UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

ASSESSING THE FEASIBILITY OF IMPLEMENTING VALUE ENGINEERING IN THE GHANAIAN CONSTRUCTION INDUSTRY

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A Dissertation in the Department of CONSTRUCTION AND WOOD TECHNOLOGY EDUCATION, Faculty of TECHNICAL EDUCATION, submitted to the School of Graduate Studies, University of Education, Winneba, in partial fulfillment of the requirements for the award of the Master of Philosophy (Construction Technology) degree

OCTOBER, 2017

DECLARATION

STUDENT'S DECLARATION

I, OSEI KWADWO RICHARD, declare that this Dissertation, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree in this University or elsewhere.

SIGNATURE:………………………..

DATE …………………………. …….

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of Dissertation as laid down by the University of Education, Winneba.

NAME: DR. HUMPHREY DANSO

SIGNATURE …………………………….

DATE …………………………………..

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DEDICATION

I wish to dedicate this work to the Lord Almighty for His strength and wisdom and also to the entire Tabi's family.

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ABSTRACT

The cost involved in undertaking a construction project nowadays comes uneasy particularly with monetary value of materials and processes associated. This call indeed requires a cost management technique to effectively reduce the cost of such projects whiles maintaining its function and quality. The study in this direction assessed the feasibility of implementing value engineering, a cost management technique in the Ghanaian construction industry to redress this need. Giving more drive to the study, emphasis was laid on the following objectives which formed the core component of this study; assessing the level of understanding of value engineering among construction practitioners in the Ghanaian construction industry, examining reasons for its non-adoption, identifying factors that influence its implementation as well as developing a FAST model for its implementation in the Ghanaian construction industry. Employing a cross sectional survey in its design from a population of architects, civil/structural engineers, project managers, quantity surveyors and contractors, 92 participants were drawn from architects (24), civil/structural engineers (13), project managers (20), quantity surveyors (21) and contractors (14) through questionnaires via electronic and self-administration in the towns of Accra, Kumasi and Sunyani respectively. Microsoft Excel and Statistical Package for Social Sciences (SPSS) Version 20 were used in analyzing the data. The resultant outcome from the analysis indicated that practitioners in the construction industry clearly understood the meaning of value engineering as not Cost cutting, Design review, Reduction of quantities, Reduction of quantities and Use of cheap labour. Conversely, quality control and renewal of old ideas rather were given as the meaning of value engineering in terms of their level of understanding. The findings again pointed to five factors as the reasons for non-adoption of value engineering in the Ghanaian construction industry. These were Knowledge barrier, Demand barrier, Awareness barrier, Readiness barrier and Human resource barrier. Regarding the factors that encouraged the implementation of value engineering, the findings showed that five factors surfaced as the key areas among the other related factors which were, reduced wastage of resources, Quality improvements, creating new ideas for improved outcomes, reduced conflict and risks and efficient labour. Subjecting these same factors to factor analysis, four factors were revealed towards implementing value engineering in the construction industry. They were Project satisfaction factor, Conceptual factor, Client satisfaction and Cooperation factor which in turn were used to develop a FAST Model. Convincingly, the turn out of the findings for the study concluded that value engineering stands feasible to be implemented in the Ghanaian construction industry. It is therefore recommended with a cue from this study that, experts in this field should enlighten clients and practitioners to recognize the impact and need of value engineering in improving the cost management technique in the Ghanaian construction industry.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The Ghanaian construction industry, so as in other parts of the world provides a bedrock for huge and a crucial segment in economic development (Djokoto et al., 2014). The construction industry is often seen among the top drivers of the economy especially in developing countries including that in Ghana (Kheni et al., 2008) against the backdrop of agriculture, manufacturing, mining and the government services respectively. The industry sector in the nation's economy recorded the highest Gross Domestic Product (GDP) growth of 9.1 percent with construction as the largest activity within the industry with a growth of 30.6 percent and a share of 14.8 percent of nominal GDP (Ghana Statistical Service, 2015). Construction is indeed esteemed as a key sector of the economy of every country (Jankovichová, 2010). As a key contributor to economic growth, the industry engages in operations as, employing skilled and unskilled labour; being engineers, consultants, artisans to labourers in both construction and maintenance of buildings, roads, bridges and other physical infrastructure all crucial to generate employment, development and growth (Gani & Clemes, 2002). This goes to suggest that a close relationship exist between economic growth and the construction industry (Songwe, 2014).

In respect of the progressive impact of the construction industry on the economy, developing countries of which Ghana is a part face many challenges in the industry (Ofori, 2001). According to Ofori (1993) dominant among the reasons for these problems arising from the weaknesses in the economy of these countries include, inadequate resources to devote to efforts to improve the construction industry and governments of these countries not recognizing the importance and needs of the construction industry hence not implementing programs for upgrading the industry. Regarding these challenges, the performance of the construction industry on projects in these countries is poor in most aspects including cost, quality and productivity. He stressed further that, the outcome of most construction projects undertaken in these countries fall short of the target set by the participants themselves in terms of budget (cost), schedules (time) and specification. Love and Irani (2003) equally share in the plight from the direction that, problems associated with the construction industry are the contractors and consultancy firms' inability to reduce the project cost, enhance project functions and shorten the completion time. This combined with lack of effective management skills and low education levels of employees result in cost overruns, low quality of work and delays in completion time for many construction projects. Ibironke and Ibironke (2011) pointed out to cases in Ghana where problems arising from cost and quality issues have led to suspension of major construction projects.

The Ghanaian construction industry has evolved tremendously over the years and even yielded to increased foreign direct investment particularly in the construction of hotels, shopping malls and others alike (Kissi et al., 2015). There is thus, the need for continuous action to improve and develop appropriate strategies to make the construction activities in the country more sustainable (Lyytimäki, 2012). Keen on the fact that Ghanaian contractor recognize the need to improve quality and cost effectiveness, most companies have no comprehensive quality improvement programs (Cheung & Duan, 2014). There is the need for the construction industry to therefore adapt and implement modern trends to keep in line with international practices (Kamenetskii, 2011). As a result, the use of advanced management technologies and skills is highlighted. Value is highlighted as a proven advanced management technique that would make valuable contribution to enhance value enhancement, cost reduction and quality requirements in the Ghanaian construction industry (Li et al., 2012). Value engineering attempts to examine all the components of cost of a product (either proposed or existing) in order to determine whether or not an item of cost can be reduced or eliminated, while maintaining functional or quality requirement (Tonarelli et al., 1995).

Value engineering should not be confused with the traditional cost reduction techniques (Kalluri & Kodali, 2016). Whereas value engineering establishes the precise function or functions that a particular component is required to perform, searches for alternative acceptable technical solutions, evaluates them and presents them as options, traditional cost reduction techniques focus the spot-light on the need to use less labour, materials and time (Concept of Value Engineering in Construction Industry, 2016). Value engineering has for its purpose the effective identification and elimination of unnecessary costs, i.e., cost which provide neither quality, nor use, nor life, nor appearance, nor customer features (Apurva, 2013). It is a problem-solving approach based on creative and positive thinking that is used to fulfill the required function(s) and provide the appropriate quality at the minimal cost (Prashant & Teli, 2015). Value engineering is directed towards analyzing the functions of an item or process to determine “best value”, or the best relationship between worth and cost (Randolph, 2014). It is about taking a wider view and looking at the selection of materials, plant, equipment and processes to see if a more cost-effective solution exists that will achieve the same project objective (Nie & Liu, 2014).

Typically, Value Engineering on projects can be used to gain benefits extending from achieving better value for money in satisfying the customer's need, savings in project costs by elimination of unnecessary cost, improving quality of project, saving time, better understanding of project's objectives, enhancing function of the project to improving team-work among professionals in the construction industry (Flaig, 2005). In this context, the application of value engineering in construction and its impact on the Ghanaian construction industry will be addressed.

1.2 Statement of the problem

Tagged as a key sector in growing the economy, the construction industry is tasked as a requirement to generate income as well as provide employment in this direction (Ofori & Debrah, 1998). The Ghanaian construction industry is regarded as developing in the infant stage in terms of advanced management technologies and skills (Kissi et al., 2015). To position ourselves, the Ghanaian construction industry, better in the 21st century, there is the need to relate and adapt a more advanced tool in creating a better product or improve a process (Annacchino, 2007). Thus, the practice and application of value engineering, a powerful tool that properly applied, adds to or improve the value of products, processes and facilities (Issa & Flood, 2014). Convincingly, various studies have laid bare the essence and impact tapped from the application and practice of this theory in the construction industry.

According to Thorne (1993), value engineering is an effective technique for reducing costs, increasing productivity and improving quality. Atabay and Galipogullari (2013) adds that the benefits earned from the use of value engineering on projects include cost reduction, time savings (schedule savings), quality improvement and isolation of design deficiencies. Further, Ahmed and pandey (2016) opines that, value engineering is considered as an effective tool for construction management that can help companies to improve their procedures, services and final products regarding the client's needs, as an end user, with respect to time, cost and quality. More to that Kemmochi and Koizumi (2012) raised alarming significance accrued from the practice of value engineering on projects which he identified as; identifying and removing unnecessary costs, enhancing understanding of total project, developing realistic budgets, improving decision making, encouraging cross-discipline communication and accelerating the design process. Currently, the practice of value engineering has been extensively used in many countries around the world. For example, the wider construction market (U.S.A, U.K, Japan, Canada, Australia, China, India etc.) has gained immensely in their respective economies by the application of this theory (Ahmed & Pandey, 2013).

However, as a tool in promoting innovation in the construction industry, there are barriers that stifle its smooth implementation. Studies have revealed that in order to apply value engineering in a perfect way, hindrances to its application must be appreciated (Kim et al., 2016). This thus goes to help practitioners assess the challenges in applying value engineering and undertake appropriate strategies for acceptance of the value engineering methodology. Simister and Green (1997) stated that in order to avoid failure in value engineering implementation six main factors should be considered in the certain period of time such as expectations, implementation, participation, power, lack of time and uncertainty about projects. Also, different construction designers believe that applying value engineering usually causes unnecessary costs for projects and it can increase the time of the projects as well, besides some designers have uncertainties regarding the qualifications of the value team members (Fong & Shen, 2000). Kim et al (2016), pointed out that, lack of value engineering experts, lack of knowledge about value engineering, lack of local value engineering guidelines as well as technical norms and standards and support policy and human resources to conduct value engineering in construction companies are the four main hindrance factors to the application of value engineering. Kissi et al., (2016), shared the same plight as they analysed the challenges facing the implementing of value engineering in public projects in developing countries. Dominant in their findings exposed value engineering team obstructions, value engineering study obstructions, value engineering implementation difficulties, conceptual problems and developing economies obstructions as the key challenges encountered by developing countries of which Ghana is no exception. Even Kissi et al., (2015) proposed some strategies for implementing value management in the construction industry of Ghana. In descending order of ranking, the significant strategies as they indicated were; development of a successful application model in the context of construction; clarifying clients' perceptions about VM, creation of VM workshops for construction professionals, creation local guidelines and data on VM techniques, and application of effective techniques and tools in VM.

The Ghanaian construction industry is earmarked as developing and the use of value engineering is unpopular although there is some evidence of value engineering process applications in the industry (Kissi et al., 2015). In fact, very few construction companies in Ghana applied value process to reduce costs and enhance the quality; it is applied mainly by foreign consulting firms or contractors as the Japanese and Korean firms (Dansoh, 2005). On the other hand, most owners are still very strange to the concept of value engineering (Boll & Nassar, 1993).

Carefully juxtaposing the benefits with the barriers that come with the application of value engineering in the construction industry, empirical studies have proved little of its capability to be implemented in the Ghanaian construction industry, thus, opening up a deficit in knowledge. This study seeks to explore the feasibility of implementing value engineering in the context of the Ghanaian construction industry within some selected towns. This will prepare the fertile grounds and also serve as a window of opportunity for practitioners to effectively implement this technique in the construction industry.

1.3 Purpose of Study

The purpose of the study is to investigate the feasibility of value engineering implementation in the Ghanaian construction industry.

1.4 Research Objectives

To achieve the purpose of the study, the specific objectives of the study are to;

1. To assess the level of understanding of the concept of value engineering among construction practitioners in Ghana.
2. To examine the reasons for non- adoption of value engineering in Ghanaian construction industry.

3. To identify the main factors that encourages the implementation of value engineering in the Ghanaian construction industry.
4. To adapt a Function Analysis System Technique (FAST) model for the implementation of value engineering in the Ghanaian construction industry.

1.5 Research Questions

This research sought answers to the following questions:

1. What is the level of understanding of value engineering among construction practitioners in Ghana?
2. What reasons have accounted for the non-adoption of value engineering in the Ghanaian construction industry?
3. What factors encourage the implementation of value engineering in the Ghanaian construction industry?
4. What FAST model will be adapted for the implementation of value engineering in the Ghanaian construction industry?

1.7 Significance of Study

The study seeks to have positive implications on the Ghanaian construction industry in applying the concept of value engineering. In this regard;

1. The outcome will enhance building organizations to improve construction value and quality and efficiency through the implementation of the measures suggested to eliminate potential barriers to the implementation of value engineering.

2. Minimizing construction cost and improving project performance thereby enhancing value for individual customers, and having a positive impact on the national economy as a whole.

1.8 Organisation of Study

A brief outline of the thesis is presented below. This research is divided into five (6) chapters.

- The first chapter (Chapter 1)

This chapter explained the problem statement, the purpose of the study, objectives, research questions and significance of the study.

- The second chapter (Chapter 2)

This chapter reviewed literature on the construction industry in the world, the Ghanaian construction industry, the concept of value engineering, factors that necessitate low patronage in value engineering, factors that will ensure increase in value in construction projects while reducing cost etc.

- The third chapter (Chapter 3)

This chapter explains the methodology that was used throughout the study. The structure of the questionnaire as well as the technique used in determining the sample sizes explained. The methods used to analyze the data are also explained.

- Chapter four (4) makes analysis and presentation of data.
- Chapter five (5) presents discussions on the data analysed.
- Chapter five (6) which is the last chapter concludes the overall research and suggests recommendations for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Since the inception of value engineering concepts as far back as the 1940s by Mr. Lawrence D. Miles, it has become a standard practice for many government agencies and private engineering firms and contractors (Miles, 1972). Value engineering has been widely practiced in the construction industry and become an integral part in the development of many civil infrastructure projects. According to Hayles and Simister (2000), value engineering is defined as proactive, creative, team approach to problem-solving in construction projects to provide the best value for money'. This chapter reviews literature on the global construction industry, the Ghanaian construction industry, overview of value engineering as well as various concepts associated with value engineering.

2.2 The Global Construction Industry

The construction industry includes all companies primarily engaged in construction such as general contractors, heavy construction (airports, highways, and utility systems), and construction by specialist trades. Also included are companies that engage in the preparation of sites for new construction and in subdividing land for building sites. Construction work may include new work, additions, alterations, or maintenance and repairs. Construction work is often described by either type, residential (home building) or non-residential (commercial and government buildings and infrastructure projects), or by funding source, public or private (Jankovichová, 2010).

The construction sector represents, for many countries, a core economic activity. It not only provides the infrastructure for all other industries, but also constitutes one of the largest single sectors in the economy on its own. Closely linked with public works, governments have relied on the construction sector as a strategically important industry for creating employment and sustaining growth. For the developing economies, the construction sector carries particular importance because of its link to the development of basic infrastructure, training of local personnel, transfer of technologies, and improved access to information channels (Patibandla, 2012). Construction services, in a large number of countries, are primarily supplied through the establishment of service suppliers at or near the site for the work by local or regional operators. On-site establishment is normally confined to the duration of the particular project, while regional or local presence may be ensured on a permanent basis to service or promote several projects. Joint ventures between foreign and domestic firms are quite common - often out of necessity for financing of projects; transfers of technology and know-how; and assistance in meeting local laws, regulations, and practices (Patibandla, 2012). In many countries, construction services may be carried out by general contractors who complete all the work for the proprietor of the project, or by specialized sub-contractors who undertake parts of the work. Analysis by the World Trade Organization Secretariat indicates that most countries have a small number of large firms, a moderate number of medium-sized firms, and a large number of small firms who specialize in certain fields or who operate in small geographical areas (Patibandla, 2012). *The International Supply of Construction Services*

The global construction industry is the single largest industry in the world. In 2004 the total value of the global construction industry exceeded four trillion dollars (Panibratov, 2008). Of even greater importance, 25% of the world's workforce worked directly for the construction industry or an entity supporting construction. Construction work is a tool to stimulate economies and project foreign policy. From 2003 to 2004, the global construction industry grew by 6.6% (Borg, 2003). In 2003 the largest global construction firms were *Vinci* of France ($12 Billion (B) domestic/$8B international revenue), and *Skanska* of Sweden ($3B domestic/$14B international) (Borg, 2003). The largest international construction market is Europe. The second largest international construction market is Asia/Australia with China being the single fastest growing market. Transportation is the largest sector in the international construction market (27.5%), followed by general building (25.4%) and petroleum infrastructure (18.7%) (Borg, 2003). According to the World Trade Organization Secretariat, the international supply of construction services involves large movements of workers at all levels of skill. Although statistics regarding the movement of workers related to the industry are not readily available, analysts believe that large portion of the movement of workers into the industrialized countries and the Middle East from Asia, Latin America and other developing regions are construction-related (Patibandla, 2012).

Because of the type of work involved, the majority of construction services are either supplied by the commercial presence of a foreign company or through the presence of natural persons. The cross-border supply of construction services is assumed to be practically non-existent as a result of technical infeasibility (i.e., construction services cannot be supplied without the movement of service providers). However, some services (such as land surveying and blue-print designing) may become increasingly traded over telecommunications infrastructures. As electronic commerce develops there may be some changes in the way that construction services are supplied (Patibandla, 2012).

2.2.1 The Ghanaian Construction Industry

Ghana is renowned as an emerging market in sub-Saharan Africa, thanks in large part to contributions from the building construction industry (Laryea, 2010). This industry is dominated by physical infrastructure and asset-based-lending as a means for growth and development (Songwe, 2014). According to Asamoah and Decardi-Nelson (2014), the construction industry contributes about 5% to 10% of Gross Domestic Product (GDP) to the country and employs nearly 10% of the working population. Ofori (2012) has identified the sporadic development of the construction industry in local areas as a means of alleviating poverty in the country.

The Ghanaian construction industry is complex in nature, representing a range of stakeholders (Dadzie et al., 2012). The Ministry of Water Resources, Works and Housing, responsible for the housing infrastructure and construction throughout the country, classifies building contractors into four groupings: projects worth up to $75,000 (D4K4); projects ranging from $75,000-250,000 (D3K4); projects worth $250,000-500,000 (D2K2); and projects over $500,000 (D1K1) (Frimpong & Kwasi, 2013). The majority of the companies in Ghana fall under D4K4 and D3K4 classification (Oxford Business Group 2014). The Chartered Institute of Building in Ghana estimates that there are over 1,600 building contractors working in Ghana since October 2012 (Oxford Business Group 2014). Although the building construction industry supports the country's economy and thus provides a means for social development, the industry is characterized by unprofessional practices (Asamoah & Decardi-Nelson, 2014). The industry suffers from a lack of planning, including inappropriate water and energy use, building material consumption, failure to meet consumer/tenant needs, and disjointed stakeholders' cooperation in the industry (Twumasi-Ampofo et al., 2013). These deficits form part of an industry mired in corruption without transparent processes for procuring the services of consultants and contractors (Asamoah & Decardi-Nelson, 2014). The unsustainable building construction processes coupled with the constant degradation of the environment continue to take their toll on Ghana's development (Djokoto et al., 2014). The problem-ridden industry must also deal with a national housing problem in need of 70,000 units annually and an accumulated delivery deficit of 250,000 units to meet the housing demands (Twamasi-Amofo et al., 2014). These numbers are backed up by the U.N. Human Settlement Program who estimates that Ghana will need two million new housing units by 2020 to meet the demand for housing (Owusu-Ansah & O'Connor, 2009). The sustainability challenge confronting the construction industry is to meet the demand for housing and other buildings in a strategic and sustainable manner.

