting & Comparison
60	Inquiry	Simplicity	*Other Specialist*	Selection	By weighting & Comparison
61	Explore the literature suggestion that the application of VE is inhibited by competitive tendering	Simplicity	**Q21** *Has your firm ever made a representation to a professional body, on the issue of, the selection of consulting engineers through the process of competitive tendering ?*	Yes/No	By weighting & Comparison
62	Seek opinion of finding surfacing in the literature review	To detail specific of previous research	**Q22** *Considering your own projects How likely would you consider it to be that another competent firm of consulting engineers could – upon payment of a fee of 0.1% to 0.3% of the total project cost Review and identify total cost savings of 3% to 5% ?*	Likert Item	By weighting & Comparison
			Q23 *General details of the respondent requested in order to qualify the results*		
63	For validitation	Simplicity	*Position held*	Selection	By weighting
64	For validitation	Simplicity	*Time in firm*	Selection	By weighting
65	For validitation	Simplicity	*Years Qualified*	Selection	By weighting
	To both engender afinity and encourage survey response	Clarity	*Email Address for copy of survey results:*	Yes/No	By weighting

6.4 CASE STUDY

Case studies are selected on the basis that they represent a sample group. They can be utilised to demonstrate particular aspects of the research topic (Beatham, 2003 pp 11, Yin, 2004). A case study is the exploration of a bounded system (Crestwell, 1998), the context of the case should involve situating the case within its setting (Stake, 1995). While the representativeness of case studies has been the subject of much consideration '*an explanation of the properties of social relationships can…be produced through the study of a single case'* (Hamel, 1993 p36) citing Lévi-Strauss. The purpose of this case study is to probe and evaluate responses to the questionnaire and to explore in a deeper way the attitudes and perceptions to value engineering existing among the directors of the consulting civil and structural engineering firm selected to act as the primary unit of analysis.

Interviews

Cognisance is taken of the strengths and weakness of interviews as a means of data collection. Weaknesses include the opportunity for bias in what questions are asked, how they are asked and in possible errors of interpretation. Strengths include the opportunity for exploration and the immediate clarification of misunderstandings (Beatham, 2003).

Unstructured and semi-structured face-to-face interviews, both open surveying methods, have being used here as the main instruments of case study data collection (the questionnaire completed by the interviewee also forms part of the background study). The use of both interview styles enabled the collection of substantive views, opinion, perception and attitude on the subject and provided the flexibility to adapt the questions as necessary. The personal interviews granted valuable first hand information from the field.

In a technique considered particularly useful for highly unstructured data (Berg, 1989), the interviews were recorded and the narrative was transcribed with the content analysed using a simple form of qualitative analysis, the methodology introduced by Fellows and Liu (2003), which involves the categorising of communication content, in order to quantify it.

The interviews took place in the firm's offices in May of 2010.

Rationale of the Research Interviews

Various methods are supported in a case study approach including the interview, participant observation and field studies; the latter two, which were not accessible, were in any case not considered due to the time constraints applicable to the study.

In order to explore the subject's initial 'unrehearsed' attitude to the topic of value engineering the case study firm was excluded from the initial round of questionnaires and a two-part interview strategy was adopted. The first interviews were unstructured and initiated without a prior introduction. Once the interview was completed the questionnaire was introduced and the interviewee asked to complete and submit it before the second interview.

The two-part strategy allowed an exploration of the interviewee's initial attitude and how this may or may not change when exposed to further consideration/information.

In deciding how many and who to interview e.g. one key player with the possibility of biased results or all/several of the decision makers, there were a number of limiting factors including the time available, resources and the pool to draw from.

The use of a single subject was believed likely to introduce questions of bias/validity whereas for multiple subjects the question of how many key people should be interviewed and what criteria should be used in choosing them had to be considered (Walker, 1997).

In dealing with the time constraints imposed by the research it was felt that a maximum of four two-stage interviews could be accommodated. This represented 100% of the head office directors and was considered sufficient to mitigate bias while being representative of the firm's overall view.

Firm directors were chosen as the case study sample as they are most likely to evaluate the impact of decisions, action and/or inaction of other variables on themselves and the other stakeholders and were therefore considered the most reliable source of relevant insight and knowledge within the firm.

6.5 LIMITATIONS

The study obtained input primarily from consulting civil and structural engineering firms and as such may not fully represent the entire construction industry perspective.

It was felt that while the author's position in a large firm of engineering consultants could have been used to elicit a higher return rate the risk of a resultant bias/skew in the results meant however that it was considered prudent not to do so.

While the natural limits of time and resources affect all studies, the importance of the literature review was recognised and it was commenced and advanced very early in the study. It is acknowledged that the search for academic journals was, to a degree, limited by the databases and resources available, the maximum use was however made of every possible academic and professional resource accessible.

Open-ended questions with a risk of vague and difficult to analyse responses were considered inappropriate for the questionnaire. It was acknowledged that the use of closed questions provided no opportunity for clarification or explanation where this may have been necessary however the questions were kept as unambiguous as possible. The dual research strategy used minimises many of the limitations associated with a single approach and with the additional and deeper information drawn from the case study, is considered to have been successful.

The phrasing of questions and the manner of response available can have an effect on the result they should therefore be as clear and precise as possible. The pilot study was very beneficial in this regard. Likert scales, as used in the questionnaire, can be subject to distortion for a number of reasons. Respondents may avoid the extremes, (*central tendency bias)*, form an *acquiescence bias* in agreeing with statements as they are presented or present the *social desirability bias* of wishing to present themselves in a more favourable light.

There has been much study into the acquiescence response tendency 'problem' and while some maintain that a partial correction can be obtained utilising the balancing effect of using both positive and negative statements (Winkler et al. 1982 and Ray 1983) others contend such an approach to be problematical, finding a 'miss-response' rate to reversed Likert items of approximately 20% (Swain, 2008). As far as possible these issues should be eliminated or minimised through rigorous design.

To overcome bias concerns the questionnaire design avoided the reversal of items mitigating the miss-response issue. The questions were designed, piloted and drafted to be as unambiguous as possible thereby minimising issues of acquiescence (Ray, 1983). To

overcome respondent inattention and possible central tendency bias the survey was introduced and laid out to retain interest and was directed at the higher management level in the firms surveyed. The high percentage of top management respondents and the interest levels indicated in the research would suggest a validation of the mitigating measures.

Questionnaires can be administered in different ways and a major concern is low response rate and the resultant validity issues. As response rate is increased in line with the number of contacts (Taylor and Lynn (1998)) appropriate measures were taken to maximise the response rate.

Considering Moser and Kalton's assertion that the results of a postal survey could be considered biased if the return rate was lower than 30-40 percent, the 39.3% percent response rate achieved can be considered as being significant (Moser and Kalton, 1971).

While the size of a firm or its geographical location could be expected to influence their propensity to respond no trends were evident that would disparage the results.

6.6 CONCLUSION, VALIDITY AND RELIABILITY

This research is unique and in light of the calibre of the respondents the results should hold particular significance. The findings of the study will be of value to engineering consultancy firms but will also have a broader global application and add to the body of literature on the subject.

Validity and reliability have been ensured through a variety of approaches encompassing commonly accepted tests used to establish the quality of the research (Yin, 1994). The representative sample and dual approach used, key informants and multiple sources lead to significant construct validity. Rigorous structure, preparation and data verification contribute to the internal validity established through the use of context and the investigation of similarities across accounts and the literature review. External validity is strengthened through the representative sample, extensive literature review and the dual approach used that will allow the findings to be generalised outside the immediate bounds of the sample. Reliability, as described, is gained in the study through the recognition and mitigation of bias, extensive piloting to minimise errors and ambiguity, together with thorough scoping.

CHAPTER 7 – Analysis of the Results

7 ANALYSIS OF THE RESULTS

7.1 INTRODUCTION

A dual approach was taken to the collection of the primary data (survey and case study). A background/correlational survey was first carried out on the engineering profession. The response rate was significant with 34 usable questionnaires being returned. A two-stage approach was then taken to the case study interviews as follows,

Stage 1 involved the use of loosely structured exploratory interviews to establish an attitudinal baseline. The interviewees were then requested to complete and return the survey questionnaire prior to the stage two interviews.

Stage 2 involved the use of semi-structured interviews to review the interviewees response to the questionnaire and to establish the reasoning behind their selections. Data collected by the wider survey was introduced at this stage.

For each question the results of the survey will be presented first, followed where appropriate by an examination of how the results compare to the literature review. The information from the case study interviews is used to investigate the underlying issues, examining how they're viewed by the engineering profession and considering their implication for the application of a value engineering service.

The survey respondents have considerable experience and were typically from the highest levels of management (Figure 7.1p).

7.2 SURVEY RESULTS AND DISCUSSION

In the following section, the response to each part of the questionnaire is presented (Figures 7.1a-p). In order to explore, in the context of the research aims and objectives, the issues relating to the provision of a value engineering service by consulting engineers the findings are evaluated, discussed and examined firstly in how they relate to the literature review, and secondly to the Stage 1 and Stage 2 case study interviews.

QUESTION 1

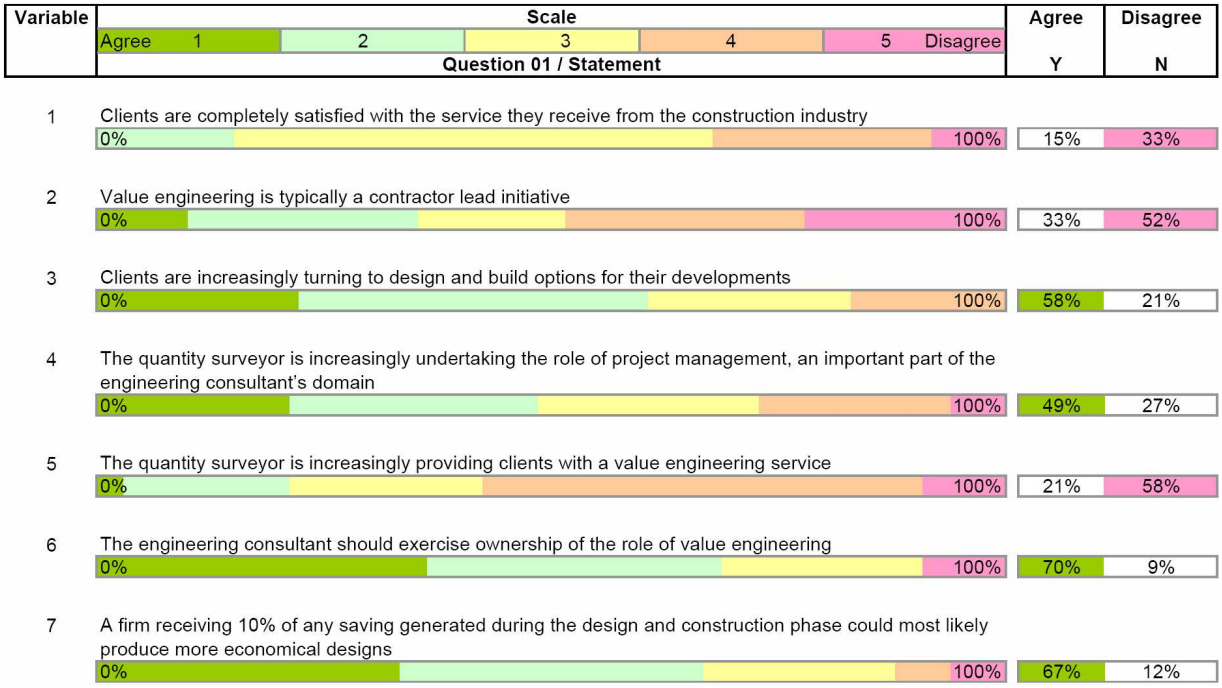

Figure 7.1a (Variable 1-7)

In line with the evidence of Kometa *et al.* (1994:433) and Cheng *et al.* (2006) just 15% of the respondents felt that their clients were completely satisfied with the service received from the construction industry, this supports the clients' own belief that they receive poor performance from their engineers (Samson and Parke, 1994) the case study adding *"I've no doubt that clients are increasingly becoming dissatisfied, but their taking the lowest price, there being swayed by bullshit." "Clients can think they're going to get gold when they can only afford silver." "It's possibly a fault of the traditional design team that what they can do for a client isn't sold very well,"*

While 52% of respondents indicated that they believed value engineering not to be simply the preserve of the contractor (agreeing with Prior and Szigeti, (2003)), 58% acknowledged that clients were increasingly turning to design-and-build options for their developments.

While half the respondents felt that quantity surveyors were encroaching on roles traditionally in the domain of the engineering consultants (in line with Kelly and Male (1993) and Potts (2004)), just 21% felt they were providing clients with a value engineering service. The case study adding *"quantity surveyors just measure other peoples designs, they can't value engineer without the input of designers."*

A significant 70% of respondents believe the consulting engineer should exercise ownership of the value engineering role and significantly a similar amount believed that they could produce more economical designs.

QUESTION 2

Variable	Scale						Agree	Disagree
	Agree	1	2	3	4	5 Disagree		
	Question 02 / Statement						Y	N
8	Engineering objectivity can be impaired through the robust financial considerations of design						55%	27%
9	The engineer's traditional roles are increasingly under threat from the expanding services of quantity surveying firms						61%	30%
10	The engineer's traditional roles are increasingly under threat from alternative procurement methods (Design & Build etc.)						70%	15%
11	The traditional design team is at risk of becoming a subordinate to the design and build contractor						61%	24%
12	Engineers are rooted in tradition and resist new construction methods and techniques						21%	64%
13	The role of the engineering consultant is diminishing						33%	46%
14	Cost savings which result from contractor initiated value engineering can initially leave the client with the impression that the engineer has failed to find the most economical design solution						67%	18%

Figure 7.1b (Variable 8-14)

While value engineering is most frequently sought only when budgets are exceeded (Reynolds Smith (1995)), 55% of consultants surveyed consider their objectivity can be impaired as a result of such robust financial consideration, with a similar percentage considering their roles to be under threat from the expanding services offered by quantity surveyors.

