AN INTEGRATED TOTAL QUALITY MANAGEMENT MODEL FOR THE GHANAIAN CONSTRUCTION INDUSTRY

A thesis presented

by

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DEDICATION

This thesis is dedicated to my late parents (Mr. and Mrs. Owusu Ansah), and my elder brother (Mr. Felix Yaw Acheampong), and most especially to my wife (Lucy Ansah). I thank them for their support and love. Without their patience, understanding and encouragement this study would not have been completed.

DECLARATION

I**,** Ansah Kwame Samuel, declare that "An integrated Total Quality Management model for the Ghanaian construction industry" is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references. The thesis is submitted in fulfilment of the requirements of the degree Doctor of Philosophy in Engineering Management.

________________________ ________________________

Samuel Kwame Ansah **Date**

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ABSTRACT

This research project investigated and modelled Total Quality Management (TQM) for the Ghanaian construction industry. The primary aim of the research was to model the extent to which Leadership/Top Management features, Company Supplier Quality Management features, Client Focus and Involvement features, Company Quality System Evaluation features, Company Vision and Plan Statement features, Product Design Management features, Product Selection Management features, Construction Process Management and Improvement features, and Construction Employees' Involvement and Motivation features predict TQM for the construction industry, these factors being classified as the exogenous variables. Mixed-methods research which involved both Qualitative and Quantitative approaches was adopted for the study. Empirical data was collected through a Delphi study and a field questionnaire survey. Analysis of results from the Delphi study was done with Microsoft Excel to output descriptive statistics. A conceptual integrated TQM for the Ghanaian construction industry model was based on the theory developed from literature review findings and the Delphi study. A questionnaire survey was conducted among the top management working in the construction industry in Ghana. From the 641 sample questionnaires, 536 questionnaires were returned which represents 83.62 per cent. An exploratory factor analysis (EFA) was conducted on the initial eight-factor constructs and their variables to determine their reliability for their inclusion in the confirmatory factor analysis (CFA). Nine-factor constructs were realized after the EFA factor loading test. Further, CFA was conducted on these nine-factor constructs using structural equation modelling (SEM) software with Eqations (EQS) version 6.2 software programme to validate and determine their reliability and inclusion in the final model. Findings from the literature on TQM studies revealed the theory that TQM implementations and practices and the latent variables lead to TQM in the construction industry. Findings from the Delphi study revealed that several factors (Leadership/Top Management features, Company Supplier Quality Management features, Client Focus and Involvement features, Company Quality System Evaluation features, Company Vision and Plan Statement features, Product Selection and Design Management features, Construction Process Management and Improvement features, and Construction Employees' Involvement and Motivation features) were considered to be the most important determinants of TQM in the Ghanaian construction industry. Both findings revealed that TQM could be considered as an eight-factor model defined by the influence of TQM practices and experts in construction industry. Findings from the field questionnaire survey revealed that the hypothesis on TQM constructs had an influence on TQM in the construction industry and could not be rejected. Hence, it was found that the SEM results on the model's goodness-of-fit and statistical significance of parameter estimates met the cut-off criteria for the hypothesized model's fit to the sample data. The study's contribution to the body of knowledge is significant because it addresses the lack of theoretical information about which factors are most significant in predicting TQM. Also, the study developed a new holistically-integrated model for the prediction of TQM for the Ghanaian construction industry. The current integrated model advances that TQM for the Ghanaian construction industry is a nine-factor construct. Another noteworthy contribution to the body of knowledge is in the methodology adopted. Hence, this study offers a base for other researchers to use as a follow-up for future studies. The study recommends that construction firms and all stakeholders involved in construction works should consider the empirically tested constructs when planning and implementing TQM programmes as this will enhance the quality of the implementation of TQM in construction industry.

Keywords: Total Quality Management, Construction Industry, Structural Equation Modelling, Latent Variables, Top Management, Ghana

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LIST OF ABBREVIATIONS

AAA	Aggrissive Affirmative Action
ADF	African Development Fund
AIT	Asian Institute of Technology
ANC	African National Congress
ANOVA	Analysis of Variance
BSc	Bachelor of Science Degree
BTech	Bachelor of Technology Degree
CDM	Construction Design and Management
CEIM	Construction Employees Involvement and Motivation
CFA	Confirmatory Factor Analysis
CFI	Client Focus and Involvement
CFI	Comparative Factor Index
CI	Construction Industry
CI	Confidence Interval
CIDB	Construction Industry Development Board
CII	Construction Industry Indicators
CIOB	Chartered Institute of Building
CIP	Contractor Incubator Programme
CPMI	Construction Process Management and Improvement
CQM	Construction Quality Manager
CQSE	Company Quality System Evaluation
CSFs	Critical Success Factors
CSIR	Council for Scientific and Industrial Research’s
CSQM	Company Supplier Quality Management
CVPS	Company Vision and Plan Statement
DF	Degree of Freedom
DK	Building and Civil Engineering Contractors
DPhil/PhD	Doctor of Philosophy Degree
DPW	Department of Public Works
DSc	Doctor of Science Degree

DTI	Department of Trade and Industry
ECDP	Emerging Contractor Development Programme
EFA	Exploratory Factor Analysis
EFQM	European Foundation for Quality Management
EPWP	Expanded Public Works Programme
EQA	European Quality Award
EQS	Equations
ESDS	Employment and Skills Development Services
EU	European Union
FV	Full Variable Model
GCI	Ghanaian Construction Industry
GDP	Gross Domestic Product
GFI	Goodness-of-Fit Index
GH¢	Ghanaian Cedi
GLM	General Linear Modelling
GSS	Ghana Statistical Service
HND	Higher National Diploma
ICT	Information Communication Technology
IGM	Interacting Group Method
IQD	Inter-Quartile Deviation
ISO	International Standard Organisation
JIT	Just-In-Time
LM	Lagrange Multiplier
LTM	Leadership and Top Management
MAD	Average (Mean) Absolute Deviation
MANOVA	Multivariate Analysis of Variance
MBNQA	Malcolm Baldrige National Quality Award
MCAR	Missing Completely at Random
MSc	Master of Science Degree
MTech	Master of Technology Degree
N	Sample Size

n.d.	No Date
NDPW	National Department of Public Works
NFI	Normal Fit Index
NGT	Nominal Group Technique
PDCA	Plan, Do, Check, Act
PSDM	Product Selection and Design Management
QC	Quality Control
QA	Quality Assurance
QI	Quality Inspection
QMS	Quality Management Systems
RDP	Reconstruction and Development Programme
RML	Robust Maximum Likelihood
RMSEA	Root Mean Square Error of Approximation
S- Bχ2	Satorra-Bentler Scaled Chi-Square
SAPOA	South African Property Owners' Association
SEM	Structural Equation Modelling
SETA	Sector Education and Training Authority
SME	Small and Medium Sized Enterprises
SON	Standard Organization of Nigeria
SPC	Statistical Process Control
SPSS	Statistical Package for Social Sciences
SRMR	Standardised Root Mean Square Residual
STATKON	Statistical Consultation Service
Stats SA	Statistics South Africa
TLI	Turker Lewis Index
TOC	Theory of Constraints
TQC	Total Quality Control
TQM	Total Quality Management
TQMEF	Total Quality Management Efficient Model
UJ	University of Johannesburg
UK	United Kingdom

US$	United States Dollar
USA	United States of America
WLS	Weighted Least Squares

CHAPTER ONE

1 INTRODUCTION

1.1 BACKGROUND

The construction industry provides physical infrastructural and contributes to national socio-economic development in every country (Ofori, 2012) as well as creating a great deal of employment in both the public and private sector. It employs and utilizes up to 10% of the working population, contributes between 5 and 10% of the Gross Domestic Product (GDP) in all countries and is accountable for about half of the gross fixed capital formation (Ofori, 2012). Hence, the construction industry is considered as an economic backbone and major contributor to the GDP. On the other hand, Ofori (2012) emphasized that a period of low construction output can adversely affect the expansion of the general economy. In Ghana, the construction sector contribution to the GDP has shown an increasing trend from 8.5% to 11.8% from 2010 to 2013 respectively (Vibe Ghana, 2014) and this shows a sign of its growing importance in the development of the nation. The Ghana Statistical Service (GSS) report (2012) showed that the major contributors to the industry sector in Ghana are the construction sector, mining and quarrying, and water and sewerage activities, which recorded a growth of 19.2%, 5.2% and 0.6% respectively.

Even though the construction sector in Ghana has much strength, there are numerous problems as indicated by Ofori (2012) that have persisted for a long period. Foster and Pushak (2011) added that in spite of Ghana's achievement with increasing access regarding infrastructural services, the quality of service remains low. Nuamah, Manu and Manu (2013) supported this assertion and opined that the level of construction in Ghana is usually poor, particularly, in the public sector. Moreover, Buertey, Amoa and Adjei-Kumi (2011) asserted that about 95% of projects carried out in Ghana experience schedule delays. Nicco-Annan (2006) conducted a survey of the construction of office structures in Accra, Ghana, and discovered that the cost of the structures overruns was between 60% and 180% without taking inflation into consideration. There were also time overruns of between 12 and 24 months and in a few situations, the structures were still not able to be used because of some significant deficiencies. As a result of poor quality management, a great deal of time, money and resources are wasted on construction projects. Understandably, clients in the construction sector, which includes the Ghanaian construction sector, have become increasingly disappointed. What they see is irregularity and under-performance. What they obtain is often poor quality, overpriced and delayed projects (Ansah, 2011).

It is therefore very important that the construction sector in Ghana is improved to produce quality works in order to augment the growth of the national economy. It is also important for the construction companies in Ghana to provide consistent value and quality regarding the products that they construct in order to remain competitive in today's construction environment. One of the ways of accomplishing this is by the application of TQM principles in the construction industry. However, the construction industry in Ghana has been slow in the implementation of TQM technique, probably owing to the reluctance to change old management techniques. Rategan's (1992) study indicated that a 90% enhancement rate in employee relations, customer satisfaction, financial performance and operating procedures is realized due to the implementation of TQM. Moreover, studies by Low and Jasmine (2004) on TQM confirmed a reduction in cost and better employee satisfaction that eventually boost client satisfaction.

Arditi and Gunaydin (1997) argued that TQM is a philosophy that involves all parties in the organization in the attempt to enhance performance. It spreads throughout every aspect of a company and makes quality a strategic purpose. Harrington and Voehl (2012) also indicated that TQM is a culture that strives for customer satisfaction through innovation and continuous improvement in every segment of the organization. The definitions of TQM are numerous, depending on the organizations' perception of quality. The definition of TQM in the BS 7850 is the company practices and management philosophy that seek to control the human and material resources of an organization in the most efficient way to achieve the goals of the organization (BSI, 1992). A report from the Asian Institute of Technology (AIT) indicates that TQM is a philosophy that reinforces the culture to foster continuous organizational enhancement through systematic, integrated, constant effort involving everything and everyone, focusing mainly on total satisfaction of internal and external customers, where employees work collectively in teams with process ownership, directed by a dedicated top management, which takes a proactive involvement (Nukulchai, 2003). On the other hand, British Quality Association defines TQM as a comprehensive business management philosophy focusing on entirely satisfying customer requirements with a maximum of efficiency and effectiveness (Wessel & Burcher, 2004). Another meaning of TQM which is utilized by USA Defence Department is that it is a philosophy and a set of directing concepts that signify the basis of a continually improving organization (Tingey, 1997).

Tang, Ahmed, Aoieoung and Poon (2005) indicated that the five core principles of TQM are continuous improvement, customer focus, employee participation, teamwork, and process Focus. These five principles are related to the five drivers of change suggested by the Egan (1998) report. These are committed leadership, integrated processes and teams, focus on the customer, commitment to people and quality driven agenda. Harris and McCaffer (2002), on the other hand, posited that TQM consists of all activities that managers carry out to improve their quality and strategy such as quality control, quality planning, quality improvement and quality assurance. It includes continuous improvement, training and re-training of staff, customer satisfaction, top management support, defect-free products at first attempt, elimination of reworks, and cost-effectiveness, amongst others.

Several researchers have verified the benefits and usefulness of TQM in the construction industry (Ahmed, 1993; Arditi & Gunaydin, 1997; Low & Jasmine, 2004; Harrington & Voehl, 2012). The benefits of TQM recognized by these researchers include improved employee job satisfaction, higher customer satisfaction, reduction in construction costs, improved schedule performance, improved relationships with subcontractors, reduced rework, improved safety, higher productivity, lower employee turnover, speeding up construction work. Other benefits of TQM recognized by these researchers include improved methods of working, better control over the construction process, gaining competitive advantage, increase profitability, decreasing waste and rework, more customers focused and better coordination of activities. Furthermore, their studies confirmed that the implementation of TQM may decrease the severity and frequency of schedule overruns.

Despite numerous benefits associated with TQM implementation in most developed countries, the principles of TQM are not employed in the construction industry in Ghana and this has led to high construction costs, low quality works and dissatisfied clients. In the quest of performance quality in the construction industries and with a growing awareness of the construction excellence, construction firms have no choice other than to ensure that clients obtain value for money. Hence, it is important that TQM is embraced in the Ghanaian construction industry in order to assist raise productivity and quality. Foster and Pushak (2011) suggested that Ghana may benefit from a systematic framework for regulating the quality of public services. However, such an objective demands that a continuous improvement process be instituted within the company in order to provide quality management. The continuous improvement process is referred to as TQM.

Lad and Beck (2009) emphasized that construction quality management such as TQM is the solution to an effective project delivery. Steyn, Basson, Carruthers, Du Plessis, Prozesky-Kuschke, Kruger, Van Eck, and Visser (2004:189) argued that quality never happens by itself: it is always an outcome of careful research into the requirements of the deliverables that will meet all the needs of the customers as well as the expectations of the stakeholders involved. Therefore the application of a TQM system in the Ghanaian construction may require extensive research to establish contributing and deliverable variables for its successful implementation. It should, however, be noted that a great deal of research has been carried out throughout the world on TQM. Despite extensive study on TQM in other countries, there is a scarcity of research on TQM in the Ghanaian construction industry. As a follow-up to the previous studies, this research was therefore undertaken to identify as much as possible the critical success factors that will help to develop a TQM model to guide TQM implementation in the Ghanaian construction industry, based on recognized TQM principles and existing frameworks. The study also discusses the implication of its findings on TQM and makes recommendations to improve the existing strategies of project management practices in Ghana.

1.2 THE RESEARCH PROBLEM STATEMENT

Performance of the Ghanaian construction industry is a major cause of concern amongst clients and stakeholders in the industry (Kwaw, Yalley, Cobbinah & Opintan-Baah, 2011). The background to this study has established that both private and public sector clients of the construction industry continue to complain about the industry's performance and its seemingly inability to deliver projects on time, within budget and to expected quality standards. Also, it was recognized that major clients are dissatisfied with consultants' performance in co-ordinating teams, in design and innovation, in providing a quick and reliable service and in providing value for money. The World Bank report (2004) indicates that in many developing countries, major investments are not generating the quality of the services demanded. Also, many of the infrastructure projects in these countries run over budget and take far longer than necessary to complete. Anvuur, Kumaraswamy and Male (2006) posit that both consultancy services and works in Ghana take extremely long to reach financial closure and are subject to unnecessary delay. This is because little attention has been given to TQM with regard to its implementation in the Ghanaian construction industry.

It has also been revealed that there is increasing global competition in the construction sector. Therefore, to remain competitive, Ghanaian construction firms have to focus their business strategies on strategic advantages through the improvement of business excellence and performance. Hence, in the pursuit of performance quality in the Ghanaian construction industries, there is a necessity for an efficient management system such as TQM. It has been emphasized that TQM practice is necessary for long-term survival in all business, including the construction industry. Nonetheless, in most developing countries and taking into consideration the Ghanaian construction industry, the principles of TQM are not employed owing to lack of knowledge and misunderstanding of its implementation. This has been confirmed by Imbeah (2012). Although real estate firms in Ghana are aware of the significance of quality, their knowledge about TQM is inadequate. Hence, it is essential that managers of construction firms have adequate knowledge of the management of time, quality, risk, and human resources, amongst others, in a bid to ensure a successful project completion and to meet clients' desires and expectations (Adusa-Poku, 2014).