Normally stakeholders within the industry have the power and capacity to influence the positive changes necessary to improve the state of the industry (Ofori, 2012). Currently, the approach the Ghanaian building construction industry is employing to tackle existing challenges is not cohesive and is adopted differently by the government and private organizations, rendering most efforts ineffective. This current approach is unstructured and contributes to a further challenge of meeting the demand for housing units. These "affordable" or low cost houses are traditionally built with local materials such as brick and tile, land concrete, adobe bricks, compressed earth bricks, pozzolana cement, bamboo, and secondary timber species to reduce costs (Twumasi-Ampofo et al., 2014).

This approach, however, has yet to align the notion of "affordable" with the real cost of the market (Twumasi-Ampofo et al., 2014) and lacks common consensus among the stakeholders' in the industry (Asamoah & Decardi-Nelson, 2014). This has often resulted in many building construction failures and is indicative of a lack of concise understanding and dialogue among stakeholders in the industry (Ampadu-Asiamah & Ampadu-Asiamah, 2013). Ofori (2012) also explains that most construction projects in Ghana have a long gestation period due to their large and complex nature and thus are slow to respond to planned and unplanned changes. Therefore, there is a need to mitigate the sustainability challenges in the building construction industry by immediately integrating sustainability into its practices.

2.3 Overview of value engineering

The value analysis concept was conceived by Mr. Lawrence D. Miles during the 1940s. He worked for General Electric, a major defense contractor, which faced the scarcity of strategic materials needed to produce their products during World War II. Miles realized that if value and related innovation improvements could be systematically "managed," then General Electric would have a competitive advantage in the marketplace. With that ambition in mind, Miles took the challenge and devised the function analysis concept, and integrated it into an innovative process that became known as Value Analysis. Miles understood that products are purchased for what they can do. These products can either do work or provide pleasing aesthetic qualities. (SAVE, 2006)

The success that Miles unleashed was quickly recognized by other companies and the U.S. Navy. The result was that value analysis began to gain in popularity, eventually leading a group of practitioners to form a learning society to share insights and advance their innovative capabilities. Thus in 1959, the "Society of American Value Engineers" was officially formed. Soon value engineering was used to improve value in government projects, the private sector, manufacturing, and the construction industry. Value engineering spread out from the USA to North and South America, Europe, Australia, Asia, the Middle East, and parts of Africa. The international growth caused the membership of SAVE to reconsider the society's name and was changed to "SAVE International" in 1996.

2.4 Theory and Concept of Value Engineering

Value Engineering (VE) is a management technique that seeks the best functional balance between cost, reliability and performance of a product, project, process or service (Flaig, 2005). Value engineering is a powerful problem-solving tool that can reduce costs while maintaining or improving performance and quality requirements. Value engineering can improve decision-making that leads to optimal expenditure of owner funds while meeting required function and quality level (Gokharn, 1998). The success of the value engineering process is due to its ability to identify opportunities to remove unnecessary costs while assuring quality, reliability, performance, and other critical factors that meet or exceed customer's expectation. An organized study of functions to satisfy the user's needs with a quality product at the lowest life cycle cost through applied creativity. There are many tools and techniques being applied in value engineering in its quest to improve value, these tools include the FAST diagram, creative thinking technique, life cycle costing and weighted scoring techniques and others (Hassan, 2017). Value engineering is a methodology that is known, accepted and has an impressive history of improving value through customizing quality and optimizing Life Cycle Cost (LCC). Value engineering is an organized process that has been effectively used by a wide range of companies and establishments to achieve their continuous goals. The success of the value engineering process is due to its ability to identify opportunities to remove unnecessary costs while assuring quality, reliability, performance, and other critical factors that meet or exceed customers" expectation. The improvements are the result of recommendations made by multi-disciplined teams from all concerned parties. Value Engineering can improve decision-making that leads to optimal expenditure of owner funds while meeting required function and quality level. Value engineering is a methodology that is comprised of many useful tools and techniques that create change on purpose rather than letting change happen accidentally.

Value engineering focuses on the value rather than the costs and to achieve the optimum balance between time, cost and quality. Value engineering concept considers the relationship between the value, functionality, quality and time in a broader perspective by eliminating unnecessary costs at a project/ system/facility. According to Kelly et al. (2004) stated the main concepts value engineering methodology express the relationship of value to function and cost as follows:

$$\textit{Value} = \frac{\textit{Function}}{\textit{Cost}}$$

Based on the approach, the value can be increased through:

a. Improving function but costs constant

b. The function constant but reducing the cost

c. Improving function and reducing the cost

d. Improving function and also increasing the cost

According to (El Khatib, 2015) there are three main elements that differentiate VE with other management processes, namely: the development of a value system to reach a decision that is value for money; team-based process that involves all stakeholders in a workshop; and function analysis to improve the understanding of the value system. Measurement of value engineering study performance is needed to measure the effectiveness and efficiency of the implementation of workshop to determine the success of team in achieving the goals of the value engineering study.

Vina and Manoj (2011) identified the success factors of the value engineering study as follows:

a. Multi-disciplinary teams/relevant expertise

b. Skills team leader/facilitator

c. A structured approach through the process of value engineering

d. The agreement about knowledge the members of team members of value engineering study

e. Have decision-takers at workshop

f. Effort team members in the process and output value engineering studies

g. Preparation of workshop in value engineering study

h. Function analysis

i. Management and team members support

j. Planning to conduct of value engineering study

2.4.1 Value

Value is a complex concept that has intrigued academics throughout the ages and before examining methods which enabled RSL's to produce value systems it is pertinent to consider what is meant by the term 'value'. Philosophers in ancient Greece understood the dynamics of value Brady (2014) though the foundations for the notion of value within the field of modern economics was set by Adam Smith's seminal text published in 1776, The Wealth of Nations. Smith identified two meanings for value namely, value in use and value in exchange which were developed into the economic theory of utility (Brady, 2014). This, in turn, was developed by Karl Marx in 1886 as part of his labour theory of value which argued that value could only be created by the application of labour in the production process. Since then, value has been viewed from an economic perspective in terms of the ratio of costs to benefits. This economic based definition has provided a foundation for other disciplines, which have derived an understanding of value that has been measured in monetary terms, though, it has long been understood that value and lowest cost does not go hand in hand (Goodhart, 2015). Other commentators have discussed and described value in numerous economic contexts including exchange properties related to the market place Su (2015), which evolved into transaction theory.

The concept of stakeholder value was introduced to state that the principal goal of management is to maximise the level of sustainable growth in profitability and thereby enhance shareholder value, defined as the maximising of returns to those who have an ownership stake in the business (Mastilo et al., 2017). Customers' expectations were then integrated with business operational and strategy issues to contribute to the creation of value Thompson (1998) with the market place being where customers actually create value within a commercial process (Sobocińska, 2015). In the discipline of philosophy core distinctions are drawn in theories of value between subjectivism and objectivism. The former relates value to different states of mind while the latter accepts that value can exist independently of human beings (Neil Gascoigne, 2009). Subjective personal feelings are a very important part of decision making and have also been studied from a social and psychological dimension with value being very much an intrinsic part of the cognitive makeup of the individual and being distinct from preferences, utility, desires and attitudes (Sobków & Traczyk, 2013). Further definitions of value have merged the economics of marketing and selling with social psychology and have stated that value is also a matter of perception of superior qualities (Töytäri & Rajala, 2015) and that customer perceived value increases proportionally as the perceived benefits grow (Schröder & Wall, 2004) with the value of a product or service only having significance in economic terms when a person is prepared to give up something in order to obtain it (Parlaktürk, 2012). A number of these ideas are encapsulated by 'lean thinking' which states that value can only be defined by the ultimate customer and is only meaningful when expressed in terms of a specific product (a good or a service, and often both at once) which meets the customer's needs at a specific price and at a specific time (Amyx & Bristow, 1999).

2.4.2 Value and value management

Randolph (2014) observed that the concept of Value relies on the relationship between the satisfaction of many differing needs and the resources used in doing so. The fewer the resources used or the greater the satisfaction of needs, the greater the value. Stakeholders, internal and external customers may all hold differing views of what represents value. The aim of Value Management is to reconcile these differences and enable an organization to achieve the greatest progress towards its stated goals with the use of minimum resources. There are so many views and opinion on the discipline of value management. T. Randolph, (2014) defined the term value management as "a style of management particularly dedicated to motivating people, developing skills and promoting synergies and innovation, with the aim of maximizing the overall performance of an organization". The concept of value management according to Society of American Value Engineers (2008) is defined as "a systematic, multi-disciplinary effort directed towards analysing the functions of projects for the purpose of achieving the best value at the lowest overall life cycle cost. This definition is not complete as observed by De Leeuw (2006) where he stated that return on investment, which is a vital issue to the private sector, is supposed to be included.

Value management according McGuffog (2011) is "a well-established methodology for defining and maximising value for money". As incomplete this definition may be, it suggests that the discipline of value management can be applied to any type of project regardless of size or timeframe and at all stages i.e. throughout the life cycle of the project from inception to completion. This may be contrary to the general belief that value management must and can only be applied at the design stage of construction project. This connote that value management is becoming dynamic and various forms of its application in the construction industry are springing up. This discrepancy is further clarified by Kelly and Male (2006) where value engineering is said to be a sub-set of value management in that the former deals mainly with the design processes while the latter deals with the overall management of value throughout the contract. Odeyinka (2006) defined value management as “a service, which maximises the functional value of a project by managing its development from concept to completion and commissioning through the audit (examination) of all decisions against a value system determined by the client”. In summary, value management can therefore be seen as “a systematic and multi-disciplinary process directed towards analysing the functions of projects from its inception to completion and commissioning (through auditing or examination) for the purpose of achieving best value and return on investment at lowest possible overall life cycle cost. The following can be described as the core of value management definition as observed by Short, et al (2008): A systematic or organised approach; Multi-disciplinary; Analysis of function (Functional analysis); Inception to completion and commissioning; Best value; Lowest possible overall life cycle project cost; and Return on investment.

The SAVE International Standard adopts the term Value Methodology (VM) and it highlights value methodology as including the processes known as Value Analysis, Value Engineering, Value Management, Value Control, Value Improvement and Value

Assurance (Male, 2002). Finnigan (2001) defined value engineering as a systematic effort to improve the value of a product or system and optimise the life cycle cost. Value management is generally divided into three stages and they are value planning (dealing with value during the early stages in the planning of a project), value engineering (dealing with value during design and/or engineering stages) and value analysis (identifying value in respect of the completed project). No wonder most authors prefer the term "value management" to "value engineering". In De Leeuw (2006) opinion, the process has more to do with "value" and "management" rather than "value" and "engineering". The primary role of the value manager as opined by Male and Kelly (2008) is to decide on structure and deliver a study style tailored to a particular value problem or value challenge, be it for a project, project program, service or organizational function

2.4.3 Value management

Value Management (VM) is a structured framework that facilitates effective decision making regarding the "best value". One of the major success factors of value management in achieving better project objectives is through the provision of beneficial input by multi -disciplinary team members being involved in critical decision-making discussions during the early stage of construction projects (Ashworth, 2002).

Value management (VM) is a service which maximizes the functional development from concept to completion, through the comparison and audit of all decisions against a value system determined by the client or customer.

Value management is an integrated, organized and structured process, led by an experienced facilitator and broken down into various stages to enhance the value of a construction project, not necessarily only by cutting costs. Value is a systematic multidisciplinary effort made to enhance the value of a construction project in many other ways than just cutting on costs. The best time to implement is the early development phases on a project. Optimal benefits will be obtained on larger and more complex projects.

The main function of VM is not to reduce costs but to improve value. Value is made up by balancing cost, time and function/quality of the product/project. Value can also be seen as the benefit the client or the occupants of such a building or structure enjoys. According to Norton (1995) there are three major ways to improve value by applying VM:

- To provide for all the required project functions but at a lower cost;
- To provide additional functions without increasing the cost;
- To provide additional functions and at the same time to lower the cost
- Life cycle costs: It is the present value of the total cost of the building/asset over its entire operating life and includes the initial capital and construction costs, operating and maintenance costs and the cost or the benefit of eventual disposal of the asset.

All decisions are examined against a value system determined by the owner or developer of the project. Both Value Management and cost management are important on a project and there are important links between them. When these two activities are combined the total combined effect is bigger than the sum of the individual effects.

2.4.4 Types of the projects that are most suitable for Value Engineering

Norton et. al. (1995) identified the following types of projects that will benefit the most from VM:

- Costly projects: Value engineering can result in savings of up to 5-15% of the total costs involved on the project and therefore it is very cost effective to apply VE to higher cost projects, in many cases higher percentage, applying value engineering to high cost projects is almost always cost effective.
- Complex projects: With a Value engineering study one has the opportunity to get expert second opinions, especially if there are members on the team that are independent from the original design team. On complex projects it is vital to get expert opinions. By using Value engineering, attention can be given to complex issues
- Repetitive projects: When the same type of building/asset needs to be built in many different locations, the utilisation of Value engineering becomes very cost effective because cost reduction and ideas that add value to the project can be incorporated into all the buildings to be built later on.

- Unique projects with new technology elements and few precedents: The reason for using Value engineering in the above type of projects is similar to complex projects. It relates to the obtaining of expert opinions.
- Projects with very restricted budgets: For these projects it is imperative to get maximum value for the least amount of money. Value engineering seeks to eliminate unnecessary costs.
- Projects with compressed design programs: Value engineering should be properly coordinated with the construction program to minimise time spent on it. Value engineering can come up with innovative ideas to relieve pressure on design programs and accelerate programs.
- High visibility projects: These are projects sponsored by the government or environmentally sensitive projects. It is important that as little as possible goes wrong on these projects to avoid the media embarrassing the parties involved on the project.

2.4.5 The role and position of value engineering in civil projects

The analysis of value engineering is an innovative attitude by fulfilling its goal identifies unnecessary costs. It means that the costs not fulfilling the applied features, life and appearance for customers, should be identified and eliminated (Hossein & Amir, 2015). Value engineering presented some guidance regarding potential saving as followings (Dell'Isola, 1992).

- Budget 1-3%
- In great loans, 5-10%

- In regions with high costs 15-25%

Fulfilling this potential saves needs systematic and innovative attitude. The estimations of improvement costs regarding life service, compared with the estimations of capital and construction costs are not considerable. Some of the important elements in the analysis of project life service costs and they should be saved as indicated by (Hossein & Amir, 2015).

- Maintenance costs
- Energy costs and utilities
- Financing cost
- Unpredicted future income growth
- Scheduling the future development

There are various available specialized tools in analysis of general issues in value engineering are as follows:

- The current value analysis
- Effectiveness analysis
- Breakeven analysis
- Liquidity and return rate analysis

All of them are useful economic tools for value engineering.

2.4.6 Achievements of using value engineering

Hossein and Amir (2015), Value engineering plays important role in achieving permanent goals and provides the ground for coordination and communication. In other words, it can be said we can manage both aspects of changes and costs and this requires permanent profitability in business. Indeed, value engineering by the following conditions in organizations makes them compete in national and international fields (Shen & Liu, 2004).

- Reduction of costs and increasing profit
- Quality improvement
- Increasing market share
- Saving project time
- Effective use of resources

2.4.7 Appropriate time for using value engineering

It has been generally agreed that Value engineering needs to be applied as early as and unnecessary commitments avoided. Dell'Isola (1997) suggested that Value engineering should be conducted as early as possible if its full potential is to be realised, before commitment of funds, approval of systems, services, or designs. He also stated that when Value engineering is applied later, two things increase: the investment required to implement changes; and resistance to change. Assaf and Jannadi *et al*. (2000) reiterated this viewpoint stating that during planning and design, choices can be made between reasonable estimates of alternative courses of action.

Timing is very important to the success of the Value engineering analysis. A Value engineering analysis should be conducted as early as practicable in the planning or development of a project, preferably before the completion of preliminary design. At a minimum, the Value engineering analysis is to be conducted prior to completing the final design. The Value engineering analysis should be closely coordinated with other project development activities to minimize the impact approved recommendations might have on: previous agency, community, or environmental commitments; the project's scope; and the use of innovative technologies, materials, methods, plans, or construction provisions. In addition, Value engineering analyses should be coordinated with risk assessment workshops such as Cost Risk Assessment (CRA) or Cost Estimate Validation Process (CEVP). Benefits can potentially be realized by performing a Value engineering analysis at any time during project development;

The work scope of value engineering depends upon the size and complexity of project. The highest return amount is done when we are in the first stage of project life. We can say that in the initial phase of design, value engineering is very effective as the theories are like concepts. The employer and designer have high flexibility in their decisions and the changes have less effect on project scheduling. During this stage, employer and consultant investigate the project budget and value engineering studies can be solving routine engineering issues including function analysis, specific creative attempt to formulate some choices for design, the lack of reduction of efficiency, dedicating costs for each function. Among other techniques applied for issues only value engineering attitude requires experience and analysis of function via creative thinking techniques effective on identification of costs elements before final budget approving. The value engineering studies of construction projects are done when about 30% of the design is performed. In other words, incomplete design should be completed based on value engineering. Generally, in a standard definition before taking important decisions in design, value engineering is recommended and it has the highest effect on costs (Hossein & Amir, 2015).

2.4.8 Value engineering application phases

It has been argued that value engineering comprises of phases (Ilayaraja & Eqyaabal, 2016).

1. First Phase: Preparation of the Study. The value must be setup to study well prepared and used in such a study:
   - Team selection and a multi-disciplinary expertise in order to obtain the largest number of ideas and is different for different size
   - Of the project team often consists of five to nine members. Does not require that all members of the team engineers, but it must be the team led by Certified Value Specialist (CVS Certified Value Specialist).
   - Review the project and field of study (Study Scope of Work) in detail and collectively.
   - Initially detailed cost and light determines the project team savings ratio to be achieved.
   - A timetable showing the beginning and end of each stage of the study.
   - Determine the date of completion of the study and the date the results of the study to the beneficiary.

- Preferably study within the area of work in building the team to easily obtain the required administrative support.

2. Phase II: Workshop on Value Engineering

   Action plan consists of seven sequential steps, where a logical sequence should be finished completely before starting any step in the next step: -

- Collect information
- Job analysis
- Innovation and brainstorm
- Evaluation and testing
- Research and development
- Briefing and presentation of recommendation

2.4.9 Benefits of value management

Value management has a lot of advantages ranging from financial benefits, to helping to build the morale of the professional team. Value management will affect everyone associated with the project, otherwise known as stakeholders. The client seeks to achieve value for money, whilst the users want a product that meets their needs as effectively as possible. The project managers are to ensure that the project is on time and falls within the budgetary constraints, the contractor wishes to provide a service which will afford them an adequate profit and the designers are keen to meet the expectations of the client whilst complying with certain standards and performance criteria. Value management can address most of these needs directly or indirectly, thus bringing a degree of satisfaction to all the stakeholders involved.

- ***Financial benefits of value management***

  Here follows a brief list of some of the benefits of Value management that is somehow directly or indirectly connected with optimising the value for money for a project (Norton et al., 1995) and (Locke et al., 1994)

- Value management creates a clearer focus on the project objectives;
- Value management works towards arriving at a more effective design;
- Identification of alternative methods of construction and favourable adjustments to the construction timeline;
- Discovery and discussion of project issues, constraints and risks involved;
- Clearer project brief and decision making;
- Identifies and removes unnecessary costs associated with the project
- VM deals with lifecycle costs also, not only initial project cost and provides an authoritative review the project in its totality and not just a few elements. Future profitability can also be assessed if the lifecycle costs are known;
- Decisions are made with greater confidence because it can be supported by data and defined performance criteria;
- All options, alternatives and innovative ideas are considered;
- Value management seeks to obtain maximum efficiency ratios;
- Over specification is addressed and an improved building program can be developed leading to time being saved and ultimately savings in cost;

- If properly implemented it can identify possible problems early on in the project;

It provides management with authoritative evaluations and supporting information of the project brief or design and their related capital and operation costs. Savings in costs of between 10-15% of total project costs can be achieved with the correct implementation of Value management. It is important to note that for these benefits to be fully realised it is important to implement Value management as soon as possible on a project

2.4.10 Purpose of Value engineering

The main objective of VE is to enhance value in addition to reducing time, improving quality, reliability, maintainability and performance. Furthermore, VE can modify human behaviour, for instance attitudes, creativity and teamwork. Value engineering can also expand the use of financial, manpower and material resources by eliminating unnecessary or excessive costs without sacrificing quality and performance (Dell'Isola, 1997). Zimmerman (1982) stated that the goal of a Value engineering study is to realise true value for the owner.