In line with Smith and Love (2001), 70% believe their role to under threat from alternative procurement methods such as design-and-build with 61% agreeing that the design team is at risk of becoming a subordinate to the design-and-build contractor and 46% believing the role of the engineering consultant to be diminishing. This supports Kelly and Male's (1993)

contention that the diversification of the industry into the total process management arena is putting pressure on consulting firms. Nevertheless 64% of consultants consider themselves to be accepting of new construction methods and techniques a flexibility which may allow them to escape the pressure Kelly and Male believe is being put especially on the smaller to medium sized technically based consulting firms. The case study adding *"it's a very regulated business …codes of practice are based on tradition while a lot of the new techniques are ahead of these"* and *"as a design engineer you tend to be conservative, the reason in a lot of cases is you're not paid to design it to the end'th degree…clients who look at things differently are in a tiny minority"*

A significant 67% of the consultants responding to the survey feel, as suggested in 1999 by Jergeas *et al.,* that cost savings achieved through contractor initiated value engineering can leave the client with the impression that they failed to find the most economical design for them. This may concern consultants to the extent that they unreasonably discredit contractor proposals as is suggested by Jergeas *et al.* potentially allowing significant savings to be lost.

QUESTION 3

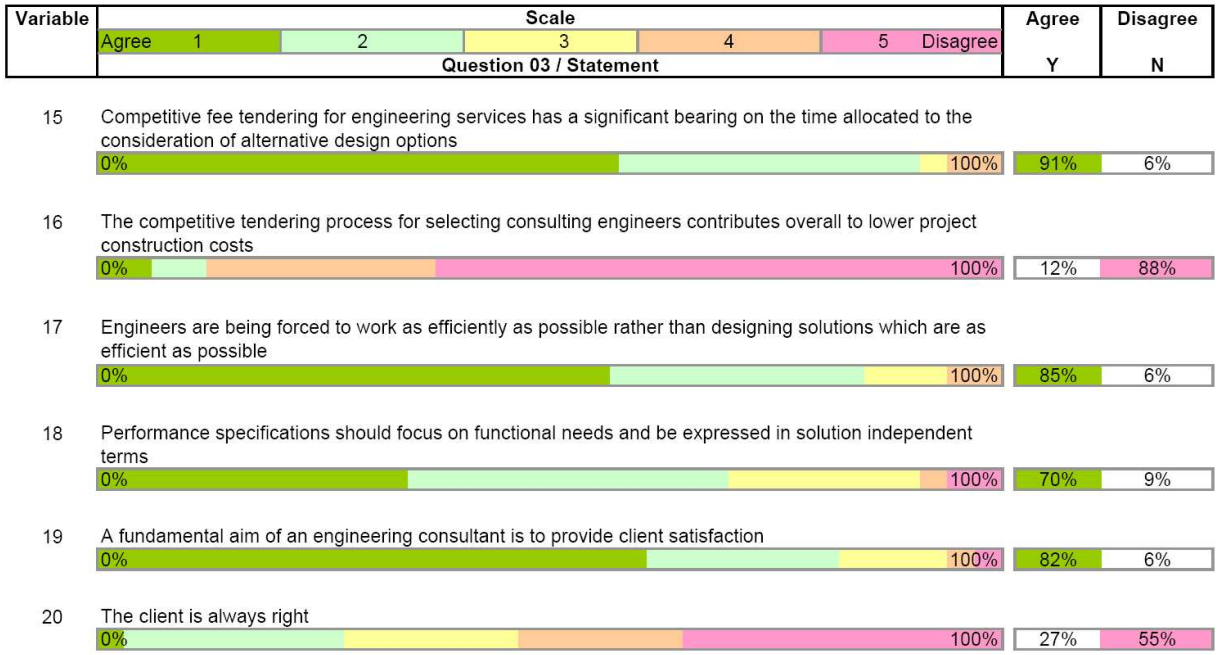

Figure 7.1c (Variable 15-20)

91% of the consulting firms responding to the survey agree with Sturts and Griffis' (2005a) contention that designers hired under the competitive fee-based procurement process are unlikely to spend enough time to make the design as efficient as possible, they maintain it has a significant bearing on the time allocated to the consideration of alternative options. 88% of respondents believe competitive tendering does not contribute to lower project costs. The case study adds, *"if someone asks you to include for value engineering in your bid, what do you put in for that? if you allow €10,000 and the guy down the road says I can do that in ten minutes and puts nothing in, he gets the job"* and *"in a fee bidding situation value engineering won't happen, everybody gets the same brief and in our experience the lowest price will get the job"*

85% of the consultants consider they are being forced to '*work as efficiently as possible*' as Gallo et al. suggest in their 2002 study for the Australian Institute of Engineers, rather than developing design solutions '*which are as efficient as possible'* for their clients. 70% of the respondents do however believe, as Spekkink (2005) maintains, that performance specifications should focus on the client's functional needs - a figure which could indicate a higher *willingness* than could be construed from Dell'Isola (1982) work that maintains the usual cost reduction methods generally give little thought to functional considerations.

While, in line with Cheng *et al.* (2006), 82% of the consulting firms surveyed maintain that they consider the satisfaction of their clients to be a fundamental aim, only one fully agreed

with the maxim that *the customer* (i.e. the client) *is always right* with 55% believing the opposite to be the case - a reflection on Prior and Szigeti (2003), who ask why clients should put up with the fact that *the customer is always right* does not apply to construction output. Effective communications clearly being as Cheng *et al.* (2006) identifies an area in which the consultant underperforms. The case study adding, *"if the project's complete and the clients unhappy with the outcome, that situation is a failure of communication."*

QUESTION 4

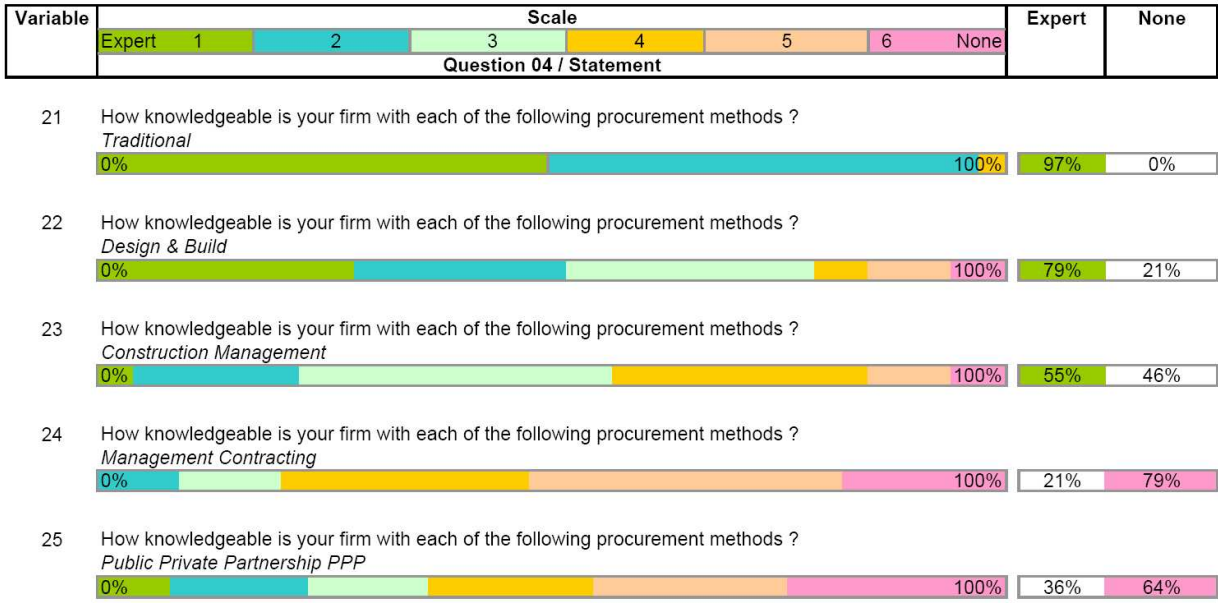

Figure 7.1d (Variable 21-25)

With clients becoming the driving force behind the development of alternative procurement methods (Smith and Love, 2001), it is significant that 97% of the responding consulting engineering firms consider themselves to have proficient-to-expert knowledge of the traditional procurement routes that Latham (1994) Egan (1998) and NAO (2001) recommend clients move away from.

A significant percentage of the respondents appear to have little or no knowledge of other procurement routes being advanced by construction clients with for example up to 79% claiming to have little knowledge of management contracting. Possibly leaving them, as implied by Kelly and Male (1993), more vulnerable to the ever-expanding services of quantity surveyors and contractors.

QUESTION 5

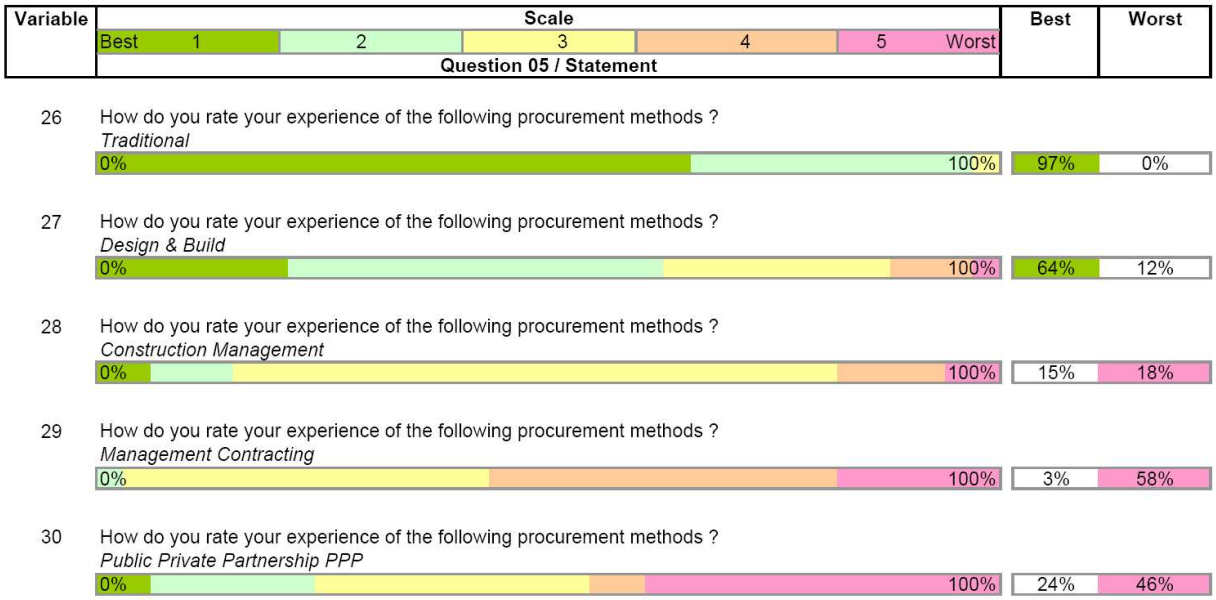

Figure 7.1e (Variable 26-30)

The respondents rate highly their experience of traditional procurement methods with 97% believing them to at the upper end of the scale. The case study adds *"we would have seldom come across Construction Management it's a very rare approach"*

Research such as that by Prior and Szigeti (2003) shows a shift away from the traditional approaches in favour of design-and-build, prime contracting and public private partnership (PPP) and while 64% indicate a reasonable degree of satisfaction with the design-and-build routes which clients are increasingly adopting, significantly less have any great experience with other procurement methods. This supports Rwelamila and Edrie's (2007) contention that engineering consultants are not sufficiently knowledgeable of the theory and practice of procurement methods available to adequately assist their clients.

This suggests that for the present clients may continue to be frustrated with the prevailing situation and turn, as Brown (2002) maintains, to other initiatives to circumvent the problem.

QUESTION 6

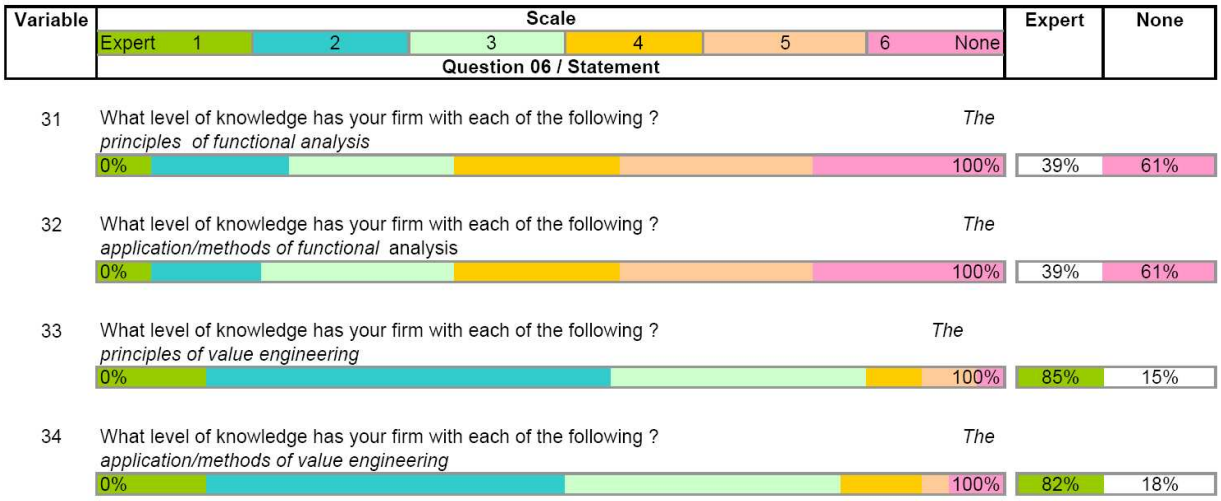

Figure 7.1f (Variable 31-34)

The application of functional analysis has been variously described as being value engineering's only distinctive characteristic (Male *et al.* 2007) and both a vital and necessary part of any value engineering study (Hunter and Kelly, 2007). While 61% of the respondents acknowledge they have little knowledge of the technique, up to 85% claim to have a good knowledge of value engineering indicating, as Tarricone (1993) and Cheah & Ting (2005) maintain that the term is frequently misunderstood.