As stated earlier, to enhance the quality of works and to reduce the cost of construction, the construction industry in Ghana needs proactive management methods (Western-oriented techniques) such as TQM. Unfortunately, such techniques of project management are not straightforward procedures that anyone can learn and implement. This is because of substantial cross-cultural problems and lack of understanding among construction professionals in applying the techniques in non-Western countries. Hence, the need for empirical evidence on reasons for lack of understanding and failure to use quality management techniques such as TQM in the Ghanaian construction industry and perhaps in other African countries with similar conditions, particularly third world countries, cannot be overemphasized. It should, however, be admitted that a great of research has been carried out throughout the world on TQM. Regardless of the extensive research on TQM in other countries, there is a lack of study on the implementation of TQM in the Ghanaian construction industry. This suggests that the application of a TQM system in the Ghanaian construction industry may require extensive research to establish contributing and deliverable variables for its successful implementation. This is important because quality always depends on an outcome of careful research into the requirements of the deliverables that will meet all the needs of the customers as well as expectations of the stakeholders involved. Based on the empirical evidence, recognized TQM principles and existing frameworks established in the study, a holistic TQM model can then be developed for the Ghanaian construction industry.

The problem that was resolved in this research is as follows: Given that the past designs of TQM established in the western world cannot be depended upon in developing nations, and the results of what decides TQM ideas in construction industry in developing nations are not known from the previously performed analyses as well as the lack of analysis into the overall effect of the direct and natural effective involvement of TQM constructs, the achievement of more consistent and high quality products that meet client/customer requirements in the construction industry is unlikely. The above problems are addressed in this study.

1.3 AIM OF THE STUDY

The aim of this study was to develop a holistic integrated Total Quality Management model for the Ghanaian construction industry. The study determined the critical factors that influence TQM implementation in the construction industry. The identified critical factors and the recognized TQM principles and existing frameworks guided the development of the integrated model for the Ghanaian construction industry. This integrated model will help construction companies in Ghana to offer more reliable quality and value to their customers/owners. Considering the increasing competitiveness in the construction sector and the need to be competitive in today's market, it is imperative that Ghanaian construction companies establish appropriate quality management techniques to reduce cost and increase the value or quality of their projects. Therefore an integrated TQM model will be an appropriate quality management technique in this regard. TQM can be a key element of a successful business but, if not properly implemented, can also lead to failure. Hence, the main objective of an integrated TQM model is to accomplish client objectives through continuous improvement of products and operations by full participation and commitment of all experts who are part of that product process.

1.4 RESEARCH MOTIVATION

The image of most contractors in the Ghanaian construction industry has been dented owing to their inability to fulfill their clients' specifications. This has led to a loss of the level of clients' satisfaction. It has therefore become relevant for contracting organizations in Ghana to establish a quality management system that will help to bring projects to a satisfactory completion within time, cost limitations and maintaining quality standards, with greater improvement in quality of construction, construction processes, and the level of clients' satisfaction.

TQM has been successfully employed in the Western economies but the question is whether this technique is applicable in Ghana. The growing weight of empirical evidence from cross-cultural management research suggests that Western management concepts may be wholly or partially inapplicable and irrelevant in other cultures. In addition, the use of such tool and technique in Africa with Ghana as a sub-region will not enhance project success if they run counter to cultural and work values. For the very reason that values at work and in social settings are culturally base. When dealing with human behaviour (i.e. managing) we must recognize the cultural context. The recognition of economic rationality and efficiency, assumed as basis for many project management tools and techniques does not reflect local realities.

Some quality gurus and project management writers such as Crosby (1979), Ishikawa (1985), Deming (1986), Feigenbaum (1991), and Juran (Juran and Gryna, 1993) in the Western Countries have developed certain propositions in the field of TQM, which have gained significant acceptance throughout the world. Their insights provide a good understanding of the

TQM philosophy, principles, and practices which they belief are straight forward procedures that anyone can learn and implement.

Contrary to the common belief that the Western-oriented techniques of project management such as TQM are just simple techniques that anyone can learn and apply, there are considerable cross-cultural problems and lack of understanding among construction experts in using the strategies in non-Western nations. Hence, the major elements that this research needs to consider and build into the proposed model are Company Vision and Plan Statement, Product Selection and Design Management, and Company Quality System Evaluation. It is important to adopt a system that offers a platform for these aspects to be incorporated and addressed. The motivation behind this research therefore was to establish techniques that could be employed to fill the gap in the Ghanaian construction industry.

1.5 SIGNIFICANCE OF THE STUDY

There is a substantial lack of understanding among construction professionals and individuals of the quality systems and tools that could be implemented in the Ghanaian construction industry to improve not only the end products, but also the processes and the overall system. It should however be noted that there are a number of techniques, such as six sigma, just-in-time and TQM that could be employed to fill that gap in the Ghanaian construction industry. These techniques were used elsewhere to improve the processes and products, ultimately resulting in more satisfied customers, which then led to increased productivity and profitability of the companies. TQM as a holistic or totality approach to quality represents a better way of solving the issues that are currently being face in the Ghanaian construction sector. Hence, the importance of this study was to develop an integrated TQM model to guide the implementation and the use of quality management concepts in the Ghanaian construction industry. Based on the proposed model, building professionals and individuals in the Ghanaian construction industry will have a better way of solving the problems that are related to construction quality. In addition, the data collected from the field survey can be used as a basis for future research as well as in longitudinal surveys.

1.6 THE RESEARCH

1.6.1 Research Questions

Based on the research problem statement and aim of the research, the following research questions emerged:

RQ1. What factors determine TQM implementation in the construction industry?

RQ2. What are the gaps in theories and literature on TQM implementation in the construction industry?

RQ3. What are the main and sub-attributes of TQM in the Ghanaian construction industry?

RQ4. What critical factors affect construction firms for not implementing TQM in Ghana?

RQ5. What constructs are required to reinforce the achievement of an integrated TQM model for Ghanaian construction industry?

RO6. To what extent does the hypothesized integrated TQM model fit into the identified model?

1.6.2 Research Objectives

In order to provide answers to the research questions and achieve the aim of the research, the following objectives are set:

RO1. To establish the factors that determines TQM implementation in the construction industry;

RO2. To investigate theories and literature on TQM implementation in the construction industry and identify the gaps that needs to be considered;

RO3. To determine the main and sub-attributes attributes of TQM in the Ghanaian construction industry;

RO4. To evaluate the critical factors that affect construction firms for not implementing TQM in Ghana;

RO5. To develop an integrated TQM model to guide construction firms in managing construction projects in Ghana; and

RO6. To determine the validity of the integrated TQM model through a comparative analysis of the Delphi and literature outcome with the field questionnaire survey outcome.

1.6.3 Research Methodology

Different methods of investigation were used in the research, such as quantitative and qualitative research designs, usually referred to as mixed-method design. This approach was used to answer research questions and meet the research objectives, as well as developing an integrated TQM model that applied to the study areas. The qualitative method used was made up of structured and semi-structured (using an interview guide) interview. This was possible through the use of the Delphi technique. The findings from this section helped to refine the survey tool (structural questionnaire) for the study. The Delphi technique was used to resolve conflicting issues on TQM in the study areas through consensus. With regard to the quantitative aspect of the study, a face-to-face administered questionnaire survey was conducted among Building and Civil Engineering Construction companies in Ghana. Data gathered via the questionnaire survey was analyzed using Structural Equation Modelling (SEM) software Version 6.2, which was used to assess the factor structure of the constructs. The conceptual variables were tested as a prior using the SEM of the questionnaire survey results. The SEM process was undertaken as Confirmatory Factor Analysis (CFA) of the prior model for an integrated TQM for the Ghanaian construction industry.

The research objectives were achieved through the following methods: Research objectives RO1 and RO2 were achieved through conducting a literature review on the subject in question. Research objectives RO3 and RO4 were achieved by conducting a Delphi survey. Research objective RO5 was achieved by conducting a field questionnaire survey.

Detail techniques used in the study were given under the research methodology section:

i. Quantitative Technique

Quantitative research is about quantifying the relationships between variables and finally measuring them. Statistical models were constructed to explain the observed variables. Certain characteristics (variables) were searched for and the study endeavoured to demonstrate something significant about how they were allocated within a certain population. The nature of the research determined the variables in which the researcher is interested. A variable needed to be measured for the purpose of quantitative analysis. Data was collected concerning many variables through a questionnaire survey. The variables in which the researcher was interested were dependent or independent.

ii. Qualitative Technique

The qualitative research technique allows the topics being researched to offer much ‘richer’ solutions to questions put to them by the researcher and can offer useful ideas which might have been missed by any other technique. Not only does it offer useful information to certain research questions in its own right, but there is a strong case for using it to complement quantitative research methods. For example if the area of interest has not been previously investigated, then qualitative research may be a vital forerunner. In conducting any quantitative research; for example, it is impossible to carry out a meaningful structured questionnaire survey if the important are not known. At the other extreme, qualitative research may also help to understand the findings of quantitative research.

iii. Structural Equation Modelling (SEM)

Structural equation modelling (SEM) represents an extension of General Linear Modelling (GLM) techniques, such as the Analysis of Variance (ANOVA) and multiple regression analysis. SEM was used to study the connections among latent constructs that are indicated by multiple measures. Sampling size is usually large (N >200) and is somewhat dependent on model complexity, the estimation method to be used, and the distributional characteristics of observed variables (Kline, 2005). The evaluation of two models from the Delphi survey and literature enabled the development of the TQM model for the Ghanaian construction industry.

iv. Mixed-Method Research

Mixed-techniques research includes the use of more than one approach to or method of design, data collection or data analysis within a single programme of research, with the incorporation of the different approaches or techniques happening during the programme of research, and not just at its finishing point (Johnson, Onwuegbuzie, Turner & 2007:120). Mixed-methods research is an investigation technique with philosophical presumptions as well as techniques of inquiry. As a technique, it includes philosophical presumptions that guide the route of the gathering and analysis of data and the mixture of qualitative and quantitative techniques in many stages in the study process. As a method, it concentrates on gathering, examining, and combining both quantitative and qualitative data in a single study or series of studies. Its main assumption is that the use of quantitative and qualitative techniques, in mixture, provides a better understanding of research problems than either strategy alone (Creswell & Clark, 2007). The quantitative data in a typical mixed-method includes closed-ended questions such as those discovered about mind-set, behaviour, or performance instruments. The collection of this kind of data involves using closed-ended guidelines, against which the researcher 'checks' the observed behaviour. Sometimes quantitative information is discovered in records, such as attendance records or census records. The analysis of the quantitative data consists of statistically examining ratings gathered on instruments and checklists to test hypotheses or to answer research questions (Creswell, 2003; 2010).

In contrast, typical qualitative data in a mixed methodology study consists of open-ended information that the researcher gathers through interviews with participants. The general open-ended questions to be used during interviews allow the participants to supply answers in their own words. These can be thematically analysed and converted into qualitative data, which can also be transcribed in quantitative data, such as the case of Delphi Studies where frequencies of measures of central tendencies are used to draw consensus. Also, qualitative data may be collected by observing participants or sites of research, gathering documents from a private or public source, or collecting audiovisual materials, such as videotapes or artifacts. The analysis of the qualitative data (words or text or images) typically follows the path of aggregating the words or images into categories of information and presenting the diversity of ideas gathered during data collection (Creswell, 2010).

The open- ended versus closed-ended nature of the data differentiates between the two types better than the sources of the data. The combination of both approaches (qualitative and quantitative) can offset the weaknesses of either approach when used itself. For instance, mixed method research provides more comprehensive evidence for studying a research problem than either quantitative or qualitative research alone. Also, researchers are given permission to use all of the tools of data collection available, rather than being restricted to the types of data collection typically associated with qualitative or quantitative research (Creswell, 2003). Further, Mixed Method research helps answer questions that cannot be answered by qualitative or quantitative approaches alone. It is also very practical because the researcher is free to use all methods possible to address a research problem. It can be used to increase the generalisability of the research result, which in this present day and age is a major consideration. It can also provide stronger evidence for a conclusion through convergence and verification of findings.

The review of literature on TQM provides the background to the study. Various sources were reviewed including books, articles in accredited journals, published and unpublished works such as dissertations, and web-based publications on the specified field of study. Two methods were used to collect the empirical data. These methods include the Delphi and field method or Questionnaire survey method. Detailed descriptions of both these methods are presented in the methodology chapter of the thesis. According to the Delphi technique, data was obtained through the use of structured questionnaires. Experts were asked to complete the questionnaires and reach consensus on the rated likelihoods and impact of various TQM factors. The process involved a three-round iterative process with the main aim of getting experts to reach consensus on the questions raised in the questionnaires. Experts were encouraged to give reasons for their dissenting views. The Delphi technique was used to explore the level to which the core attributes or sub-factors effect or affect TQM in the construction industry.

Data that was collected in the questionnaire survey was the evidence of factors of TQM concept, namely leadership and top management, company supplier quality management, client focus and involvement, company quality system evaluation, company vision and plan statement, product selection and design management, construction process management and improvement, and construction employees' involvement and motivation. In addition, data regarding TQM at project level was also required. The TQM was determined from perceptions of respondents. This included all top management working in construction firms in Ghana. The top management considered were those working on on-going projects. The data was obtained by means of questionnaires.

i. Data Sources

In the Delphi study, data regarding the ratings of the impact of factors on TQM was obtained from the expert panel. On the other hand, data from the questionnaire survey was obtained from top management working either for construction clients, designers or contracting organisations. The data related to on-going construction projects.

ii. Data Analysis

Data obtained from the Delphi was analysed with Microsoft EXCEL spreadsheet software. The output from the analysis was a set of descriptive statistics such as means, median, standard deviations and derivatives of these statistics. SEM was utilized using the EQS software packages to analyse data obtained from the field questionnaire survey. Outputs from the analysis were univariate and multivariate descriptive statistics as well as measures of goodness-of-fit of the hypothesised model. Other outputs included measures of statistical significance of parameter estimates.

1.7 CONTRIBUTION TO KNOWLEDGE

Generally, literature provided knowledge on TQM but most often these research studies were carried out in environments that were totally different from those of the developing countries and Ghanaian conditions. Hence, this research identified and evaluated the critical factors and issues that affect TQM implementation in the Ghanaian construction industry. After reviewing the existing TQM literature and critically analyzing the research results, it became clear that this study was the only one that consistently investigates the consequences and factors affecting TQM execution in Ghanaian construction companies.

In this research, new knowledge was generated from existing TQM knowledge integrated with specific characteristics of Ghanaian construction firms. This study has therefore delivered in-depth understanding of TQM implementation in the construction industry. Thus, new knowledge related to TQM implementation in construction firms has been derived. Specifically, the following contributions to knowledge were achieved:

- Extensive review of TQM literature from both developed and developing countries;
- Main factors and principles that underpinned TQM within the construction industry were determined:

- Critical factors and issues that impact TQM execution in Ghanaian construction firms were determined; and
- An integrated TQM model to guide construction firms in managing construction projects in Ghana was developed.