'The value may come in the form of removing unnecessary cost to the project, or it may come in the form of providing a more workable product that would decrease the costs of owning and operating the facility. Value is that elusive commodity that we all attempt to achieve in our design. Value, in this context, is considered to be the value for money that is received in return of a project or service'.

2.5 Team Management Values

To study the value depends on collective action for that team selection is a multi-disciplinary expertise, so as to get most amounts of ideas. Team size varies for different size of the project but mostly consists of 5-9 members and consists of the designer and the recipient, structural engineer and the end user the remaining individuals are selected according to selection of the project value engineering study group can be an internal team (design team) and can be external teams and each team has advantages and disadvantages (Ilayaraja & Eqyaabal, 2016).

.2.5.1 Advantages of using an External Team to Study the Value Engineering

External team is specialized in the studies value is contracted to conduct the study in a specific time and specific wage and the use of such a team has advantages as following:

1. Can be selected by a team of various disciplines required the design team while the former component.
2. Objectivity. Must have specific task to accomplish.
3. The team outside of the client confirms that the design done by the design team is good.

2.5.2 Disadvantages of using an External Team to Study the Value Engineering

When using the external team may note some defects that can be summarized as follows:

1. The design team hard to accept the new team.

2. The design team for the absorber design and has experience in both advantages and disadvantages, which could take the time outside of the team for consideration.
3. In some cases, the team may try to cash outside the current design to show his proficiency and his ability to accomplish the design better.
4. Use an external team better.

2.6 Applying Value Engineering to Standards

For any project, following industry standards makes sense (Donald, 2006). Standards provide a basis to judge and compare and a means to ensure a minimal level of performance. Codes often reference numerous safety standards to assure the minimum functional requirements of a given material or component. Safety standards provide criteria for applicable testing of a component or system for safety. Other standards are not written for safety requirements, but are written for product performance or conformance. In general, standards are established as a basis to quantify, compare, measure or specify in terms of capacity, quantity, content, extent, value and quality. Standards for information transport systems (ITS) projects are no different. These voluntarily adopted standards represent industry consensus on requirements and best practices. A significant benefit of standards in the ITS industry is the interoperability of components and systems by multiple manufacturers. For example, if a manufacturer of network interface cards (NICs) does not adhere to standards developed by IEEE 802.3, IEEE Standard for Information Technology for Ethernet Operation, then their product may not properly interoperate with other standards- compliant products. Independent organizations exist that may specialize in a combination of establishing, certifying and maintaining these standards. Standards are developed by many industry trade organizations, and national and international standards-setting bodies. Many industry standards are developed by manufacturers. Their design paradigm may include more equipment than is required to perform the function.

2.7 Capability of value engineering to implement sustainable construction

It has been confirmed that the consideration of sustainable construction in Value engineering workshops remains an under exploited topic because of a shortage of information. Value engineering is an appropriate technique to diffuse sustainable construction principles amongst its team members (Abidin & Pasquire, 2003). However, sustainable construction is inherent in most Value engineering workshops, but the level of consideration differs from workshop to another (Abidin & Pasquire, 2005). The environment of the Value engineering workshop can help to spread the knowledge of sustainability among the team through the facilitator or sustainable construction/environmental instructor; or through sharing the experiences between members. The Value engineering job plan is systematic approach, which helps team members to identify problems and find the right solutions in a scientific environment. It can help to raise sustainable construction principles during the workshop and there are sufficient tools and techniques to help decision-makers take the appropriate actions in order to realize value for many in a project. Furthermore, the: function analysis phase enables the team members to apply sustainability issues in assigning the component of a project; whereas the creativity phase generates many alternatives for accomplishing objectives and avoiding the unsuitable alternatives in terms of sustainability. When integrating sustainable construction themes early in the Value engineering job plan, all processes such as function analysis, ideas evaluation and development can be used to help to meet the objectives.

2.8 Type of Projects That Benefit Most for Value Engineering

There are costs associated with value engineering; therefore, it is probably impractical to use it on every project (Ilayaraja & Eqyaabal, 2016). However, it is good idea to apply value engineering if any one of the following items is the case on the particular project as suggested by (Senay Atabay & Niyazi Galipogullari, 2013).

2.8.1 Costly Project

Since value engineering will usually result in costs saving in the order of 5 to 10%, or in many cases higher percentage, applying value engineering to high cost projects is almost always cost effective.

2.8.2 Complex Project

A value engineering study affords an opportunity to get expert second opinions. When using value engineering, team members who are independent from the original design team for very technically complex project, getting a second opinion is almost always an excellent idea.

2.8.3 Repetitive Costs

When an organization is involved with repetitive type construction project those which they tend to build many times in various locations, the utilization of value engineering is usually very cost effective because the cost reduction ideas can be incorporated in each of the latter project of the same type.

2.8.4 Unique Projects with Few Precedents or with New Technology Elements

This is very simple situation to complex projects. Again, the benefit of value engineering is in achieving an expert second opinion when independent team members are included.

2.8.5 Projects with Very Restricted Construction Budgets

With projects of this type, it is imperative to achieve maximum value for money. Since by definition value engineering seeks to achieve the elimination of unnecessary costs, its application on projects with tight budgets is usually a very good idea.

2.8.6 Projects with Compressed Design Programs

The old saying ‘haste makes waste’ is especially true with regard to construction projects. Whilst value engineering is an added requirement which can have a tendency to add to projects programs, this time can be minimized if the value engineering activity is properly coordinated with the design programs.

2.8.7 High Visibility Projects

This situation applied to the government sponsored or environmentally sensitive construction projects. If errors or problems developed on a project they tend to be seized upon by the media and publish headline news. Again, as value engineering provides an opportunity to obtain expert second opinion it is very effective tool for avoiding problems of this nature.

2.9 The Value Methodology Job Plan.

"The Job Plan outlines specific steps to effectively analyse a product or service in order to develop the maximum number of alternatives to achieve the products or service's required functions" (SAVE, 1998).

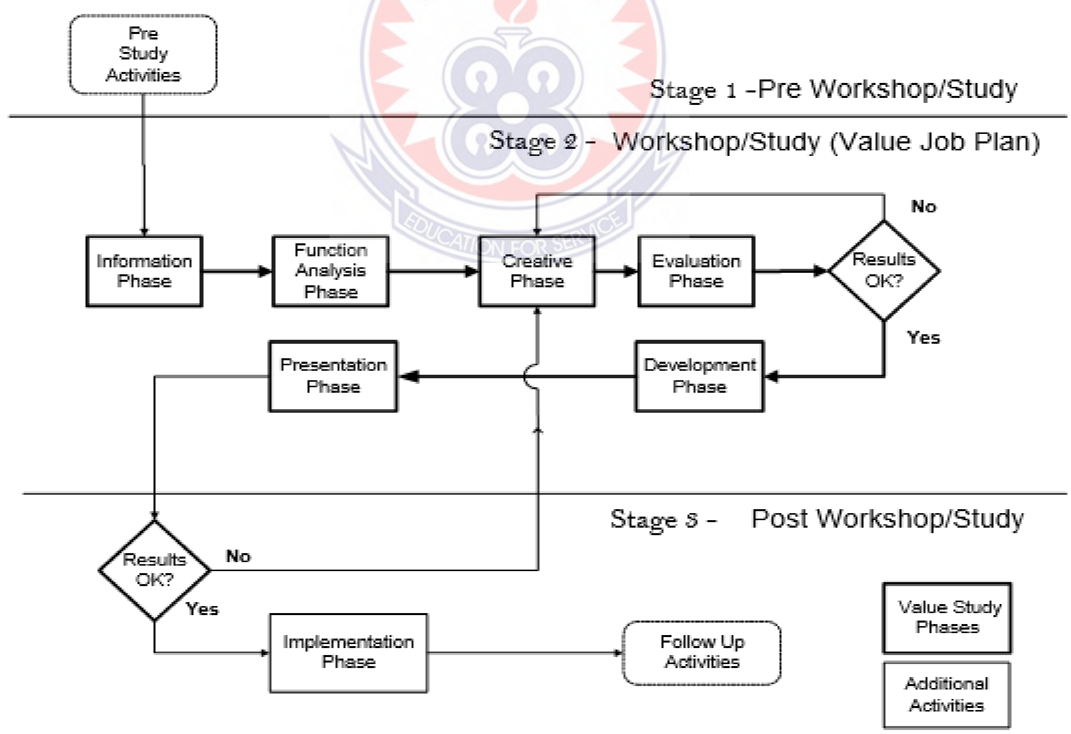

Figure 2. 1 Six systematic value Job Plan

Source: SAVE International (2007).

The six systematic Job Plan used by the value engineer are outlined:

- Information Phase: Gathering of information to better understand the project.

  All Possible Information regarding the product is collected in this Pre-study. The value engineering team starts to identify the areas that will allow for the most improvements. The team gathers information about the present design and cost, then determines the needs, requirements, and constraints of the owners/users/stakeholders, as well as the design criteria.
- Function Analysis Phase: Analyzing the project to understand and clarify the required functions. The team defines the project functions using a two-word active verb measurable noun context. The team analyzes these functions to determine which need improvement, elimination, or combination. Tools used during this phase include: Random Function Identification, Function Analysis System Technique (FAST), Function Listing, and Value Index.
- Creative Phase: Generating ideas on all the possible ways to accomplish the required functions. Alternatives to the analyzed functions surface through e.g. the alternatives are recorded, but not discussed and selected. The team uses a variety of creative techniques, such as brainstorming, to generate alternative ideas to perform the project functions.
- Evaluation phase: Synthesizing ideas and concepts to select feasible ideas for development into specific value improvement. The Best alternatives are regarding, function-cost relationship is selected. The team refines and combines ideas, develops functional alternatives, and evaluates by comparison. Appropriate

tools of comparison include advantage and disadvantage comparison and an evaluation matrix with weighted criteria.

- Development Phase: Selecting and preparing the "best" alternative(s) for improving value. Based on the evaluation phase, the team begins to develop in detail the alternatives with the greatest potential value. During this phase it is essential to establish costs and backup documentation needed to individually convey the alternative solutions.
- Presentation Phase: Presenting the value recommendation to the project stakeholders.

The objectives of this final phase are to get the approval of the sponsor to proceed in implementing the recommendations. The implementation plan, included in the study summary report, should identify the person who will be responsible for the implementation of the changes that have been approved by management. In addition, the plan should address the general impact on design and construction costs, letting date, manpower requirements, consultant resources, design and construction schedules, and any other impact resulting from team recommendations. Specific changes required by these impacts shall be determined and addressed by the project manager.

2.10 Life-Cycle Costing

It has been argued that, Life-cycle costing as part of value engineering is approach used for ability attainments that employments a complete economic analysis of competing alternatives. The analysis compares initial investment options and identifies least-cost alternatives for a project or acquisition over its serviceable or useful life span. Life-cycle costing examines the associated ownership costs of competing alternatives by discounting both the positive and negative cash flows throughout the facility's service life (Ali & Ebrahimi, 2004). Life cycle costing is a tool to be used during the development phase of a VM study. Whole life costing assesses the cost of an asset over its lifetime. This takes into consideration initial capital costs, finance costs, operational costs, maintenance costs and replacement or disposal costs at the end of its life. In calculating whole life costs all future costs and benefits are brought back to a present-day value through the use of discounting techniques.

2.10.1 Using Life Cycle Costing with Value Engineering

The concept of economic analysis, which is used in life-cycle costing, requires that comparisons be made between things similar in nature. In value engineering all alternatives can be compared using life-cycle costing because the alternatives for each project component are defined to satisfy the same basic function or set of functions. When the alternatives all satisfy the required function, then the best value alternative can be identified by comparing the first costs and life-cycle costs of each alternative. For many projects there is a viable sustainable development alternative or enhancement. Sustainable development may include more recycled material contents, require less energy or water usage, reduce construction waste, increase natural lighting, or include other opportunities that contribute to an optimal facility (Ali & Ebrahimi, 2004).

2.11 The approaches for Value Management

The success of value management lies in its methodical approach. However, the focus of value management is not on cost but function and optimum value for money. It is an ongoing process and should be used to review continuously all aspects of the project against customer needs. There are many customer benefits in using the whole project team and involving end users, as appropriate and if possible. These include the advantages of better teamwork throughout the project and users taking a stake in the end result. There are a number of pre-requisites to ensure a smooth running of the approaches such as, willing participation, management support, an appropriate study team and experienced facilitator. There are many established procedures for value management. Those of the most popular approaches are discussed below (Male & Kelly, 1998; Norton & McElligott, 1995).

2.11.1 The charette

This approach is undertaken at the end of the compilation of the brief, after the appointment of the design team but before design commences. Client representatives and the design team meet under the chairmanship of the value manager for one or two days. The value manager acting as chairman is termed the value management team coordinator (VMTC).

2.11.2 The 40-hour workshop

The 40-hour, five-day workshop is the most widely accepted formal approach to value management and is seen as being quick and economical. It comprises the formation of a second design team to review the design at 35% of design or sketch design stage.

2.11.3 The Value Management Audit

This follows the same procedure as either a charette or the 40-hour workshop. Its objective is to give a corporate or public client a clear indication of the worth of a scheme or development inspired by a subsidiary. The parent organization may then appoint a value manager to carry out a charette in consultation with personnel from the subsidiary company and their design team. Alternatively, the parent company may appoint a value management team to carry out a full feasibility study after the proposed scheme has been developed to sketch design stage.

2.12 The Value Engineering Method Hierarchy

To reduce costs, we use a modified form of Value Engineering. Value Engineering or “the Value Method” was a problem-solving methodology developed by Larry Miles at General Electric in the 1940s. Value Engineering is described as a systematic approach to analyze and improve the value in a product (Lawrence, 1972). The formal creative-team approaches in the classic value engineering are very useful but they tend to be time intensive because they require the formation of a team of decision-makers. We propose a number of techniques to lower product cost before resorting to classic value engineering. They include:

- Redesign – The classic value engineering approach involves re-design to reduce parts count, simplify assembly/test, and use lower cost parts. This method, often called "cost avoidance", yields the biggest result when initiated at the beginning of the project. Avoiding cost before the first revenue ship (FRS) is easier than decreasing cost afterwards.
- Existing Component Cost – The fastest, least intrusive way to decrease product cost is to decrease how much you are paying for parts. On common components this may be done by renegotiation, or sourcing through a different vendor.
- Component Substitution – The second fastest method is to substitute components. In the best-case scenario, an equivalent part with lower cost replaces an existing component. More likely, an existing part is replaced by a lower quality component with lower cost but that still meets design and quality assurance goals. Determining what is the lowest cost part is a dynamic process since prices change constantly.
- Re-sourcing/Out-sourcing – Custom parts and manufacturing sites can be re-sourced or out-sourced to a lower cost producer.
- De-Featuring – Another fast method of lowering cost is to examine what features and options are really valued by customers and offer only those which make economic sense.

2.13 Non-adoption of value engineering in the construction industry

Construction process in certain developed countries in the world, aimed towards achieving value for their clients, but yet Value engineering seems to be not adopted in the Ghanaian Construction industries. Some factors are drawing back the adoption of value engineering into the construction industry.

The following are factors militating against the adoption of value engineering in most of African countries of which Ghana is not exempted. (Zhang, Mao & AbouRizk, 2009), identify the key factors for non-adoption of value engineering in the construction industry.

- Inadequate knowledge of benefits of value management.
- Lack of knowledge and practice of value management.
- Lack of understanding.
- Lack of involvement of specialists' right from the onset.
- Poor management especially in the part of the client.
- Lack of trained professionals in value management.
- Use of quack professionals for construction works.
- Lack of total quality management principle in construction firm.
- Lack of information.
- Greediness of the contractors and consultants.
- Technology level.
- Government policy.
- Inadequate finance/funding
- Unstable economy.

- Conflicts of objectives by different project stakeholders.
- Ambiguous design.
- Government factor.
- Human factor.
- Communication gap.
- Construction methodology.
- Professional incompetence.
- Time of completion/delay
- Lack of professionals for construction works.
- Procurement style.
- Not suitable for low cost projects.
- Conflict management.
- Interruption to normal work schedule.
- Lack of training opportunities in value management.
- Too expensive to carry out Value management.

2.14 Function Analysis System Technique (FAST) Model for value engineering

Function Analysis System Technique (FAST) diagramming is a tool that has been the mainstay of value management profession since its introduction in 1965 (Zhang & Mu, 2013). FAST is a horizontal diagram portraying functions within a project (Al-Yami et al., 2006). FAST diagrams provide a graphic representation of how functions work or are linked together in a system (product or process) to deliver the intended goods or services (Borza, 2011). Borza (2011) further elaborates that, in 1964, this function based approach to the analysis of products and processes was enhanced by contributions of Charles

Bytheway, who provided a graphical representation and logical structure to the function analysis step of the value Methodology. This graphical representation, known as FAST Diagram (Function Analysis System Technique), organizes the functions that need to be performed by the product, process or system under study into How/Why? Relationship. Charles presented his technique in a paper delivered at a 1965 SAVE International Conference and it became an instant hit, adopted by practitioners, the society and Larry Miles himself, as a valuable tool for improving results in value studies. Today, it is an integral part of the value Management Job Plan- the six phase process of a value study. The power of the FAST Diagram lies in depicting the logical relationships that exist between the various functions being performed.

Before we get into the details of terminology and construction of FAST Diagrams, let us first define what a function is. A function is defined as that which "a product or process must do to make it well and sell" (Borza, 2011). It is the original intent or purpose that a product, process or service is expected to perform. In FAST Diagrams, the description of a function is restricted to a two word format-an Active Verb + Measurable Noun. Some examples of functions are: carry load, transmit light, generate voltage, project image etc. by constraining the description to just two words, it forces participants to clearly and concisely capture what task needs to be performed, not how is performed. This eliminates the physical constraints of the product from our thinking and allows us to explore alternatives more easily. It is a way of overcoming "functional fixedness Kato and Henry (2011), which is what Charles Bytheway was trying to accomplish. As shown in the Figure 2.2 even the FAST Diagram is purposely arranged counter to our left-to-right convention in reading and writing, with the output function at the left and input function at the right, in an attempt to break the user out of conventional thinking processes.