This conflict is further examined in the section on contradictory questionnaire responses. The case study adds *"I'm not surprised people have a misconception of what value engineering is … they think its one thing but are likely off the track somewhat." "For all I know, maybe I do know a huge amount about functional analysis - but the term means nothing to me"* and *"People think value engineering is about the engineering of a job, its not…engineering is being used here as a verb."*

QUESTION 7

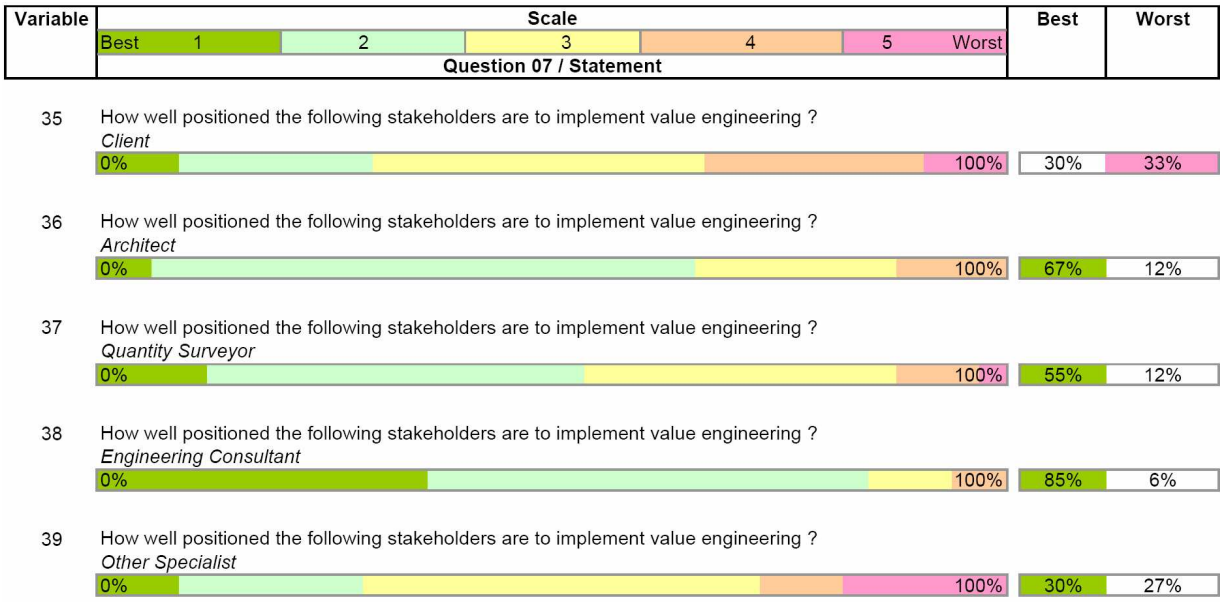

Figure 7.1g (Variable 35-39)

Despite the fact that the success of a service-delivery is, as Smedlund (2008) contends heavily reliant on the clients input, 33% of the respondents rated the client as being poorly positioned to implement value engineering. A high percentage of the respondents were undecided and relatively few believed the client to be in the best position to implement the concept.

This view appears to be considerably out of step with the established literature which maintains that value engineering should be introduced as early as possible. According to Kelly and Male (1993) it should occur during the development of the client brief and Fletcher and McClintock (2004) believe it should occur at the 25% to 35% design stage. The case study adds *"the briefing stage is crucial for value engineering because there is a lot of interaction with the client"* and *"while* [clients] *make the decision and its their money, they don't carry out the technical aspect of* [value engineering]*"*

The response to Question 7 appears to indicate a departure from the established view of the concept/design phase representing the greatest opportunity for return on a value engineering investment. Nevertheless in question 16, 79% of respondents indicate they believe value engineering should be implemented early though the case study adds *"the tendency towards the design stage rather than the briefing stage may be because relatively few* [engineers] *are involved in the briefing stage, their involvement being later* [in the process]*."*

85% of the consultants responding to the questionnaire strongly believe themselves to be in the best position to implement value engineering. However 91% (in question 3) indicated the

issue of competitive fee tendering to have a significant implication for the amount of time they could allocate to the consideration of alternatives, suggesting that commercial reality would be the limiting factor in the effective application of value engineering. The case study adding *"the reality is that if you put it in the context of competitive fee bidding, then the design team are effectively not involved in briefing at all"* and *"where we're not competing for fees were better positioned to provide more service to the client, we're in there with them."*

QUESTION 8-13

Variable	Question 08-13 / Statement	Yes	No
40	Does your firm provide a value engineering service ?	73%	27%
41	Does your firm hold value engineering workshops ?	42%	58%
42	Would you consider attending training on the subject of value engineering ?	82%	18%
43	Has your firm been involved in a value engineering workshop run by others ?	39%	61%
44	Do you believe value engineering can provide any real benefits ?	97%	3%
45	Is the competitive tendering process for consultants beneficial to the client in terms of design quality ?	9%	91%

Figure 7.1h (Variable 40-45)

While 73% of the respondents claim to provide a value engineering service and 97% believe value engineering can provide real benefits 91% consider the competitive tendering process for consultants to be a problem. The case study adds "if you tender for a job, you get the brief, the design team have no input into it" also, *"fee tendering to me is a problem if you're expecting to get advice on value engineering."*

In light of Brahtz's (1978) contention that firms gain competitive advantage through the additional services enabled by enhanced capabilities, it is notable that while, as Sturts and Griffis (2005a) contend many engineers feel their role is being undervalued 82% of the respondents indicated a willingness to attend training on the subject of value engineering. The case study indicates however that for some, the additional training may be a burden. *"If it isn't value engineering its project management, its QA, or CPD, the whole safety 'situation' is a quagmire…what you were asked to do is only taking up a fraction of the day … the peripheral stuff is taking up a huge amount time… are we losing the plot?"*

QUESTION 14

Variable	Question 14 / Statement		Yes	No
46	Does your firm employ any staff trained in the following ?	*Value engineer*	15%	85%
47	Does your firm employ any staff trained in the following ?	*Quantity Surveyor*	21%	79%
48	Does your firm employ any staff trained in the following ?	*Architect*	12%	88%
49	Does your firm employ any staff trained in the following ?	*Planner*	12%	88%
50	Does your firm employ any staff trained in the following ?	*Other Specialist*	52%	49%

Figure 7.1i (Variable 46-50)

The results indicate that the majority of engineering consultants are single discipline in nature.

While 73% of respondents claim (in question 8) to provide a value engineering service for their clients only 15% indicated that they have staff trained to any degree in the technique.

The disparity here is difficult to resolve but it may indicate a belief that specific training is considered somewhat unnecessary. 82% did however indicate (in question 10) that they would consider training on the subject.

QUESTION 15

Variable	Scale						Agree	Disagree
	Agree	1	2	3	4	5 Disagree		
	Question 15 / Statement						Y	N
51	Value engineering can provide greater definition of, and a more systematic identification, of client requirements than traditional briefing methods							
	0%					100%	55%	15%

Figure 7.1j (Variable 51)

Again this question presents some disparity. While 97% of the respondents had previously indicated they believed value engineering could provide real benefits, surprisingly only 55% considered value engineering could provide greater definition to the briefing process.

Kelly and Male (1993) maintain that all value engineering authors agree that the maximum value engineering potential occurs early in the briefing/design process and Yu et al. (2006b) suggest that, through both research and legislation, value management has been shown to be a solution for the improvement of briefing performance.

Yet the results show that only half the respondents are able to agree that value engineering could contribute to improvement in the briefing process, the other half being undecided or

disagreeing. This appears to indicate a misunderstanding more than a lack of knowledge, of the subject. Part of the reason for this disparity may lie in the notion that the more limited ones knowledge is, the higher they may perceive their level of understanding to be. The case study adding *"I think there probably is a lack of clarity and a lot of confusion in the whole area"*

QUESTION 16

Variable	Scale					Early	Late
	Conceptual	Briefing	Prelim Design	Design Stage	Construction		
	Question 16 / Statement						
52	Most appropriate stage for the implementation of value engineering concept's						
	Early				Late	79%	21%

Figure 7.1k (Variable 52)

In line with the contention of Zimmerman and Hart (1982), Dell'Isola (1982) and Davis (2004) that the best place for the value engineering effort is in the early planning and design stages. 79% of respondents agreed with its early implementation and just 6% felt that the conceptual stage was appropriate, a similar percentage believed the briefing stage to be suitable.

While the majority indicate the preliminary design stage to be the most appropriate for the application of value engineering, the result is somewhat unclear. In the literature Brahtz (1978) contends the concept/design phase to represent the greatest opportunity while Fletcher and McClintock (2004) maintain the optimum time as being the 25% and 35% stage. In hindsight, as the application of value engineering will likely spread across various project stages, perhaps if in the presentation of the question the respondent had been permitted to overlap where they place the implementation of value engineering, a more useful result may have been obtained.

QUESTION 17-19

Variable	Question 17-19 / Statement	Agree Y	Disagree N
53	Do you agree with the selection of consulting engineers by the competitive tendering process ?	30%	70%
54	Should the civil/structural engineering syllabus contain a value engineering module ?	97%	3%
55	Have of your staff received specific training in briefing methods and procedures ?	24%	76%

Figure 7.1l (Variable 53-55)

With 91% of respondents indicating their belief that competitive tendering is not beneficial to the client in terms of design quality (question 13), 91 % believing it to have an adverse impact on the time allocated to consideration of design alternatives and 88% not believing it to lower client costs (question 3) it is surprising that 30% nevertheless agree to the selection of

consulting engineers by the competitive tendering process. Although the question was clear the responses perhaps indicate there to be more an acceptance, to work within the current situation, rather than necessarily a full agreement with it - should alternatives be available.

97% indicate that value engineering should be included in the civil/structural engineering syllabus with 82% previously indicating that they would consider undertaking training in the technique. While it is an area that could be explored further, it does however suggest there is an appreciation of the 'value' of the technique.

With 76% of responding firms reporting that they have no staff with specific briefing training and 85% having no one trained in value engineering while there appears to be considerable scope for improvement. The case study questioned the value of additional [briefing] training adding *"it's very hard to have all these procedures and training, you end up with a situation where you get nothing done."*

Nevertheless, the high percentage of consulting firms that indicate a lack of knowledge, a need, and a willingness to accept training on the subject of value engineering is positive and presents a very real opportunity, and challenge, for education providers and the professional bodies.

QUESTION 20

Variable	Question 20 / Statement		Agree Y	Disagree N
56	Does your firm have a partnering arrangement with any of the following ?	*Value Engineer*	3%	97%
57	Does your firm have a partnering arrangement with any of the following ?	*Quantity Surveyor*	30%	70%
58	Does your firm have a partnering arrangement with any of the following ?	*Architect*	30%	70%
59	Does your firm have a partnering arrangement with any of the following ?	*Planner*	18%	82%
60	Does your firm have a partnering arrangement with any of the following ?	*Other Specialist*	46%	55%

Figure 7.1m (Variable 56-60)

The respondents typically report few partnering arrangements, and similar to question 14, the results indicate that the majority of the practices are single discipline in nature. Areas of inefficiency or a lack of proficiency will therefore directly impact on their clients and their clients' projects. The first step in resolving deficiency is awareness, this research should go some of the way to addressing this.

QUESTION 21

Variable	Question 21 / Statement	Agree Y	Disagree N
61	Has your firm ever made a representation to a professional body, on the issue of, the selection of consulting engineers through the process of competitive tendering ?	46%	55%

Figure 7.1n (Variable 61)

Considering the apparent level of negative impact that competitive fee tendering appears to have on the projects of design professionals it is notable that less than half of them have made any representation on the issue. Whether it results from complacency or a resignation to the prevailing situation is unclear, nevertheless there appears to be scope for a more concerted effort to deal with the issue. The case study indicated that *"the professional bodies and organisations are not dealing with this properly…Government bodies are seeing it* [the negative impact] *happening…The IEI ACEI and the RIAI should be doing something about It."*

QUESTION 22

Variable	Scale: Likely 1 / 2 / 3 / 4 / 5 Unlikely — Question 22 / Statement	Likely	Unlikely
62	Considering your own projects How likely would you consider it to be that another competent firm of consulting engineers could – upon payment of a fee of 0.1% to 0.3% of the total project cost Review and identify total cost savings of 3% to 5% ?	46%	30%

Figure 7.1o (Variable 62)

While a clear majority of 97% indicated they believed value engineering to provide tangible benefits and 67% felt they could likely produce a more economical design were they to receive 10% of any saving, there was little consensus to the above question.

21% considered it likely that savings could be identified, 24% also believed savings could be achieved but were less confident, 24% couldn't decide either way, 21% believed savings were somewhat unlikely and 9% believing it unlikely that savings could be identified.

The reason for the loss of previously apparent conviction is unclear. The complex way in which the question was presented may have a bearing on the mixed response. The suggestion of a proposed fee scale without an indication of project value is likely to have introduced some concern, the case study added, *"I think the scale of the project would have a significant bearing on this,"* and *"on say a €1m project for example, you couldn't check designs for the*

suggested fee of €3000, but for a larger job, then in that case, maybe you can do something", "If there's sufficient scale and complexity its probably viable but it would have to be profitable"

Anticipated resistance to being "value engineered" is an issue concerning the case study participants, *"the original designer of a building reportedly 10% over designed, may say, 'who says! are you prepared to certify this* [re-designed] *building?… no?… well neither am I… so my design says f… off.'"*

QUESTION 23

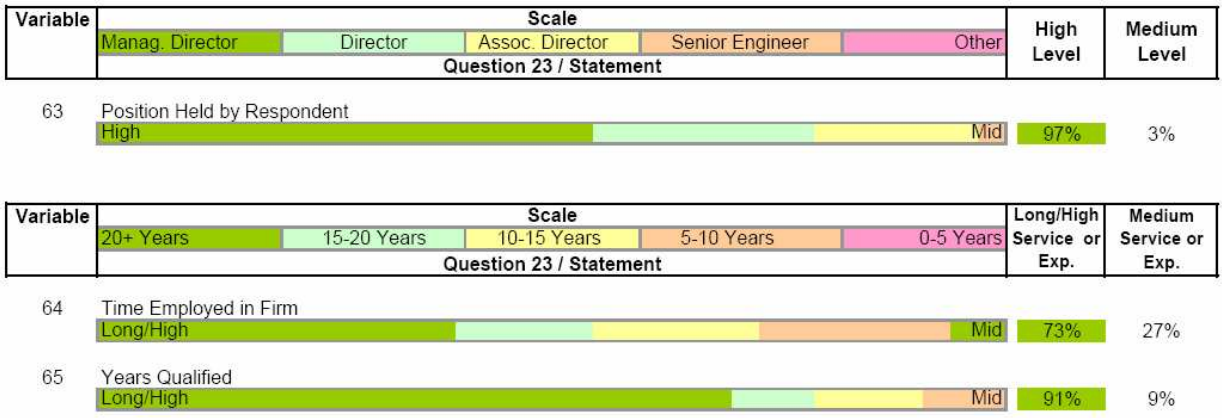

Figure 7.1p (Variable 63-65)

The authority of the survey is enhanced by the nature of the respondents who have extensive experience, are typically from the highest levels of management and have been employed in their respective firms for some considerable time, more than half for twenty years or more.