1.7.1 Value of the Study

The integrated TQM model which has been developed by this study will help construction companies in Ghana to offer more reliable quality and value to their customers or owners. It will also represent a more effective way of solving the problems that are related with construction quality and that are currently being face in the Ghanaian construction sector. An integrated TQM is a process of getting rid of poor quality from production rather than getting rid of poor quality products. It is a perspective that includes everyone in a company in constant efforts to improve quality and achieve customers' satisfaction. Continuous enhancement is the perspective that seeks to make continuous developments to the process of transforming information into results. Several researchers have revealed that the implementation of TQM concepts can allow companies to compete globally (Womack, Jackson & Roos, 1990; American Quality Base and Ernst & Young, 1991;Easton, 1993; Handfield, 1993; Hendricks & Singhal, 1996, 1997). Hence, with increasing global competition in the construction industry, the Ghanaian construction firms which are expected to participate on this global scale need to adopt the integrated TQM model which has been developed by this study to enable them to generate quality works, to be more effective, and to increase their competitive advantage.

1.7.2 Delimitations

This study concentrates on the TQM in the context of the Ghanaian construction industry. The reason for the selection of this area for the research is the role that the construction industry playss in the provision of infrastructure and development of the Ghanaian economy. The research concentrated on areas where quality in the construction industry needs to be applied such as workmanship, processes and materials because poor quality results in any of these areas can potentially lead to significant losses throughout the industry. Basically, the study is delimited to TQM in the Ghanaian construction industry with emphasis on the principles and practices of TQM, construction professionals' and top management's level of understanding and usage of TQM principles, as well as critical factors and issues that affect implementation of TQM. Finally, an integrated TQM model was developed to guide construction firms in managing construction projects in Ghana.

1.8 ETHICAL CONSIDERATION

Ethical issues were a key consideration in undertaking this research. The principle of voluntary participation was upheld. This requires that people would not be coerced into participating in research. Furthermore, participants were only involved in the research when they had given informed consent. Great effort was made to help protect the privacy of research participants by ensuring confidentiality by not making available identifying information to anyone who is not directly involved in the study. Confidentiality was further enhanced by keeping participants anonymous throughout the study. The study will also be subject to independent review by the promoters to help protect all participants and the researcher against potential legal effects of failing to address important moral issues or to uphold integrity, honesty and quality assurance.

1.9 OVERVIEW OF CHAPTERS

The compilation of the entire research project was organised as follows:

Chapter 1 – Introduction

The introductory chapter provides the background to the subject. It also communicates the importance of the research, problem statement, and guiding questions that were investigated. The delimitation, rationale/motivation of the study, purpose and objectives of the study were also presented in this section.

Chapter 2 – Theoretical and Conceptual Perspectives of TQM Research

This chapter reviews theories and concepts applied in this research regarding quality management practices and improvement measurement.

Chapter 3 – Gaps in the TQM Research

This chapter addresses the gaps observed in TQM research.

Chapter 4 – The Construction Industry and TQM

This chapter presents an overview of the construction industry and TQM in general. The chapter discusses types of construction undertaken by the construction industry and the working environment in the construction industry. This is significant because the working environment in the construction industry is crucial to its success. This chapter also describes how TQM is implemented in the construction industry and its associated issues such as benefits and critical success factors (CSFs) affecting its implementation.

Chapter 5 – TQM Implementation in Developed Countries

This chapter discusses TQM implementation in developed countries. The chapter specifically examines TQM implementation in China. The chapter also discusses the evolution of TQM and its implementation in developed countries. An evaluation of policies and government intervention with regard to TQM implementation is also presented. In addition, the views of quality pioneers in developed countries and their contribution towards the TQM concepts are highlighted in this chapter.

Chapter 6 – TQM Implementation in Developing Countries

This chapter discusses TQM implementation in developing countries. The chapter examines the construction industry in Nigeria and South Africa and how the TQM concept has been accepted in these countries. An evaluation of policies and government intervention with regard to TQM implementation is also presented. Furthermore, the philosophical basis for TQM implementation in Nigeria and South Africa is discussed. Also explored in this chapter are the challenges facing TQM implementation in the Nigerian and South African construction industries.

Chapter 7 – TQM Implementation in the Ghanaian Construction Industry

This chapter discusses TQM implementation in Ghanaian construction industry. The chapter looks into the construction industry in Ghana and how the TQM concept has been accepted by Ghana as a country. An evaluation of policies and government interventions with regard to quality management implementation is also presented. In addition, the philosophical basis for

TQM implementation in Ghana is discussed. Also explored in this chapter are the challenges facing TQM implementation in the Ghanaian construction industry.

Chapter 8 – Research Methodology

This chapter presents an outline of the way in which the research was designed and conducted. It describes the research tools and their design, the method for the data collection, the research technique used, the data treatment, the population, and the sampling design. It also indicates how the results are interpreted.

Chapter 9 – Results from Delphi Study

This chapter presents the results of the data analysis from the Delphi study.

Chapter 10 – The Conceptual Integrated TQM Model

This chapter presents the conceptual integrated TQM model of the study.

Chapter 11 – Survey Analysis

The chapter on survey analysis presents results of the empirical study. They are presented as statistical measures in literature, tables, charts and graphs. This chapter also presents the development of a TQM model for a holistic approach to construction quality management based on the outcomes of the study.

Chapter 12 – Discussion of Survey Results

This chapter presents discussions and an analysis of the findings presented in Chapter 11. Discussions are relative to the guiding questions. The chapter also presents test results and the analysis from the model test surveys.

Chapter 13- Summary of Findings, Conclusion and Recommendations

The summary presents summaries of all results from the literature, as well as the empirical study and the model validation surveys. Conclusions are made on the entire study. Based on the conclusions drawn from the study, recommendations are also presented in this chapter.

1.10 CONCLUSION

The first step in conducting the study is to acquire an understanding of the research study. Chapter 1 therefore introduced the subject of the research study and gave insight into the structure, the background and significance thereof. An outline of the technique adopted for the research was also provided. Furthermore, it relayed information on how the research report was presented. The perceived contribution to the body of knowledge has been provided as well. The motivation for the study was that TQM is a major challenge to the construction industry. It was noted that construction industry in Ghana is still lagging behind in terms of TQM. Therefore, it is necessary to develop an integrated TQM model to guide the construction contractors and construction professionals/managers in their daily routine in the management of construction projects.

CHAPTER TWO

2 THEORETICAL AND CONCEPTUAL PERSPECTIVES OF TQM RESEARCH

2.1 INTRODUCTION

This chapter discusses the review of theories and concepts applied in this research and followed with quality management practices and improvement measurement. To understand the theory behind quality management, it is necessary to be familiar with the process and how the interacting elements within the TQM theory work. This is explained in detail in this chapter.

2.2 THEORY AND DEFINITION

2.2.1 What is Theory?

Several definitions of theory exist within and across disciplines as indicated by Hamilton (1997). Moreover, Kinloch (1977), Silva (1977) and Dublin (1978) opined that there are many relevant terms such as conceptual framework, axiom, assertion, prediction, postulate, forecast, proposition, system, theoretical design and typology. These terms are occasionally used as synonyms for theory but have particular and often different definitions. The link of theory to research has been commonly argued and several definitions of theory are abundant. There is a universal accord that theory is important to consistently arrange and synthesise information, find out connections among variables, and guide the finding of new information to move research forward (Touliatos & Compton, 1988; Creswell, 2003). Without theory-based research, a discipline chaotically moves in every direction in the absence of an objective (Mitchell & Jolley, 1992). The link of theory to research techniques has been similar to the use of a roadmap when driving. "Without it, all roads look the same, you can never tell for sure where you are, you spend a lot of time making incorrect turns and losing your way, and when you get to where you are going, you may not know it" (Guy, Edgley, Arafat & Allen, 1987:64). This shows that advances in any field of study are unlikely without an understanding of theory and conceptual frameworks. Therefore, scientists can communicate their findings without any difficulty with sets of agreed upon concepts. In order to inform the model constructs for the present study on an integrated TQM model, previous theoretical frameworks are reviewed.

Lennon and Burns (2000:221) asserted that a theory "…allows us to describe and forecast behaviour, it also dictates which and whose behaviour are deserving of study and which should be omitted from the study". Theory development can take place through deductions or induction. In deduction, the researcher moves from theory to fact or from the general to the specific (Guy et al., 1987). Both qualitative and quantitative research techniques depend on theory. According to Creswell (2003:125), deductive theory is often used in quantitative research. "The researcher advances a theory, gathers information to test it, and reflects on the confirmation or disconfirmation of the theory by the outcomes." The theory becomes a framework for the whole research.

2.2.2 Theories towards the Implementation of TQM

2.2.2.1 Deming's Theory

The theoretical significance of the Deming approach to TQM concerns the creation of an organizational system that encourages learning and cooperation for facilitating the execution of process management practices, which, in turn, results in continuous enhancement of procedures, products, and services as well as employee fulfilment, both of which are necessary to client care, and eventually, to company success (Anderson, Rungtusanatham, & Schroeder, 1994). Edwards Deming motivated a thorough strategy to problem solving and promoted the commonly known Plan, Do, Check, Act (PDCA) cycle. The PDCA cycle is also known as the Deming cycle, although it was designed by a colleague of Deming, Dr Shewhart. The Deming cycle is a worldwide enhancement technique, the idea being to regularly enhance, and thereby decrease the difference between the needs of the customers and the performance of the process. The cycle is about studying and continuous enhancement, studying what works and what does not in a systematic way; and the cycle repeats; after one cycle has been completed, another is started. Deming also placed significance and liability on management at the individual and company level, knowing management to be liable for 94% of quality problems. Deming therefore insisted that management's responsibility is to build excellent systems that promote high quality management. He proposes that the reason for applying quality management techniques is to help companies stay in business and that quality improvement has to be led by management. His fourteen-point plan is a complete philosophy of management that can be applied to small or large organisations in the public, private or service sectors. He believed that the adoption of, and action on, the fourteen points were indications that management intended to stay in business (Anderson et al., 1994 in Tam, 2000).

2.2.2.2 Crosby's Theory

Philip B. Crosby is well-known for the theories of "Quality is Free" and "Zero Defects" (Crosby, 1979). He emphasized avoidance rather than after-the-event examination, doing things right the first time, and zero problems. Crosby asserted that errors are due to two reasons: Lack of facts and lack of concentration. Education and training can remove the first cause and an individual commitment to quality (zero defects) and concentration to detail will alleviate the second. He is another person acknowledged with beginning the TQM movement. He made the point, much similar to that of Deming, that if you spend money on quality, it is money that is well spent. Crosby's concept relies on four absolutes of quality management as follows (Crosby, 1979):

- Quality is defined as to sticking requirements,
- Prevention is the best way to guarantee quality,
- Zero defects (mistakes) is the performance standard for quality, and
- Quality is measured by the cost of non-conformity.

2.2.2.3 Joseph Juran's Theory

Joseph M. Juran is responsible for what has become well-known as the "Quality Trilogy". The quality trilogy is made up of quality planning, quality control and quality improvement. High quality management requires quality actions to be planned, improved and managed. The procedure accomplishes control at one level of quality performance, and then plans are made to improve the performance on a project-by-project basis. This activity eventually achieves breakthrough to an improved level, which is again controlled, to prevent any deterioration. He stresses that if a quality enhancement project is to be successful, then all quality enhancement actions must be well organized and managed. Juran also believed quality is related to client satisfaction or dissatisfaction with the product, and emphasised the need for ongoing quality enhancement through a succession of small enhancement projects carried out throughout the organisation. He concentrated not just on the end customer, but on other external and internal customers. Each person along the chain, from product designer to final user, is a supplier and a customer. In addition, the person will be a process, carrying out some transformation or activity (Juran &.Gryna, 1993).

2.2.2.4 Ishikawa's Theory

Originator of the last theory, Kaoru Ishikawa is often known for his namesake diagram, but he also developed a theory of how companies should handle their quality improvement tasks. Ishikawa takes a look at quality from a human viewpoint. He points out that there are seven basic tools for quality improvement, namely:

- **Pareto Analysis** - Pareto analysis enables to recognize the big issues in a process;
- **Cause and Effect Diagrams** - Cause and effect diagrams help to get to the main cause of problems;
- **Stratification** - Stratification examines how the information that has been gathered fits together;
- **Check Sheets** - Check sheets look at how often a problem happens;
- **Histograms** - Histograms observe difference;
- **Scatter Charts** - Scatter charts illustrate connections between different types of factors; and
- **Process Control Charts** - A control chart helps to determine what variations to focus upon (Ishikawa, 1985).

He considered these seven tools should be known commonly, if not by everyone, in an organisation and used to analyse issues and develop improvements. Used together they form an effective kit. One of the most well-known of these is the Ishikawa (or fishbone or cause-and-effect) diagram. Like other tools, it assists groups in quality improvements. It organises the minimal and major causes leading to one effect (or problem), describes the issue, and recognizes possible and potential causes by figuring out the possible ones. The diagram consistently symbolizes and analyses the real causes behind a problem or effect. It organises the major and minor contributing causes leading to one effect (or problem), defines the problem, and identifies possible and potential causes by figuring out the possible ones. It also helps groups to be systematic in the creation of ideas and to confirm that it has stated the direction of causation properly. The diagrammatic format helps when presenting results to others (Ishikawa, 1985).

2.3 THEORY ADOPTED FOR THIS STUDY

This study adopted Deming’s theory of profound knowledge which is a management philosophy grounded in systems theory. System theory is based on the principle that each organization is composed of a system of interrelated processes and people which make up system’s components. The success of all workers within the system is dependent on management’s capability to orchestrate the delicate balance of each component for optimization of the entire system (Bowen, 2010).The system of profound knowledge is based on system appreciation to understand the company's processes and systems, variation knowledge to understand the occurrence of variation and their causes, knowledge theory to understand quality programs and psychology knowledge to understand human nature. In Deming’s fourteen points, he proposed that among other points, management commitment, positive corporate culture, employee’s education and training and proper communication system is paramount in implementation of TQM. He further noted that if a company focuses on costs, the costs rise while quality deteriorates (Kenya Institute of Management, 2009). This is consistent with the theory of constraints discussed by Zadry and Yosuf (2006). The Theory of Constraints (TOC) which is a set of concepts, principles and tools that can be used to improve management of systems and maximize performance by identifying the most restrictive limiting factor that constraints the system’s performance and managing it. It focuses on improving performance rather than reducing costs.

This study is anchored on these two theories in that: it takes all the organizations’ systems to have a successful implementation of TQM and the organization performance is highly dependent on its ability to continuously improve on management of its systems.

2.3.1 System Theory

Systems theory is not a new concept. The notion of thinking about things in wholes rather than parts, have been discussed by early philosophers. Even then, some philosophers have varying perspectives on ways to view the world. For example, Aristotle pondered about the notion of wholeness, whereas Descartes supported the notion of breaking things down into smaller parts. Aristotle and Descartes viewed the living human body in different ways. Aristotle argued that the whole body is much more than the sum of its parts, while Descartes viewed the body as separate from the mind (Mazzochi, 2008). According to Aristotle, all things have several parts, and that the whole is different from its parts. Aristotle also talked about connections between bodies or elements that creates unity and one-ness (Cordon, 2013). This is evident in the following passage from *Metaphysics*, written by Aristotle: In the case of all things which have several parts and in which the totality is not, as it were, a mere heap, but the whole is something beside the parts, there is a cause; for even in bodies contact is the cause of unity in some cases, and in others viscosity or some other such quality. Aristotle argued that the whole living body is much more than the sum of its body parts (Cordon, 2013).

Conversely, according to Descartes, the mind is separate from the body; and that they are two separate entities. Descartes was the first to introduce reductionism to western thinking (Mazzochi, 2008). This reductionist approach to science, informed the work of Newton, and the development of Newtonian epistemology. This worldview states that complexities in the world can be resolved by analyzing and reducing phenomena to their simplest components (Mazzochi, 2008). Contrary to Aristotle's view, reductionism is a worldview that asserts that a complex system is nothing but the sum of its parts, and that it can be described by describing its individual constituents (Cordon, 2013). In the reductionist approach, individual factors within systems can be analyzed to get a better understanding of the larger whole. As stated previously, system theory is based on the principle that each organization is composed of a system of interrelated processes and people which make up system's components. Systems theories can be used as a framework to solve many complicated problems and system issues. Systems theories are also helpful in understanding organic systems, or systems involving living beings. As organic systems are always interacting with each other and with their environment, the system is always changing. Systems theories can help us better understand how changes in nature occur, for example in evolution. Systems theories can also be used to help us better understand how humans interact with each other, and with their environment, and the intricacies that exists within their systems.