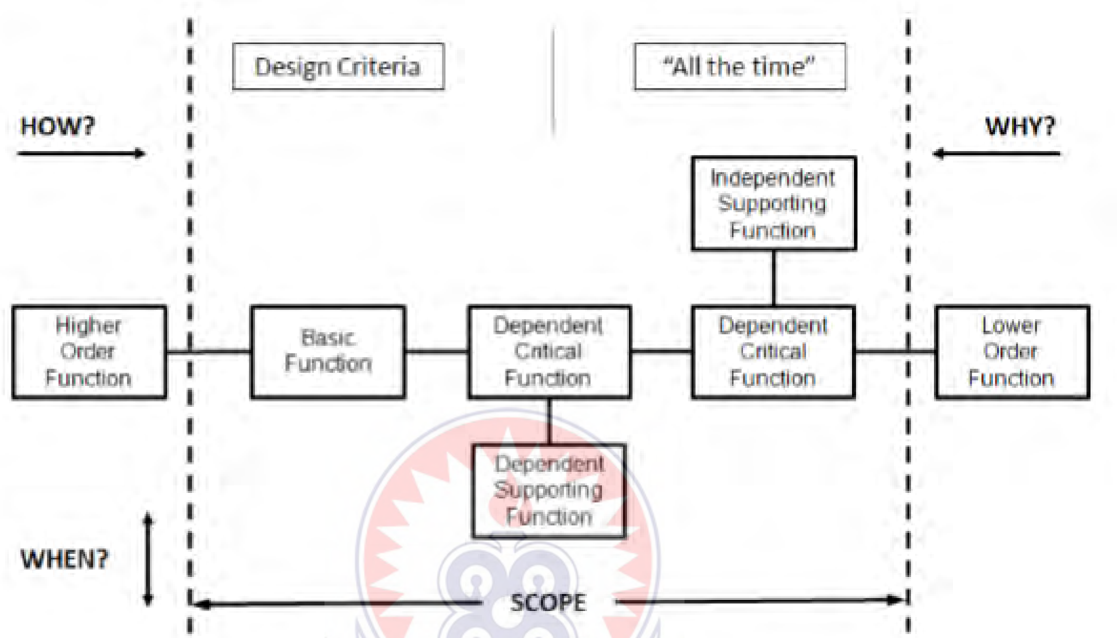

Figure 2. 2 A Fast Model

Source: Borza (2011).

You will note in the figure that there are several different classifications of functions. The two major categories are *Basic* and *Secondary*.

Basic functions is described the characteristics or task, which form the user's point of view, is the primary reason for the existence of an item. It is what the product or process was designed to do.

Secondary functions are those designed in functions which are required to cause or allow the basic function to occur. It is any function that directly contributes to accomplishing the Basic function. Secondary functions can be further sub-divided into several other categories.

Dependent critical functions are those which help the basic functions to be delivered better, faster, longer etc.

Design criteria are performance requirements applicable to the overall subject system. These are typically related directly to the basic function.

All-the-time functions are broad requirements applied within the subject scope, and are not usually directly related to the basic function. These would be items assumed in the market place as being delivered by the product or process, such as minimum level of quality and reliability, corrosion resistance etc.

2.15 Fast Model for the study

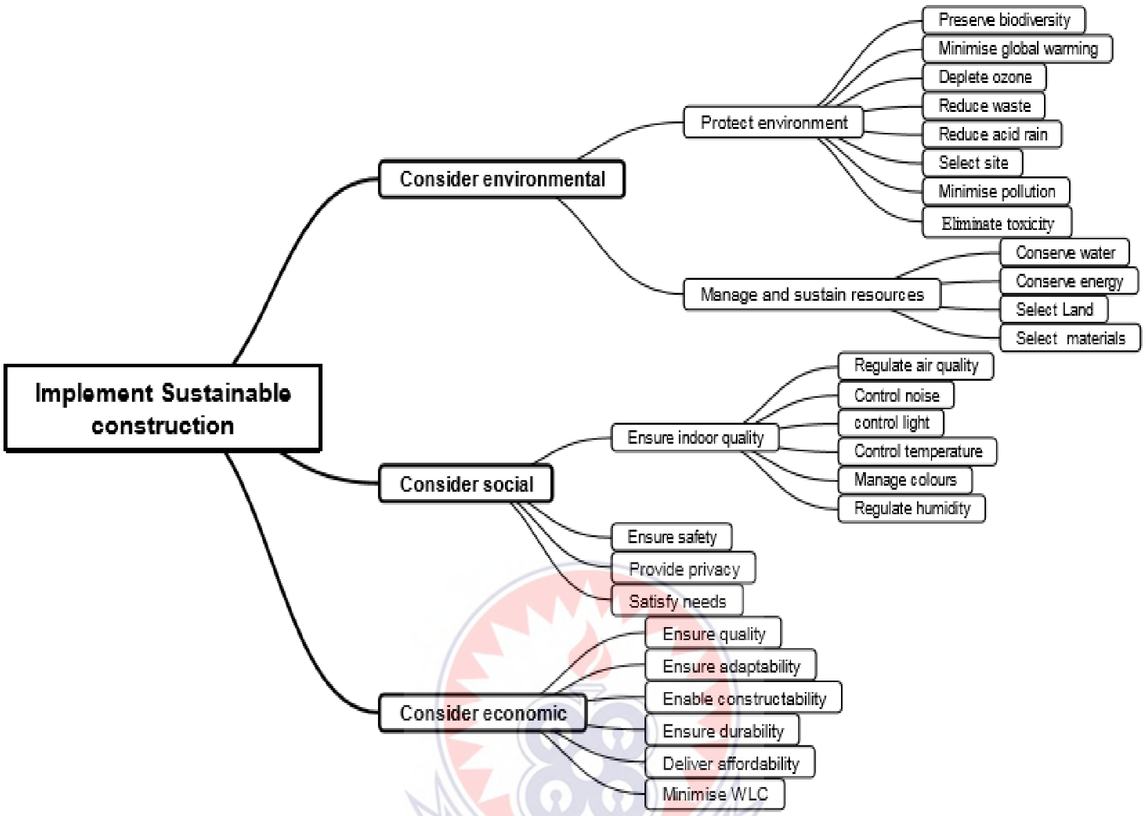

Figure 2. 3 A FAST Model for sustainable construction.

Source: Al-Yami (2006) A FAST Model for implementing sustainable construction in building briefing project.

Figure 4 shows a FAST model depicting the implementation of sustainable construction explained through indicators such as the environmental factors, social factor and economic factor. These factors are further influenced by their sub-factors to explain how the functions are accomplished. Function Analysis System Technique (FAST) models provide a graphical representation of how functions work or are linked together in a system (product or process) to deliver the intended goods or services (Borza, 2011). He stressed additionally that, by focusing on functions, teams and individuals can focus on what is truly important and not be constrained by physical features of products or processes leading to a better definition of the problem and a clearer path to a solution.

The ultimate purpose according to Al-Yami (2006) for the model in Figure 2.3 in the implementation of sustainable construction is laid on the left hand side of the diagram. The basic functions including the purpose of the design are located next to the highest-order functions which in this case are the environmental factors, social factors and economic factors. The level one function (environmental factor) is broken down into level two functions (protect environment and manage and sustain resources), which are then broken down into further sub-level functions to describe how the functions are achieved Figure 2.3. More so, the next level one function (social factor) also shares two levels of functions and having one of these levels broken down to further sub-levels all directed to attaining the ultimate function of the product. The final level (economic factor) uses just a level with sub-levels to explain its function in achieving the desired requirement of the project. The various levels of functions articulated in the model are classified into two categories: basic and secondary. A basic function in a FAST diagram explains the primary aim for which that project is designed. It must be accomplished to satisfy the purpose of the project. Secondary functions are defined as those that support the basic function (Borza, 2011). They can be broken down into a sub classifications functions to improve the analytical evaluation process (SAVE International 1998).

In the assertion of Al-Yami (2006), the model demonstrates a relationship between the various functions through a critical path in sequence of operation. He alludes that, this proposed model has considerable potential to accelerate the understanding and implementation of sustainable construction.

2.16 Summary

Ultimately, value engineering is an efficient approach for achieving best value for money, while maintaining or improving quality, safety, reliability and maintainability. It is a problem-solving technique based on analysis of the project functions demanded by the owner in order to meet the end user's requirement and needs. Value engineering uses multi-discipline teams to analyse a product design, an engineering concept or a construction approach.

CHAPTER THREE

METHODOLOGY

3.1. Introduction

The focus of this chapter is to present an in-depth descriptive plan on the processes and methods adopted in pursuance of this research, primarily on the research design, study population, study areas, sample and sampling techniques, data collection instrument, validity, reliability and finally data analysis procedure.

3.2. Research Design

Cross-sectional survey was used for the research design. Owing to the fact that, the study was conducted across participants over a short period of time and apparently did not warrant the researcher to make follow-ups of the participants captured. This design was much desirable as it sought to compare many different variables and gather a pool of opinions and practices at the same time which in turn allowed the researcher to obtain a detailed inspection on the feasibility of applying value engineering in the Ghanaian construction industry. Quantitative approach with structured questionnaire was used to source data on the level of understanding of value engineering, reasons for its non-adoption and factors that will encourage its implementation in the Ghanaian construction industry eventually. This approach was preferable as the study been exploratory in nature yielded an outcome that was easy to summarize, compare and generalize.

The study been a two - phase design used structured questionnaire for the first phase to secure data on the level of understanding of value engineering, reasons for its non-adoption and factors that will encourage its implementation respectively. The second phase constituted a framework developed for the implementation of value engineering in the Ghanaian construction industry by using the factors that encouraged its implementation as indicated earlier which also was obtained with structured questionnaire.

3.3. Population

Population is all members of a group been studied (Vorauer & Quesnel, 2016). In order to meet the research objectives, the study was conducted among construction and consulting firms in Accra, Kumasi and Sunyani targeting architects, contractors, project managers, civil/structural engineers, quantity surveyors and consultants mainly involved in the practice of value engineering. A distinctive feature of value engineering is its multi-discipline team approach which calls for such experts in the construction industry for its evaluation entirely (SAVE, 2007).

3.4. Study Areas

The study was done within three geographical towns namely: Sunyani, Kumasi and Accra. These towns were selected due to the huge presence of foreign direct investors (China, Portugal, Brazil etc.) who virtually practice value engineering in their line of work, into the industry sector which the construction industry accounts for a greater significance in growing the economy through its contribution to Growth Domestic Product (GDP) (Ghana Statistical Service, 2015). Also capital intensive construction projects dominate these towns characterised by massive construction and infrastructure developments which will necessitate clients to engage in contemporary methods in its processes and executions. Moreover, the rate of construction works by empirical evidence are very high in these towns as people from far and near are continuously putting up structures and definitely, clients involved would require a cost effective technique in this perspective.

Figure 3. 1 Map of Ghana

Source: Ghana Statistical Service (2010).

3.4.1. Accra

The Greater Accra Region has the smallest area of Ghana's 10 managerial districts, possessing an aggregate land surface of 3,245 square kilometers or 1.4 percent of the aggregate land range of Ghana. It is the second most populated district, after the Ashanti Region, with a populace of 2,905,726 in 2000, representing 15.4 for every penny of Ghana's aggregate populace. The Greater Accra Region was a piece of the Eastern Region before 1982 and Greater Accra district was made from the Eastern Region in 1982 and right now harbors the seat of government in Accra.

It has been a hub of many construction projects in the country at this period, from construction of recreational centers to construction of individual houses. Some of the projects been undertaken in this area are, west hills mall, Accra stadium which hosted the CAN 2008, Tetteh Quarshie Interchange, Circle Interchange and a whole lot of gargantuan projects in the country. Due to the regular construction projects and the hub of most international and domestic contractors, it would deem fit to undertake the study there.

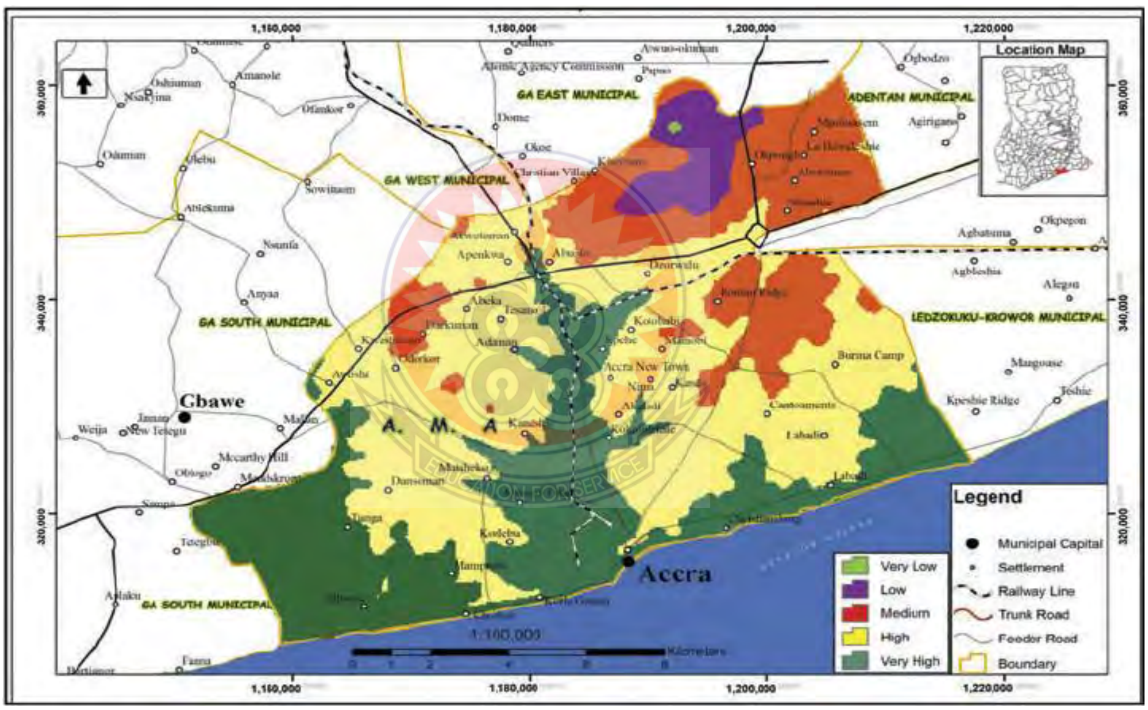

Figure 3. 2 Map of Accra Municipality

Source: Ghana Statistical Service (2010) Population and Housing Census, District Analytical Report-Accra Metropolitan

3.4.2. Kumasi

Kumasi (historically spelled Comassie or Coomassie) is a city in Ashanti, South Ghana. Kumasi is located near Lake Bosomtwi, in a Rain Forest region, and is the commercial, industrial and cultural capital of Asanteman. Kumasi is approximately 300 miles (480 km) north of the Equator and 100 miles (160 km) north of the Gulf of Guinea. Kumasi is known as "The Garden City" because of its many beautiful species of flowers and plants. Kumasi has a population of 2,069,350 people.

It is the second most developed area in Ghana having seen the likes of the refurbishment of Kumasi Sports stadium, Sofoline Interchange, KNUST Jubilee Shopping mall, KNUST overhead pass, ongoing Kumasi City mall, etc. Kumasi been one of the most developed places in the country and was chosen due to the high anticipation of construction works.

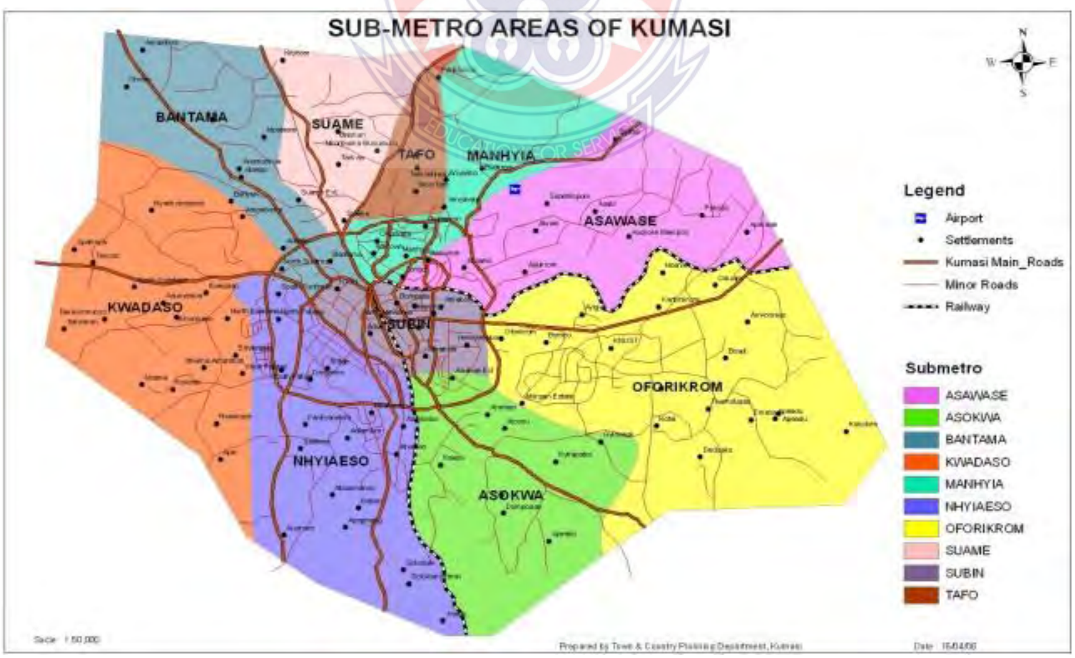

Figure 3.3 Map of Kumasi

Source: Ghana Statistical Service (2010) Population and Housing Census, District Analytical Report-Kumasi Metropolitan

3.4.3. Sunyani

Sunyani is the regional capital of Brong-Ahafo region. Sunyani is a city and the capital of Sunyani Municipal and Brong-Ahafo of south Ghana. Sunyani has a population of 248,496 people as of 2012 census.

Sunyani has turned out to be one of the areas now encountering a lift in the construction industry. There is a great deal of progressive developmental works in the region. It has already encountered some overwhelming development works such as the Ultra-Modern Regional hospital, the Sunyani coronation park, the Jubilee Park, the cocoa board building, Queen of Peace building etc. Sunyani was chosen because of its current involvement in the construction industry so as to keep a balance and not be biased in the selection of areas.

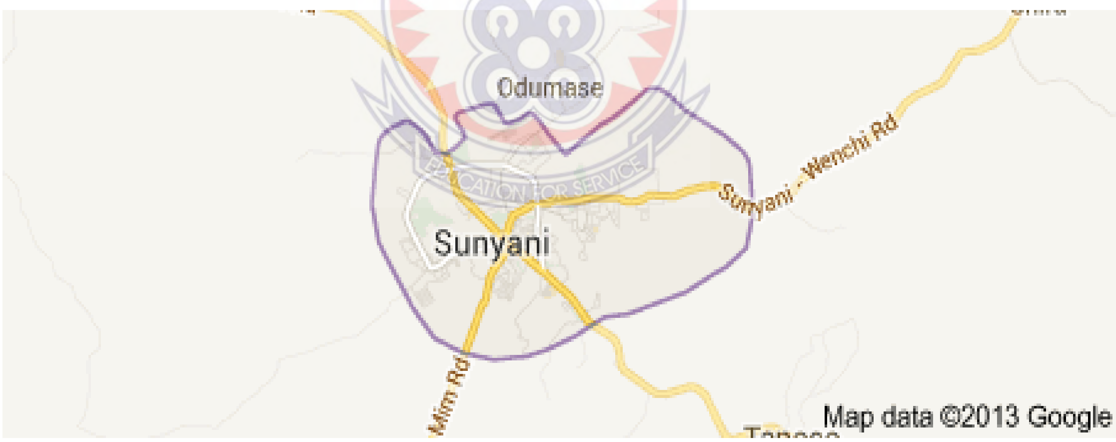

Figure 3.4 Map of Sunyani

Source: Ghana Statistical Service (2010) Population and Housing Census, District Analytical Report-Sunyani Municipal

3.5. Sampling Technique and Sample size

According to Hammersley and Mairs (2004), sampling technique is the process whereby a researcher chooses her sample. Also, Louangrath (2014) defines sample size is a part of the population chosen for a survey or experiment. Dependent on its usage, two non-probability sampling techniques were used for the study.

The construction and consulting firms were purposely selected as well as the respondents who fell within the research scope. This was to get to the firms that practiced mainly value engineering. Purposive sampling is where a researcher selects a sample based on their knowledge about the study and population (Knotters & Brus, 2012). Value engineering is a multidisciplinary team approach that requires members who have the experience and expertise in their respective fields (SAVE, 2007). Underpinned by this assertion guaranteed its application in the survey.