The experience captured is of some significant value, 88% of the respondents requested a copy of the completed research indicating a high degree of engagement and further validation of the study.

7.3 CONTRADICTORY QUESTIONNAIRE RESPONSES

Cross referencing the respondents' answers to the questionnaire reveals a considerable misunderstanding of the concept of value engineering by those claiming to understand and provide this service.

While only 39% of respondents felt they had good or better knowledge of the principles of functional analysis (the basis of value engineering) 85% nevertheless maintained they had a good or better knowledge of the principles of value engineering.

The knowledge level of each of the 39% of respondents who indicated that they had a good understanding of the principles of functional analysis typically equalled the knowledge level they claimed for the principles of value engineering suggesting they did indeed have a reasonable grasp of the concept while the remaining 61% who claim to have little or no understanding of functional analysis but claim to have a good knowledge of value engineering clearly misunderstand the concept.

92% of the group who indicating that they had a good understanding of the principles of functional analysis claimed to provide a value engineering service. Of the respondents who claimed to have staff trained in value engineering 80% also came from this group.

Of the respondents who claimed they held value engineering workshops 50% came from the grouping with a good understanding of functional analysis and value engineering and 50% from those who appear to misunderstand the concept.

Of the 73% of the respondents who answered yes to Q9 (V40) "D*o you provide a value engineering service?"* 54% came from the group exhibiting a good knowledge of value engineering and 46% from the group who clearly appear to misunderstand the concept.

75% of the group who appear to misunderstand the value engineering concept indicated their willingness to undertaking training on the subject.

75% of the group exhibiting a good knowledge of value engineering indicated that they believe value engineering can provide a greater definition of and more systematic identification of client requirements, while only 43% of the group who appear to misunderstand the concept believe the same.

7.4 CASE STUDY DISCUSSION

What is Value Engineering?

"It's a new term but I would have said that it is something that we always did" was one reply with others considering: *"No mater what part of a project you're in, you should always be trying to develop the optimal design, and that's value engineering"*. The term appears to have differing connotations for different people *"The important distinction* [in the term] *is the engineering of value … but when you talk to people, and I would count myself amongst them, is that they use it in the context of alternative construction approaches"*.

As indicated above while some pick up on the word 'value' *"At preliminary design stage we do budget costing's and …look at options one, two, three - I consider that value engineering"*; for others it is the word 'engineering' that becomes the focus: *"Value engineering as I understand it has not got to do with engineering it's using the word engineering in a different context"*. It is worthwhile recalling that the technique was born 'value analysis' (Brown (2002)) only adopting the name 'engineering' in the 1950's to overcome a military embargo on the hiring of 'analysts' (SAVE, (2007)).

Referring to a prominent project design team meeting, one case study participant offered the following: *"I don't think they really knew what they were asking for, the first time it* [value engineering] *came up nobody really knew what it was, but because of the word engineering every one looked at the engineering consultant."*

Some stretched the use of the term value engineering whereby they believe *"in some ways you could say that the new forms of contract are value engineering because you're getting a fixed price lump sum and to some extent that's value engineering"* and feel *"it's not necessarily cost cutting but it could be cost cutting…"*.

Functional Analysis

The disparity previously highlighted around the 'distinctive' (Male *et al.* 2007) and 'vital and necessary' (Hunter and Kelly, 2007) application of functional analysis is also reflected in the case study: *"I haven't heard the term functional analysis though it seems a logical term, I don't think it's about cost cutting, I think its about minimising cost, optimising costs…"*, for others it didn't *"ring any major bells"*.

A misunderstanding of what constitutes value engineering is, clearly apparent throughout both the literature and the primary research conducted. Perhaps the misunderstanding that exists has its roots the adoption of the word 'engineering'.

Current Use of the Technique

"Maybe value engineering is the formalisation of something that we believe automatically happens." The respondents understanding of the concept appears to have a bearing on whether they believe they conduct value engineering or not and much conflict appears around this in the primary research conducted: *"…if offering an alternative design is value engineering then we would have* [provided a value engineering service in the past]*, if not, then I'm not aware that we would have done so"*.

In the case study firm, some believe *"engineering consultants pride themselves on saying that they've always offered value engineering"*. Others believe it to have been *"scheduled on the list of things to do but I don't think that we have done it in the way"*. Others consider that they *"would do value engineering at the preliminary stage and the design stage as part of* [their] *normal work"* or would "*not really* [perform value engineering]*, not in a formal way, though people may have referred to it as* [value engineering]".

"I think the expectation with clients is that the exercise is being done as part of the normal work and they're entitled to think that."

When is Value Engineering Best Applied

There is considerable study into the optimum time to apply value engineering. Kelly and Male (1993) maintain that no less than 'all value engineering authors' agree that the maximum value engineering potential occurs early in the briefing/design process. This view is reflected in the case study: *"from what I understand the principle to be to be, at the briefing stage, at an early stage before design happens, at maybe 20% of the design phase, I think people will need to have done something"*.

Others suggest value engineering's application may have a wider applicability at other stages with some participants understanding the concept to include tendered alternatives: *"while we have accepted alternative designs in various circumstances, I don't think we've ever picked a contractor on the basis of an alternative"*.

"It's not particularly often that you're presented with alternatives at tender stage, it's probability less than 5% of the time".

Client Briefing

While briefing sets the direction a project will take, for the client the consulting engineer is more and more frequently considered to be simply the provider of a technical service or, as Sturts and Griffis (2005b) contend a commodity. But while engineers may argue that *"there's more to it* [design] *than that, there's interaction between the client and his professional advisor, he's getting a huge amount of benefit from that, he's not getting it free of charge, but its part of the relationship and fee that goes with that"* they appear to be unable to quantify their value to potential clients (Sturts and Griffis, 2005b) - they are simply not selling themselves adequately.

"A critical point is very early on in the briefing phase, what's required? There can be a very serious mismatch, and before it's realised, its way down the road."

Communication

There are serious failings evident in how clients and their engineers communicate. Stoughton (2009) maintained that clients find it difficult or impossible to be clear about their requirements. *"Clients and engineers don't talk the same language even when you bring it to their attention. Often it's not until they see the design that they say 'that's not what I was talking about at all', there does tend to be an 'understand-gap'"*. While there is an acknowledgement of differing perspectives: *"engineers are problem solvers, they don't have much training in business function…corporate and technical people can be different"*, the consultant appears reluctant to take ownership of the problem and resists the notion of the customer being always right. *"In the business that he knows… yes the client is right in that sense, but he's not necessarily right when he talks about buildings."*

Nevertheless clients feel up to 71 percent of projects are not successful (Stoughton, 2009) and are clearly becoming increasingly frustrated (Brown, 2002) believing the consultant to underperform in many key areas Cheng *et al.* (2006). While the consultants acknowledge there is inadequate coordination between the parties involved *"in a lot of traditional design…what you find is that drawings go back and forwards and back and forwards and there's never really proper coordination"*. The blame appears to be persistently placed with the client. The consultants considering *"sometimes the client doesn't understand or there's a lack of appreciation of what their design team are going to do for them, what there going to give them"*.

Value Engineering as a Service

Value engineered improvements are considered by clients to be included in the engineer's fee Jergeas *et al.* (1999) as part of their normal design work (Davis, 2004) and while engineers may consider it to be a waste of time (Mansour, 1991) clients believe engineers are not doing their job where they fail to consider it (Jergeas and Revay, 1999).

For consultants to offer value engineering as a defined service to their clients there are many perceived hurdles and some reluctance on the part of professionals and clients to be overcome (Fletcher and McClintock, 2004). Some *"don't think that system would work* [they] *think it would cause mayhem because you would have big guy's making little of smaller ones and visa versa - there could be hidden agenda's."*

There is considerable unease surrounding the issue of reviewing the work of other consultants. *"There's a risk that if you bring in a value engineering team inevitably there's a group that didn't get the job who're going to wish to demonstrate to the client that they should have got the job and those that did get the job shouldn't have got it, and shouldn't get any more. "* Others believe *"there could be an opening, but there might be knock on effects…consultants might not get paid if they're scrutinised by another guy… organisation like the IEI ACEI may take issue with the likes of that"*.

While value engineering is considered to be beneficial some believe its provision as an independent service *"could be counter productive and lead to all sorts of delays, confusion, rows…that's not easily going to be resolved"*.

The ownership of design may become a sensitive issue where engineers feel change is being forced upon them. *"The problem is that you are now asking the engineer who designed the job to accept an alternative…he might not be willing to do that…and I'm not too sure he should be obliged to do it either."* Nevertheless while there can be an negative/adversarial view (Jergeas *et al.* 1999) and a lack of support/flexibility/awareness and knowledge (Cheah and Ting, 2005) which are cause for its limited application, if an engineer believes value engineering can turn out more economical designs as 97% of respondents have indicated then according to Dell'Isola (1982) a formal value engineering program should be initiated.

Client Satisfaction

While in line with Cheng *et al.* (2006) 82% of the consulting firms surveyed maintained they considered the satisfaction of their clients to be a fundamental aim only one fully agreed with the maxim that *the customer* (i.e. the client) *is always right* 55% believe the opposite to be true *"sometimes he doesn't understand, he doesn't realise what he wants…. It can be his own fault."* Client satisfaction can appear valid only when it falls in line with the thinking of the designer. *"I believe, that he believes he's always right, ultimately you'd have to convince him, of what we, believe to be good advice."* Others consider the client's validity exists primarily *"in the business that he knows… yes, the client is right in that sense, but he's not necessarily right when he talks about buildings"*.

The gap between what a client needs as against what he may express, and what he may ultimately get, appears to remain *"once it looks well and he's happy with it, the physical structure, what he's got, that's as much as you can do for him its not your business if the people don't walk in the door"*.

"If they built a car showrooms and they find there not selling cars can they blame the building?"

Competitive Fee Tendering

Respondents believe competitive fee tendering to be a cause of client dissatisfaction *"there's no doubt about that, but I would think that the client doesn't know, I think that if he is dissatisfied he says I picked the wrong engineer - he doesn't think that he picked the wrong system."* A designer hired solely under a competitive fee-based procurement process is unlikely to make the design as efficient as possible (Sturts and Griffis, 2005a) and this is reflected according to Hoxley (2000) in the decline in the checking and reviewing of designs and the investigation of alternatives. While some believe the present system won't change *"I think whether we like it or not competitive tendering is something that we're not going to change as much as we may like to"*. In the United States fee-based bidding is illegal in many states (Sturts and Griffis, 2005b). Clients need to be informed of the *'cost'* of competitive fee tendering. *"What's happening all the time is that price is taking over and unfortunately professional advisors are unable to give the client the benefit of their advice"*. Engineers can lament the commoditisation of their services (Sturts and Griffis, 2005b) or they can work with their clients to break out of the current situation to the benefit of all.

7.5 SUMMARY

Engineering consultants maintain that their client's satisfaction is a fundamental aim. However they are aware, and agree that their clients are not completely satisfied. It appears that client satisfaction may frequently only be validated when it is aligned with the engineer opinion.

The majority of engineering consultants believe that value engineering can bring real benefits, is not the sole preserve of the contractor and that they themselves should exert ownership of the role.

Most engineering consultants believe their role to be threatened by the alternative procurement routes that many are unfamiliar with, and agree there is a tendency towards their role becoming subordinate.

Engineering consultants not only believe themselves to be in the best position to implement value engineering but they agree they can produce more economical designs and that value engineering should be implemented early in the design process. While most of the consultants realise that contractor initiated value engineering savings give the client the impression they've failed, the majority admit however that when hired under the competitive fee-bidding they're unlikely to spend the time necessary to design as efficient as possible.

Competitive fee tendering is having a significant impact on the amount of time allocated to the consideration of design alternatives and is considered a barrier by most consultants *"professional advisers can't give the benefit of their advise to the client"*. While most believe competitive fee tendering to be a major cause of client dissatisfaction less than half have made any representations on the matter to their professional bodies.

The ownership of designs [value engineered by others] can be a sensitive issue, that some of engineering consultants believe could "*cause mayhem*", delays, confusion and dispute that may be difficult to resolve.

The majority of the firms surveyed, claim to provide value engineering to their clients yet few of them appear to understand it and less have any staff trained in either value engineering or briefing methods. However most would consider training on the subject and believe that value engineering should be included on the engineering syllabus.

The respondent's level of understanding of the concept has a bearing on whether they believe they conduct value engineering or not. Three quarters of those with a good understanding of the concept believe it can provide greater definition of the clients needs compared to less than half for those who misunderstand the concept.

Notably the introduction of the word 'engineering' appears to be a significant factor in the widespread misunderstanding of the concept. It may skew how the theory is being viewed, particularly within the engineering profession. This view does not appear to have been raised before in value engineering literature and its resolution may have considerable benefits for the uptake and understanding of the value engineering concept.

CHAPTER 8 – Summary and Conclusions

8 SUMMARY AND CONCLUSIONS

The aim of this research was to investigate the opportunity for enhancing the consulting engineer's role through the introduction of value engineering as an additional service for their clients. Using a questionnaire survey and the correlating case study this research has discovered the opinion, attitude and perspective of a representative sample of Irish-based consulting engineers. It will enable consulting engineers, their clients and construction professionals in general to develop a better understanding of the variables that affect the application and introduction of value engineering. It could form the basis of an agenda to re-examine policy in the areas of value engineering and competitive fee tendering.

8.1 THE KEY FINDINGS OF THE RESEARCH

Having explored value engineering and the corresponding relationships with the consulting engineer, their role, and their client, there appears to be a persistent and anomalous behavioural pattern with regard to the fundamental value for money needs of the client and the often contrary and entrenched attitude of their consultant engineers to these particular needs.

Research has clearly established the widely accepted primary/stakeholder benefits obtainable from the value engineering process. The savings are typically reliable and clearly identifiable.

While the discipline of value engineering itself, its specific attributes and various techniques, have all been well established, outside of the United States the research indicates the principles are frequently misunderstood - a fact clearly borne out in the primary research.