According to Cordon (2013), a system is defined as "a regularly interacting or interdependent group of items forming a unified whole", and as "a group of devices or artificial objects or an organization forming a network especially for distributing something or serving a common purpose (Cordon, 2013). Meadows (2009) also defined system as "a set of things–people, cells, molecules, or whatever – interconnected in such a way that they produce their own pattern of behaviour over time" (Meadows, 2009). These definitions are consistent with other existing definitions of a system, as they share four common elements: (1) having a group of objects, molecules, or forces; (2) the relationships and interactions between the groups within their environment; (3) how these groups make up a larger whole; and (4) the function or purpose of the elements within the group, that affects the function or purpose of the group as a whole. Systems may be open or closed, simple or complex. A complex system is one that includes many other micro-systems, or a network of systems, thus forming a much larger and complex system. When a group of people are interacting together in an environment, much more complicated systems develop. These systems include socio-cultural systems, and symbolic systems. In addition, information systems, as part of this complicated system, also become much more complicated as new structures emerge, new relationships and social systems are formed, hierarchy and rules develop, and intangible elements, such as culture and beliefs, are created. Despite the complexities, all of these elements are interconnected and play a role with within a larger system (Meadows, 2009).

When looking at systems, it is important to look at the smaller components of the system, within the context of the larger system. Fundamentally, a system is made up of components that are interdependent of each other. By looking at the components in isolation, and without looking at the larger system as a whole, the whole system could collapse. The interdependency of each of the component means that minute changes to any of the component could result in a domino effect, thus ultimately changing the system as a whole. This is also true of large and complicated systems that are composed of smaller systems. Changes to the smaller systems cannot be made without taking into consideration its potential effect on the larger system.

According to Meadows (2009), a system can lose its 'system-ness' when the multiple inter-relations that held it together no longer function and dissipates (Meadows, 2009). Looking at the biological structure of a man, if the interconnected nerves stopped functioning, then the transfer of information and signals to the other organ systems will also not occur. For example, if the nerves that innervate the respiratory system and the cardiac system stopped sending signals to the heart and lungs, the heart and lungs will cease to function, ultimately causing death. Again, using the human body as an example, if the nervous system is only partially functional, then other interrelated systems will find ways to compensate for this partial loss, to make the larger system, which is the body, to continue its function. To elaborate on this further, if a small part of the nervous system is affected, such as damage to the 5th thoracic vertebrae of the spinal cord (T5 spinal cord injury), then the flow of information to parts of the body that are innervated by the nerves in that area will also be affected (Cordon, 2013). As the flow of information from the nervous system to other systems, such as the musculoskeletal and excretory system is incomplete, full function of the body will also be incomplete. Depending on the severity of the injury, individuals with this type of injury usually have complete bladder incontinence, and paralysis of the lower body and legs (Cordon, 2013). Although the upper body will try to compensate for the loss of function, other elements, such as a wheelchair, will need to be introduced to the system for the body to maintain homeostasis. In this context, homeostasis means preserving the person's ability to mobilize. Ultimately, the musculoskeletal system in the lower body will continue to deteriorate, and the wheelchair will take its place within this new system. The result is a new functioning system, that is adapted, but not quite the same as the old system. One of the greatest attributes of a system is its ability to change and adapt (Meadows, 2009). In construction organizations, which involve people, processes and structures, there are multiple types of systems that are involved. Each of the systems is inter-related with one another. Leaders need to be systems thinkers in order to facilitate sustainable change in their organizations.

2.3.2 Theory of Constraints

The theory of constraints (TOC) is a concept that emphasizes the role of constraints in limiting the performance of an organization. TOC drives managers to attack constraints in order to reach their primary goal. It focuses management's attention on the factors that impede system performance. It also provides an action framework that combines the activities of managers around a few highly visible system elements. Central to the TOC philosophy was that any organization (or system) has a constraint (or small number of constraints) which dominate the entire system. The secret to success lies with managing these constraints, and the system as it interacts with these constraints, to get the best out of the whole system.

The key to success can be found with handling these constraints and the ssystem as it communicates with these constraints to get the best out of the whole system. TOC has wide applications in production companies, but it can also be used successfully to increase efficiency in places outside of production, such as the construction industry. TOC can be used together with other management techniques such as TQM and just-in-time (JIT) to provide an extensive, connected set of methods that highlight continuous enhancement in all areas of operation (Goldratt, 1995).

There are numerous key principles underlying TOC. A few of these key principles are worth stressing because of their importance for implementing the management approach in organizations (Goldratt, 1995). The principles include the following:

- Processes/organizations are chains. This is critical to TOC. If processes and organizations function are regarded as chains or flows, the weakest links can be found and reinforced. The linkages in question can be between the different steps or activities in a process or between different organizations within a supply chain.
- Local versus system optima. Because of differences and interdependence, the best possible performance of a system as a whole is not the same as the sum of all the local optima. (Local optima are calculated measures for functional areas within an organization).
- Cause and effect. All systems operate in an environment of cause and effect. One event causes another to happen. This cause-and effect relationship can be very complex, especially in complex systems. Capturing the essence of cause and effect within the system and identifying measurements that emulate these relationships are the keys to optimizing system performance.
- Physical versus policy constraints. Most of the constraints experienced in systems develop from policies, not physical things. Physical constraints, such as the number of nurses in a hospital or the number of production machines in a factory, can be logically recognized and worked with. Policy constraints (e.g. behaviour patterns, attitudes, lack of information and assumptions) are possibly more destructive than physical constraints, yet are much more difficult to recognize and deal with. The perception that generating in large batches is optimal is an example of a policy constraint that can make applying TOC or related advanced manufacturing approaches challenging.

- Total system impact. All organizations are systems comprised of interdependent activities, each with its own level and type of variability. In order to optimize performance, management needs to understand and focus on the total system impact of an event or decision, not just on its local or immediate effects (Goldratt, 1995).

Revealing the main fundamental principles of TOC, the following five steps that create a framework for TOC implementation and utilization emerged (Goldratt, 1995):

- Step 1. Identify the system's constraints. The first phase is to recognize the constraint in the system that limits throughput or enhancement toward the objective.
- Step 2. Decide how to *exploit* the constraint(s). Make a decision on a plan for the main constraint that best facilitates the system's objective. This needs taking advantage of the existing capacity at the constraint, which is often wasted by making and selling the incorrect products, and by inappropriate policies and procedures for scheduling and controlling the constraint.
- Step 3. Subordinate everything else to the above decisions. Modify or handle the system's policies, processes, and/or other resources to support the above decisions. Management guides its initiatives toward enhancing the efficiency of the constraining task or activity and any other task or activity that directly impacts the constraining task or activity.
- Step 4. Elevate the constraint(s). Add potential or otherwise change the position of the unique resources as the prominent main constraint. In this phase, extra potential is acquired that will increase (elevate) the overall outcome of the constraining task or activity. This varies from step 2 in that the added output comes from additional purchased capacity, such as buying a second machine, tool, or applying new technology.
- Step 5. Return to step 1. Do not let inertia become the new constraint - go back to step 1, but do not allow past decisions made in steps 2 to 4 to become constraints. As a result of the focusing process, the improvement of the original constraining task or activity may cause a different task to become a constraining task or activity. Inertia could blind management to additional steps necessary to improve the system's output now limited by a new constraint (Goldratt, 1995).

The five concentrating actions allow management to remain targeted on what is vital in an organization - the system's constraint(s). Why is the constraint the most essential target? Obviously, it is the pacesetter for the entire system. No matter how fast the other elements can do their job, the system cannot produce at a rate quicker than its slowest element.

2.4 EMPIRICAL RESEARCH ON TQM RESEARCH

Globally, a considerable number of studies have been carried out in the area of TQM implementation. It was apparent that different scientists and researchers implemented different TQM definitions and frameworks, depending on their own understanding of TQM and research goals. As a result, there is little consensus on the meaning of TQM and what it comprises. TQM can be defined as a set of techniques and procedures used to remove or decrease variation from a production process or service-delivery system in order to enhance performance, quality and reliability (Steingard & Fitzgibbons, 1993). It incorporates fundamental management techniques, existing enhancement efforts, and the technical tools (US Department of Defense, 1988) under a disciplined approach focused on continuous improvement. Kanji and Asher (1996) posited that TQM is a consistent procedure of enhancement for individuals, groups of individuals, and whole firms. It has a set of four principles (delight the client, management by fact, people-based management, and continuous improvement) and eight primary concepts (customer fulfilment, internal customers are real, all work is process, measurement, teamwork, individuals make quality, continuous improvement cycle, and prevention). TQM can as well be described as the application of quality principles for the incorporation of all functions and processes within the firm (Ross, 1993). On the other hand, TQM can be defined as a management approach for an organization, focused on quality (ISO 8402, 1994), depending on the involvement of all its members and seeking long-term success through customer satisfaction and benefits to all members of the organization and to society.

Flynn, Schroeder and Sakakibara (1994) described TQM as an incorporated way of achieving and retaining high quality outcome, concentrating on the maintenance and continuous enhancement of procedures and problem prevention at all stages and in all functions of the firm to get to know or surpass client objectives. Ho and Fung (1994), however, argued that TQM is a way of managing to enhance the efficiency, versatility, and competition of a business as a whole.

It is also a technique of eliminating waste by including everyone in helping the way things are done. Vuppalapati, Ahire and Gupta (1995), on the other hand, posit that TQM is an integrative idea of management for consistently helping the quality of products and processes to accomplish client satisfaction. Hackman and Wageman (1995) consistently analyzed the three great quality gurus' (Deming, Juran, and Ishikawa) suggestions about TQM. According to their analysis outcome, the following five interventions are the core of TQM, namely precise recognition and measurement of client wants and needs; creation of supplier partnership; use of efficient teams to recognize and fix quality problems; use of scientific methods to observe efficiency and recognize points of high leverage for efficiency improvement; and use of process management heuristics to improve team efficiency.

Choi and Eboch (1998) considered the TQM paradox using management of process quality, human resources control, strategic quality planning, and information and analysis as the constructs of TQM implementation. Black and Porter (1996), on other hand, recognized ten significant factors of TQM as being clients, people and management, supplier partnership, teamwork structure for improvement, communication of improvement information, client satisfaction orientation, external interface management, strategic quality management, operational quality planning, quality improvement measurement systems, and corporate quality culture. Research conducted by Powell (1995) also identified the following components as TQM framework: Executive dedication, adopting philosophy, nearer to customers, nearer to suppliers, benchmarking, open organization, training, employee empowerment, zero-defects mentality, flexible manufacturing, process improvement, and measurement. Ho and Fung (1994) recognized ten TQM elements as commitment, leadership total customer satisfaction, continuous improvement, total involvement, training and education, ownership, reward and recognition, error prevention, and cooperation and teamwork. On the other hand, Waldman (1994) recognized eight key TQM components as top management commitment to place quality as a top priority, a broad definition of quality as meeting customers' expectations, TQM values and vision, the development of a quality culture, involvement and empowerment of all organizational members in cooperative efforts to achieve quality improvements, an orientation toward managing-by-fact, the dedication to continuously improve employees' capabilities and work processes through training and benchmarking, and attempts to get external suppliers and customers involved in TQM efforts.

Even though a considerable number of studies have been carried out in the field of TQM implementation, no globally accepted TQM definition or elements currently are available. In fact, researchers have different thoughts about the TQM concept and elements. Nevertheless, most agree with the fact that TQM is a philosophy or approach to management focusing on continuous improvement, customer focus, systematic process management, supplier partnership, and teamwork. The achievement of such a management philosophy requires a set of practices.

2.5 QUALITY AND FORMS OF QUALITY MANAGEMENT PRACTICES

2.5.1 Quality

Quality definition is dynamic since the clients differ based on their views. Some common explanations of quality are conformance to requirements, fitness for use, and value for price paid. Tang et al. (2005) described quality as a state that satisfies the legal, aesthetic and functional requirement of a product or project by clients. Duncan, Thorpe and Sunmer (1990) refer quality to standards and the ways and means by which those standards are achieved, maintained and improved upon. According to the International Organization for Standardization (1994: 19), quality is "…the totality of characteristics of an entity that bear on its ability to meet stated or implied needs."

The term 'quality' is often misused, especially when associated with prestigious products. Although quality is applicable to those products, it does not necessarily refer to their prestigious attributes, but merely to the fitness of purpose to the customer's requirements. Harris and McCaffer (1995: 364) emphasize that quality is meeting client requirements. Looking at quality from the fitness for purpose perspective, Duncan et al (1990: 15) state that before we can say whether fitness for purpose has been achieved, we need to know what exactly the purpose is and how fitness in terms of factors such as performance, duration, reliability, and accuracy, among others, is to be defined and measured.

2.5.1.1 Quality Past vs. Present

Quality has existed from the earliest decades as behaviour, so we can refer to quality as anything prepared or manufactured with a degree of excellence or as the worth of a product or service. For more than 25 years there have been many changes towards improved quality. As shown in Table (2.1), each civilisation has implemented a part of the concept of quality, but this knowledge started in the USA, and particularly in the manufacturing sectors.

Table 2.1: Changing View of Quality

Past	Present
Quality is the responsibility of blue collar workers and direct labour employees working on the product	Quality is everyone's responsibility, including white-collar workers, the indirect labour force and the overhead staff
Quality defects should be hidden from the customers and management	Defects should be highlighted and brought to the surface for corrective action
Quality problems lead to blame, faulty justifications and excuses	Quality problems lead to cooperative solutions
Corrections-to quality problems should be accompanied with minimum documentation	Documentation is essential for "lessons learnt" so that mistakes are not repeated
Increased quality will increase project costs	Improved quality saves money and increases business
Quality is internally focused	Quality is customer focused
Quality will not occur without close supervision of people	People want to produce quality products
Quality occurs during project execution	Quality occurs at project initiation and must be planned for within the project

Source: Kerzner (2003)

2.5.2 Quality Control

Quality control entails checking that all the various levels of the procedure of serving the client have been carried out perfectly and any problems identified have been fixed. According to Zairi (1991: 37), quality management can be defined as "…operational methods and actions aimed both at tracking a procedure and removing causes of unsatisfactory performance of relevant levels of the standard loop (quality spiral) in order to result in economic effectiveness." Zairi (1991: 37) further defines quality control as "…the use of methods (mainly statistical) to obtain, sustain and try to improve on quality requirements of products and services." On the other hand, quality control is defined fundamentally as the actions and techniques used to obtain and sustain the standard of a product, procedure, or service (Oakland and Marosszeky, 2006). It includes a tracking activity but is also concerned with finding and removing causes quality problems so that the requirements of the client are continually met. To simplify this definition one can say quality control refers to a set of activities and methods used to complete quality requirements, by registering, analysing and writing reports about all information related to quality so that this information is the basis when making decisions related to quality.

Quality control is significant for the following reasons:

- It helps to follow the path of specification required;
- It helps in the design of the product required;
- It helps to inspect the product during manufacture or production to determine whether it is in conformance to the customer's specification; and
- It helps to monitor the use of products and gives feedback if there is a necessity for improvement (Zairi, 1991).

There are three types of quality control which include the following:

- Irregular control: This is the type of control applied when a customer complains about the product.
- Routine control: This type of control is regular control taken at different stages of production/construction.

- Scientific control: This is control through measurement and it is analysed using statistical sampling theory (Zairi, 1991: 38).