Snowball sampling technique was used through its nucleus to reach construction firms and respondents who practiced value engineering but were difficult to trace. Snowball technique is a sampling technique where research participants recruit other participants for a test or study (Etikan, 2016). It is used where potential participants are hard to find (TenHouten, 2017). In all, 18 construction firms and consultancies with 9 from Accra, 11 from Kumasi and 2 from Sunyani were identified due to the fact that they practice value engineering. Getting at least two respondents from each firm, the total sample size for the study numbered 117. This sample was drawn from architects, contractors, civil/structural engineers, quantity surveyors and consultants.

3.6. Data Collection Instrument

Questionnaire was used to collect data through field surveys from primary sources on respondents' level of understanding of value engineering, reasons for its non-adoption and factors that will encourage its implementation. As a structured instrument, its development was supported by literature and was classified under five main broad headings. The first part examined the demographic characteristics of the respondents. The second part based on the basic knowledge and level of understanding of value engineering by construction practitioners was rated using a five-point Likert scale. The Likert scale is a survey question that offers a range of answer options-from one extreme attitude to another (Wakita et al., 2012). They emphasised further that, this scale is widely used to measure attitudes, opinions, perceptions and behaviours with a greater degree of nuance than a simple "yes/no" question. The same scale was used to rate the reasons for non-adoption of value engineering in the construction industry as well as the factors that encouraged its implementation. The former formed the third part of the design and the latter made the fourth part respectively.

Subsequently, the last part provided open ended questions for respondents to list recommendations for increasing understanding, acceptance and implementation of VE in the construction industry, if any. A total of 117 questionnaires were disseminated with 75 delivered by hand and 40 via electronic mail. In achieving this total, an internet link of the questionnaire was developed using Google Document which was made accessible to respondents either through a computer (email system) or a smart phone (whatsapp media) using the internet connection. In its functioning, the end results after successfully completing a questionnaire automatically ended up in my email account as by way of its design. All the respondents attended to, had the option whether to go electronic or hand depending on their preference. Willingly, those who opted for the electronic format gave out their numbers rather than their email accounts as almost all of them wanted it on their smartphones through the whatsapp media than through their email address systems. Here a respondent through this process was marked, for example, as one, to add up to the total number of respondents. The tally continued for all the other respondents who used this format instead. Again, owing to the challenge in tracing some of the experts and adopting the snowball approach, respondents who were contacted were humbly requested to help trace their fellow colleagues in the profession which they agreed and equally gave their contacts but after they formally introduce me over a phone conversation. Luckily some of these experts also shared a common platform (whatsapp media) where the link was sent and through this snowball nucleus, helped me get more people to contact. Friends who readily identified these experts through this same approach also helped to secure more contacts for the study. This method was helpful to get the experts involved in this field to respond to the questionnaire specifically on merit of its ease to access, speed and comfort. Consequently, 100 of them of which 30 were received through the email system and 70 by hand were eventually acquired but only 92 were used for the study. This indicated a response rate of about 79% resulting from some anomalies that were recorded arising from 3 uncompleted and 5 incomplete hand delivered questionnaires. The exercise for the entire data collection lasted at least a month although respondents were reminded continuously so as to increase the response rate. This instrument was preferred on the merit that the topic is quantitative in nature and thus, recommends the use of this instrument coupled with the cost and the number of respondents associated (Kothari, 2004). Additionally, this instrument was chosen because it kept the respondents on the subject, provided the easiest means of reaching them and obtained the desired information in the limited time available.

3.7. Validation of instrument

Validity is the extent to which an instrument accurately measures what is supposed to measure (Frisby et al., 2014). To ensure the accuracy of information, the questionnaire was given to the supervisor whose recommendation upon thorough scrutiny was used to formulate the instrument that had the ability to obtain the expected relevant data. After the design, a pilot study was conducted among two experts who have experience in the practice of value engineering in the Ghanaian construction industry. They were made to assess the comprehensiveness of all the items in the questionnaire for clarity and appropriateness on the feasibility of implementing value engineering in the Ghanaian construction industry. The experts were allowed to exclude unimportant factors and add factors they perceived necessary. The questionnaire was subjected to rating and the content validity index (CVI) computed using the formula;

Average of CVI=number of items rated valid/all items in questionnaire. A value of 0.96 obtained met the recommended validity of 0.7 as suggested by Amin (2005), which rendered the questionnaire valid for data to be collected. Content validity refers to how accurately an assessment or measurement tool taps into the various aspects of the specific construct in question (Smith, 2005).

3.8. Reliability of the instrument

The questionnaire was pre-tested on seven selected respondents who shared the same characteristics as the actual group to ensure its reliability. This was done to ensure consistency and dependency of the research instrument and its ability to tap data that answered the objectives of the study. Next, the five-point scale in determining its reliability was subjected to a reliability analysis from which the Cronbach's coefficient alpha was computed. According to Hair et al. (2010), the acceptable lower limit for the Cronbach's alpha is usually considered to be 0.7. A Cronbach's alpha of 0.845 obtained which is above the recommended threshold value of 0.7 confirmed the reliability of the five-point scale measurement.

3.10. Data analysis procedure

The quantitative data collected from the field through the use of structured closed ended items were analyzed on a Statistical Package for Social Sciences (SPSS) version 20 and Microsoft Excel software. Inferential and descriptive statistics were engaged in the data analysis process. One sample T test, factor analysis, Cronbach's coefficient alpha and correlation tables under the realm of inferential statistics were used to draw conclusions, reduce datasets, test reliability, establish differences and relationships accordingly.

One sample T test was used to establish the significant difference in opinions of respondents in assessing the level of understanding of value engineering among construction practitioners in Ghana. Factor analysis was also used to summarise the data appropriately to underlying dimensions in dealing with the reasons for non-adoption of value engineering in Ghanaian construction industry as well as the main factors that encouraged its implementation. Again, Cronbach's coefficient alpha accounted for the reliability of the five-point scale. Moreover, correlation tables were used to demonstrate the relationship between variables responsible for non-adoption of value engineering in Ghanaian construction industry. The tool was then again used to show the relationship that existed between factors that encouraged the implementation of value engineering in the Ghanaian construction industry.

On the other hand, descriptive statistics which deals with frequencies and percentages were applied. The demographic characteristics of respondents were analysed through this process.

In ranking the main factors that encourage the implementation of value engineering, the Mean Relative Analysis (MRA) was adapted. This institution was based on the 5-point Likert scale from highly encourage to strongly discourage. The mathematics was done with the formula;

$$Mscore= (5n_5+4n_4+3n_3+2n_2+1n_1)/ (n_5+n_4+n_3+n_2+n_1)$$

Where n_5, n_4, n_3, n_2, and n_1= number of respondents who answered from strongly encourage to strongly discourage.

The Function Analysis System Technique (FAST) Model for the implementation of value engineering in the Ghanaian construction industry was designed with underlying factors obtained through factor analysis from data for the third objective (factors that encouraged the implementation of value engineering in the construction industry).

CHAPTER FOUR

RESULTS AND ANALYSIS

4.1 Introduction

This chapter contains the description of results analyzed from the data collected for this survey. The layout of this chapter is consistent with the objectives of this study. The demographic characteristics of respondents form the first part. The second part bears on the outcome obtained from respondent's level of understanding of value engineering in the Ghanaian construction industry which also is contained in the first objective. Results on the reasons for non-adoption of value engineering in the construction industry which constitute the second objective is presented in the third part. The fourth part constitutes the results achieved from factors that encourage the implementation of value engineering in the construction industry then again summing up the third objective with the last part which settles on the FAST model development for the implementation of value engineering in the construction industry also concluding the fourth objective

4.2 Demographic characteristics

Table 4.1 provides information on the demographic characteristics of respondents used in the survey. It focuses on the respondent's academic background, professional background, relativeness of their job to the construction industry and work experience.

Table 4. 1 Demographic characteristics of respondents

Characteristics	Categories/options	Frequency	Percentage
Profession	Architect	24	26.1
	Civil/ Structural Engineer	13	14.1
	Project Manager	20	21.7
	Quantity surveyor	21	22.8
	Contractor	14	15.2
Occupation relative to industry	General consultancy	43	46.7
	Architectural consultancy	16	17.4
	Quantity surveying firm	20	21.7
	Civil / Structural engineering consultancy	13	14.1
Education	BSc. Honors	53	57.6
	PG Diploma	11	12.0
	MSc/MEng	12	13.0
	M.Phil.	12	13.0
	PhD	4	4.3
Work Experience	5 years or less	17	18.5
	6 – 10 years	21	22.8
	11 – 15 years	45	48.9
	above 15 years	9	79.8

BSc. Honours came up as the highest academic qualification of the respondents (57.6%), followed by MSc/MEng and MPhil sharing the same spot each with (13%) as PG Diploma only made (4%). In terms of professional background, about quarter of the respondents were Architects (26.1%) with Quantity surveyors (22.8%) coming next, and then Project managers (21.7%), Contractors (15.2%) and Civil/structural Engineers (14.1%) following in a logical manner. Also, the respondent's occupation relative to the construction industry had General consultancy, Quantity surveying consultancy firm, Architectural consultancy and Civil/structural engineering consultancy accounting for 46.7%, 21.7%, 17.4% and 14.1% respectively. With regards to work experience, respondents who were 11-15 years totaled 48.9% and 6-10 years were also 22.8% with those who were 5 years or less just recording 18.5%.

4.3 Assessing the level of understanding of the concept of value engineering among construction practitioners in Ghana

Table 4.2 represents the descriptive analysis of the level of understanding of value engineering in the Ghanaian construction industry. The findings depict variation in the mean values clearly indicating a fall of some of the values below the hypothesized mean of 4.0. This mean value was taken as a measure of rating for agreement for each factor on the level of understanding of value engineering in the Ghanaian construction industry. This decision was influenced by the respondents' ratings on a 5-point Likert scale of between strongly disagree and strongly agree. Emanating from the responses, an impressive understanding of what value engineering is, can be said about the participants. Interestingly, two items; 'Quality control', recorded the highest rating with a mean value of 4.07 closely followed by 'Renewal of old ideas' also attaining a mean value of 4.00, rating them equal to the hypothesized mean of 4.00. This proof significantly attest to their understanding of what value engineering is, in the Ghanaian construction industry.

Table 4. 2 level of understanding of value engineering

Factor	Mean	SD	T	Sig.	Mean Diff	Remark
Cost cutting	3.89	1.094	-.953	.343	-.109	Don't Agree
Design review	3.85	.825	-1.77	.080	-.152	Don't Agree
Quality control	4.07	.899	.696	.019	.065	Agree
Reduction of project profit	3.73	1.168	-2.23	1.000	-.272	Don't Agree
Renewal of old ideas	4.00	1.059	.000	.028	.000	Agree
Reduction of quantities	3.74	1.047	-2.39	.488	-.261	Don't Agree
Use of cheap materials	3.58	1.424	-2.86	.065	-.424	Don't Agree

Source: Field Survey, 2017

Contrarily, opinions on five factors; Cost cutting (mean=3.89), Design review (mean=3.85), Reduction of project profit (mean=3.75) and Use of cheap material (mean=3.58) suggested between neutral to disagreement by respondents on what value engineering is in the construction industry in terms of their level of understanding.

Comprehensively, a pre-determined significance level ($p<0.05$) was used to pre-empt each item as statistically significant. Pegging at this p-value rendered Cost cutting ($p=0.343$), Design review ($p=0.80$), Reduction of project profit (p=0. 1.000), Reduction of quantities ($p=0.488$) and Use of cheap materials (p=0. .065) as statistically insignificant as their p-values exceeded the indicated significance level. It is therefore expedient by evidence from the preceding p-values to ascertain that, it is statistically insufficient to conclude the understanding of value engineering among respondents as simply Cost cutting, Design review, Reduction of project profit, Reduction of quantities and Use of cheap materials (Table 4.2).

4.4 Examining the reasons for non-adoption of value engineering in Ghanaian construction industry.

To arrive at a concrete conclusion regarding the reasons for non-adoption of value engineering in the Ghanaian construction industry, views raised by respondents on the various variables were streamlined to appropriate dimensions by the use of factor analysis.

4.4.1 Factors responsible for the non-adoption of value engineering in Ghanaian construction industry

To highlight the reasons for non-adoption of value engineering in the construction industry, Table 4.3 provides a summary of results established using factor analysis to ascertain the reliability and confidence of the dataset. The eigenvalue of 1 or greater picked five factors which explained about 59% of total variance meeting the set standard of explaining 5%. Relatively, the breakdown of the accrued percentage explained individually gave 27.46%, 9.032%, 8.785%, 7.229% and 6.323% with each corresponding with component 1, component 2, component 3, component 4 and component 5 accordingly (Table 4.4). This relation was further consolidated by the scree plot displayed in Figure 4.1, which identified five factors also. Each component had at least two clusters of variables.

Table 4. 3 Total Variance explained

Total Variance Explained									
Components	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.139	27.46	27.46	7.139	27.46	27.46	4.509	17.3432	17.3432
2	2.348	9.032	36.492	2.348	36.492	36.492	3.064	11.7842	29.1274
3	2.284	8.785	45.277	2.284	45.277	45.277	2.912	11.1992	40.3266
4	1.879	7.229	52.506	1.879	52.506	52.506	2.615	10.0582	50.3848
5	1.644	6.323	58.829	1.644	58.829	58.829	2.195	8.4432	58.828

Extraction Method: Principal Component Analysis.

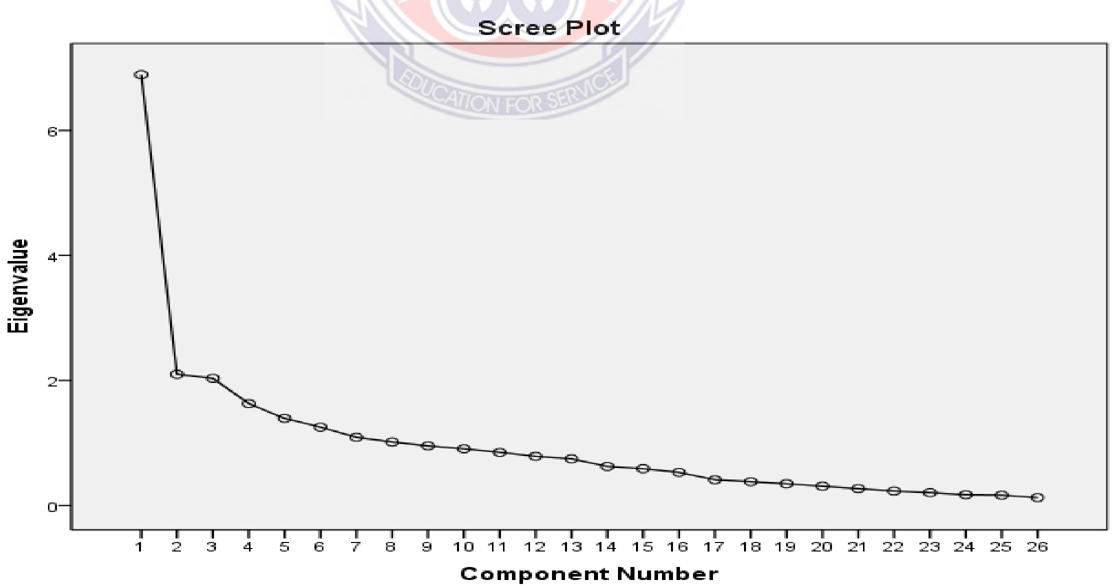

Figure 4. 1 Scree Plot

To ascertain the reasons for non-adoption of value engineering in the construction industry, Table 4.4 outlines a clearer picture of the factors loaded onto the various components using the Varimax method of rotation. In all, five components were established with the first component receiving the highest number of factors (9 factors) loading onto it.

Table 4. 4 Factors responsible for the non-adoption of Value engineering

	Factors				
	1	**2**	**3**	**4**	**5**
Lack of legislation providing for the application of Ve in construction industry	**.723**				
Lack of professionals for construction works	**.655**				
Non-cooperative attitudes from other participants	**.643**				
Lack of contract provisions on implementations of VE between owners	**.643**				
Unqualified VE facilitators	**.555**				
Unstable economy	**.528**				
Lack of knowledge and practices	**.524**				
Technology level	**.510**				
Outdated standards and specification	**.422**				
Clients don't often pay for the services		**.757**			
Clients don't often request for the services		**.739**			
Not suitable for low cost projects		**.620**			
Procurement style		**.554**			

Inadequate finance/ funding	**.816**		
Inadequate knowledge of benefits of value management	**.678**		
Lack of understanding by client organizations	**.551**		
Lack of support and active participation from owners and stakeholders	**.549**		
Lack of culture to accept the change	**.524**		
Lack of theoretical basis to underpin the field of value engineering in higher institution of learning		**.688**	
Inadequate time to test appropriateness of the ideas generated		**.587**	
Lack of local guidance and information		**.584**	
Non-involvement of building services contractors		**.557**	
Lack of trained professionals in Value management			**.805**
Lack of VE experts			**.738**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 10 iterations.

These factors constituted; Lack of legislation providing for the application of Value engineering in construction industry (0.723), Lack of professionals for construction works (0.655), Non cooperative attitudes from other participants (0.643), Lack of contract provisions on implementations of VE between owners (0.643), Unqualified VE facilitators (0.555), Unstable economy (0.528), Lack of knowledge and practices (0.524), Technology level (0.510) and Out dated standards and specification (0.422). This essentially agrees with the designated significant value staged at 0.40 for this analysis. The second component had four factors loading onto it which included; Clients don't often pay for the services (0.757), Clients don't often request for the services (0.739), Not suitable for low cost projects (0.620) and Procurement style (0.55). The third component equally had five factors loading onto it which consisted; Inadequate finance/ funding (0.816), Inadequate knowledge of benefits of value management (0.678), Lack of understanding by client organizations (0.551), Lack of support and active participation from owners and stakeholders (0.549) and Lack of culture to accept the change (0.524). Next was the fourth component also having four components loading onto it. These were; Lack of theoretical basis to underpin the field of value engineering in higher institution of learning (0.688), Inadequate time to test appropriateness of the ideas generated (0.587), Lack of local guidance and information (0.584) and Non-involvement of building services contractors (0.557). The fifth and sixth components each had two factors loading onto each. Loaded under the fifth component were; Lack of trained professionals in Value management (0.805) and Lack of Value engineering experts (0.738).

Table 4. 5 KMO and Bartlett's test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.714
Bartlett's Test of Sphericity	Approx. Chi-Square	921.127
	Df	325
	Sig.	.000

Adding more meaning to the variables analyzed, Table 4.5 presents an overview of results from the Kaiser- Meyer-Olkin measure of Sampling Adequacy (KMO) and the Bartlett's Test of Sphericity. The KMO value of 0.714 and the Bartlett's test (chi-square=921.127, df=325 and $p< 0.000$) significantly warrants factor analysis to proceed as it proves sampling adequacy and also provides enough evidence to reject the null hypothesis of identity matrix as in the case of the latter.

4.4.2 Relation between variables responsible for non-adoption of value engineering in Ghanaian construction industry

Table 4.6 displays a two-tailed non-directional spearman's correlation matrix on the reasons for non- adoption of value engineering in the construction industry. The table puts out the inter-relationship between variables, a preamble to consider before carrying out factor analysis. In this pursuit, the relationship between the variables is not only established but also an indication of the direction of the relationship. At ($p<0.05$) indicating the level of significance, mild multicollinearity was identified although majority of the variables correlated positively. This disclosure underpins the need to reject the null hypothesis of identity matrix. Eventually, Lack of knowledge and practice and inadequate time to test appropriateness of the ideas generated came up with the highest correlation coefficient of 0.437 in relation to the reasons for non-adoption of value engineering in the construction industry given no particular direction as used in this data analysis.