The secondary benefits of implementing a value engineering service are however not clearly defined and while it has been shown that the process of value engineering can question the original designer's plans and reasoning. The resulting resistance needs further exploration in light of the potential benefits.

No research was found that explores the possibility of secondary benefits accruing to the consulting engineer through the implementation a value engineering service nor on the resultant opportunity it could present in redefining or strengthen their role.

Through the case study some engineers indicate the belief that by offering value engineering as a separated function they may be perceived negatively by their clients also present is the fear that they risk a hostile reception from other consultants who may feel scrutinised through their firm's role as a value engineer of external projects. Such issues present a very real barrier to the advancement of value engineering as a service and while they are not insurmountable

and all agree there is much benefit to achieved in finding a way, and a will to resolve them, collective action will be needed to address many of the issues that will arise.

8.2 LIMITATIONS

While the natural limits of time apply to all tasks, the time applied to the research project far exceeded that recommended in the module description.

Every effort was made in the correlational/background survey (questionnaire) to reach a representative survey sample from consulting civil and structural engineering firms, nevertheless it remains a sample, and as such may not be fully representative of the entire profession or industry perspective. The 39.3% percent response rate achieved however is considered to be significant (Moser and Kalton, 1971).

The selection and phrasing of questions and the manner of response can have an effect on the result and be subject to distortion through bias. Where possible these issues were eliminated or minimized through the application of rigorous design with a number of measures being taken to maximise survey response rate. The application of a dual research strategy was used to minimise many of the limitations associated with a singular approach.

8.3 HYPOTHESIS

The hypothesis to be tested by the research was: '*If consulting engineers want to expand their role in the market place they should provide a value engineering service for their clients'*.

It is considered that the hypothesis is supported through both the literature review and the primary research conducted and while there are hurdles to overcome and much perceived apprehension surrounding the introduction of value engineering the outlook for its implementation is optimistic.

8.4 CONCLUSIONS

Having explored the issues related to the application of value engineering by engineering consultants there are a number of conclusions that can be drawn in answer to the aims and objectives of the research:

Objective 1. *To critically analyse the existing body of literature relating to value engineering.*

1. A thorough review of the literature was conducted that clearly established the benefits of value engineering, a view supported by the primary research. A considerable consensus was also found to exist in when, and how best to apply the technique. A widespread resistance to the application of value engineering is clearly established in the literature however its underlying source is not fully appreciated, further research is necessary.

While the success of its application was found to be inextricably tied to the rigor of the briefing process, little research was uncovered to expand on this. The profoundly negative effect that competitive tendering has on the application of value engineering was clearly established yet not addressed in any significant detail in the current literature.

While the client has been shown to be satisfied with the technical ability of their engineers they are however dissatisfied with the service they received and a persistent disparity exists in service level expectations of the client and their engineers.

The consulting engineer/design team recognise the satisfaction levels of their clients, admit they have the ability to provide a better service and are aware of the resulting trend towards alternative procurement methods that diminishes their role, yet they appear unable or unwilling to challenge the situation.

The consulting engineer must recognise and act on the prevailing situation. They must strive to put in place the mechanisms that will enable them to refocus on client satisfaction and on how they might provide increased value to, and from their role. The only valid determination of success must be that of the client.

Objective 2. *To explore the existing attitudes and perceptions to the value engineering concept, to seek an understanding of consulting engineer's opinions and to examine the factors that guide these opinions.*

2. The survey reached a high percentage of the target population the results are significant and point to strongly held opinions that are not supported by a sound knowledge of the subject. Given with the widespread misunderstanding what of constitutes 'value engineering' it is notable that it is viewed in a positive light by the majority of the respondents. While the general population is at present unlikely to have sufficient knowledge to apply the technique, most expressed an openness to learn about value engineering.

Initially while some of the respondents considered 'value engineering' to be something of a buzz-word or believed it to be 'something' they carried out routinely, their initial perception wavered through the process of the initial interview, questionnaire and follow-up interview to a position where they became more 'open' to the concept as being more significant.

There is a need for value engineering modules within undergraduate and postgraduate engineering degree courses and for its incorporation into continuing professional development (CPD) programmes.

Objective 3. *To examine and discover the reasons, where they exist, for resistance to the introduction of a value engineering service.*

3. The research found considerable consensus to suggest that although while engineers considered they had the ability to perform value engineering and could see the benefit in doing so, they felt restrained by many issues that inhibit their ability and confidence to introduce it, such as,

a. Competitive tendering
b. Anticipated negative peer pressure
c. Anticipated negative client reception
d. Lack of opportunity
e. Lack of knowledge
f. Prevailing culture
g. Type and scale of projects
h. Design responsibility
i. Lack of policy

The apprehension seen in consulting engineers towards the introduction of a value engineering service need not be viewed negatively. Such cautiousness is reasonable and typical of the engineer. The introduction of a new concept requires a champion, the support and promotion of value engineering by institutions and both professional and government bodies will be crucial to its successful implementation.

Objective 4. *Explore the technical, cultural, and commercial feasibility of introducing a value engineering service.*

4. The engineering profession agree that they have the technical ability, are well positioned, and believe that they should exercise ownership of the value-engineering role. The significant commercial benefit [to clients] of value engineering is widely accepted. While there are many reasons to avoid doing something new, and the introduction of value engineering is no different, with clients taking more control and demanding ever increasing levels of service consulting engineers have little option but to accept and react to these changes.

While the financial benefits available to the engineer are not easily identifiable there is little commercial viability in resisting what is good for the client. Value engineering may offer a significant competitive advantage to firms who find a way to offer it.

Objective 5. *Investigate the potential value engineering may have in constructing the brief.*

5. Many project failures can be traced directly back to the project brief. There is a considerable consensus to suggest the root of construction problems stem from a lack of project definition. Three quarters of the engineers surveyed (with a good understanding of the concept) believe that value engineering can provide an increased definition of client needs, they agree with the literature that it should be employed early and believe it can bring real benefits.

A systematic approach to the identification of client objectives is necessary. Value engineering can focus the client and design team more effectively and there is a growing body of research to suggest that it may be a valid solution to poor briefing performance however at present very few of the firms surveyed have any staff trained in either briefing or value engineering techniques. There is much scope for the development of this area and potential for competitive advantage to be gained.

Other conclusions reached include:

6. Competitive fee tendering is having a significant impact on the level of service being made available to clients.

7. The word 'engineering' appears be a significant factor in the widespread misunderstanding of value engineering within the engineering profession.

8. The Irish engineers are not lobbying their professional bodies and institutions on issues that affect the direction of their profession.

8.5 RECOMMENDATIONS

The recommendations which result from this research stem from an extensive review of the available literature, a survey representative of the Association of Consulting Engineers of Ireland, and an in-depth case study carried out to capture the deeper attitudes of the profession. Many of the recommendations could have a significant economic impact not only for the case study firm and its clients, but also for the profession and the national economy as a whole.

In conjunction with the need for further academic research there is justification for the establishment of a Government task force to investigate and report on the applicability of value engineering in the context of the Irish construction industry. The findings of this task force should include clear recommendations and direction for both Government Departments and Professional Bodies.

It is recommended that pilot value engineering studies be commissioned on public works projects to explore its applicability. The possibility of subventions, tax breaks or other incentives for private enterprise to pilot value engineering studies should be considered. A mechanism should be established to record the success or otherwise, and lessons learned on these studies.

Any engineering consultancy that would be in a position to develop pilot studies and could align itself to, or advise/partner such a task force could develop a pivotal position in the industry. It is a potential the case study firm should consider.

Further recommendations include:

1. The case study firm should initiate training in effective briefing and value engineering.

2. The case study firm should trial value engineering workshops to explore/ascertain actual effectiveness and commercial viability.

3. The case study firm should explore the application/provision of defined briefing and value engineering service, initially with its regular clients.

4. A drive to move away from competitive fee tendering should be championed by individual firms, the Association of Consulting Engineers of Ireland and Engineers Ireland with representation highlighting the negative effect on overall project value.

5. A value engineering module should be introduced as part the engineering syllabus at undergraduate and postgraduate level.

6. Professional bodies should consider the consequences of both competitive fee tendering and value engineering in Ireland and perhaps encourage industry research in the area.

7. The 'Green Lobby' should be encouraged to support the *sustainability* of value engineering.

8. Professional bodies should arrange value engineering seminars and conferences for engineers and clients (private and public).

9. The engineering journals should 'call' for papers on value engineering and its implementation.

10. Professional bodies should establish appropriate directives on the subject of continuing professional development (CPD) to ensure the profession meet the changing needs of its clients.

CHAPTER 9 – Bibliography

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CHAPTER 10 – Appendix

10 APPENDIX A

10.1 SURVEY SAMPLE

SURVEY SAMPLE			
The Association of Consulting Engineers of Ireland 2009 Directory (Civil/Structural only, Firm Head Office Only)			
Ref:	Company	Firm Address	Telephone:
1	Albert Fry Associates	15 Northwood Court, Northwood, Santry, Dublin 9.	Tel: 01 862 2969
2	ARUP Consulting Engineers	50 Ringsend Road, Dublin 4.	Tel: 01 233 4455
3	Barrett Mahony Consulting Engineers	Sandwith House, 52/54 Lower Sandwith Street, Dublin 2.	Tel: 01 677 3200
4	J.B. Barry & Partners Ltd.	Tramway House, 32 Dartry Road, Dublin 6.	Tel: 01 497 5716
5	Ronald J. Bergin Consulting Engineers	'St Heliers' Stillorgan Park, Blackrock, Co Dublin.	Tel: 01 288 3227
6	BJS Consultants Ltd.	Faraday Court, Rockboro Ave., Old Blackrock Road, Cork.	Tel: 021 4315610
7	Blue Hills Consulting Engineers	10b North West Business & Tech. Pk, Carrick on Shannon, Leitrim.	Tel: 071 9621875
8	Building Design Partnership	Building Design Partnership, Blackhall Green, Dublin 7.	Tel: 01 474 0600
9	Bunni & Associates Ltd.	42 Thormanby Road, Howth, Co. Dublin.	Tel: 01 8391141
10	J.J. Campbell & Assoc's Ltd.	Unit F1 Nutgrove Office Park, Rathfarnham, Dublin 14.	Tel: 01 2980538
11	Clifton Scannell Emerson Associates	Seafort Lodge, Castledawson Ave, Blackrock, Co Dublin	Tel: 01 288 5006
12	P. Coleman & Associates	Bank Place, Ennis, Co Clare.	Tel: 065 6829731
13	Concannon Healy Heffernan	13 Quay Street, Sligo.	Tel: 071 9161844
14	Paul Condron Consulting Engineer Ltd.	10 Rectory Way, Herbert Road, Bray, Co. Wicklow.	Tel: 01 272 4018
15	John Creed & Associates	145 The Faythe, Wexford.	Tel: 053 9147429
16	Daly Knight Associates	58 – 60 St. Agnes Park, Crumlin Village, Dublin 12.	Tel: 01 4099746

17	DBFL Consulting Engineers	Herbert House, Harmony Row, Dublin 2.	Tel: 01 4004000
18	Doherty Finegan Kelly	Botanic Court, 30 – 32 Botanic Road, Glasnevin, Dublin 9.	Tel: 01 8301852
19	Downes Associates	Cashel Business Centre, Cashel Road, Kimmage, Dublin 12	Tel: 01 490 1611
20	Duffy Chartered Engineers	Jocelyn House, Jocelyn Street, Dundalk, Co. Louth.	Tel: 042 9351600
21	John Egan Associates	The Loft Studio, 74, Heather Road, Sandyford Industrial Estate, Sandyford, Dublin 18.	Tel: 01 2938576
22	Fahy Fitzpatrick Consulting Engineers	2057 Castle Drive, Citywest Campus, Naas Road, Dublin 24.	Tel: 01 4660566
23	Fearon O'Neill Rooney	17 Fitzwilliam Square, Dublin 2.	Tel: 01 676 6167
24	Fehily Timoney & Company	Core House, Pouladuff Road, Cork.	Tel: 021 4964133
25	Fitzsimons Doyle & Associates	250 Harolds Cross Road, Dublin 6W.	Tel: 01 496 6011
26	Niall Fitzsimons & Co	Ocon House, 2 Tivoli Gardens, Tivoli, Cork.	Tel: 021 4551260
27	Thomas Garland & Partners	Garland House, 28-30 Rathmines Park, Dublin 6.	Tel: 01 4964 322
28	Ignatius Greaney & Associates	'Clarig', Kilcolgan, Co Galway.	Tel: 091 796015
29	R.G. Greene & Associates	5 New Docks, Galway.	Tel: 091 564 157
30	Grontmij Ireland Ltd.	Frankfort Court, Dundrum Road, Dublin 14.	Tel: 01 207 4800
31	Harewood Associates	13 Mill Street, Galway.	Tel: 091 561 046
32	Colm Hassett Consulting Engineers	North Main Street, Naas, Co. Kildare.	Tel: 045 897 764
33	Hendrick Ryan & Associates	10 Priory Hall, Stillorgan, Co Dublin.	Tel: 01 283 4866
34	Hickey Moynihan Design	Courtyard House, The Courtyard, Fairhill, Killarney, Co. Kerry.	Tel: 353 06439946