These three types of quality control are all relatively effective but irregular quality control tends to make a customer lose confidence in the quality of goods produced. Routine and scientific controls are very good approaches to quality control because the product is still in the production process when they are carried out. They ensure the quality of the finished product conforms to the specified requirements in the long run.

Burke (2007: 260) also defines quality control as "…the procedure companies go through to validate that the item has reached the essential situation as determined by the specifications, build-method and the contract." Quality control means monitoring whether specific project results conform to appropriate quality standard and identifying causes of unsatisfactory outcomes. The method of testing should be outlined in the project quality plan. This could involve checklists, inspections, reviews, verification, and validation against standards and requirements. The project quality plan should also give a definition of deviation and state how to approach deviation. Harris and McCaffer (1995: 362) note that quality control introduced inspection to stages in the development of goods and services to ensure that they are carried out to specified requirements. Inspection is the process of checking or confirming that what is produced is what is required. They also indicate that quality control is done on a sampling basis dictated by statistical methods. An example in the construction industry is the making of concrete and sampling cube tests.

Quality control is the earliest and most basic form of quality management, primarily concerned with defect detection. Quality control is a useful tool that helps to detect defects early enough during execution and provides for correction to ensure the product meets the quality specification. Harris and McCaffer (1995: 364) pointed out that the major objectives of quality control can be defined as follows:

- To ensure the completed work meets the specification;
- To reduce customers' or clients' complaints;
- To improve the reliability of products or work produced;

- To increase customers' or clients' confidence; and
- To reduce production costs.

There are five stages of approach to quality control. These are the following:

- Set the quality standard or quality of design required by the customer;
- Plan to achieve the required quality;
- Manufacture right first time;
- Correct any quality deficiencies, i.e. defective work; and
- Provide for long-term quality control and planning (Harris & McCaffer, 1995: 364).

As noted above, authors have different ideas when it comes to quality control, but their major goal in quality control is to derive a method of detecting and documenting defects and to devise means of correction before the product is completed. This has particular significance to the present research in that projects are unique so that there is no possibility of 'returning' a defective final product. Moreover, the products of construction have high value (cost) and are expected to have long duration so that investment in quality at all steps of the process are rewarded by reduced maintenance, longer life of the infrastructure and reduced risk of failure, with the possible negative consequences to public health and safety.

2.5.3 Quality Assurance

Several authors (Duncan et al., 1990; Zairi, 1991; Oliver, 1992; Harris & McCaffer, 1995) have different approaches to the understanding of quality assurance, which is reflected in the diversity of their definitions. Duncan et al. (1990: 16) define quality assurance as a structured procedure put in place to help prevent, manage and control so that the products being produced satisfy requirements, meet up with time objectives and are cost effective. Harris and McCaffer (1995: 366) state that quality assurance emphasizes problem prevention, unlike quality control which focuses on problem detection once the item is produced or constructed. Quality assurance concentrates on the production or construction management methods and procedural approaches to ensure that quality is built into the production system.

Oliver (1992: 18) refers to BS4778: Part 1 to define top quality guarantee as "…all those organized and methodical activities necessary to provide sufficient assurance that a service or product will fulfill given requirements for quality". From this context, quality assurance documents build confidence to both purchaser or client (customer) and the management. The client has the assurance that the product will meet his or her quality requirements while management is assured that the product meets up with their own requirements, that of the client or customer and those of society. The group of activities aimed at providing confidence to a purchaser is called external quality assurance, while internal quality assurance comprises the activities aimed at providing confidence to the management of an organization. Zairi (1991: 40) argues that quality assurance means that quality control is carried out in a systematic way. Zairi (1991: 40) further explains that quality management uses what is referred to as a "death certificate approach", which means that it rejects inspection as the answer to quality problems and encourages the implementation of procedures in order to comply with standards. He also argues that to make sure that products and services are in compliance with set standards, quality assurance relies on the use of statistical process control techniques.

According to Burke (2007: 255), quality assurance is defined as "...a systematic process of defining, planning, implementing and reviewing the management processes within a company in order to provide adequate confidence that the product will be consistently manufactured to the required condition". The Project Management Body of Knowledge defines quality assurance as the planned and systematic activities implemented within the quality system to provide confidence that the project will satisfy the relevant quality standards (Project Management Institute, 2000). It is evident that quality assurance emanated from and is dependent on quality control. Quality assurance builds confidence in the client and the supplier that steps have been taken to ensure that the specified requirements needed by the client have been followed by the supplier during production or execution.

2.5.4 Quality Management

As defined by Zairi (1991: 41), quality management is "…that aspect of the overall management functions that determines and implements the quality policy and as such, is the responsibility of the top management." Quality management refers to all activities of the overall management function that determine the quality policy, objectives and responsibilities, and the implementation of these by means such as quality planning, quality control, quality assurance and quality improvement within the quality system (ISO 9000 Handbook, 1994: 19). The ISO Handbook also states that quality management is not separate from general management. When used effectively, quality management should be an integral part of an organisation's overall management approach**.** Abdul-Rahman (1995: 23) states that the management of quality in construction is related to time and cost management and vice versa. He also notes that a poorly managed project may lead to extra cost and time extensions and that a poor time- and cost-controlled project can affect conformance with a client's requirements, a crucial aspect of project quality management. Moreover, poor quality management causes re-work in construction projects when the quality of a project does not meet the required specification, satisfy the needs of the customer or the outcome of the project is not fit for the purpose it is needed for. The effects of re-work on projects are time and cost overruns.

According to Love and Li (2000: 479), quality failures have become an epidemic of the procurement process in construction and invariably lead to time and cost overruns in projects. The procurement system adopted for projects can be a major determinant in the achievement of quality in construction projects. Love and Li (2000: 479) argue that in order to improve the performance of projects, it is necessary to identify the causes and costs of re-work. Love and Li (2000: 479) recommended that construction companies and consultant firms (particularly design consultants) implement quality management practices as well as placing emphasis on coordinating project documentation during the design development process so that the amount of rework in projects can be reduced or even eliminated. Re-work can be reduced from the development stage of a project when the design and planning for the project are in progress. Love and Li (2000: 489) state that if the construction industry is to improve its performance, all organizations involved in the project supply chain should implement quality management practices. It is evident that there is a need for the management of the executing company to be involved with the suppliers' organisation to plan on how quality is to be achieved in all projects they execute.

2.5.5 Total Quality Management

Total Quality Management (TQM), as the name implies, is the management of all aspects of quality (Zairi, 1991: 41). TQM has several definitions based on the organisations' understanding of quality. BS 7850 (BSI, 1992) describes TQM as the management philosophy and company practices that aim to utilize the material and human resources of a company in the most effective manner to attain the goals of the company. The British Quality Association defines TQM as "…an all-embracing business management philosophy concentrating on completely satisfying client requirements with a maximum of efficiency and effectiveness" (Wessel & Burcher, 2004). On the other hand, the Department of Defence in the USA defines TQM as a philosophy and a set of guiding rules that represent the foundation of a continually improving organization (Tingey, 1997).

Zairi (1991: 42) argues that TQM can be defined by several parameters, such as leadership, attitudes, systems, continuous improvement and customer supply chains. He explains that leadership is possibly the most essential element in the TQM philosophy, as expressed by quality management gurus such as Deming, Juran and Crosby. He stated further that a company's ambitions and desire to succeed are a reflection of the company's leadership which is implemented through a series of actions and ideas. TQM is not about attaining certain standards of competitiveness or introducing new technologies. It is about changing attitudes and behaviour towards doing business where parameters are set by the client or agreed with the client.

Of all the definitions, a simple definition of TQM is a meeting of internal and external customer requirements, and the main difference between quality and TQM is that the quality term usually focuses on a temporary process. An example is in construction: in order to obtain a proper strength for concrete according to the specifications, it should be cured by water for three to four days until the required quality is achieved. This is a temporary process, while TQM is a long-term process and adopts a strategic dimension to guide each production, financial, marketing and administrative plan in the direction which supports the strategic dimension.

2.6 MODELS FOR TOTAL QUALITY MANAGEMENT IMPLEMENTATION

2.6.1 Formal Quality Award Models

Globally, there are numerous quality prizes and awards, such as the Deming Prize in Japan (1996), the European Quality Award in Europe (1994), and the Malcolm Baldrige National Quality Award in the USA (1999). The primary aim of these awards is to increase awareness of TQM because of its significant input to higher levels of competitiveness. Other aims include to encourage understanding of the requirements for the achievement of quality excellence and successful implementation of TQM and also to encourage companies regarding the introduction of a continuous improvement process. Each award model is based on a supposed model of TQM. The award models do not focus exclusively on service, product excellence or traditional quality management methods, but consider a variety of management activities that influence the quality of the final offerings. They give a useful audit framework against which companies can assess their TQM implementation practices. Even though each award has its individual distinctive categories and focus, there are some common areas. Each award model has two parts: One is TQM implementation (that is, the enablers); the other is the overall business outcomes. All three award models highlight the significance of leadership, human resources management, employee participation, employee education and training, process management, strategy and policy, information, supplier quality management, and customer focus. These models give an understanding of the practical way of applying TQM, as well as a firm foundation for this research, and give the researcher a better understanding of the TQM concept.

2.6.2 Other Models for Total Quality Management

Zairi (1991:49) in Ayandibu (2010) describes a model that shows that TQM depends on building blocks which influence the strength of the organization. The building blocks are summarized below:

i. The foundation: These are necessary for a successful TQM programme. Improvement, introduction of change, flexibility and adaptability should be the basics of the organization. People should be properly nurtured, provided with the right tools, right working environment, and given flexibility to take part in the continuous improvement by contributing to their own tasks and solving problems.

ii. The pillars: These are the various ways and processes (quality systems) by which human inputs are conveyed to output to benefit the end user. These include procedure, documentation, recording and analysis, workplace design, and technological innovation, amongst others. The strength of the whole organization is dependent on the strength of each pillar, thus management should increase the strength of each pillar and add more where applicable.

iii. The top: Just like the roof of a building, this part should be weather resistant because it covers the whole organization. This part represents the senior management and they should have vision for the future of their organization when planning for quality. The figure below shows the proposed model by Zairi (1991:49) looking at the three levels of TQM; the top, the pillars and the foundation.

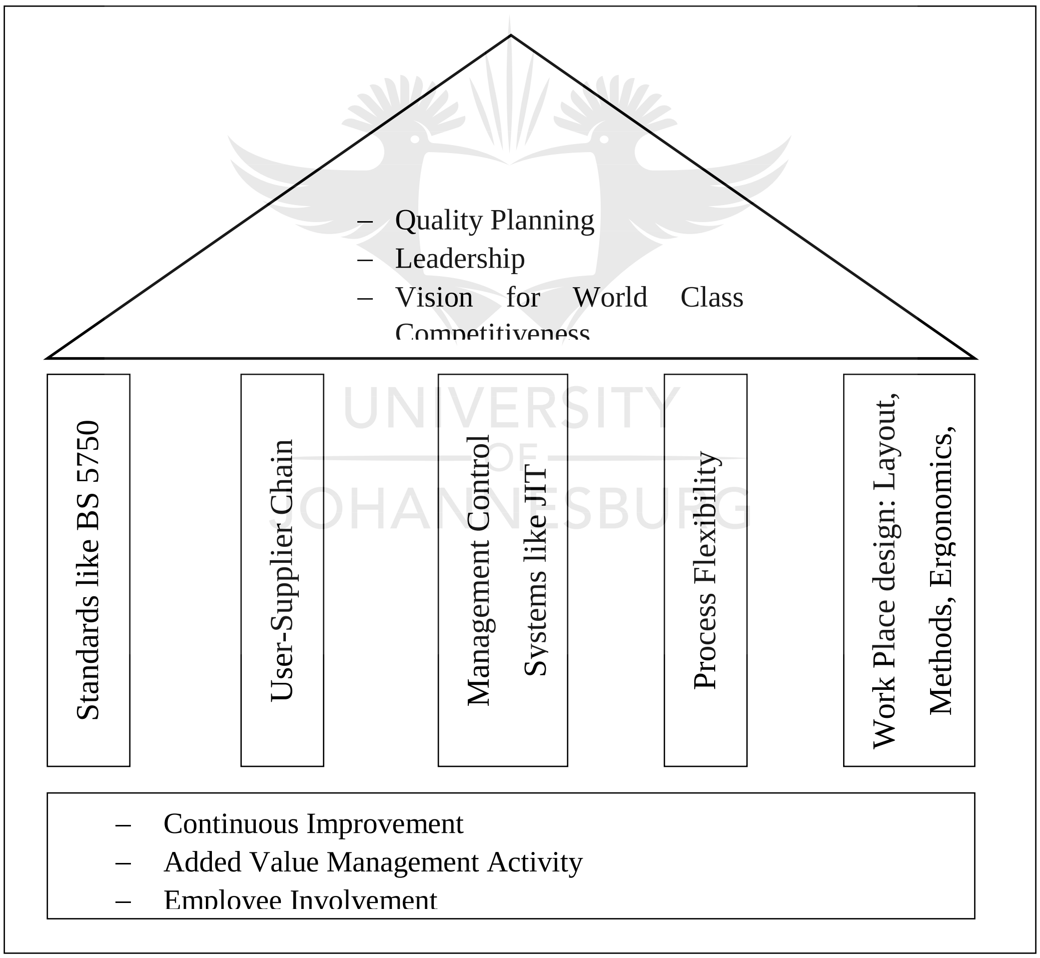

Figure 2.1: TQM: Building blocks (Source: Zairi 1991: 49 in Ayandibu 2010:25)

There are also some models which have also been suggested recently. One is the TQM-efficient model (TQMEF) suggested by Subhash and Narag (2007), and targeted at suggesting a TQM model for Indian organizations, as revealed in Figure 2.2. Critical components of TQM that have appeared in this model are processes and efficiency. Without sufficient concentration on efficiency, there will be no product enhancement and all TQM effort will be lost. The TQM managers must keep an eye on cost and waste reduction, resources planning and usage and, above all, safety to have a positive effect on society and the growth of the organization. The key issue is concentrating on client care and making operations effective.

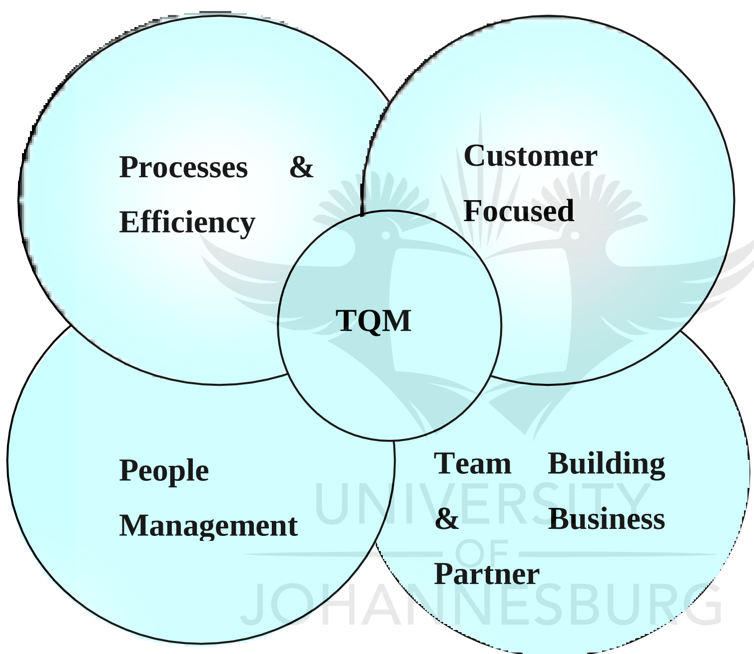

Figure 2.2: TQMEF (TQM-Efficiency) Model (Source: Subhash & Narag, 2007)

The TQM framework developed by Adusa-Poku (2014) is also a recently proposed TQM framework for the Ghanaian construction industry. This framework relies upon a set of primary principles and aspects that is the base for developing the key performance specifications within the quality framework. The set of fundamental factors forming the building blocks of the suggested TQM framework in harmony with the study are Process Management, Continuous Improvement, Employees' Satisfaction/Empowerment, Supplier Chain Management, Customer Focus, Management/Leadership, and Training. The suggested framework by Adusa-Poku (2014) is dependent on the European Foundation for Quality Management (EFQM). EFQM is a quality model depending on nine (9) outcomes; five (5) enablers and four (4) components which are outcomes. A simple model illustrating the correlation between enablers and outcomes is shown in Figure 2.3 and it illustrates that when people acquire proper process management techniques then performance improves. It was noted that process management is at the centre of all performances. Excellent process management leads to better performance.