REASONS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Lack of local guidance and information	1																									
Lack of knowledge and practices	.090	1																								
Outdated standards and specification	.118	.340**	1																							
Lack of culture to accept the change	.077	.312**	.398**	1																						
Lack of VE experts	.337**	.370**	.093	.259*	1																					
Lack of legislation providing for the application of VE in construction industry	.000	.365**	.245*	.356**	.160	1																				
Unqualified VE facilitators	.087	.192	.177	.314**	.133	.512**	1																			
Lack of contract provisions on implementations of VE between owners	-.002	.260*	.294**	.357**	.083	.358**	.159	1																		
Lack of support and active participation from owners and stakeholders	-.086	.282**	.463**	.546**	.079	.189	.108	.417**	1																	
Lack of understanding by client organizations	.168	.296**	.355**	.379**	.148	.144	.177	.289**	.389**	1																
Clients don't often pay for the services	-.007	.294**	.220*	.254*	.134	.312**	.154	.162	.273**	.144	1															
Clients don't often request for the services	-.052	.110	.145	.165	.149	.296**	.044	.104	.188	.165	.470**	1														
Additional time and cost required to train team /participants	.194	.118	.259*	.224*	.162	.014	.264*	.210*	.116	.321**	.061	-.144	1													
Inadequate time to test appropriateness of the ideas generated	.225*	.437**	.406**	.368**	.111	.272**	.076	.286**	.263*	.301**	.302**	.079	.236*	1												
Non-involvement of building services contractors	.192	.364**	.401**	.158	.201	.294**	.108	.431**	.129	.295**	.055	.137	.188	.392**	1											
Lack of theoretical basis to underpin the field of value engineering in higher institution of learning	.273**	.198	.200	.107	.081	.139	.142	.133	.250*	.077	-.084	-.028	-.044	.265*	.454**	1										
Non-cooperative attitudes from other participants	.119	.198	.171	.182	.085	.091	.233*	.152	.317**	.287**	.279**	.168	.107	.180	.291**	.312**	1									
Technology level	.144	.111	.175	.225*	.031	.235*	.176	.409**	.253*	.090	.024	-.148	.238*	.155	.308**	.151	.266*	1								
Inadequate finance/ funding	.113	.141	.242*	.435**	.198	-.034	.122	.013	.270**	.268*	.039	-.050	.224*	.251*	.112	.155	.195	.133	1							
Unstable economy	-.113	.131	.183	.285**	.173	.169	.140	.259*	.279**	.344**	-.004	.184	.126	.145	.275**	.085	.259*	.069	.358**	1						
Lack of professionals for construction works	.255*	.198	.348**	.201	-.072	.294**	.183	.145	.154	.092	.213*	.327**	-.052	.172	.280**	.176	.221*	.161	-.098	.087	1					
Lack of trained professionals in Value management	.119	.267*	.209*	.299**	.434**	.106	.129	.201	.130	.164	.221*	.094	.135	.100	.182	-.013	.094	-.030	.143	.040	.015	1				
Inadequate knowledge of benefits of value management	.172	.251*	.217*	.170	.268*	.060	-.092	.104	.108	.315**	.017	.055	.198	.141	.267*	.061	.064	.057	.353**	.158	-.013	.212*	1			
Not suitable for low cost projects	.000	.311**	.151	.202	.129	.157	.179	.075	.201	.167	.298**	.086	.115	.288**	.156	.287**	.090	-.211*	.193	-.023	-.173	.132	.106	1		

Procurement style	.169	.228*	.313**	.301**	.208*	.247*	.133	.180	.137	.165	.124	.222*	.174	.273**	.353**	.194	.106	.111	.086	.131	.322**	-.053	.007	.266*	1	
Interruption on normal work schedule	.135	.120	.306**	.172	.185	.166	.252*	.219*	.141	.321**	.151	.098	.266*	.089	.265*	.208*	.217*	.205	.288**	.273**	.116	-.008	.053	.274**	.475**	1

4.5 Main factors that encourage the implementation of value engineering in the Ghanaian construction industry.

In the quest to identify the factors that encourage the implementation of value engineering, the variables coined from the questionnaire were subjected to a Mean relative analysis. The outcome in Table 4.7 shows weight and rank obtained by each item dependent on the ratings obtained by each using Mean Relative Analysis to access variables that encourage the implementation of value engineering on a 5-point scale from highly encourage to highly discourage.

Table 4. 7 Ranking of variables that encourage the implementation of value engineering

FACTORS	1	2	3	4	5	TOTAL	∑W	Mean	Rank
Reduced wastage of resources	3	2	4	39	44	92	395	4.29	1
quality improvements	1	2	8	41	40	92	393	4.27	2
Create new ideas for improved outcomes	1	4	8	47	32	92	381	4.14	3
Reduce conflict and risks	0	2	16	41	33	92	381	4.14	3
Efficient labour	0	6	11	39	36	92	381	4.14	3
Create a climate of shared understanding	3	1	13	38	36	91	376	4.13	6
A better definition of program or project objectives	2	1	14	44	31	92	377	4.10	7
Early improvement	2	2	11	53	24	92	372	4.04	8
A better understanding of needs and the functions necessary to meet those needs	3	3	12	43	31	92	371	4.03	9
Savings can be redirected to add value	0	5	16	43	28	92	370	4.02	10
Improved communication between the parties	0	4	19	40	29	92	370	4.02	10
Local material usage	2	3	16	41	30	92	370	4.02	10

FACTORS	1	2	3	4	5	TOTAL	∑W	Mean	Rank
Programmers can be staged or phased, allowing progress	2	4	16	41	29	92	367	3.99	13
time savings (schedule savings)	3	6	14	35	33	91	362	3.98	14
cost reductions	4	2	13	47	26	92	365	3.97	15
Client insight into the project	1	5	19	39	28	92	364	3.96	16

Clearly presented in the results, it is observed that the top five items that distinguished themselves as the most important factors that encourage the implementation of value engineering included; Reduced wastage of resources, Quality improvements, Creating of new ideas for improved outcomes, Reduction of conflicts and risk and Efficiency in Labour.

Accordingly, reduced wastage of resources was the most important factor that encouraged the implementation of value engineering with mean value of 4.29 and ranked first. Next most important factor was Quality improvements getting a mean value of 4.27 and placing second on the rank. Creating new ideas for improved outcomes, reducing conflicts and risks as well as Efficiency in labour were ranked third most important factors that encourage the implementation of value engineering with each securing mean value of 4.14

Inversely, the least important factor that encouraged the implementation of value engineering was Client insight into the project which had a mean value of 3.96.

4.5.1 Relationship between factors that encourage the implementation of value engineering.

Table 4. 8 Relationship between factors that encourage the implementation of value engineering

Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cost reduction	1																
Time saving	.420**	1															
Quality improvements	.253*	.472**	1														
Reduced wastage of resources	.268**	.271**	.500**	1													
A better understanding of needs and the functions necessary to meet those needs	.471**	.280**	.323**	.470**	1												
Create new ideas for improved outcomes	.356**	.249*	.480**	.268**	.431**	1											
Create a climate of shared understanding	.338**	.267*	.413**	.517**	.464**	.368**	1										
Reduce conflict and risks	.157	.111	.445**	.495**	.280**	.345**	.509**	1									
A better definition of program or project objectives	.274**	.146	.334**	.249*	.349**	.412**	.332**	.418**	1								
A better definition of program or project objectives	.162	.234*	.212*	.172	.267*	.254*	.119	.228*	.510**	1							
Programmers can be staged or phased, allowing progress	.244*	.318**	.229*	.267*	.288**	.387**	.375**	.289**	.194	.318**	1						
Client insight into the project	.295**	.209*	.197	.254*	.430**	.391**	.434**	.245*	.454**	.400**	.439**	1					
Savings can be redirected to add value	.114	.270**	.339**	.248*	.226*	.377**	.278**	.281**	.280**	.282**	.417**	.504**	1				
Improved communication between the parties	.242*	.182	.138	.219*	.434**	.162	.346**	.180	.392**	.225*	.168	.444**	.407**	1			
Early improvement	.267*	.254*	.299**	.132	.359**	.339**	.173	.207*	.491**	.345**	.284**	.284**	.204	.270**	1		
Local material usage	.279**	.223*	.250*	.216*	.086	.242*	.314**	.355**	.258*	.234*	.227*	.225*	.177	.225*	.295**	1	
Efficient labour	.284**	.177	.445**	.429**	.390**	.227*	.489**	.420**	.290**	.303**	.191	.404**	.264*	.311**	.245*	.323**	1

The correlation matrix pre-requisite to the performance of factor analysis is displayed in Table 4.8. Most of the variables correlated above 0.3 and none is seen not correlating with each other. Moreover, a mild multicollinearity is noticed which in turn is significant enough to reject the null hypothesis of identity matrix. The highest correlation coefficient gave 0.489 existing between efficient labour and creating a climate of shared understanding at a significant level of ($p<0.05$).

4.6 Function Analysis System Technique (FAST) Model for the implementation of value engineering in the Ghanaian construction industry.

In fulfillment of this objective, a FAST Model was designed from the data collected for the third objective centering specifically on the degree of ratings from each participant on the variables. Through the use of factor analysis, these variables were named under respective components through which they emerged.

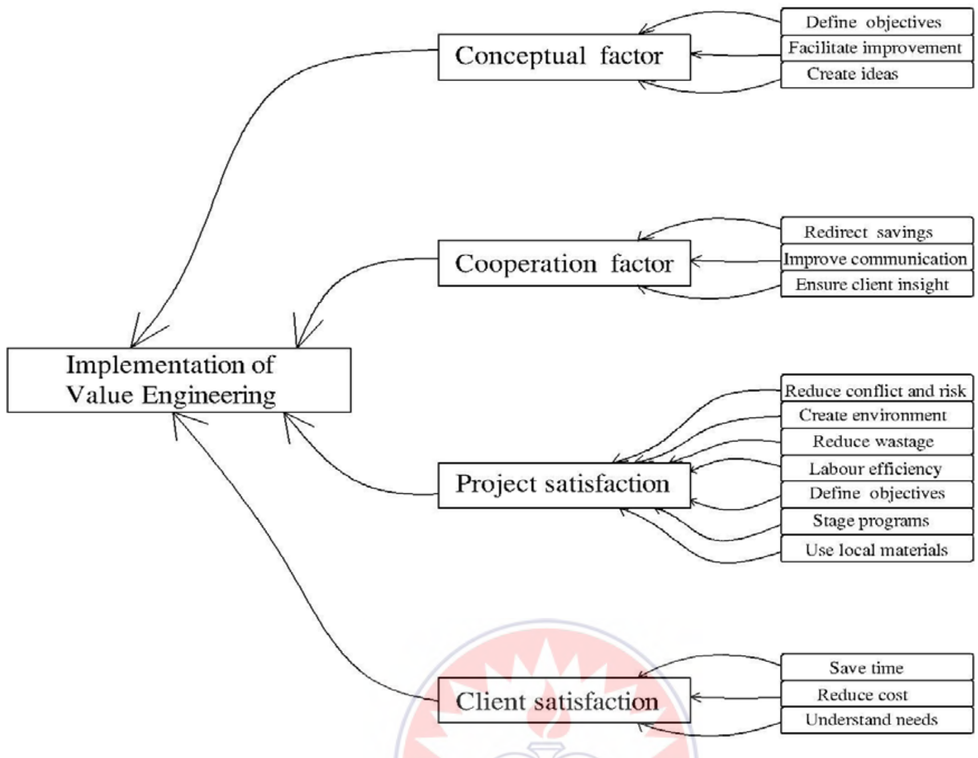

Figure 4. 2 FAST Model

4.6.1 Factor Analysis

To assess the factors that encourage the implementation of value engineering in the construction industry, Table 4.9 gives the results acquired after running factor analysis on the dataset. Five factors explained a total variance of 66.82% with all meeting the 5% mark of variance each factor needs to explain. Also, the eigenvalue of 1 or more gave four factors. By inspection, the scree plot shown in Figure 4.3 endorsed the factors obtained by the eigenvalues as it adequately points to four factors.

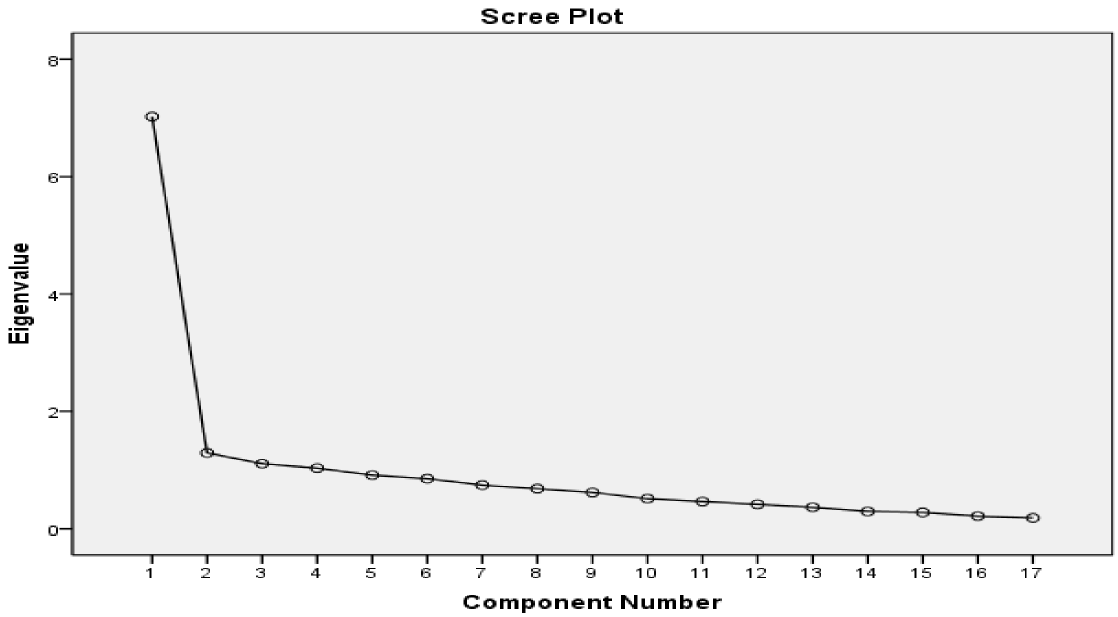

Figure 4. 3 Scree Plot

Table 4. 9 Total Variance explained for factors extracted

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.021	41.300	41.300	7.021	41.300	41.300	3.094	18.200	18.200
2	1.293	7.607	48.907	1.293	7.607	48.907	2.722	16.012	34.212
3	1.108	6.521	55.428	1.108	6.521	55.428	2.209	12.992	47.205
4	1.032	6.070	61.498	1.032	6.070	61.498	2.126	12.509	59.714
5	.914	5.374	66.872	.914	5.374	66.872	1.217	7.159	66.872

The expected adequacy required to carry on with factor analysis is presented in Table 4.10. The KMO value of 0.86 and the Bartlett's test (chi-square=668.527, df=136, p<0.000) affirms the suitability of factor analysis to continue.

Table 4. 10 KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.860
Bartlett's Test of Sphericity	Approx. Chi-Square	668.527
	Df	136
	Sig.	.000

Table 4.11 stages the loadings of the variables onto its constituent factors using the Varimax method of rotation. From the table, six variables loaded onto factor one which are; Reduce conflict and risks (0.752), Create a climate of shared understanding (0.734), reduced wastage of resources (0.709), efficient labour (0.699), Programmers can be staged or phased, allowing progress (0.456) and Local material usage (0.430). A better definition of program or project objectives (0.831), Early improvement (0.714) and Creating new ideas for improved outcomes (0.683) are the three variables that loaded onto factor two. Equally, three variables are seen loading onto the third factor which are; Time saving (0.791), Cost reduction (0.770) and a better understanding of needs and the functions necessary to meet those needs (0.421). Lastly loading onto factor four are three variables; Savings can be redirected to add value (0.737), improved communication between the parties (0.675) and Client insight into the project (0.622).

Table 4. 11 Factor Analysis on the implementation of value engineering

	Factors			
	1	2	3	4
Reduce conflict and risks	**.752**			
Create a climate of shared understanding	**.734**			
Reduced wastage of resources	**.709**			
Efficient labour	**.699**			
Programmes can be staged or phased, allowing progress	**.456**			
Local material usage	**.430**			
A better definition of program or project objectives		**.831**		
Early improvement		**.714**		
Create new ideas for improved outcomes		**.683**		
Time saving			**.791**	
Cost reduction			**.770**	
A better understanding of needs and the functions necessary to meet those needs			**.421**	
Savings can be redirected to add value				**.737**
Improved communication between the parties				**.675**
Client insight into the project				**.622**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

Reliability of the test items

Table 4. 12 Reliability of test items

Cronbach's Alpha	No. of Items
.845	66

Table 4.12 shows Cronbach's Apha tested on 66 items. Obtaining a value of 0.845 places the items justifiable to make inferences and draw conclusions.

CHAPTER FIVE

DISCUSSION OF RESULTS

5.1 Introduction

This chapter presents the discussion of results presented in the preceding chapter. It argues out views and opinions as well as provides explanations to the issues raised in the survey, specifically in relation to the objectives outlined in the study. Clarifications are further given to these issues in ideas, theory, thought and philosophy with support from literature.

5.2 Reasons for non-adoption of value engineering in the construction industry.

The fundamental tenet adapted in summarizing or reducing data when dealing with large dataset is the use of factor analysis (Koutra et al., 2015). Acceptably, this technique was employed in this survey to establish the reasons for non-adoption of value engineering in the Ghanaian construction industry. This data reducing technique used in the study examined the associations between the variables based on the correlations between them and further explained these variables in terms of their common underlying factors (Yu et al., 2011).

Factor analysis is a statistical tool purposed to regroup variables into a limited underlying dimension based on shared variance (Milosan, 2016). Reichwein Zientek and Thompson (2006) add that, it possesses a core objective of summarizing data to facilitate its ease in understanding and better interpretation of relationships and patterns. Considering the reliability of this tool in this study, Hair et al. (1998) assigned a range of 20-50 variables deemed appropriate to carry out factor analysis, buttressing with a recommendation that, variables beyond this scope provides inaccurate factors typically in the extraction process. Comparative to this study, 33 reasons for non-adoption of value engineering in the construction industry were captured.

By requirement, factor analysis is determined by the sufficiency of the correlation matrix of variables involved (Li, 2008). Equally, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) and Barttlett's Test of Sphericity should both be tested on the dataset to confirm the suitability and adequacy to use the tool. The Barttlett's test (chi-square=921.127, df= 325, p<0.0000) was strong to reject the null hypothesis of identity matrix but rather justified a correlation matrix between the variables Table (4.4). Obtaining a KMO of 0.714 makes it imperative to continue with factor analysis as suggested by Amoah (2014) that as a general guide, the KMO value greater than 0.5 renders it adequate and satisfactory for factor analysis.

Under orthogonal rotation, varimax method of rotation was used to reduce the number of variables with high loadings as well as compressing smaller loadings further. The eigenvalue of 1 or greater as a rule of thumb identified five variables, reflecting the selected five factors that explained 58.829% of the total variance. This invariably coincides with the scree plot on the same number of factors after careful examination. This technique has been used for similar analysis by Kissi, Adjei-Kumi and Badu (2016), Kim et al. (2016) and Amoah (2014).