35	Horgan lynch Consulting Engineers	Tellengana, Blackrock Road, Cork.	Tel: 021 4936100
36	Jennings O'Donovan & Partners	Finisklin Business Park, Finisklin, Sligo.	Tel: 071 9161416
37	JODA Engineering Consultants	Model Farm Road, Cork.	Tel: 021 4544244
38	Kavanagh Mansfield & Partners	76 Merrion Road., Ballsbridge, Dublin 4.	Tel: 01 660 6966
39	Ray Keane & Associates	2, Clogheen Business Park, Blarney Road, Cork.	Tel: 021 4399799
40	David Kelly Partnership	Nelson House, Emmet Place, Youghal, Co Cork.	Tel: 024 92412
41	Vincent Kelly Ltd.	'Dooega', Hettyfield, Douglas, Cork.	Tel: 021 4292533
42	Lee McCullough Consulting Engineers	67 Lr Baggot Street, Dublin 2. Dublin	Tel: 01 6763666
43	MacArdle McSweeney Associates	11/12 Warrington Place, Dublin 2 Dublin	Tel: 01 6618122
44	McCabe Delaney Consulting Engineers	20 Harcourt Street, Dublin 2. Dublin	Tel: 01 405 2620
45	Mott MacDonald Pettit	South Block, Rockfield, Dundrum, Dublin 16.	Tel: 01 2916700
46	McDonnell & Dixon	(Engineering Section) 20 Ely Place, Dublin 2.	Tel: 01 676 2379
47	The McKenna Pearce Practice	Histon House, Cornelscourt Village, Dublin 18.	Tel: 01 2897260
48	John J. McShane & Associates	124 Foxfield Park, Raheny, Dublin 5.	Tel: 01 832 3610
49	Malone O'Regan	2B Richview Office Park, Clonskeagh, Dublin 14.	Tel: 01 260 2655
50	Malone O'Regan McGillicuddy	Day Place, Tralee, Kerry.	Tel: 066 7123130
51	Mescal & Associates	Enterprise House, Centre Park Road, Cork.	Tel: 021 4314388
52	Molony & Millar	Riverbank House, Ballyboden Road, Rathfarnham, Dublin 14.	Tel: 01 493 0211
53	Moylan Consulting Engineers	Wilson House, Fenian Street, Dublin 2.	Tel: 01 8833600

54	Markham, Treacy, Wallace	Unit 4, MTW House, Broomfield Business Park, Malahide, Co Dublin	Tel: 01 846 3505
55	Muir Associates Ltd.	17 Fitzwilliam Place, Dublin 2.	Tel: 01 676 2788
56	Nestor Kelly Consulting Engineers	Sheraton House, Hartlands Ave., Cork.	Tel: 021 4963777
57	O'Connell Harley O'Dwyer	11 South Mall, Cork.	Tel: 021 4273266
58	O'Connor Sutton Cronin	9 Prussia Street, Dublin 7.	Tel: 868 2000
59	HGL O'Connor & Company Ltd.	Woodquay Court, Woodquay, Galway .	Tel: 091 563 191
60	T.J. O'Connor & Associates	Corrig House, Corrig Road, Sandyford, Dublin 18.	Tel: 01 295 2321
61	Nicholas O'Dwyer Ltd.	Nutgrove Office Park, Nutgrove Ave, Dublin 14.	Tel: 01 2969000
62	N.J. O'Gorman & Associates	5 Adelaide Court, Adelaide Road, Dublin 2.	Tel: 01 475 5244
63	Pat O'Gorman & Associates	Unit C2, Nutgrove Office Park, Rathfarnham, Dublin14.	Tel: 01 205 1101
64	Denis O'Leary & Partners	12 Rockville Drive, Blackrock, Co Dublin.	Tel: 01 288 3420
65	D. O'Malley & Associates	McHale Retail Park, Castlebar, Co Mayo.	Tel: 094 9023850
66	Don O'Malley & Partners	92 O'Connell Street, Limerick.	Tel: 061 318 677
67	Mark O'Reilly & Associates	Greenmount House, Harolds Cross Road, Dublin 6W.	Tel: 01 453 4423
68	C.S. Pringle Ltd.	Monaghan Road, Castleblayney, Co. Monaghan.	Tel: 042 9746492
69	Michael Punch & Partners Ltd.	97 Henry Street, Limerick.	Tel: 061 221 200
70	Roughan & O'Donovan	Arena House, Arena Road, Sandyford, Dublin 18.	Tel: 01 294 0800
71	RPS Consulting Engineers Ltd.	West Pier Business Campus, Dun Laoghaire, Co. Dublin.	Tel: 01 488 2900
72	Oliver Russell & Associates Ltd.	Palmerstown Lodge, Oldtown, Co. Dublin.	Tel: 01 8350988

73	Ryan Associates Consulting Engineers	Unit C4, Nutgrove Office Park, Nutgrove Avenue, Rathfarnham, Dublin 14.	Tel: 01 2990730
74	Ryan Hanley Consulting Engineers	Sherwood House, Sherwood Avenue, Taylor's Hill, Galway.	Tel: 091 587 116
75	Colin Short Associates	Brookfield, Glen Road, Delgany, Co. Wicklow.	Tel: 01 287 3711
76	WDR & RT Taggart	32B Westland Square, Dublin 2.	Tel: 01 677 2197
77	Tobin Consulting Engineers	Fairgreen House, Fairgreen Road, Galway.	Tel: 091 565 211
78	Paul Twomey & Associates Ltd.	18, St Patrick's Hill, Cork	Tel: 021 4507784
79	Malachy Walsh and Partners	Park House, Mahon Technology Park, Bessboro Road, Blackrock, Cork.	Tel: 021 4536400
80	WYG Ireland Ltd.	Apex Business Centre, Blackthorn Road, Sandyford, Dublin 18.	Tel: 01 293 1200

10 APPENDIX B

10.2 QUESTIONNAIRE

MSc CPM/WIT 2010 Questionnaire No: 0 1 Serial No 04110909
CARD 1 of 4

Value Engineering Survey – Engineering Consultancy Questionnaire

QUESTIONNAIRE
05/02/10

Value engineering has been described as an organised approach to identifying and eliminating unnecessary cost through the complete analysis of function rather than simply engineering attributes (Watson, 2005).

In 1996 President Clinton signed into law an Act obliging all executive agencies to establish value engineering procedures, the estimated savings for that year alone were c$2.19B (Elias, 1998).

(In the context of your experience of the in the Irish construction industry)

Q 01. **Please rate your opinion on each of the following statements**

		Agree				Disagree	
❑	Clients are completely satisfied with the service they receive from the construction industry	1	2	3	4	5	(01)
❑	Value engineering is typically a contractor lead initiative	1	2	3	4	5	(02)
❑	Clients are increasingly turning to design and build options for their developments	1	2	3	4	5	(03)
❑	The quantity surveyor is increasingly undertaking the role of project management, an important part of the engineering consultant's domain	1	2	3	4	5	(04)
❑	The quantity surveyor is increasingly providing clients with a value engineering service	1	2	3	4	5	(05)
❑	The engineering consultant should exercise ownership of the role of value engineering	1	2	3	4	5	(06)
❑	A firm receiving 10% of any saving generated during the design and construction phase could most likely produce more economical designs	1	2	3	4	5	(07)

Q 02. **Please rate your opinion on each of the following statements**

		Agree				Disagree	
❑	Engineering objectivity can be impaired through the robust financial considerations of design	1	2	3	4	5	(08)
❑	The engineer's traditional roles are increasingly under threat from the expanding services of quantity surveying firms	1	2	3	4	5	(09)
❑	The engineer's traditional roles are increasingly under threat from alternative procurement methods (Design & Build etc.)	1	2	3	4	5	(10)
❑	The traditional design team is at risk of becoming a subordinate to the design and build contractor	1	2	3	4	5	(11)
❑	Engineers are rooted in tradition and resist new construction methods and techniques	1	2	3	4	5	(12)
❑	The role of the engineering consultant is diminishing	1	2	3	4	5	(13)
❑	Cost savings which result from contractor initiated value engineering can initially leave the client with the impression that the engineer has failed to find the most economical design solution	1	2	3	4	5	(14)

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CARD 2 of 4

Q 03. **Please rate your opinion on each of the following statements**

	Agree				Disagree	
❑ Competitive fee tendering for engineering services has a significant bearing on the time allocated to the consideration of alternative design options	1	2	3	4	5	(15)
❑ The competitive tendering process for selecting consulting engineers contributes overall to lower project construction costs	1	2	3	4	5	(16)
❑ Engineers are being forced to work as efficiently as possible rather than designing solutions which are as efficient as possible	1	2	3	4	5	(17)
❑ Performance specifications should focus on functional needs and be expressed in solution independent terms	1	2	3	4	5	(18)
❑ A fundamental aim of an engineering consultant is to provide client satisfaction	1	2	3	4	5	(19)
❑ The client is always right	1	2	3	4	5	(20)

Q 04. **How knowledgeable is your firm with each of the following procurement methods ?**

	Expert	Very Good	Good	Fair	Little	None	
❑ Traditional	1	2	3	4	5	6	(21)
❑ Design and Build	1	2	3	4	5	6	(22)
❑ Construction Management	1	2	3	4	5	6	(23)
❑ Management Contracting	1	2	3	4	5	6	(24)
❑ Public Private Partnership PPP	1	2	3	4	5	6	(25)

Q 05. **How do you rate your experience of the following procurement methods ?**

	Best				Worst	
❑ Traditional	1	2	3	4	5	(26)
❑ Design and Build	1	2	3	4	5	(27)
❑ Construction Management	1	2	3	4	5	(28)
❑ Management Contracting	1	2	3	4	5	(29)
❑ Public Private Partnership PPP	1	2	3	4	5	(30)

Q 06. **What level of knowledge has your firm with each of the following ?**

	Expert	Very Good	Good	Fair	Little	None	
❑ The principles of functional analysis	1	2	3	4	5	6	(31)
❑ The application/methods of functional analysis	1	2	3	4	5	6	(32)
❑ The principles of value engineering	1	2	3	4	5	6	(33)
❑ The application/methods of value engineering	1	2	3	4	5	6	(34)

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CARD 3 of 4

Q 07. Please rate in your opinion how well positioned the following stakeholders are to implement value engineering

	Best				Worst	
❑ Client	1	2	3	4	5	(35)
❑ Architect	1	2	3	4	5	(36)
❑ Quantity Surveyor	1	2	3	4	5	(37)
❑ Engineering Conslt.	1	2	3	4	5	(38)
❑ Other Specialist	1	2	3	4	5	(39)

Q 08. Does your firm provide a value engineering service ?

Yes	1	
No	2	(40)

Q 09. Does your firm hold value engineering workshops ?

Yes	1	
No	2	(41)

Q 10. Would you consider attending training on the subject of value engineering ?

Yes	1	
No	2	(42)

Q 11. Has your firm been involved in a value engineering workshop run by others ?

Yes	1	
No	2	(43)

Q 12. Do you believe value engineering can provide any real benefits ?

Yes	1	
No	2	(44)

Q 13. Does your firm believe the competitive tendering process for consulting engineers is beneficial to the client in terms of design quality ?

Yes	1	
No	2	(45)

Q 14. Does your firm employ any staff trained in the following ?

	Yes	No	
Value engineer	1	2	(46)
Quantity Surveyor	1	2	(47)
Architect	1	2	(48)
Planner	1	2	(49)
Other Specialist	1	2	(50)

Q 15. Value engineering can provide greater definition of, and a more systematic identification, of client requirements than traditional briefing methods
(Select one only)

Agree	1	
	2	
	3	
	4	
Disagree	5	(51)

Q 16. Which of the following stages in your opinion, is most appropriate for the implementation of value engineering concept's ?
(Select one only)

Client / conceptual	1	
Briefing stage	2	
Preliminary design	3	
Design stage	4	
Construction	5	
Don't know	6	(52)

Q 17. Do you agree with the selection of consulting engineers by the competitive tendering process ?

Yes	1	
No	2	(53)

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CARD 4 of 4

Q 18. **Should the civil/structural engineering syllabus contain a value engineering module ?**

Yes	1	
No	2	(54)

Q 19. **Have of your staff received specific training in briefing methods and procedures ?**

Yes	1	
No	2	(55)

Q 20. **Does your firm have a partnering arrangement with any of the following ?**

	Yes	No	
Value engineer	1	2	(56)
Quantity Surveyor	1	2	(57)
Architect	1	2	(58)
Planner	1	2	(59)
Other Specialist	1	2	(60)

Q 21. **Has your firm ever made a representation to a professional body, on the issue of, *the selection of consulting engineers through the process of competitive tendering ?***

Yes	1	
No	2	(61)

Q 22. **Considering your own projects**

How likely would you consider it to be that another competent firm of consulting engineers could –

upon payment of a fee of 0.1% to 0.3% of the total project cost

Review and identify total cost savings of 3% to 5% ?

likely	1	
	2	
	3	
	4	
Unlikely	5	(62)

Q 23. **General details of the respondent requested in order to *qualify* the results**

☐ Position held	**Managing Director**	**Director**	**Associate Director**	**Senior Engineer**	**Other**	
	1	2	3	4	5	(63)
☐ Time in firm	**0-5 Years**	**5-10 Years**	**10-15 Years**	**15-20 Years**	**20+ Years**	
	1	2	3	4	5	(64)
☐ Years Qualified	**0-5 Years**	**5-10 Years**	**10-15 Years**	**15-20 Years**	**20+ Years**	
	1	2	3	4	5	(65)

his questionnaire is being used as a source of primary data for an MSc dissertation entitled "Value Engineering - An Opportunity for Consulting Engineers to Redefine Their Role"

Thank you for taking the time to fill out the survey, if you wish I will send you a copy of the final work,

Email Address for copy of survey results:

Once completed please return in the reply paid envelope to:

Peter K O'Farrell C/O (R. Smyth)
Department of Construction and Civil Engineering
School of Engineering
Waterford Institute of Technology
Cork Road, Waterford.

I would like to assure you that all the information collected will be kept in the strictest confidence, and used for research purposes only. It will not be possible to identify or infer the response of any particular individual, firm, or company address in/from the results.

Peter K O'Farrell (*peterkofarrell@gmail.com*)

Reference: Watson, G. (2005) 'Putting Value Back into Engineering', ASQ World Conference on Quality and Improvement Proceedings, pp.163-174
Elias, S. (1998) 'Value Engineering: A Powerful Productivity Tool', Computers and Industrial Engineering, Vol. 35, No's 3-4, pp. 381-393

10 APPENDIX B (SAMPLE COVER LETTER)

Serial No	04110900S

VALUE ENGINEERING:

AN OPPORTUNITY FOR CONSULTING ENGINEERS TO REDEFINE THEIR ROLE

Name Surname
Company Associates,
Consulting Engineers,
Address One,
Address Two,
City.

5th FEBURARY 2010

Dear Sir,

I wish to thank your firm for agreeing to participate in this research study.

In conjunction with the Waterford Institute of Technology, this research is being undertaken to explore the subject of value engineering and its particular significance to the Consulting Engineer.

The sampling frame selected for the survey is the current directory of ACEI registered member companies dated 2009 (restricted to the head office of each firm).

With the attached questionnaire being a source primary data, a high participation will inevitably lead to a more significant result. There are just twenty three questions and your firms input would be valuable, appreciated and lead to a more complete and worthwhile study.