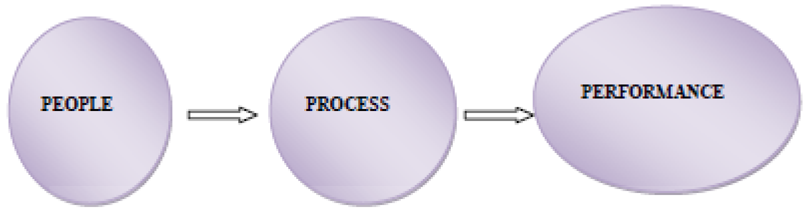

Figure 2.3: Simple Model (Source: Adusa-Poku, 2014)

The proposed TQM framework by Adusa-Poku (2014) is dependent on the above simple model and EFQM and is as shown in Figure 2.4.

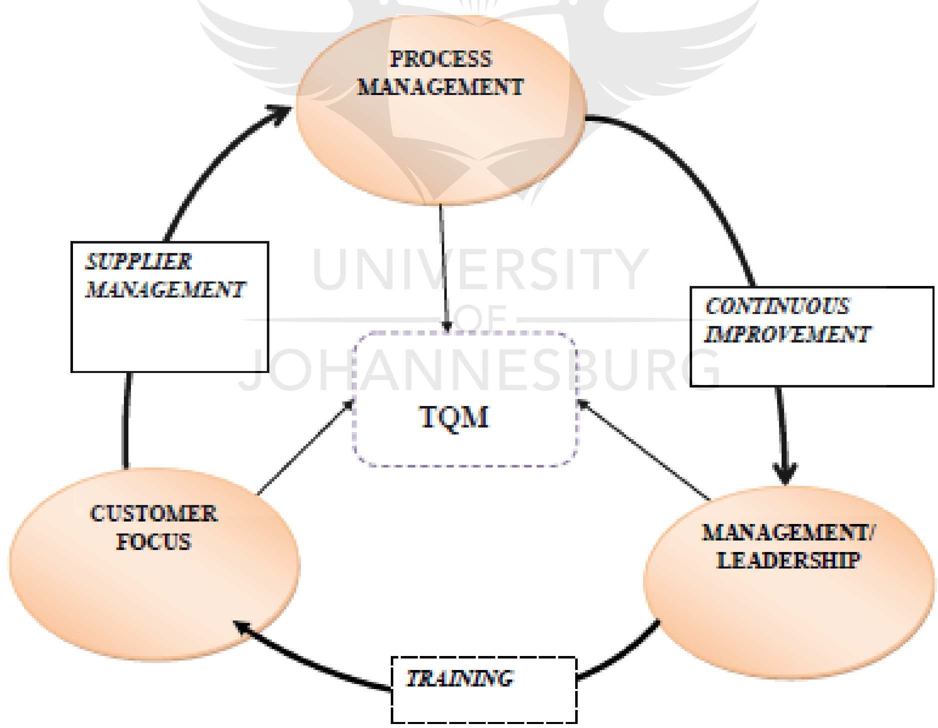

Figure 2.4: TQM Framework (Source: Adusa-Poku, 2014)

The suggested framework by Adusa-Poku (2014) relies upon six criteria. Three of them are the triangular pillars on which TQM originates its support and are fundamental requirements needed for a successful execution of TQM Framework. The three fundamental requirements are Process Management, Leadership/Management, and Customer Focus. Process Management is at the top of the triangle, showing that without process management the framework will be unsuccessful. Customer Focus and Leadership/Management are the Human Resources who perform their role effectively in handling all necessary processes. When one of these criteria fails, TQM will also fail. The connectors to the main pillars for an effective and efficient TQM implementation are Continuous Improvement, Training, and Supplier Management.

2.7 CONCLUSION

The chapter reviewed the theories and concepts applied in this research. How the interacting elements within the TQM theory work were explained in this chapter. Quality management principles, practices and improvement measurement were also discussed. The chapter further considered the propositions of quality gurus (Deming, Juran, Crosby, Feigenbaum, and Ishikawa) on concept of TQM. The study adopted Deming's theory of profound knowledge which is a management philosophy grounded in systems theory in order to help to understand and develop a framework for TQM. Systems theory is based on the principle that each organization is composed of a system of interrelated processes and people which make up the system's components. The three quality award models identified also provide a framework for identifying a range of intangible and tangible processes that influence the firm's TQM implementation and the end results. The next chapter addresses the gaps identified in TQM research.

CHAPTER THREE

3 GAPS IN TOTAL QUALITY MANAGEMENT RESEARCH

3.1 INTRODUCTION

This chapter addresses the gaps identified in TQM research. These gaps have not been evaluated as all-inclusive constructs in the previous models, and they form the additional new constructs for the current study's conceptual framework. The identified gaps and new constructs are Vision and Plan Statement, Product Selection and Design Management, and Company Quality System Evaluation. The identified gaps and how to achieve them in TQM implementation are discussed in this section.

3.2 OBSERVED GAPS IN THE TQM LITERATURE

The extensive review of TQM literature proposes that TQM includes an enormous variety of topics and perspectives. Different writers have had diverging opinions on the concept of TQM and its basic elements or constructs since its inception in 1920. Nawaz and Ikram (2013) agreed that though TQM can be applied in the construction sector, there is a lack of consensus on the implementation process and lack of understanding of the critical success factors (CSFs) as well. Hence, it should be noted that for a successful implementation of TQM, it is very important that construction companies understand the TQM constructs and its critical success factors (CSFs). It should also be noted that an enormous of research has been carried out in the field of TQM and its implementation. Sila and Ebrahimpour (2002) reviewed 347 article papers on TQM from 1989 to 2000 and established twenty-five TQM factors which are extensively used by researchers to measure TQM implementation. Their research discovered eight common cores of the factors viz: leadership and top management commitment, employee training, customer focus and satisfaction, teamwork, employee involvement, continuous improvement and innovation, and quality information and performance.

It should be acknowledged that quality pioneers such as Crosby (1979), Ishikawa (1985), Deming (1986), Feigenbaum (1991), and Juran (Juran and Gryna, 1993) in advanced countries, have also given some suggestions relating to the TQM field, which have achieved considerable recognition throughout the globe. The details of their works give a better appreciation of the

TQM principles, philosophy, and practices. It was found in the previous section that quality gurus have dissimilar opinions about TQM, though some resemblances can be found. It was also found in the previous section that the three quality award models also provide a framework for firms' TQM implementation. These models provide a solid foundation for this study, and give the researcher a better understanding of the concept of TQM and its constructs. But it was obvious that there are some gaps in their conceptual framework that have failed to capture the factors affecting TQM implementation in Ghana and other developing countries as well as the TQM studies in general.

Using the conceptual frameworks of Saraph, Benson and Schroeder (1989); Flynn, Schroeder and Sakakibara (1994); Ahire, Golhar and Waller (1996) and those of quality award models i.e the Deming Prize Quality Award model for Japanese firms, the European Quality Award Model for European firms, and the Malcolm Baldrige National Quality Award model for American firms, it becomes clear that most of the research studies relating to TQM implementation were done in developed countries. On the other hand, studies on TQM implementation conducted in developing countries and in Ghana in particular indicated factors affecting TQM implementation but these studies have not adequately provided an overview of the concept compared to those conducted in developed countries. The next section of the study therefore identifies the gaps in the TQM implementation theoretical frameworks and attempts to address them. The consideration of the identified gaps is based on the notion that a TQM model cannot be achieved without an understanding of TQM concepts and its constructs. This is because the TQM model is not a simple, single-track factor assessment but a combination of numerous variables. Hence, a more robust holistically integrated model of TQM implementation is developed in the current model by considering all the critical variables identified in this study.

3.2.1 Lack of Consensus of TQM Concept and Constructs

Even though several research studies have been carried out in the TQM field, no generally accepted TQM concepts and constructs currently exist. In fact, researchers have diverse views about TQM concept and constructs. The concept is still an issue of discussion (Easton & Jarrell, 1998), and still an unclear and confusing concept (Dean & Bowen, 1994). Hence, TQM appears to mean different things to different people (Hackman & Wageman, 1995). The Asian Institute of Technology (AIT) defines TQM as a philosophy that reinforces the culture to promote continuous organisational development through orderly, integrated, consistent attempt including everything and everyone, concentrating mainly on full fulfillment of external and internal customers, where workers work together in groups with process ownership, guided by a dedicated and proactive top management (Nukulchai, 2003). On the other hand, the British Quality Association defines TQM as an all-embracing business management philosophy focusing on completely satisfying customer requirements with greatest effectiveness and efficiency (Wessel & Burcher, 2004). Also the Department of Defence in the USA defines TQM as a philosophy and a set of guiding principles that represent the foundation of a continually improving organization (Tingey, 1997). All the definitions address TQM as a philosophy but from diverse points of view. Hence, a common word in TQM definition and concept is a *philosophy*.

Zairi (1991: 42) argues that TQM can be defined by several parameters, such as leadership, attitudes, systems, continuous improvement and customer supply chains. He explains that leadership is possibly the most essential element in the TQM philosophy. A company's ambitions and desire to succeed are a reflection of the company's leadership which is implemented through a series of actions and initiatives. These definitions clearly indicate that TQM has come to mean different things to different people. This study therefore identifies constructs that are brought together to form a TQM definition and also promote a better understanding of the TQM concept in the construction industry.

The articles written by Saraph et al. (1989), Flynn et al. (1994), and Ahire et al. (1996) were the three commonly recommended articles in the field of TQM implementation. Ahire et al. (1996) strongly suggested that a combination of the three frameworks identified in the three articles should be considered for future study on TQM. This study follows that recommendation and attempts to integrate their TQM constructs as much as possible as well as incorporating the constructs identified in framework developed by Adusa-Poku (2014) in Ghana. Table 3.1 indicates the TQM constructs in this study and the other four frameworks i.e. Saraph et al. (1989), Flynn et al. (1994), Ahire et al. (1996), and Adusa-Poku (2014) frameworks. The two constructs "Product quality" and "Supplier performance" in the Ahire et al. framework were not incorporated in this framework since they represented TQM outcomes. "Role of quality department” in the framework of Saraph et al. was not included in this framework since every department in any organization would be involved in quality management. “Benchmarking” and “Internal quality information usage” in the Ahire et al. framework is related to the construct of “Evaluation” in this study. “Process control” and “Cleanliness and organization” in the Flynn et al. framework are comparatively the same as the construct of “Construction process management and improvement” used in this study. Also “Process Management” and “Continuous Improvement” in the Adusa-Poku framework are comparatively the same as the construct of “Construction process management and improvement” adopted in this study. “Customer involvement” in the Flynn et al. framework and “Customer focus” in the Ahire et al. and Adusa-Poku frameworks are merged in this study. All the motivational related constructs (Employee education and training, Employee empowerment, Employee involvement, Continuous improvement, Employee relations, Feedback, Teamwork) identified in the four frameworks i.e. those of Saraph et al. (1989), Flynn et al. (1994), Ahire et al. (1996), and Adusa-Poku (2014) are considered as construction employees’ involvement and motivation constructs in this study. This study added three more constructs, “Company vision and plan statement” “Product selection and design management” and “Company quality system evaluation”. Hence, this TQM concept covered a broader scope of TQM in comparison with the four frameworks. TQM could therefore be defined in this study as follows:

A management philosophy for continuously improving overall performance of organization based on leadership and top management, company supplier quality management, client focus and involvement, company quality system evaluation, company vision and plan statement, product selection and design management, construction process management and improvement, and construction employee involvement and motivation.

Table 3.1 lists the eight (8) TQM elements in this study and the TQM elements identified in the other studies framework.

Table 3.1: Framework Comparison

This framework	i: Leadership and top management; ii: Company supplier quality management; iii: Client focus and involvement; iv: Company quality system Evaluation; v: Company vision and plan statement;

vi: Product selection and design management; vii: Construction process management and improvement; viii: Construction employee involvement and motivation.

Saraph, Benson and Schroeder's framework

i: Role of divisional top management and quality policy; ii: Role of quality department; iii: Training; iv: Product/service design; v: Supplier quality management; vi: Process management/operating; vii: Quality data and reporting; 8: Employee relations.

Flynn, Schroeder and Sakakibara's framework

i: Quality leadership; ii: Quality improvement rewards; iii: Process control; iv: Feedback; v: Cleanliness and organization; vi: New product quality; vii: Interfunctional design process; viii: Selection for teamwork potential; ix: Teamwork; x: Supplier relationship; xi: Customer involvement.

Ahire, Golhar and Waller's framework

i: Top management commitment; ii: Customer focus; iii: Supplier quality management; iv: Design quality management; v: Benchmarking; vi: SPC usage; vii: Internal quality information usage; viii: Employee empowerment; ix: Employee involvement; x: Employee training; xi: Product quality; xii: Supplier performance.

Adusa-Poku's framework i: Process management; ii: Leadership commitment; iii: Customer focus; iv: Continuous improvement; v: Training and development; vi: Supplier management

Thus, TQM in this study involves eight elements. Hence, to implement TQM in construction industry is simply to implement these elements, which happens through a set of practices such as using certain quality techniques and tools. There are practices that can support the implementation of each of the eight elements identified in this study. The conceptual definitions and the practices that support the implementation of the three constructs identified in this study are presented in the following sub-section.

3.2.1.1 Gap One: Company Vision and Plan Statement (CVPS)

The company vision and plan statement appear in two aspects: The vision statement and plan statement which are explained as follows:

A vision statement explains how a company wants to be seen in its chosen business. In this regard, it explains standards, principles, and values. In addition, a vision statement is the advertisement of the intention to change. As such, it drives the company ahead and acts against complacency. All workers should be able to understand how they can contribute to the vision. A statement of values and behaviour is an influential motivating force that can be used to impel a process of change forward (Kanji & Asher, 1993). The purpose of a vision statement is to communicate the firm's values, principles, aspirations and purpose so that workers can make decisions that are consistent with and supportive of these objectives (Meredith & Shafer, 1999). An effective vision statement tends to be written using language that can motivate workers to high stages of performance and further, to foster their commitment. Hence, a company should have a long-term vision statement. A diversity of workers should be involved in the development of the vision statement and quality policy, which in return, should be well conveyed to workers at different stages to stimulate commitment. A quality policy is the general direction and intention of an organization with regard to quality, as formally articulated by top management (ISO 8402, 1994). Likewise, a quality policy explains how a company wants to be seen concerning its quality. Therefore a quality policy is a quality 'vision statement'. In fact, a vision statement generally flows down to mission statements that detail short-term firm goals or departmental aims. In order to understand a vision statement, a company must make plan statements that support the realization of its vision (Mann, 1992).

A plan statement, on the other hand, is a formalization of what is intended to occur at some time in the future. A plan cannot guarantee that an event will actually happen; it is a statement of intention that "will happen" (Slack, Chambers, Harland, Harrison & Johnston, 1995). In a firm, there are several kinds of plans, including a strategic business performance plan, quality goal plan, and quality improvement plan. A strategic business performance plan can be divided into long- and short-term business performance plans that include, for example, market share, profits, annual sales, exports, and sales growth. A quality goal plan can include conformity rate, defect rate, internal failure costs, external failure costs, performance, reliability, and durability. A quality improvement plan aims for quality enhancement, which is an action taken throughout the business to increase the effectiveness and efficiency of activities and processes in order to provide added benefits to both the business and its customers (ISO 8402, 1994).