The existing factors for component one were; Lack of professionals for construction works, Non cooperative attitudes from other participants, Lack of contract provisions on implementations of VE between owners, Unqualified VE facilitators, Unstable economy, Lack of knowledge and practices, Technology level, Outdated standards and specification and Lack of legislation providing for the application of value engineering in construction industry was labeled **Knowledge barrier** and explained 17.3432% of the variance. Four factors were loaded onto the second component and they were; Clients don't often pay for the services, Clients don't often request for the services, not suitable for low cost projects and Procurement style. These factors explained 11.7842% of the variance and thus named **Demand barrier**. The third component that explained 11.1992% consisted; Inadequate finance/funding, Inadequate knowledge of benefits of value management, Lack of understanding by client organizations, Lack of support and active participation from owners and stakeholders and Lack of culture to accept the change also labeled as **Awareness barrier**. Factors like; Lack of theoretical basis to underpin the field of value engineering in higher institution of learning, Inadequate time to test appropriateness of the ideas generated, Lack of local guidance and information and Non-involvement of building services contractors settled for the fourth component explaining 10.0582% of variance. This subsequently was captioned **Readiness barrier**. Eventually, the fifth component had the following as their factors; Lack of trained professionals in Value management and Lack of VE experts. This component explained 8.4432% of variance and was named **Human resource barrier.**

5.2.1 Component one: knowledge barrier

The principal component described 27.46% of the total variance with four factors contributing to the non-adoption of value engineering in the construction industry. These were; Lack of legislation providing for the application of Value engineering in construction industry, Lack of professionals for construction works, Non-cooperative attitudes from other participants and Lack of contract provisions on implementations of VE between owners. Lack of legislation providing for the application of Value engineering in construction industry emerged as the highest loadings out of the nine factors that were loaded onto this component with 0.723. Accordingly, next to this factor were Lack of professionals for construction works (0.655), Non-cooperative attitudes from other participants (0.643) and Lack of contract provisions on implementations of VE between owners (0.643). The other relating factors were; Unqualified VE facilitators (0.555), unstable economy (0.528), Lack of knowledge and practices (0.524), Technology level (0.510) and out dated standards and specification (0.422). This component reveals one of the many reasons for non- adoption of value engineering in the Ghanaian construction industry. Knowledge in value engineering envelops its principles, applicability, methodology and its benefits. The barrier in knowledge creates a chain of unqualified value engineering experts, incompetent value management team, inadequate professionals, influx of wrong ideas and attitudes and others alike (Kim et al., 2016).

A study in Vietnam, which stands in the same bracket as Ghana in adapting value engineering in the construction industry confronted with this challenge started by employing human resources with experience and knowledge about value engineering for promoting and developing value engineering especially in the domestic construction industry (Kim et al., 2016). Achieving this, they introduced foreign certification system granted by SAVE international and also trained more value engineering experts. Adapting this intervention will enlighten and broaden the knowledge base of practitioners and encourage its adoption in the Ghanaian construction industry.

5.2.2 Component two: demand barrier

Awareness barrier under this principal component explained 9.032% of the total variance and consists of four factors loading onto it. Loading in descending order, it included; Clients don't often pay for the services (0.757), Clients don't often request for the services (0.739), not suitable for low cost projects (0.620) and Procurement style (0.554). Client's commitment as suggested by Al-Yami (2008) was among the five major hindering factors of value engineering implementation in Pakistan. Clients are often limited in knowledge as well as advice or guidance in value engineering application. A concern attributed extensively from the lack of value engineering experts, clients in a great deal take this value improvement technique as an embodiment of the whole project cost and many a time become reluctant in paying for this extra cost in implementing the process as they are completely naïve of its returning benefits. Sometimes blurred with the understanding of incurring extra cost, clients request for this approach is often stifled. Interestingly, many practitioners devoid of this practice rate the traditional procurement system of cost cutting even to the value engineering process. This sends a strong notification of their unawareness of the impact of this tool in the Ghanaian construction industry.

5.2.3 Component three: awareness barrier

The third principal component accounted for 8.785% of the total variance consisting of five factors. These comprised; Inadequate finance or funding (0.816), Inadequate knowledge of benefits of value management (0.678), Lack of understanding by client organizations (0.551), Lack of support and active participation from owners and stakeholders (0.549) and Lack of culture to accept the change (0.524). Inevitably, accepting change in our part of the world both in deed and practice is very challenging. Still glued to the traditional methods, it becomes uneasy to embrace value engineering into our system. Typical in practice is the use of Bill of Quantities (a key contract document for over a century and the reason for the development of quantity surveying as a separate profession) which gradually is diminishing (Potts, 2004).

A study in Europe by Kelly and Male (1993) emphasized surveyors in this area especially those in large private practice are expanding and diversifying from their traditional roles to a total process management service. Many in the Ghanaian construction industry fear this technique may scrap off their profession and even add little or no improvement to the traditional method. This belief has generated in them a hostile perception restraining them to assume this methodology therefore tend to exclude themselves in its support, participation or involvement in its implementation in the construction industry. Practitioners reluctant attitude in this way tend to obstruct its implementation in the construction industry. This is contended by Cheah and Ting (2005) that the lack of knowledge and awareness about value engineering is a major cause for its limited application.

As known, an intensive training by way of seminars and workshops for practitioners will bring them up to speed to the current trends and processes of value engineering in the construction industry (Concept of Value Engineering in Construction Industry, 2016).

5.2.4 Component four: readiness barrier

Principal component four had four factors loading onto it and explained 7.229% of the total variance. The factors were; Lack of theoretical basis to underpin the field of value engineering in higher institution of learning (0.688), Inadequate time to test appropriateness of the ideas generated (0.587), Lack of local guidance and information (0.584) and Non-involvement of building services contractors (0.557). Some practitioners in the Ghanaian construction industry as well as owners may have little or no idea of value engineering. Kim et al., (2016) suggest that, little awareness and too little of its application can result in lack of interest and confidence from both parties. Many owners still remain clouded as they equate cost cutting to value engineering. They argue that this technique consumes time and add extra cost to the project.

Overriding this barrier and making it beneficial to this group whiles aiming at improving awareness, seminars, training workshops should be organized to update and upgrade owners and practitioners in the construction industry. This can help them to better appreciate the need of value engineering so as to support and encourage its implementation (Naderpour & Mofid 2011).

5.2.5 Component five: human resource barrier

The principal component explained 6.323% of the total variance with two factors loading onto it. These factors were; Lack of trained professionals in Value management (0.805) and Lack of VE experts (0.738). Value engineering is not just “good engineering”, it is not a suggestion program and it is not a routine project or plan review (Prashant & Teli, 2015). It is a process which uses function analysis, team-work and creativity to improve value (Ahmed & Pandey 2016). The proceedings clearly indicate the features bonded to value engineering in terms of training, requisition, and sense of competency one has acquire to be qualified before applying value engineering (Naderpour and Mofid, 2011). Lack of experts can lead to lack of knowledge and lack of trained professionals in implementing value engineering in the construction industry (Kim et al., 2016).

A remedial to this barrier places responsibility on the Ghanaian construction industry to invite experts from countries advanced in this methodology to enlighten and train practitioners in this direction (Kemmochi & Koizumi, 2012). Again, engaging in exchange programs with such countries to learn and gain this body of knowledge which would lead to certification to be fully qualified in this field and in turn replicate this knowledge especially in the domestic construction industry (Zhang et al., 2009).

5.4 The need to implement value engineering in the construction industry

More on the attempt to institute the factors that encourage the implementation of value engineering, a subsequent analysis aimed at establishing the relationship between factors was conducted to arrive at a reduced set of factors which readily can be used in practice (Kim et al., 2016). Logically, factor analysis was applied to facilitate this process.

According to Lautre and Fernández (2004), factor analysis is used to uncover latent dimensions of a set of variables. It reduces information from a larger number of variables to a smaller number of factors. Factor analysis targets at selecting a subset of variables from a larger set based on which original variables have the highest correlation with the principal component factor (Balu & Furtuna, 2006). As a criterion in conducting factor analysis, it requires the existence of a correlation matrix among the variables. This claim is validated by the Bartelett's test of sphericity (Table 4.10). Producing a Bartelett's test of (chi-square=668.527, df=136, p<0.0000) testifies the expected inter-relationship among the variables, key for factor analysis to be carried out. A value of 0.860 given by the Kasier-Meyer Olkin (KMO) test clearly admits the adequacy of the survey data for factor analysis to proceed. The variables after the preliminary analysis were subsequently analysed using the principal component analysis and varimax rotation. Four factors were eventually extracted in the process. The assistance offered in choosing these factors included; obtaining an eigenvalue of 1 greater picking four factors, the scree plot also pointing out to four factors explaining 66% of the total variance (Kim et al., 2016).

The original factors representing component one was; Reduce conflict and risks, create a climate of shared understanding, Reduced wastage of resources, Efficient labour, Programmers can be staged or phased allowing progress and Local material usage. Explaining 18.200% of the overall variance, it was named **Project satisfaction factor**. The second component explained 16.012% of the variance and was labelled **Conceptual factor** and had the following factors loading onto it; a better definition of program or project objectives, early improvement and Create new ideas for improved outcomes. Component three explained 12.992% of variance having the following factors; Time saving, Cost reduction and a better understanding of needs and the functions necessary to meet those needs. This component was named **client satisfaction**. The fourth component explained 12.509% of variance and was called **Cooperation factor**. Under this component had the following factors loading onto it; Savings can be redirected to add value, Improved communication between the parties and Client insight into the project.

5.4.1 Component one: project satisfaction factor

The principal component explained 41.300% of the total variance with six factors loading onto it. They are; Reduce conflict and risks (0.752), Create a climate of shared understanding (0.734), Reduced wastage of resources (0.709), Efficient labour (0.699), Programmers can be staged or phased, allowing progress (0.456) and Local material usage (0.430). Value methodology is a structured discipline aimed at improving value (Mendes et al., 2017). It is a multidisciplinary team consisting of experts who oversee the activities of the whole process strictly against the opinions of individuals which in turn clamps down conflicts and risk anticipated in the working process.

As a team work and creative activity, this technique allows ideas to manifest where they are developed into alternatives to the original concept or design (Prashant & Teli, 2015). Influential enough, this structured tool subsequently leads to reduced wastage of material and improved communication among members all directed towards accomplishing the goals and objectives of the project. Equipped with this knowledge by practitioners would foster its smooth implementation in the construction industry (Zhang, Mao & AbouRizk, 2009).

5.4.2 Component two: conceptual factor

The principal component accounted for 7.607% of the total variance with three factors loading onto it. These included; a better definition of program or project objectives (0.831), early improvement (0.714) and creating new ideas for improved outcomes (0.683). Regarded as an organized approach, value engineering provides a practical guide for applying the principles of the value methodology in a consistent manner to improve value whiles preserving the basic functions (purpose of the project) (El Khatib, 2015). The purpose noted here indicates the projects objectives expected to be reached at the end of the project. As a team work approach, value engineering draws upon collective viewpoints, experience, and knowledge and identifies alternatives at the early stage of decision process to establish the basic information of the project before dedicating resources for its design and development (Ganiyu et al., 2015). Primarily, giving freedom to the misconstrued ideas and thoughts by practitioners and stakeholders about value engineering on the basics of its significance and application, understanding and enlightenment would prevail and the outcome greatly felt in the construction industry.

5.4.3 Component three: client satisfaction factor

The third principal component with three factors explained 6.521% of the total variance with these factors loading onto it; Time saving (0.791), Cost reduction (0.770) and A better understanding of needs and the functions necessary to meet those needs (0.421). Hegan (1993) points out that value engineering is a creative and disciplined process that endeavours to offer the client a reliable opportunity for cost savings without detriment to quality or performance. Elimination of unnecessary cost, maintaining value, quality and function are all directed to meet the client's requirements. Brown (2002) observed that value engineering studies frequently result in a 10% to 30% reduction in the total cost of a project and they often have a profound effect on the ultimate design. Clients understanding and involvement in the value process will impact immensely on the Ghanaian construction industry.

5.4.4 Component four: cooperation factor

The principal component recorded 6.070% of the total variance with three factors. These factors were; Savings can be redirected to add value (0.737), improved communication between the parties (0.675) and Client insight into the project (0.622). Value engineering is the process of improving value shares the role of pulling together a complete construction team and making them more effective and more efficient (Boorman, 2009). The benefit obtained from this systematic functional inquiry of product or services often extend beyond their functional improvements by creating more effective communications and teamwork among the stakeholders (Cheach & Ting, 2005).

Acclaimed as teamwork activity, value engineering can only begin by the client's initiation. Clients understanding of the process coupled with their expected roles and the associated benefits would provide a fair and transparent platform attractive for the implementation of value engineering in the construction process.

5.3 Factors that encourage the implementation of value engineering

Referencing from the results in Table 4, reduced wastage of resources was ranked first by the respondents. Save (2007), measures resources as materials, time, labour, price and others alike. Ribeiro (1999) opines that value engineering seeks to identify unnecessary cost in design items and in turn proposes alternatives to reduce life cycle cost whiles quality, function and performance of the design are maintained. This approach expresses a reduction in the cost-value-ratio of a design and aspires the increase of value through either an increase in functionality or a reduction of resources (Dekker & Smidt, 2003). This view is supported by Atabay and Galipogullari (2013) who explain that value engineering uses rationalist evaluation techniques that exposes unnecessary costs targeted to be eliminated from the project, so that a building's value is increased and resources (money, material and workforce) are not wasted. This proclamation makes it very rare and uncommon by practitioners to embrace this tool in the construction industry.

Quality improvement, another important determinant that encourages the implementation of value engineering was ranked second. Quality improvements, reduction of risk is just few of the benefits enjoyed besides improving the value of a product (Fermentini & Romano, 2011). This assertion is evidenced by Cerqueiro et al. (2011). Save (2007) elaborates further that, value engineering is a multidisciplinary group that houses professionals, experienced and experts in their respective fields. Such expertise keen on the project objectives will ensure that products and services comply with requirements according to set standards. A technique that ensures the quality of project is improved is pertinent to adapt in the construction industry.

The fundamental component from which value engineering is carved is derived from the ability to use alternate ideas and apply creativity to a project whiles focusing on reducing cost, improving product or both (Farrell & Simpson, 2009). This goes to expand the third ranked factor of creating new ideas which in the rightful place corroborates the implementation of value engineering in the construction industry. Prashant and Teli (2015) explain also that, as a problem-solving approach, value engineering requires creative and thinking abilities to fulfil its requirements. Encouraging critical thinking and creative minds in the construction industry positions this proposition significant in its implementation in the construction industry (Xue & Zhang, 2017).

Ranking fourth was reduction in conflict and risks. Value engineering follows a structured, disciplined procedure opposed to the interest and opinions of an individual (Hurka, 2001). This systematic process is carried out and supervised by experienced and expertise multidiscipline team pulled together from their respective disciplines (Assaf et al., 1996). With clearly defined project goals and objectives, the elimination of any obstructions and incompatibilities is prevalently on the high. This in totality goes to enhance its implementation in the construction industry (Prashant & Teli, 2015).

Fifth among the factors was efficient labour. Boorman (2009) suggests that value engineering is very influential in undertaking the responsibility of putting together a complete construction team and making them more effective and more efficient. Thompson and Rizova (2015) determines that value engineering allows weakness in operation to be eliminated thus halt the injection of capital into the operation which is of no value to the client but only creates cost. Value engineering is focused on ways of maximizing revenue. Maximizing revenue also is dependent on efficient labour (Moro, 2004). Knowledge of such correlation and its impact on the construction industry technically will boost its implementation.

5.5 Level of understanding of the concept of value engineering among construction practitioners in Ghana

A key concern of this study is to unearth the level of understanding of value engineering among practitioners in the construction industry. To establish this assessment, a one sample t-teat analysis was conducted on the dependent variables (Lu, Longnecker & Zhou, 2016).

A one sample t-test is a statistical procedure used to determine whether a sample of observations could have been generated by a process with a specific mean (Schmidt, Faldum & Kwiecien, 2017). The objective of a one sample t-test is to determine if the null hypothesis should be rejected given the sample data (Stokes, 2014). Pinned as significant at 0.05 and under a hypothesized mean of 4 or greater, quality control and renewal of old ideas emerged significant concurrent with the understanding of value engineering of practitioners in the construction industry. The mean ratings demonstrated the degree of statistical significance of one factor to another (Singh & Singh, 2008). Mario (2004) describes quality control as verifying that work and materials used satisfy the applicable standards as specified within the project objectives. This submission consequently falls in the ambit of value engineering as a tool that identifies unnecessary cost and determines to eliminate them from the project (Atabay & Galipogullari, 2013).

As a structured systematic procedure, any specified standard outlined in the project objective which does not lead to an increase in the projects value and resources are easily detected and dealt with (Green, 1994). Sharma (2012) hints moreover that, value engineering is not limited only to value improvement but also preserves the quality and function of the design. Maintaining quality in this regard places quality control as an element of value engineering attuned to its understanding by practitioners in the construction industry.

Renewal of old ideas was the next element emerging as the industries level of understanding of value engineering. Prashant and Teli (2015) puts value engineering as a process that uses creativity and team work to improve value of a design. Rather, practitioners argue that the introduction of this technique either improved an aspect of the design or made some adjustments but the main idea of the design's functionality and quality still remains. This they claim is no deviation viewing value engineering as renewal of ideas in the construction industry.

However, opinions pulled by respondents from Table 4.2 showed a strong disapproval to cost cutting, design review, reduction of project profit, reduction of quantities and use of cheap labour as the meaning of value engineering in the Ghanaian construction industry. According to Prashant and Teli (2015), value engineering is not typical cost reduction, in that it doesn't cheapen the product or service, nor does it cut corners. Similarly, Atabay and Galipogullari (2013) explain value engineering as not cost cutting but rather, a systematic method to improve the value of goods or product and services by examination of functions. Dutt (2002) maintains that value engineering is a management technique that seeks the best fundamental balance between cost, reliability and performance of a product, project, process or service. Agreeably, Jergeas and Revay (1999) point out that, value engineering is not cost cutting, reduction of quantities, cheaper materials or lower standards; nor is it quality control or 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. The ability of the practitioners to sideline the factors mentioned from the proceedings of this argument justifies their consciousness of the existence of value engineering in the Ghanaian construction industry.

5.6 FAST Model for the implementation of Value engineering

Figure 5.1 shows a FAST Model for implementing Sustainable Construction adapted from Al-Yami et al (2006).

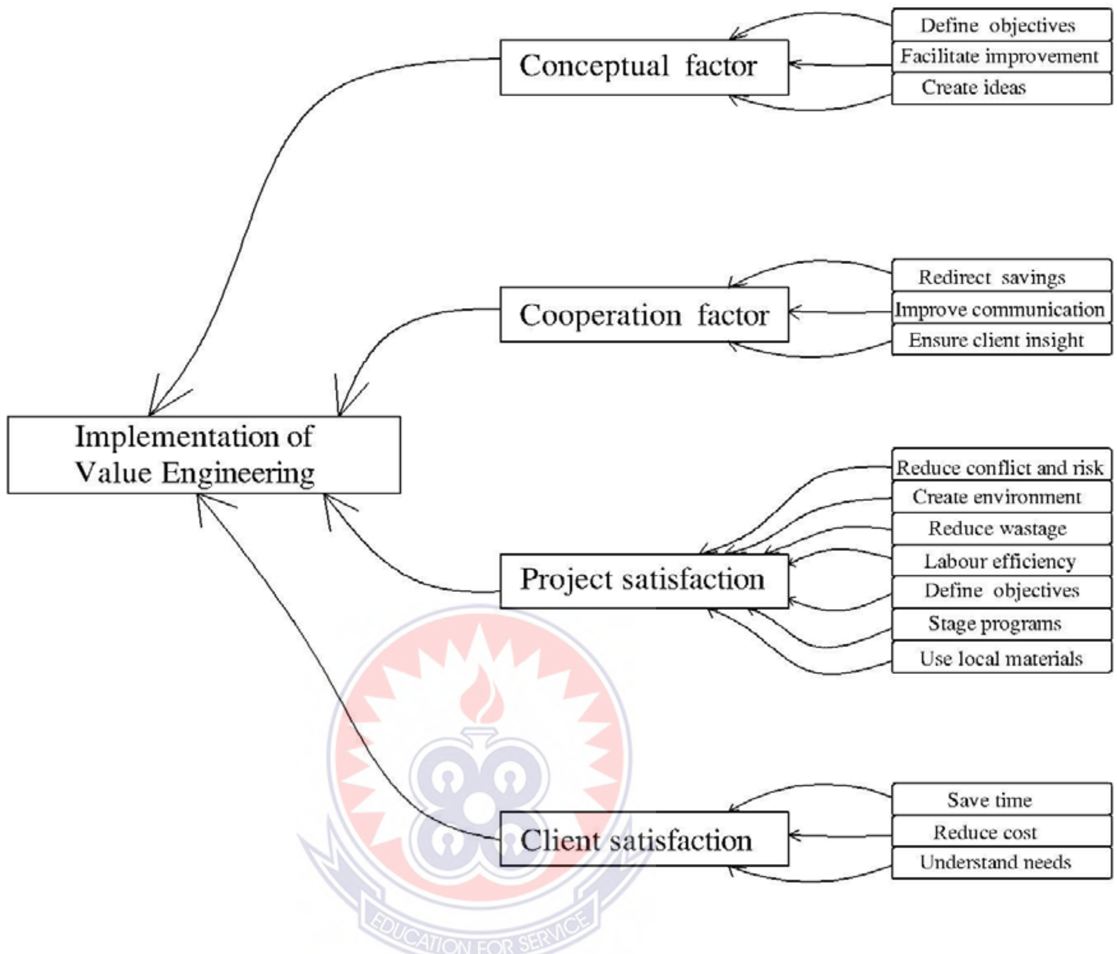

Figure 5. 1 FAST Model for implementing value engineering

Source: FAST Model for implementing Sustainable Construction adapted from Al-Yami et al (2006).