A copy of the research will be made available free on request to all participating firms.

Your response will be treated in confidence. Data will be presented in such a way, that it will not be possible to identify or infer, the identity of participating firms in the results.

For your convenience, we have included a reply paid envelope to return the questionnaire.

Yours sincerely….

Peter K O'Farrell C/O (R. Smyth)
Department of Construction and Civil Engineering
School of Engineering
Waterford Institute of Technology
Cork Road, Waterford.

10 APPENDIX C

10.3 QUESTIONNAIRE RESULTS

No	Dublin	Q1 01	Q1 02	Q1 03	Q1 04	Q1 05	Q1 06	Q1 07	Q2 08	Q2 09
1	TRUE	4	5	2	4	4	3	2	2	4
2	FALSE	4	5	2	4	4	3	2	3	2
3	TRUE	4	2	2	3	3	2	2	3	4
4	TRUE	3	3	1	1	4	1	1	1	1
5	FALSE	5	1	2	2	2	1	3	2	1
6	FALSE	3	2	2	3	4	3	4	4	4
7	FALSE	3	5	3	2	3	1	5	2	2
8	TRUE	2	1	2	3	4	1	1	5	3
9	FALSE	5	2	4	3	4	2	1	5	2
10	FALSE	2	4	1	4	2	2	2	4	5
11	TRUE	3	5	1	5	5	1	3	5	5
12	FALSE	3	4	4	2	2	2	1	1	2
13	FALSE	3	5	1	1	1	1	1	1	1
14	TRUE	5	5	3	2	2	4	3	4	1
15	FALSE	4	5	1	1	5	1	3	1	1
16	FALSE	3	2	4	4	4	3	2	1	3
17	FALSE	4	3	4	2	3	3	1	2	2
18	TRUE	3	4	3	2	2	2	1	1	2
19	TRUE	2	3	3	1	3	2	2	3	1
20	TRUE	3	3	2	2	3	1	1	2	2
21	FALSE	2	5	3	3	4	1	2	4	2
22	TRUE	3	4	2	4	4	3	2	5	4
23	FALSE	3	2	3	3	2	2	3	3	2
24	FALSE	3	5	2	2	4	2	2	1	2
25	TRUE	4	2	4	4	4	2	4	3	4
26	FALSE	3	4	4	4	4	3	5	1	3
27	TRUE	3	4	1	2	4	4	1	2	4
28	TRUE	2	3	1	5	4	2	1	5	4
29	TRUE	4	4	2	1	3	1	3	2	1
30	FALSE	4	2	2	1	4	1	3	3	1
31	FALSE	3	4	4	3	3	4	1	2	2
32	FALSE	3	1	3	1	5	1	2	2	4
33	FALSE	3	2	2	3	4	2	2	2	2
1		0	3	7	7	1	12	11	8	8
2	14 T	5	8	12	9	6	11	11	10	12
3	19 F	17	5	7	8	7	7	7	6	3
4		8	8	7	7	16	3	2	4	8
5		3	9	0	2	3	0	2	5	2
6										
Total		33	33	33	33	33	33	33	33	33

No	Q2 10	Q2 11	Q2 12	Q2 13	Q2 14	Q3 15	Q3 16	Q3 17	Q3 18	Q3 19
1	2	2	4	4	2	2	5	1	2	1
2	1	1	4	2	2	2	5	1	2	1
3	2	2	4	4	3	1	5	1	3	2
4	1	1	5	5	1	1	5	1	5	5
5	2	2	5	3	2	1	5	1	1	3
6	2	2	3	5	4	2	5	4	2	2
7	2	2	5	2	3	2	4	2	1	3
8	2	4	5	4	2	2	4	2	2	1
9	1	3	2	1	1	1	5	1	2	1
10	1	1	4	5	4	1	5	1	3	2
11	5	5	5	5	3	3	3	3	3	3
12	4	4	3	3	1	1	5	1	2	2
13	1	1	1	1	2	1	5	1	1	1
14	3	4	2	2	4	4	4	4	2	4
15	2	1	2	2	1	1	5	1	1	1
16	3	4	2	4	2	1	4	2	2	2
17	2	2	1	2	2	4	5	2	3	1
18	2	2	5	2	3	1	5	1	2	1
19	2	2	3	1	4	1	5	1	3	1
20	4	4	4	4	2	2	5	3	3	1
21	3	3	5	4	4	2	5	3	1	1
22	5	5	5	5	2	2	4	2	5	3
23	3	2	3	3	3	1	1	2	2	2
24	2	2	4	3	2	1	4	2	4	2
25	2	2	4	3	2	1	5	1	3	1
26	2	3	5	5	4	2	5	1	2	1
27	2	1	4	2	1	1	3	1	1	1
28	3	1	5	3	2	1	5	1	1	1
29	1	2	5	4	1	2	4	1	1	1
30	2	1	3	2	2	1	5	2	1	1
31	2	3	2	4	2	1	5	1	1	1
32	4	5	5	5	2	1	1	2	2	1
33	1	3	5	3	2	2	4	1	1	1
1	7	8	2	3	6	19	2	19	11	20
2	16	12	5	8	16	11	2	9	12	7
3	5	5	5	7	5	1	0	3	7	4
4	3	5	8	8	6	2	8	2	1	1
5	2	3	13	7	0	0	21	0	2	1
6										
Total	33	33	33	33	33	33	33	33	33	33

No	Q3 20	Q4 21	Q4 22	Q4 23	Q4 24	Q4 25	Q5 26	Q5 27	Q5 28	Q5 29
1	2	1	1	3	5	1	1	1	3	4
2	5	2	3	2	4	6	2	4	3	3
3	4	2	2	2	2	2	2	3	3	3
4	5	1	1	1	2	2	1	1	1	2
5	3	2	2	2	2	4	3	3	3	3
6	2	2	3	4	6	6	2	2	3	3
7	5	1	3	2	6	6	1	3	1	5
8	3	2	3	4	4	3	1	2	3	4
9	3	2	3	4	5	4	2	1	3	4
10	5	1	1	6	5	4	1	1	2	5
11	5	1	1	5	5	1	1	1	4	4
12	5	2	6	2	6	6	2	5	2	5
13	1	1	2	3	3	6	1	2	3	4
14	2	1	3	3	5	5	1	3	3	5
15	3	1	2	3	4	4	1	1	3	4
16	2	2	3	3	4	5	2	2	3	4
17	4	3	6	6	6	6	1	3	3	3
18	4	2	3	3	4	4	1	3	5	4
19	2	2	5	3	3	6	2	4	3	3
20	2	1	1	4	4	5	1	2	3	3
21	5	1	1	2	5	5	1	2	3	3
22	4	1	1	4	4	2	2	2	3	3
23	5	2	4	4	3	2	1	2	3	4
24	5	2	5	3	5	5	1	3	2	4
25	3	2	4	4	5	6	2	4	3	3
26	5	1	2	4	5	3	1	2	4	4
27	5	2	1	5	6	4	2	1	3	3
28	4	1	1	4	5	1	1	2	3	3
29	5	1	2	5	5	3	1	2	5	4
30	2	2	3	3	4	3	1	2	4	5
31	4	2	5	3	6	5	1	2	3	5
32	2	1	2	3	3	5	1	2	3	3
33	3	1	2	4	4	2	1	3	4	4
1	1	16	9	1	0	3	22	7	2	0
2	8	16	8	6	3	5	10	14	3	1
3	6	1	9	11	4	4	1	8	22	13
4	6	0	2	10	9	6	0	3	4	13
5	12	0	3	3	11	7	0	1	2	6
6			2	2	6	8				
Total	33	33	33	33	33	33	33	33	33	33

No	Q5 30	Q6 31	Q6 32	Q6 33	Q6 34	Q7 35	Q7 36	Q7 37	Q7 38	Q7 39
1	1	5	5	2	2	3	2	3	2	3
2	2	4	3	3	2	4	4	2	2	4
3	2	2	2	2	2	2	2	2	2	2
4	2	5	5	1	1	3	3	3	3	3
5	3	2	2	2	2	3	2	3	1	3
6	3	6	6	2	3	2	2	2	2	2
7	5	2	3	2	2	4	3	2	1	2
8	3	4	4	2	2	3	2	1	1	3
9	5	2	3	2	2	1	2	3	4	5
10	5	5	5	3	4	3	2	3	2	3
11	1	1	1	1	1	1	1	5	1	1
12	5	6	6	2	2	2	4	1	2	2
13	5	4	4	2	2	4	2	3	1	5
14	5	5	5	3	3	3	2	2	1	3
15	5	5	5	3	3	2	2	2	4	5
16	4	6	6	2	2	2	2	2	2	1
17	3	6	6	6	6	3	3	3	3	3
18	2	4	4	2	3	3	2	2	2	5
19	5	4	4	3	3	4	2	2	2	3
20	5	5	5	1	1	2	3	2	1	3
21	3	1	1	1	1	3	2	3	1	3
22	2	4	4	2	2	4	4	2	2	3
23	5	3	2	2	3	3	2	1	2	3
24	5	6	6	5	5	5	4	3	1	2
25	3	3	3	3	3	5	3	4	2	1
26	3	3	3	2	2	2	2	2	2	2
27	4	2	2	2	2	4	2	3	2	3
28	3	3	3	3	3	4	3	2	2	2
29	3	3	3	3	3	3	2	4	1	5
30	3	3	4	4	4	1	2	4	3	5
31	5	6	6	4	4	4	2	3	2	4
32	5	5	5	3	3	3	1	1	1	3
33	2	6	6	5	6	5	3	2	1	4
1	2	2	2	4	4	3	2	4	12	3
2	6	5	4	15	13	7	20	14	16	7
3	10	6	7	9	10	12	7	11	3	14
4	2	6	6	2	3	8	4	3	2	3
5	13	7	7	2	1	3	0	1	0	6
6		7	7	1	2					
Total	33	33	33	33	33	33	33	33	33	33

No	Q8 40	Q9 41	Q10 42	Q11 43	Q12 44	Q13 45	Q14 46	Q14 47	Q14 48	Q14 49
1	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE
2	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
3	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE	TRUE
4	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
5	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE
6	FALSE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
7	TRUE	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	TRUE
8	TRUE	TRUE	FALSE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE
9	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
10	FALSE	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
11	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE
12	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE
13	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
14	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE
15	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE
16	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
17	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
18	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
19	FALSE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
20	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
21	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
22	TRUE	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE
23	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE	FALSE	FALSE	FALSE	TRUE
24	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
25	FALSE	FALSE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
26	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
27	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE	TRUE
28	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE
29	TRUE	TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
30	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
31	TRUE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
32	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
33	FALSE	FALSE	TRUE	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
1										
2	24 T	14 T	27 T	13 T	32 T	3 T	5 T	7 T	4 T	4 T
3	9 F	19 F	6 F	20 F	1 F	30 F	28 F	26 F	29 F	29 F
4										
5										
6										
Total										

No	Q14 50	Q15 51	Q16 52	Q17 53	Q18 54	Q19 55	Q20 56	Q20 57	Q20 58	Q20 59
1	FALSE	2	3	2	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
2	FALSE	1	3	1	TRUE	FALSE	FALSE	FALSE	TRUE	FALSE
3	TRUE	2	3	2	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
4	FALSE	1	3	2	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
5	FALSE	1	3	2	TRUE	TRUE	FALSE	TRUE	TRUE	FALSE
6	FALSE	4	3	1	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
7	TRUE	2	3	2	TRUE	TRUE	FALSE	TRUE	FALSE	TRUE
8	FALSE	2	3	2	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE
9	FALSE	2	3	2	TRUE	TRUE	FALSE	FALSE	TRUE	FALSE
10	TRUE	3	3	1	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
11	TRUE	1	3	1	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE
12	TRUE	2	3	2	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE
13	FALSE	1	4	2	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
14	TRUE	2	3	1	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE
15	TRUE	4	4	1	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
16	FALSE	4	4	1	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
17	FALSE	3	3	2	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
18	FALSE	3	3	2	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
19	FALSE	3	4	2	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
20	TRUE	3	4	2	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE
21	FALSE	1	4	2	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
22	FALSE	4	3	2	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE
23	TRUE	1	1	1	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
24	TRUE	3	3	2	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
25	FALSE	2	3	2	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
26	TRUE	4	2	2	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE
27	TRUE	1	3	2	TRUE	TRUE	FALSE	TRUE	TRUE	TRUE
28	TRUE	3	3	1	TRUE	FALSE	FALSE	TRUE	TRUE	TRUE
29	FALSE	2	3	1	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
30	TRUE	3	2	2	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
31	TRUE	3	1	2	TRUE	FALSE	FALSE	TRUE	TRUE	FALSE
32	TRUE	1	3	2	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
33	TRUE	3	4	2	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
1		9	2							
2	17 T	9	2	Y 10	32 T	8 T	1 T	10 T	10 T	6 T
3	16 F	10	22	N 23	1 F	25 F	32 F	23 F	23 F	27 F
4		5	7							
5		0	0							
6										
Total		33	33							

No	Q20 60	Q21 61	Q22 62	Q23 63	Q23 64	Q23 65	Sought copy
1	FALSE	TRUE	1	2	5	5	TRUE
2	FALSE	TRUE	2	1	2	5	TRUE
3	TRUE	FALSE	4	1	3	4	FALSE
4	FALSE	TRUE	2	1	5	5	TRUE
5	TRUE	FALSE	1	1	5	5	TRUE
6	FALSE	FALSE	4	1	5	5	TRUE
7	TRUE	TRUE	4	1	5	5	TRUE
8	TRUE	FALSE	2	2	2	3	TRUE
9	TRUE	TRUE	1	4	2	2	TRUE
10	FALSE	FALSE	1	3	4	5	TRUE
11	TRUE	TRUE	4	2	2	5	FALSE
12	TRUE	FALSE	3	1	3	5	FALSE
13	FALSE	TRUE	5	1	5	5	TRUE
14	TRUE	FALSE	3	2	4	5	TRUE
15	FALSE	TRUE	2	1	4	5	TRUE
16	FALSE	FALSE	3	1	5	5	TRUE
17	FALSE	FALSE	1	1	3	5	TRUE
18	FALSE	FALSE	2	1	5	5	TRUE
19	FALSE	TRUE	4	1	5	5	TRUE
20	TRUE	FALSE	1	1	5	5	TRUE
21	FALSE	FALSE	5	1	3	5	FALSE
22	TRUE	TRUE	1	3	2	2	TRUE
23	FALSE	TRUE	3	2	3	3	TRUE
24	FALSE	TRUE	2	1	5	5	TRUE
25	FALSE	FALSE	4	1	1	5	TRUE
26	TRUE	TRUE	5	3	1	3	TRUE
27	TRUE	FALSE	3	3	2	2	TRUE
28	TRUE	TRUE	2	2	4	4	TRUE
29	FALSE	TRUE	2	2	4	5	TRUE
30	FALSE	FALSE	4	1	5	5	TRUE
31	TRUE	FALSE	3	2	5	5	TRUE
32	FALSE	FALSE	3	3	2	3	TRUE
33	TRUE	FALSE	3	3	3	4	TRUE
1			7	18	2	0	
2	15 T	15 T	8	8	7	3	29 T
3	18 F	18 F	8	6	6	4	4 F
4			7	1	5	3	
5			3	0	13	23	
6							
Total			33	33	33	33	