3.2.1.2 Gap Two: Product Selection and Design Management (PSDM)

Product design translates customer anticipations for functional requirements into specific engineering and quality characteristics, which can be called specifications. Juran and Gryna (1993) assert that sound product design can add to the improvement of product quality to be better than that of competitors, escalating a company's competitive advantage in the marketplace. Product design begins with market research. Hence, it is an essential practice for design engineers to have some marketing experience and knowledge, making it easier for them to appreciate customer desires, expectations, and future requirements. In this regard, product design will be more market-oriented (Feigenbaum, 1991; Juran & Gryna, 1993).

In order to have efficient product design, design engineers are required to have some shop floor experience such as processing technology, understanding of performance of production equipment, skill for operating production equipment, and production processes. Such knowledge can contribute to robust product design. Thus, there will be fewer problems during the process of production (Feigenbaum, 1991; Juran & Gryna, 1993; Slack et al., 1995). Before production, a new product design should be carefully reviewed in order to avoid problems during production. Design review is documented and a comprehensive and systematic examination of a design is done to assess its capability to fulfil the requirements for quality, identify problems, if any, and propose the development of solutions (ISO 8402, 1994). Customer requirements and expectations also should be carefully taken into consideration during the process of product design. It is imperative that the design team should get detailed information from the field. Field failure data and customer complaints should be adequately detailed to offer a means of analyzing the causes so that appropriate corrective action can be taken towards improving product design (Feigenbaum, 1991; Juran & Gryna, 1993). Different sections in a company should take part in new product design. Deming (1986) informed that such design teams comprised of people from sections such as engineering, design, production, and sales can contribute to the improvement of product design and design for the future. According to Juran and Gryna (1991), the involvement of different sections in product design can guarantee fewer problems during the process of production as well as after products have been delivered to customers.

Price is still an essential factor influencing the competitive capability of products in the marketplace (Meredith & Shafer, 1999). Consequently, cost should be paid enough attention during the process of product design. It is important that reducing production cost does not sacrifice product performance. Value engineering is a technique for assessing the design of a product to guarantee that the important functions are provided at minimal overall cost (Juran & Gryna, 1993).

For traditional products, the product design process is not difficult and can be realized by experienced design engineers without using any unique techniques. For contemporary products, certain unique methods and techniques should be used to attain successful product design (Juran & Gryna, 1993). According to the reseacher’s previous research (Zhang, 2000) experimental design is an extensively used tool in product design. Its application has greatly reduced the time and expense needed to develop the new product, significantly improved the performance of the new product, and led to the success of new product design.

Quality function deployment is also a significant and efficient method in product design (Slack et al., 1995). It is mainly concerned with the correlation between customer desires and new product attributes which can support the establishment of a market advantage (Slack et al., 1995). This technique consists of a series of interconnecting matrixes that translates customer needs into product and process characteristics (Juran & Gryna, 1993).

3.2.1.3 Gap Three: Company Quality System Evaluation (CQSE)

The concept of evaluation can be defined as a systematic examination of the extent to which an entity is able of fulfilling specified requirements (ISO 8402, 1994). Juran and Gryna (1993) affirmed that a formal evaluation of quality provides a starting point by offering an understanding of the size of the quality issue and the areas demanding attention. Evaluation can recognize the difference between actual performance and the goal. Evaluating the situation in a company's quality management practices offers an important base for the company to enhance its quality management practices. Such evaluation information should be communicated to workers in order to encourage workers to make things better. Hackman and Wageman (1995) suggested that evaluation of variability is a change principle. Uncontrolled variance in processes or outcomes is the main cause of quality problems and must be evaluated and controlled by those who perform the firm's frontline work. Only when the root causes of variability have been identified are workers in a position to take corrective steps to enhance work processes.

It should be noted that a company functions in a turbulent and dynamic environment. In order to maintain competitive advantages in this environment, the company should continuously evaluate its various business strategies. A business strategy is a set of objectives, plans, and policies for the company to compete successfully in its markets (Meredith & Shafer, 1999). In effect, the business strategy specifies what the company's competitive advantage will be and how this advantage will be attained and sustained. Based on such evaluation activities, the company can amend its business strategy in order to keep it dynamic (Mann, 1992).

A quality audit can be used for quality systems, processes, products, and services. One function of a quality audit is to evaluate the need for improvement or corrective action (ISO 8402, 1994). A quality audit is systematic and independent examination to establish whether quality activities and associated results comply with planned arrangements, and whether these arrangements are implemented effectively and are appropriate to accomplish goals.

Benchmarking is also an effective tool to use as a continuous process of evaluating a company's products, services, and processes against those of its strongest competitors or of companies well-known as world-class or industry leaders. A benchmark is a point of reference by which performance is judged or measured. Competitive benchmarking is the continuous process of measuring products, services, and practices against those of the strongest competitors or leading companies (DuBrin, 1995). Slack et al. (1995) stated that there are numerous types of benchmarking such as external, internal, competitive, non-competitive, performance, and practice. Benchmarking is capable of judging how sound an operation is performing, and can be seen as one approach to setting reasonable performance standards. It is a useful tool for guiding the establishment of quality improvement goals, evaluating various activities within the company, and assessing customer requirements (Hackman & Wageman, 1995).

In order to encourage workers to pay attention to quality, quality-related data should be used for evaluating employee performance. Quality-related indices should be combined with general employee performance standards. Quality-related data should also be used to evaluate the performance of employees at different levels and the performance of the whole company, and should be exhibited on the shop floor in order to enable workers to understand what happens regarding quality. It should be noted that the main objective of evaluation is improvement, not criticism. In order to have an effective evaluation, a quality information system is essential as it is an organized method of collecting, storing, analyzing, and reporting information on quality to assist decision-makers at all levels (Mann, 1992; Juran & Gryna, 1993).

3.3 CONCLUSION

Different writers have had conflicting opinions on the concept of TQM since its inception. It was also obvious that there are some gaps in their conceptual framework that have failed to capture the factors affecting TQM implementation in Ghana and other developing countries, and the TQM studies in general. The chapter therefore addressed the gaps observed in previous TQM research frameworks which were not evaluated as all-inclusive constructs in the previous models. The identified gaps and new constructs are Vision and Plan Statement, Product Selection and Design Management, and Company Quality System Evaluation. These identified gaps are discussed in relation to how to achieve them in TQM. In addressing the gaps, several works were drawn upon but the work of Saraph et al. (1989), Flynn et al. (1994), Ahire et al. (1996), Adusa-Poku (2014) as well as the Deming theory were specifically used. The three qualities award models also give an insight into the practical way of implementing TQM, as well as providing a solid foundation for this study, and a better understanding of the concept of TQM.

CHAPTER FOUR

4 THE CONSTRUCTION INDUSTRY AND TOTAL QUALITY MANAGEMENT

4.1 INTRODUCTION

This chapter presents an overview of the construction industry and TQM implementation in general. The chapter discusses types of construction undertaken by the construction industry and the working environment in the construction industry. This is significant because the working environment in the construction industry is crucial to its success. This chapter will also elucidates on how TQM is implemented in the construction industry as well as its associated issues such as benefits and critical success factors (CSFs) affecting its implementation.

4.2 OVERVIEW OF CONSTRUCTION INDUSTRY AND TQM

The construction industry is described as a collection of industries (Kwakye, 1998). This could be the best description possible because any completed building is composed of materials and equipment produced from other industries. Hence, understanding the nature of the construction industry and how it works is an important part of managing and developing the construction process.

Hinze (2001) posits that the construction of various types of facilities often represents the culmination of the efforts of several designers. Construction includes all immobile structures, decks, bridges, sewage treatment plants, and factories. Most of the reshaping of the earth's surface can be attributed to the construction industry. Hinze also indicated that the failure rate for construction firms is relatively high, with business failures in construction accounting for approximately 12% of all business failures. It has also been estimated that 20% of all construction-related businesses eventually fail. Failures result from many factors, including over-extension of resources, subcontractor default, inadequate labour, acts of God, managerial inexperience, and other economic causes.

The construction industry is one of the industries that are prone to problems, and most of these problems are serious and need robust and appropriate approach to overcome or at least to reduce their consequences. The construction industry has several issues that need a concerted effort from all parties involved in this sector to address them. Moreover, the construction industry is classified as a one of the riskiest sectors because of the fragmentation of supply chains and the short-term relationships between main contractors on the one side and sub-contractors and suppliers on the other side. Therefore, through this literature review, the researcher has endeavoured to answer the question as to whether TQM is the right approach to solve these problems. To address this, many issues will come under discussion in the following paragraphs.

The construction industry occupies a huge economic segment for any country, and has a significant effect on the efficiency and development of other industries. It is characterized by the participation of many parties and the existence of a proper management system becomes paramount to manage and direct those parties. The construction project usually consists of three primary participants: the client, the consultant or designer, and the contractor. The process of most construction projects is similar and starts with the client and the consultant's office where the client's requirements are transferred into drawings and specifications (the design stage). The project is usually placed out for bidding to contractors: each contractor attempts to provide better prices than their competitors, and usually (though not always) the lowest price will win the project. There is a contractual agreement that will be established between the client and the contractor under the umbrella of the consultant's office and during this stage, the consultant works as a supervisor for the project to ensure that all work is implemented according to the project drawings and specifications. The contractors may be classified as general contractors or subcontractors (specialty contractors). General contractors are responsible for executing most major construction projects in all ranges of construction activities. On the other hand, subcontractors limit their activities to one or more construction specialty activity, such as water-proofing, electrical work, heating, or excavation.

Hinze (2001) emphasized that the construction industry is characterized by custom-built projects, whereas standardized methods (mass production) are common in manufacturing. In most manufacturing or service sectors, all activities are implemented in-house, in other words, in a closed and shaded area, while a construction project is usually implemented in an open area with a large number of people, much equipment and materials, unpredictable weather, the attitudes of different people and a large number of activities within a specific and limited time. Therefore, many researchers are working to find out how to apply a quality system which could offer a solution for this environment, such as Burati and Kalidindi, (1991) whose research into the application of TQM in the construction industry has been ubiquitous in the last decade.

Implementing TQM in construction companies means a comprehensive change in every aspect of the construction process. The process of change is difficult for two main reasons: firstly, historically the construction industry has been reluctant to implement change. Secondly, a longer time is needed than in other sectors. Sommerville and Sulaiman (1997) analysed the implementation of TQM in construction companies and found that most construction managers tend to lack a long-term strategy and systemic views of construction management, and have a relatively conservative attitude towards managerial changes.

As mentioned earlier, one of the definitions of quality is meeting requirements, and the question which arises in the construction industry is that of whose requirements have to be met. The answer is fourfold: the requirements of designer, supervisor, owner, and constructor. According to Culp, Smith and Abbott (1993), there is a difference between quality in fact and quality in perception. This means that a product can be of high quality (quality in fact) and yet it may not meet a customer's needs and vice versa.

Since the pace of construction industry development is very fast, and in order to reduce redoing work, the needs for change become increasingly important. According to Love, Li, Irani and Holt (2000), the industry's problems will remain until all organizations involved in the procurement of construction begin to take responsibility for initiating changes within their own organizations. Such change can be initiated through the effective implementation of TQM (Nesan & Holt, 1999).

4.3 TYPES OF CONSTRUCTION

There are several ways the construction projects can be categorized. Hinze (2001) stated that there are four broad categories, namely housing construction, non-residential building construction, engineering construction, and industrial construction. Many authors such as

Hudson, Sears, and Keoki (2000) have classified the common main types of construction as building construction, highway construction and industrial construction.

4.3.1 Building Construction

The construction of a building involves several subdivisions and the majority of these subdivisions consist of small renovations, which are privately owned, with the owner of the property generally acting as labourer, paymaster, and design team for the entire project. The important point is that it does not matter what kind of building project it is as they all have some common elements of design, financial and legal considerations, whether it is a public project or a privately owned. Construction projects, if not managed or executed properly, may experience cost overruns, structural collapse and/or litigation. People involved in construction may mitigate these issues by making detailed plans and maintaining a schedule to ensure a positive outcome (Hudson, et al., 2000 in Al-Musleh, 2010).

For the construction of large buildings, the client normally hires consultants and ensures his or her own team of workers and advisors deal with the overall process. This is done to ensure that the project runs smoothly and the required standards and specifications are met. The role of advisors can be those of mortgage bankers, project financiers, accountants, lawyers, insurance brokers, architects, designers or engineers (Hudson, et al., 2000 in Al-Musleh, 2010).

4.3.2 Highway Construction

The development of infrastructure is dependent on our transportation system. Bridges, roads, rail, airports, harbours, mining, arcades, plazas, high rises and canal system are all included in this category of heavy or highway construction. Usually these projects are publicly owned, but they can be privately owned if it is a case of the development part of the government development scheme. As discussed above in the previous section on building construction, heavy or highway construction involves design, financial, and legal considerations. However, these projects are not usually for profit, but undertaken for the public interest. It is essential that heavy/highway construction teams should deliver work of high quality as this type of construction has a direct effect on the environment and the infrastructure itself (Hudson, et al., 2000 in Al-Musleh, 2010).

4.3.3 Industrial Construction

Industrial construction is a very important component of the construction industry. These constructions are usually owned by industrial corporations, which are without question for-profit organisations. These corporations and organisations are in fields such as medicine, petroleum, chemical, power generation, and manufacturing. Highly specialized skills and expertise are needed in this type of construction, as it requires special installation of equipment and machinery. As with the other types of construction explained above, industrial construction has legal and contingency requirements (Hudson, et al., 2000 in Al-Musleh, 2010).

4.4 SPECIFIC CHARACTERISTICS OF CONSTRUCTION SECTOR

The European Commission Communications (1997) in (Al-Musleh, 2010) stated that the construction sector is highly regulated, with the following specific characteristics which differentiate it from other industrial sectors:

- It is a heterogeneous and fragmented sector which depends on a large number of very different professions, including diversity of technology, customers, projects, and market sectors.
- Logistical and transport aspects are very important. Construction is one of the most geographically dispersed sectors with marked regional differences.
- The final product is one of the few non-transportable industrial products, adaptable to a variety of uses and representing one of the most durable of human artifacts. It forms the physical infrastructure for living and working, for production and transportation and for essential services. Half of construction projects relate to renovation.
- Most construction projects are prototypes.
- Investments in machinery, tools and other elements have to be depreciated over a shorter period than is usual for other industrial sectors.
- The entry-level for new contractors is relatively low because the need for operational capital is small.

- It is closely linked to the economic cycle, and, being generally conducted outside, is affected by seasonal climatic variations;
- The sector is very labour intensive, with high mobility of the workforce and growing skills needed as construction technology becomes more sophisticated. The duration of contracts is often linked to the length of the site construction phase.
- Accident rates tend to be high.
- Finally, the sector generates an enormous quantity of construction waste and demolition material (European Commission Communications, 1997 in Al-Musleh, 2010).

The above paragraphs reveal that the nature of the construction industry is unique or has different characteristics compared to other industries such as the manufacturing industry.

The large number of workers and the diversity of daily activities are critical characteristics of the construction industry. Therefore, it is essential for adequate management systems to manage construction company workers and activities and guide their processes

4.5 MANAGEMENT ORGANIZATION SYSTEM IN THE CONSTRUCTION COMPANIES

Newcombe, Fellows, Langford and Urry (2001) proposed the management organization system in a construction company as seen in Figure (4.1). The system includes the following:

i Strategic system: The strategic system performs the task of deciding and managing the long-term direction of the construction companies. The strategic management of the business receives inputs in the form of market intelligence, assessment of the firm’s current capabilities and internal and external stakeholder’s attitudes.

ii Social system: The social system’s sole input is people of various types and levels. Through the processes of motivation, group formation, leadership and commitment, the system seeks to achieve an output of satisfied, committed and involved personnel.

iii Information system: The information system provides the life blood running through the arteries of the construction company.

iv Management system: The management system is shown in Figure (4.1) as central to the whole organisational system. It occurs at three levels in the construction organisation, namely strategic, administrative and operational, each with distinct functions.