The FAST Model was synthesized through a review of literature and consolidated by data gathered through structured questionnaires from experts involved in the application of value engineering in the Ghanaian construction industry. The data collected for the third objective, that is, factors that encourage the implementation of value engineering was used and subsequently distilled through factor analysis to obtain the underlying factors emerging from an aggregate of related variables. The factors eventually were conceptual factor, cooperation factor, project satisfaction factor and client satisfaction factor. This model thus proposes an approach expedient in encouraging the implementation of value engineering in the Ghanaian construction industry. Adapted from Al-Yami et al (2006), this proposed model has considerable potential to accelerate the understanding and implementation of value engineering in the Ghanaian construction industry. In explaining the model, Al-Yami et al (2006) placed the output at the left hand side of the model and the input function at the right hand side of the model generally required as a rule of thumb in designing a FAST Models Figure 2.3. From his analysis the ultimate purpose or basic function; implementation of sustainable construction, is laid at the left hand side of the diagram and its three dimensions explaining it; environmental, social and economic factors, known also as the secondary functions, placed at the right hand side of the diagram respectively. Each of these factors bears underlying sub-functions that equally explains them and further contributes directly to accomplishing the ultimate or basic function. The environmental factor according to Al-Yami et al (2006) is explained through sub-functions such as; project environment as well as managing and sustaining resources. Project environment in turn is also explained by sub-factors such as; preserving biodiversity, minimizing global warming, depleting ozone, reducing acid rain, selecting site, minimizing pollution and eliminating toxicity. Also the function, managing and sustaining resources is explained through sub-factors like; conserving water, conserving energy selecting land and selecting materials. Al-Yami et al (2006) explained the other two underlying dimensions (social and economic functions) in a similar approach which technically, is all directed towards achieving the ultimate goal of implementing sustainable construction.

With an insight from his model however, some adjustments have been tailored contrary to its intended purpose to suit the demand of this survey. The original factors used for implementing sustainable construction have been modified a bit more to tally with the needs of this study. Factors such as conceptual factor, cooperation factor, project satisfaction factor and client satisfaction factor have replaced environmental, social and economic factors. In consonance with the detail of the model given by Al-Yami et al (2006) in their quest to implement sustainable construction, value engineering implementation in the Ghanaian construction industry is also explained through the same phenomenon. The ultimate or basic function, implementation of value engineering in the construction industry is placed at the left hand side of the model Figure 2.3. This function is explained by four underlying factors known also as secondary functions which include conceptual factor, cooperation factor, project satisfaction factor and client satisfaction factor placed evenly at the right hand side of the model. This exemplifies the fact that for value engineering to be implemented, it has to be through these four factors placed at the right hand side of the model Figure 2.3. In corresponding to the model by Al-Yami et al (2006), each of these four factors, that is, the secondary functions is explained by their underlying sub-factors. To achieve the implementation of value engineering in the construction industry according to the model, all the secondary function has to be fulfilled through their sub-functions which explains each of them. Chronologically, Conceptual factor has sub-functions such as, defining objectives, creating ideas and facilitating improvement. Cooperation factor has redirecting savings, improving communication and ensuring client insight as its sub-functions. Project satisfaction factor shares sub-functions such as, reducing conflict and risk, creating climate, reducing wastage, labour efficiency, staging programs and using local materials. Saving time, reducing cost and understanding needs also representing the sub-functions of Client satisfaction factor.

Regarding the conceptual factor, it implies that, the potential of value engineering in its ability to clearly define the projects objectives, develop the use of creative skills in coming up with ideas and alternatives in a team as well as its function of identifying and eliminating unnecessary cost at the early stages in improving the projects performance will stimulate practitioners on the need to practice this technique in the construction industry (Tang, 2013). Introducing value engineering to the project at initiation, establishing goals, budgets, and schedules conveys value engineering to be a beneficial contribution which is supposed to be encouraged and valued (Mansour & Hulshizer, 1997).

On the cooperation factor, Barrett and Stanley (1999) opines that, if construction participants want to improve their briefing performance they should concentrate on empowering the client, managing project dynamics, engaging appropriate user involvement, and developing team building. Client's reliance on their involvement in project briefings which is a key component of this technique and also doubles as a team approach SAVE, (2007) enforces a strong communication among its implementers. It focuses on a team other than an individual (SAVE, 2007). Instituting a rapport through this sense will propel its implementation in the construction industry.

Considering the project satisfaction factor, the significance incurred in the application of value engineering especially in leading to the attainment of a project's objectives is enormous (Shen & Liu, 2004). These benefits extend from reduced conflicts and risk, the use of local materials, reducing wastage of resources, efficient labour to creating a climate of shared understanding and others as related. A guarantee that ensures successful development of projects amid its advantages definitely will warrant its implementation in the construction industry (Atabay & Galipogullari, 2013).

Attending to the client satisfaction factor, Cheng et al (2006) defines client satisfaction as one of the major determinants of project success and therefore a fundamental issue for construction participants to constantly seek to improve their performance in order to survive in the market. Conversely, Prior and Szigeti (2003) claim that one of the most difficult challenges facing the construction industry is the need to refocus on clients requirements. When clients are confronted with the fact that value engineering possesses the tendencies of understanding their needs, saving their time and most importantly reducing cost of their projects, they are motivated to support and reinforce its implementation in the construction industry.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Summary of Finding

This research executed a survey to assess the feasibility of implementing value engineering in the Ghanaian construction industry. This appraisal was made manifest through clearly defined and specified objectives that formed the basis of the study. These were, assessing the level of understanding of the concept of value engineering among construction practitioners in Ghana, examining the reasons for non- adoption of value engineering in Ghanaian construction industry, identifying the main factors that encourage the implementation of value engineering in the Ghanaian construction industry and developing a framework for the implementation of value engineering in the Ghanaian construction industry. 92 valid respondents were used out of 117 questionnaires distributed for the study. These were drawn from a population of architects, contractors, civil/structural engineers, quantity surveyors and consultants. Data was collected through field survey from the respective respondents. Below are the findings under each specific objective accordingly.

6.1.1 Level of understanding of value engineering among construction practitioners

The study identified seven factors that valuated the level of understanding of the concept of value engineering among construction practitioners in Ghana. Employing a One Sample t-test technique with a hypothesized mean significant at 4.0, ‘Quality control’ and ‘Renewal of old ideas’ emerged significant as the meaning of value engineering regarding practitioner’s level of understanding. However, the other five factors from the findings which included, 'Cost cutting', 'Design review, 'Reduction of quantities' Reduction of quantities' and 'Use of cheap labour' came forth as insignificant to be ascribed as the meaning of value engineering by practitioners in respect of their level of understanding in the construction industry.

6.1.2 Reasons for non-adoption of value engineering in the Ghanaian construction industry.

In determining the reasons for non-adoption of value engineering in the Ghanaian construction industry, factor analysis was used to dimension 33 of the 37 factors captured in the survey which in turn were analysed further and categorized eventually into five principal components: (1) Knowledge barrier, (2) Demand barrier, (3) Awareness barrier, (4) Readiness barrier and (5) Human resource barrier.

6.1.3 Factors that encourage the implementation of value engineering in the construction industry.

An exploration was sought to identify the factors that encouraged the implementation of value engineering in the construction industry. In total, 16 factors were identified. Ranking them according to their mean and weight, 'Reduced wastage of resources', 'Quality improvements', create new ideas for improved outcomes', Reduce conflict and risks' and 'Efficient labour' came top as the five most dominant factors that encouraged the implementation of value engineering in the Ghanaian construction industry.

By using factor analysis, 22 of the 26 factors were analysed and subsequently classified into four principal components: (1) Project satisfaction factor, (2) Conceptual factor, (3) Client satisfaction and (4) Cooperation factor.

6.1.4 FAST Model for implementation of value engineering.

The four principal components, (1) Project satisfaction factor, (2) Conceptual factor, (3) Client satisfaction and (4) Cooperation factor that encouraged the implementation of value engineering were subsequently used to develop a FAST model for its implementation based on a framework for implementing sustainable construction in building briefing project adapted from Al-Yami et al. (2006).

6.2 Conclusion

Value engineering bestows a contemporary management technique aimed at eliminating unnecessary cost especially in the construction industry. Industries, particularly the construction industry where a great deal of capital is injected in its activities requires appropriate and systematic procedures in its execution in order to meet its target and budget. It is therefore imperative to adapt a more prudent method to meet this need particularly, in a country like Ghana where its economy is persevering to find its feet. This well-structured management tool, value engineering, already embraced by many countries in the construction industry possesses the potential to improve the cost of projects whiles maintaining its quality and function. The study in this direction sought to assess the feasibility of its implementation in the Ghanaian construction industry. The brain behind the study was to uncover an effective cost management technique that had the ability to relieve clients of the burden of heavy cost expended on building projects most importantly in times like this.

Dependent on the analysis of the data collected, it was revealed that most practitioners were conscious of what value engineering stood for in the light of their level of understanding. This was disclosed through their responses as they admitted that value engineering was not Cost cutting, Design review, Reduction of quantities, Reduction of quantities and Use of cheap labour. Conversely, quality control and renewal of old ideas rather were given as the meaning of value engineering in terms of their level of understanding.

Again, five main compounded factors were discovered as the reasons for non-adoption of value engineering in the Ghanaian construction industry. They were Knowledge barrier, Demand barrier, Awareness barrier, Readiness barrier and Human resource barrier. This discovery implies that, addressing these barriers adequately would positively influence its adoption by practitioners in the construction industry.

Moreover, advancing into the factors that encouraged the implementation of value engineering in the construction industry, five main factors were pointed out by practitioners as more pressing ahead of the other relating factors although they all accounted for the same merit. Notably were, reduced wastage of resources, Quality improvements, creating new ideas for improved outcomes, Reducing conflict and risks and efficient labour. Correspondently, it was identified that some factors through another approach also encouraged the implementation of value engineering. Numbering four, these factors were Project satisfaction factor, Conceptual factor, Client satisfaction and

Cooperation factor. Consequently, these factors were used to develop a FAST Model for the implementation of value engineering. It was also found that these factors were inter-related as the success of one influenced the success of the others.

The study therefore concludes that value engineering stands feasible to be implemented in the Ghanaian construction industry if the reasons to its non-adoption (Knowledge barrier, Demand barrier, Awareness barrier, Readiness barrier and Human resource barrier) are well attended to while taking a keen look at the factors that encourage its implementation (Project satisfaction factor, Conceptual factor, Client satisfaction and Positive relationship factor).

6.3 Recommendations

Based on the findings and discussions of the study, the following recommendations were put out:

1. The construction authorities and regulators should seek to develop the domestic human resources with knowledge and experience about value engineering. This can be consolidated additionally by introducing a foreign certification system such as Certified Value Specialist, Associate Value Specialist, and Value Methodology Practitioner granted by SAVE International. This will promote and develop its application in the construction industry.

2. Awareness creation must be intensified by practitioners or experts of this service in the country to our domestic industry. Enlightening them will afford people the opportunity to accept, support and participate actively in its implementation in the construction industry. Equally organising value engineering seminars and training

both to clients and practitioners will help them realize the significance and benefits of value engineering.

3. Government must outline a legislation to enforce the use of value engineering in building projects to promote its development like other developed countries. The United States, for instance, had implemented legally based on their laws as Public Law 104-106 - Section 4306 - Value Engineering for Federal Agencies, which stated that each agency shall establish and maintain cost effective procedures based on value engineering (Latief & Untoro, 2009).

4. Institutions pursuing construction programs must have value engineering inculcated in their course of study. Students in this field must be thought the practical application of this tool in eliminating unnecessary cost whose need in real times can readily be applied to the construction industry.
5. Construction authorities and regulators should engage practitioners in exchange programs with countries well advanced in the use of this methodology to learn from their experience to promote its implementation in the construction industry.

6.4 Limitation and Recommendations for future research studies

The entire structure regarding the methodology and design of this study were without limitations. Construction firms and consultancies practicing value engineering in the study areas were very difficult to locate owing to their limited number. It is suggested that the areas of study should be extended to construction firms and consultancies in other areas.

The following areas are recommended for further study:

1. Recognising the impact and need of value engineering in improving the management style used in the construction industry.
2. Roles of construction practitioners in implementing value engineering in the construction industry.
3. Suitability of value engineering on the management approaches in the Ghanaian construction industry.
4. Assessing the reality of value engineering on building projects as applied to the Ghanaian construction industry.

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APPENDICE

APPENDIX A

QUESTIONNAIRE

Osei Richard Kwadwo (Student ID No. 8151760013)

UEW-K Research Student

Department of Wood and Construction Technology

Kumasi

Tel. 024-5407892 Date: 21/04/2017

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Dear Sir/Madam,

RESEARCH QUESTIONNAIRE SURVEY

I am a final year student at the University of Education Winneba-Kumasi campus, carrying out a project on the topic **"THE FEASIBILITY OF IMPLEMENTING VALUE ENGINEERING IN THE CONTEXT OF THE GHANAIAN CONSTRUCTION INDUSTRY"**.

This questionnaire is intended to assess the level of understanding of value engineering, reasons for its non-adoption and factors that will encourage its implementation in the Ghanaian Construction Industry.

Your consent and help is being sought to enable me carry out this exercise for the betterment of our construction industry.

All information provided by you in this exercise is **strictly confidential** for academic purposes and no information will be disclosed without your consent.

Thank you.

Yours faithfully,

……………………………………..

QUESTIONNAIRE ON

THE FEASIBILITY OF IMPLEMENTING VALUE ENGINEERING IN THE CONTEXT OF THE GHANAIAN CONSTRUCTION INDUSTRY

There are **five parts** of the questionnaire:

Part A: Particulars of the respondent / General Information

Part B: The level of understanding of value engineering by construction practitioners.

Part C: The reasons for non-adoption of value engineering in the construction industry.

Part D: Factors that encourage the implementation of value engineering in the construction industry.

Part E: Recommendations for increasing understanding, acceptance and implementation of value engineering in the construction industry.

Osei Richard Kwadwo

(Research student)

MPhil. Construction Technology

UEW-K

For any question(s) or clarification, please contact me on

Tel. No. 0245407892

PART A: PARTICULARS OF RESPONDENTS (OPTIONAL) / GENERAL INFORMATION

Please answer the questions below by ticking **(√)** as appropriate

1. What is your academic qualification?

BSc. Honors [ ] P.G. Diploma [ ] MSc. /MEng [ ] MPhil. [ ] PhD. [ ]

2. What is your professional background?

Architect [ ] Civil/Structural Engineer [ ] Project Manager [ ] Quantity Surveyor [ ]

Contractor [ ] others, (please specify) ……………………………….

3. What is your occupation relative to the construction industry?

General consultancy [ ] Architectural consultancy [ ] Quantity Surveying firm [ ]

Civil/Structural Engineering consultancy [ ] Others (please specify) ………………….

4. Number of years in the profession (work experience)?

5 years or less [ ] 6 – 10 years [ ] 11 – 15 years [ ] above 15 years [ ]

PART B: THE LEVEL OF UNDERSTANDING OF VALUE ENGINEERING BY CONSTRUCTION PRACTITIONERS.

5. How do you assess the level of understanding of value engineering by construction practitioners? Rank on Likert scale of 1 to 5.

Please indicate (√) your level of agreement by ranking each option

5 = Strongly Agree 4 = Agree 3 = Neutral 2 = Disagree 1 = Strongly Disagree

SN	Factors	1	2	3	4	5
1	cost cutting					
2	Design review					
3	Quality control					
4	Reduction of project profit					
5	Renewal of old ideas					
6	Reduction of quantities					
7	Use of cheap materials					

PART C: REASONS FOR NON-ADOPTION OF VALUE ENGINEERING IN THE CONSTRUCTION INDUSTRY

6. The following are reasons for non-adoption of value engineering in the construction industry. Using a scale of 1-5, where 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree and 1 = Strongly Disagree; ***determine the reasons for non-adoption of value engineering in the construction industry by ticking (√).***

SN	REASONS	1	2	3	4	5
1	Lack of local guidance and information					
2	Lack of knowledge and practices					
3	Out dated standards and specifications					
4	Lack of culture to accept the change					
5	Lack of VE experts					
6	Lack of legislation providing for application of VE in the construction industry					
7	Unqualified VE facilitators					
8	Lack of time to conduct VE studies					
9	Inexperienced and incompetent VM team members					
10	The complexity of proposed projects to apply VE					
11	Lack of contract provisions on implementation of VM between owners					
12	Lack of support and active participation from owners and stakeholders					
13	Lack of understanding by client organizations					
14	Client's don't often pay for the services					
15	Clients don't often request for the service					
16	Resistance from design consultants					
17	Additional time and cost required to train clients' team/participants					
18	Inadequate time to test appropriateness of the ideas generated					
19	Non-involvement of building services					

	contractors					
20	Lack of theoretical basis to underpin the field of value engineering in higher institution of learning					
21	Non cooperative attitudes from other participants					
22	Greediness of the contractors and consultants.					
23	Technology level.					
24	Inadequate finance/funding.					
25	Unstable economy.					
26	Lack of professionals for construction works.					
27	Lack of trained professionals in value management.					
28	Inadequate knowledge of benefits of value Management.					
29	Construction methodology.					
30	Not suitable for low cost projects.					
31	Procurement style.					
32	Interruption to normal work schedule.					
33	Professional incompetence.					

PART D: FACTORS THAT ENCOURAGE THE IMPLEMENTATION OF VALUE ENGINEERING

7. What factors encourage the implementation of value engineering?

Please rank (√) the following factors on the merit at which they encourage value engineering using a scale of 1-5. 5= Highly Encouraged, 4= Encouraged, 3= Neutral, 2=Discouraged 1= Highly Discouraged.

SN	Factors	1	2	3	4	5
1	cost reductions					
2	time savings (schedule savings)					
3	quality improvements					
4	isolation of design deficiencies					
5	Reduced wastage of resources					
6	A better understanding of needs and the functions necessary to meet those needs					
7	Improved operational efficiencies					
8	Create new ideas for improved outcomes					

9	Enhance the skills of the participants					
10	Create a climate of shared understanding					
11	Reduce conflict and risks					
12	A better definition of program or project objectives					
13	Programmers can be staged or phased, allowing progress					
14	Client insight into the project					
15	Savings can be redirected to add value					
16	Risks can be better forecasted and understood by all					
17	Improved communication between the parties					
18	Expedited decision making					
19	Responsiveness to client's priorities					
20	Proper construction					
21	Early improvement					
22	Local material usage					
23	Adapting proper method					
24	Efficient labour					
25	Material Quality					

PART E: RECOMMENDATIONS FOR INCREASING UNDERSTANDING, ACCEPTANCE AND IMPLEMENTATION OF VALUE ENGINEERING IN THE CONSTRUCTION INDUSTRY.

8. Please add any comment(s) or suggestion(s) geared towards increasing understanding, acceptance and implementation of value engineering in the construction industry..
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Thank You!