Variable 1						Variable 2						Variable 3						Variable 4						Variable 5					
R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D
1	0	0				1	3	9.09				1	7	21.2				1	7	21.2				1	1	3.03			
2	5	15.2				2	8	24.2				2	12	36.4				2	9	27.3				2	6	18.2			
3	17	51.5				3	5	15.2				3	7	21.2				3	8	24.2				3	7	21.2			
4	8	24.2				4	8	24.2				4	7	21.2				4	7	21.2				4	16	48.5			
5	3	9.1				5	9	27.3				5	0	0.0				5	2	6.1				5	3	9.1			
∑	33		15.2	51.5	33.3	∑	33		33.3	15.2	51.5	∑	33		57.6	21.2	21.2	∑	33		48.5	24.2	27.3	∑	33		21.2	21.2	57.6

Variable 6						Variable 7						Variable 8						Variable 9						Variable 10					
R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D
1	12	36.4				1	11	33.3				1	8	24.2				1	8	24.2				1	7	21.2			
2	11	33.3				2	11	33.3				2	10	30.3				2	12	36.4				2	16	48.5			
3	7	21.2				3	7	21.2				3	6	18.2				3	3	9.1				3	5	15.2			
4	3	9.1				4	2	6.1				4	4	12.1				4	8	24.2				4	3	9.1			
5	0	0.0				5	2	6.1				5	5	15.2				5	2	6.1				5	2	6.1			
∑	33		69.7	21.2	9.1	∑	33		66.7	21.2	12.1	∑	33		54.5	18.2	27.3	∑	33		60.6	9.1	30.3	∑	33		69.7	15.2	15.2

Variable 11						Variable 12						Variable 13						Variable 14						Variable 15					
R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D
1	8	24.2				1	2	6.06				1	3	9.09				1	6	18.2				1	19	57.6			
2	12	36.4				2	5	15.2				2	8	24.2				2	16	48.5				2	11	33.3			
3	5	15.2				3	5	15.2				3	7	21.2				3	5	15.2				3	1	3.0			
4	5	15.2				4	8	24.2				4	8	24.2				4	6	18.2				4	2	6.1			
5	3	9.1				5	13	39.4				5	7	21.2				5	0	0.0				5	0	0.0			
∑	33		60.6	15.2	24.2	∑	33		21.2	15.2	63.6	∑	33		33.3	21.2	45.5	∑	33		66.7	15.2	18.2	∑	33		90.9	3.0	6.1

Variable 16						Variable 17						Variable 18						Variable 19						Variable 20					
R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D
1	2	6.06				1	19	57.6				1	11	33.3				1	20	60.6				1	1	3.03			
2	2	6.1				2	9	27.3				2	12	36.4				2	7	21.2				2	8	24.2			
3	0	0.0				3	3	9.1				3	7	21.2				3	4	12.1				3	6	18.2			
4	8	24.2				4	2	6.1				4	1	3.0				4	1	3.0				4	6	18.2			
5	21	63.6				5	0	0.0				5	2	6.1				5	1	3.0				5	12	36.4			
∑	33		12.1	0.0	87.9	∑	33		84.8	9.1	6.1	∑	33		69.7	21.2	9.1	∑	33		81.8	12.1	6.1	∑	33		27.3	18.2	54.5

Variable 21						Variable 22						Variable 23						Variable 24						Variable 25					
R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D
1	16	48.5				1	9	27.3				1	1	3.03				1	0	0				1	3	9.09			
2	16	48.5				2	8	24.2				2	6	18.2				2	3	9.1				2	5	15.2			
3	1	3.0				3	9	27.3				3	11	33.3				3	4	12.1				3	4	12.1			
4	0	0.0				4	2	6.1				4	10	30.3				4	9	27.3				4	6	18.2			
5	0	0.0				5	3	9.1				5	3	9.1				5	11	33.3				5	7	21.2			
6						6	2	6.1				6	2	6.1				6	6	18.2				6	8	24.2			
∑	33		97.0	N/A	0.0	∑	33		78.8	N/A	21.2	∑	33		54.5	N/A	45.5	∑	33		21.2	N/A	78.8	∑	33		36.4	N/A	63.6

Variable 26						Variable 27						Variable 28						Variable 29						Variable 30					
R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D
1	22	66.7				1	7	21.2				1	2	6.06				1	0	0				1	2	6.06			
2	10	30.3				2	14	42.4				2	3	9.1				2	1	3.0				2	6	18.2			
3	1	3.0				3	8	24.2				3	22	66.7				3	13	39.4				3	10	30.3			
4	0	0.0				4	3	9.1				4	4	12.1				4	13	39.4				4	2	6.1			
5	0	0.0				5	1	3.0				5	2	6.1				5	6	18.2				5	13	39.4			
∑	33		97.0	3.0	0.0	∑	33		63.6	24.2	12.1	∑	33		15.2	66.7	18.2	∑	33		3.0	39.4	57.6	∑	33		24.2	30.3	45.5

Variable 31						Variable 32						Variable 33						Variable 34						Variable 35					
R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D
1	2	6.06				1	2	6.06				1	4	12.1				1	4	12.1				1	3	9.09			
2	5	15.2				2	4	12.1				2	15	45.5				2	13	39.4				2	7	21.2			
3	6	18.2				3	7	21.2				3	9	27.3				3	10	30.3				3	12	36.4			
4	6	18.2				4	6	18.2				4	2	6.1				4	3	9.1				4	8	24.2			
5	7	21.2				5	7	21.2				5	2	6.1				5	1	3.0				5	3	9.1			
6	7	21.2				6	7	21.2				6	1	3.0				6	2	6.1									
∑	33		39.4	N/A	60.6	∑	33		39.4	N/A	60.6	∑	33		84.8	N/A	15.2	∑	33		81.8	N/A	18.2	∑	33		30.3	36.4	33.3

Variable 36						Variable 37						Variable 38						Variable 39					
R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D	R	∑	%	% A	% U	% D
1	2	6.06				1	4	12.1				1	12	36.4				1	3	9.09			
2	20	60.6				2	14	42.4				2	16	48.5				2	7	21.2			
3	7	21.2				3	11	33.3				3	3	9.1				3	14	42.4			
4	4	12.1				4	3	9.1				4	2	6.1				4	3	9.1			
5	0	0.0				5	1	3.0				5	0	0.0				5	6	18.2			
∑	33		66.7	21.2	12.1	∑	33		54.5	33.3	12.1	∑	33		84.8	9.1	6.1	∑	33		30.3	42.4	27.3

Variable 40			
R	∑	% A	% D
1	24	72.7	
2	9		27.3
∑	33		

Variable 41			
R	∑	% A	% D
1	14	42.4	
2	19		57.6
∑	33		

Variable 42			
R	∑	% A	% D
1	27	81.8	
2	6		18.2
∑	33		

Variable 43			
R	∑	% A	% D
1	13	39.4	
2	20		60.6
∑	33		

Variable 44			
R	∑	% A	% D
1	32	97	
2	1		3.03
∑	33		

Variable 45			
R	∑	% A	% D
1	3	9.09	
2	30		90.9
∑	33		

Variable 46			
R	∑	% A	% D
1	5	15.2	
2	28		84.8
∑	33		

Variable 47			
R	∑	% A	% D
1	7	21.2	
2	26		78.8
∑	33		

Variable 48			
R	∑	% A	% D
1	4	12.1	
2	29		87.9
∑	33		

Variable 49			
R	∑	% A	% D
1	4	12.1	
2	29		87.9
∑	33		

Variable 50			
R	∑	% A	% D
1	17	51.5	
2	16		48.5
∑	33		

Variable 51					
R	∑	%	% A	% U	% D
1	9	27.3			
2	9	27.3			
3	10	30.3			
4	5	15.2			
5	0	0.0			
∑	33		54.5	30.3	15.2

Variable 52					
R	∑	%	% A	% U	% D
1	2	6.06			
2	2	6.1			
3	22	66.7			
4	7	21.2			
5	0	0.0			
∑	33		78.8	N/A	21.2

Variable 53			
R	∑	% A	% D
1	10	30.3	
2	23		69.7
∑	33		

Variable 54			
R	∑	% A	% D
1	32	97	
2	1		3.03
∑	33		

Variable 55			
R	∑	% A	% D
1	8	24.2	
2	25		75.8
∑	33		

Variable 56			
R	∑	% A	% D
1	1	3.03	
2	32		97
∑	33		

Variable 57			
R	∑	% A	% D
1	10	30.3	
2	23		69.7
∑	33		

Variable 58			
R	∑	% A	% D
1	10	30.3	
2	23		69.7
∑	33		

Variable 59			
R	∑	% A	% D
1	6	18.2	
2	27		81.8
∑	33		

Variable 60			
R	∑	% A	% D
1	15	45.5	
2	18		54.5
∑	33		

Variable 61			
R	∑	% A	% D
1	15	45.5	
2	18		54.5
∑	33		

Variable 62					
R	∑	%	% A	% U	% D
1	7	21.2			
2	8	24.2			
3	8	24.2			
4	7	21.2			
5	3	9.1			
		0.0			
∑	33		45.5	24.2	30.3

Variable 63			Variable 64			Variable 65		
R	∑	%	R	∑	%	R	∑	%
1	18	54.5	1	2	6.06	1	0	0
2	8	24.2	2	7	21.2	2	3	9.1
3	6	18.2	3	6	18.2	3	4	12.1
4	1	3.0	4	5	15.2	4	3	9.1
5	0	0.0	5	13	39.4	5	23	69.7
		0.0			0.0			0.0
∑	33		∑	33		∑	33	

R	Likert Rating
∑	Sum of Results
%	Percentage
% A	Percentage Agree
% D	Percentage Disagree

∑	33	Dublin ?	∑	14	42.4	%T	∑	19	57.6	%F

∑	33	E-mail ?	∑	29	87.9	%T	∑	4	12.1	%F

10 APPENDIX D

10.4 UNSTRUCTURED INTERVIEW GUIDING TOPICS

1. What do you know about VE …First thoughts?
2. Have you been involved with it … Who requested it?
3. When is VE typically applied… Before pen to paper…After design complete…During const… When out of money?
4. When is VE best applied?
5. What is involved in VE… Is it cost cutting….Alternatives… What's Functional analysis?
6. Is it legislated for?
7. Have you ever included VE clauses in contracts?
8. Have you assessed VE proposal's?
9. Have the VE proposals caused the contractor to be chosen over others?
10. A college may to need increase teaching capacity by 50%, does the building need to increase by 50% could the schedules be changed to utilise the existing space better?
11. Is a built-solution always required?
12. Would you propose other than a build solution for customer satisfaction and future business?
13. Do clients and engineers speak different languages – is a business objective/solution the same as a built solution?
14. Would you consider offering a briefing service separate to a design services to enable clients to determine their requirements?
15. If you & team, (QS, Arch, M&E, and builder) had the opportunity to review the design package of another project, would you be able produce a more economical design?
16. Is there an opening for the provision of a VE service only (perhaps on someone else's design)?
17. Do you know of anyone doing this…is there an opportunity?
18. While clients may get what they asked for are the satisfied that the outcome meets their needs?

10.5 GLOSSARY

AutoCAD	Computer aided design and drafting software application from Autodesk Inc.
Charette	An intense period of collaborative design activity.
Client Requirement Processing	(CRP) involves the presentation of the client's requirements in a format that enhances an understanding of the clients' needs and desires. (Kamara et al. 2000a)
Expert Choice	An analytic hierarchy process with qualitative consideration ranking. (Smith et al. 1998)
Function Analysis System Technique	*Classical FAST Model:* A function displaying the interrelationship of functions to each other in "how-why" logic that was developed by Charles Bytheway. (Save, 2007)
Function Analysis	The process of defining, classifying and evaluating functions. (Save, 2007, pp28-31)
Job Plan	A sequential approach for conducting a value study, consisting of steps or phases used to manage the focus of a team's thinking so that they innovate collectively rather than as uncoordinated individuals. (Save, 2007, pp28-31)
Quality Function Deployment	Quality Function Deployment is a method to transform user demands into design quality, to deploy the functions forming quality, and to deploy methods for achieving the design quality into subsystems and component parts, and ultimately to specific elements of the manufacturing process (Akao, Yoji)
SMART methodology	A value management framework basis for design decision making developed to link value management and value engineering methodologies. (Smith et al. (1998))
Strategising	Neural network techniques as a basis to choose between alternatives. (Smith et al. 1998)
Theory of Inventive Problem Solving	A methodology/systematic tool developed by Soviet Union researchers for the generation of innovative ideas and solutions that go beyond traditional brainstorming technique of value engineering. (Zhang et al. 2009)
Total Quality Management	Total Quality Management is a management concept The basis of which is to reduce the errors produced during the manufacturing or service process, increase customer satisfaction, streamline supply chain management, aim for modernization of equipment and ensure workers have the highest level of training. (W. Edwards Deming)
Value Analysis	The application of value methodology to an existing project, produce or service to achieve value improvement. (Save, 2007)
Value engineering	The application of a value methodology to a planned or conceptual project/service to achieve value improvement. (Save, 2007)
Value Management	The application of value methodology by an organization to achieve strategic value improvement. (Save, 2007, pp28-31)
Value Methodology	A systematic process used by a multidisciplinary team to improve the value of projects through the analysis of functions. See Value Engineering, Value Analysis and Value Management. (Save, 2007, pp 28-31)