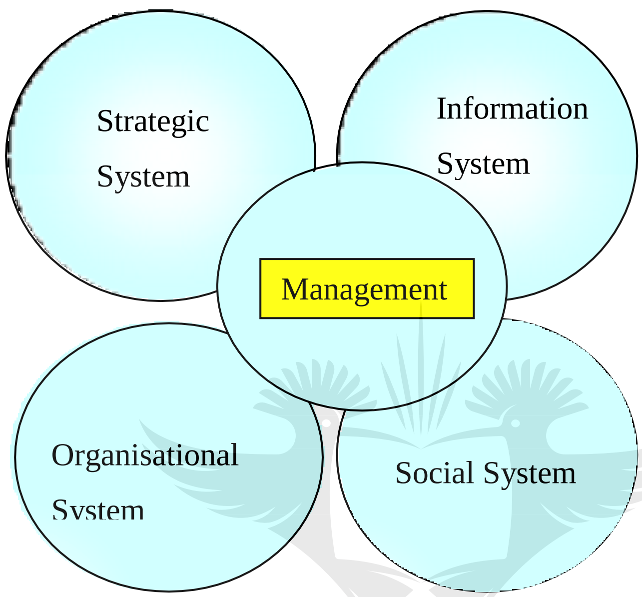

Figure 4.1: Construction Organisation System

Source: Newcombe et al. (2001)

The working environment in the construction industry is crucial to its success. Consequently, to be successful within the construction industry, there are five M's that must be available for any construction company to survive: Management, Manpower, Money, Machineries, and Materials. On the other hand, a construction company could lose its reputation if five D's emerge: Delay, Defective, Dirty, Dispersed, and Discontinuous. The interesting factor is the relations which exist between the five M's and the five D's because any default in one of the M's could lead to five D's (Newcombe et al., 2001).

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4.6 CONCEPT OF TQM

The concept of TQM started in the manufacturing industry, giving the impression that TQM cannot be applied in any other industry but the manufacturing industry. Regardless of the fact that construction is different from the manufacturing sector in terms of its uniqueness in production, studies according to Ahmed (1993), Arditi and Gunaydin (1997), Low and Jasmine (2004), and Harrington and Voehl (2012) have all confirmed the benefits and applicability of TQM in the construction industry.

TQM is a system focusing on customer satisfaction through the concept of continuous improvement. This concept emerged after the 1980s with the purpose of developing and expanding quality management strategy by adding more aspects related to quality. Most of the literature indicates that the interest in the TQM concept at the level of production began in the USA as only theories and but these were implemented in practice in Japan after World War II in order to improve the quality of industrial production consistently and comprehensively (Alfred & Mike, 1986).

The TQM concept is one of the modern management concepts which have helped to increase the competitiveness among organizations. This has resulted from the level of customer awareness which helps them to select a product or service of high quality and at a reasonable price. Electronic Business Magazine reported in (1992) that 91 % of 70 companies using TQM had indicated that their quality had improved when compared with that of their competitors (Talha, 2004). In general, TQM is a way for managers to improve the effectiveness, flexibility, and competitiveness of a business as a whole.

TQM is considered by many researchers as an important approach in quality and business performance improvement, and therefore other industries are forcing the construction industry to adopt TQM. Pheng and Ann Teo (2004) discussed the implementation of TQM in construction firms, and concluded in their study that TQM has been recognised as a successful management philosophy in the manufacturing and service industries, so can likewise be embraced in the construction industry to help raise quality and productivity.

The US and European industries begun to understand that poor quality costs companies significant amounts in sales revenues nationally, and improving the quality of goods and services would help to improve productivity, lower costs and increase profitability. The US and Europe have woken up little late, after the competitiveness of Japanese manufacturing in the early 80's. There is no doubt that most Japanese products are better quality, and lower in cost than US and European products, which may be a result of Japanese manufacturers understanding the TQM concepts earlier than others.

4.7 IMPLEMENTATION OF TQM IN THE CONSTRUCTION INDUSTRY

The implementation of TQM in construction has been the subject of many arguments. Several studies have examined the implementation of TQM in construction and the general observation is that the construction industry, which includes the Ghanaian construction industry, is slow in implementing the TQM concept despite its identified potential benefits (Ansah, Aigbavboa & Thwala, 2015). Haupt and Whiteman (2003) stated that this is one reason why construction remains behind regarding the implementation of TQM. Agha (2011) opines that the reason for the late arrival of the construction industry to the TQM approach is that construction professionals are not familiar with its principles and techniques. However, Boaden and Dale (1992) note that the relative immaturity of the construction industry in adopting TQM may be an advantage if companies learn from the mistakes and the best practices of other organizations. Ramachandran (2010) observed that the construction industry is more complex compared to other industries and that the use of the TQM approach can be useful in analyzing and remedying defects as soon as they occur.

Since TQM is a long-term endeavour, some of the firms in the construction industry may not want to engage in an effort that may not provide any yield till after several years. On the other hand, contractors often perceive TQM as an extra cost which they may not be willing to incur. Tutesigensi and Pleim (2008) identified reasons for lack of implementation of quality plans by small and medium construction firms to include lack of knowledge, the perception that customers may not need such plans, and lack of resources. Gunning and McCallion (2007) enumerated obstacles to TQM as seen by contracting firms and they include lack of commitment from management, lack of communication in organisations, cultural attitudes, and lack of training. Hassin, Tookey and Vidalakis (2007) recommend that training and education are key factors in the implementation of TQM. Other factors include customer satisfaction, employee participation and quality policy. Love et al. (2000) made a case for a cultural and behavioural shift in the mindset of practitioners, academics and professional institutions if the construction industry is to improve its performance and competitiveness. This view was reiterated by Mahmood, Yusoff and Mohammed (2008) and Ramachandran (2010), stating that the implementation of TQM requires a culture change and change in management behaviour. Organisations would need to devise a strategy to bring all parties on board their quality policies and plans so there can be better participation and cooperation on all levels. Two aspects addressed in literature are the need for a radical culture change and the commitment of top management in the implementation of TQM.

Pheng and Teo (2004) investigated how TQM can be applied more actively in the construction industry in Japan. They noted that TQM can be embraced in the construction industry to help raise quality and productivity and concluded that for the successful implementation of TQM, organizations needed to develop a culture change and a change in status quo. It is easier to teach new employees about TQM strategy than to try to teach old employees who are set in their ways.

McIntyre and Kirschenman (2000) surveyed the acceptance of TQM in upper Midwestern United States and they found that the majority of their respondents (72.5%) who employed TQM practices and benefits articulated include higher customer satisfaction and improved schedule performance. They recommended an increased effort to be put into the education and training requirements regarding the implementation and application areas of TQM and a more systematic approach to the collection and analysis of data concerning the overall TQM process. A survey by Koh and Low (2010), found that out of eight identified elements of TQM, customer management, process management and top management leadership were implemented at a higher level by construction companies.

Agha (2011) studied the suitable applications of TQM in different phases of construction projects and concluded that though the industry is late in adopting TQM, it is a suitable tool for improving business quality, increasing customer satisfaction and saving time. Sannni and

Windapo (2008) evaluated contractors' quality control practices on construction sites in Nigeria and they found that over 80% of contractors did comply with some form of quality control plan and recommended that contractors be evaluated based on their compliance or otherwise with quality plans.

TQM philosophy is applicable on various platforms in the construction industry, from the office management to site operations, whether pre-construction phase or during construction, as a necessary avenue for securing customer satisfaction and improving productivity while enhancing organizations' profitability.

4.8 CRITICAL SUCCESS FACTORS (CSF) OF TQM IMPLEMENTATION IN THE CONSTRUCTION INDUSTRY

To successfully implement TQM, it is important to identify the factors required for the implementation process. Saraph et al. (1989) defined CSFs as critical areas of managerial planning and action that must be practised to achieve effective quality management in a business unit. These factors may be constructs with latent variables which cannot be measured directly, but can still be assessed indirectly from their manifestation. In a pioneering study, Saraph et al. (1989) developed a quality management instrument, identifying eight (8) critical success factors of TQM, namely the role of divisional top management and quality policy, role of quality department, training, product/service design, supplier quality management, process management/operating, quality data and reporting, and employee relations. Their study had considerable influence on later studies, and subsequent research has resulted in the development of different frameworks and constructs based on varying perceptions and objectives (Zhang, 2000). Although these frameworks or models have different TQM approaches, they all place the emphasis on leadership, strategic planning, customer and market focus, human resources focus, process management, continuous improvement, supplier management and business results in one way or another (Conca, Llopis & Tari, 2003).

Constructs or elements of CSFs identified in frameworks for TQM point to two categories of factors: soft and hard dimensions of TQM (Kanji., 1995; Powel., 1995; Dow, Samson & Ford, 1999; Oakland., 2000). Hard components of TQM concentrate on the tools and techniques, systems and the supplementary measurement and control of the work process, ensuring conformance to performance standards and the reduction of variability. On the other hand, soft components relate to areas of behavioural concerns such as increasing customer orientation, employee management, organizational and quality culture. These dimensions are interrelated and together are very important for the successful implementation of TQM.

A great deal of research has been conducted in the field of TQM and its implementation. The study by Sila and Ebrahimpour (2002) reviewing 347 articles on TQM from 1989 to 2000 identified 76 studies that employed factor analysis to extract factors for the successful implementation of TQM. Out of these, they compiled 25 TQM constructs which are widely used by researchers to measure TQM implementation. Their study revealed seven (7) common cores of the factors, namely customer focus and satisfaction, employee training, leadership and top management commitment, teamwork, employee involvement, continuous improvement and innovation, and quality information. Literature also reveals that different countries have adopted similar TQM factors as criteria for quality awards under different titles (Metri, 2005). However, the criteria for all these quality awards are derived from four basic frameworks: the Malcolm Baldrige National Quality Award (MBNQA), the European Quality Award (EQA) now called European Foundation for Quality Management, the (EFQM) Excellence Award, and the Deming Prize.

Jha and Iyer (2006) address the determination of the critical factors affecting quality performance in construction projects. A preliminary survey was based on Indian construction projects. The CSFs identified were project manager's competence, top management's support, monitoring and feedback by project participants, interaction among project participants, and owners' competence. On other hand, conflict among project participants, a hostile socio-economic environment, harsh climatic conditions, PM's ignorance and lack of knowledge, faulty project conceptualization, and aggressive competition during tendering are the factors that most adversely affected the quality performance of construction projects.

Another study of TQM's CSFs was conducted by Ramirez and Loney (1993) and covered US companies from the manufacturing and service sectors. The results of this study showed that the most critical factors are Management commitment, Customer satisfaction, Culture change, Education, Participation management, Strategic planning, Goal clarity, Error prevention, Top management steering committee.

Metri (2005) emphasises other critical factors when he analysed the critical success factors of the fourteen most prominent TQM frameworks. Based on this, he proposed ten CSFs of TQM for the construction industry. The following ten CSFs have emerged from his analysis: Top management commitment, Quality culture, Strategic quality management, Design quality management, Process management, Supplier quality management, Education and training, Empowerment and involvement, Information and analysis, and Customer satisfaction.

4.9 BENEFITS OF TQM IMPLEMENTATION IN CONSTRUCTION INDUSTRY

The potential benefits offered by TQM techniques are varied and the consensus from various studies is that it has been successfully applied in other industries and can also be beneficial in the construction industry. Hassin et al. (2007) studied TQM implementation in the electrical generation industry and found that its adoption would be of pre-eminent importance to the industry in Libya. In considering the application of TQM to environmental construction, Kiwus and Williams (2001) concluded that TQM techniques may reduce the frequency and severity of schedule overruns, higher customer satisfaction, reduction in construction costs, improved employee job satisfaction, and improved schedule performance.

Other benefits for implementing TQM include improved relationships with subcontractors, reduced rework, improved safety, higher productivity, lower employee turnover, speeding up construction work, improved methods of working, better control over the construction process, gaining competitive advantage, increase profitability, decreasing waste and rework, better coordination of activities and being more customer focused (Love et al., 2000; McIntyre & Kirschenman, 2000; Chini & Valdez, 2003; Love et al., 2004; Hassin et al., 2006; Al-Momani, 2007; Khadour & Darkwa, 2008).

4.10 CONCLUSION

The chapter presented an overview of the construction industry and TQM implementation in general. The chapter also discussed types of construction undertaken by the construction industry and the working environment in the construction industry. This was significant because the working environment in the construction industry is crucial to its success. The large number of workers and the diversity of daily activities are critical characteristics of the construction industry. Therefore, there is a need for adequate management systems to manage construction company workers and activities and guide their processes. The chapter therefore clarified how TQM is implemented in the construction industry and its associated issues such as benefits and CSFs affecting its implementation.

CHAPTER FIVE

5 TQM IMPLEMENTATION IN DEVELOPED COUNTRIES

5.1 INTRODUCTION

This chapter discusses TQM implementation in developed countries. The chapter specifically looks into TQM implementation in China. The chapter also discusses the evolution of TQM. An evaluation of policies and government intervention with regard to TQM implementation is also presented. Finally, the views of quality pioneers in developed countries and their contribution towards TQM concept is highlighted in this chapter.

5.2 THE EVOLUTION OF TQM IN THE DEVELOPED COUNTRIES

The beginning of TQM is traced back to the 1920s when statistical methods were employed in analysing product quality control. Twenty years later, Americans such as Deming, Juran, Crosby and Feigenbaum improved on this concept by expanding its focus from product quality to quality in all issues of an organisation. Martinez-Lorente, Dewhurst and Dale (1998) mentioned that the concept of TQM was developed through the huge evolution in quality which took place in the US. The concept emerged after the 1980s with the purpose of developing and expanding quality management strategy by adding more aspects related to quality.

Most of the literature indicates that the interest in the TQM concept at the level of production which began in USA was as only theories and it was implemented in practice in Japan after World War II in order to improve the quality of industrial production consistently and comprehensively. One of the major reasons the Japanese have been so successful in business is their ability to take a concept or idea from another culture and improve on it in a uniquely Japanese fashion (Alfred & Mike, 1986). The growing intensity of global competition, especially from Japan, led the US to follow Japanese strategy. This happened when Hewlett-Packard criticized US chips manufacturers for poor product quality compared with their Japanese competitors.

The proponents of quality started with quality control (QC) that deals with the inspection of works. QC is where products are sampled and inspected for errors or defects. Later on, Quality

Assurance (QA) that is about prevention of defects was introduced. The principles for QA are 'Fit for Purpose' and 'Right first Time'. QA is a program covering activities necessary to provide quality in the work to meet the project requirements (Arditi & Gunaydin, 1997). Currently the standard for ensuring quality work is by the concept of TQM. It is a philosophy that involves every organization in the industry in the effort to improve performance. It permeates every aspect of a company and makes quality a strategic objective (Arditi & Gunaydin, 1997). It integrates fundamental management techniques, existing improvement efforts, and technical tools under a disciplined approach focused on continuous improvement. TQM is as a culture that strives for customer satisfaction through continuous improvement and innovation in all sectors of the business (Harrington & Voehl, 2012).

According to Zairi (2007), TQM was "coined" in the first instance in the US military. Defenders of TQM diffused the concept through business consultancies in Western countries, and its influence spread from manufacturing to the construction and service industries and finally to education (Ishikawa, 1985). Feigenbaum (1993) in Hossain et al. (2010) identified the following six phases in the evolution of quality:

- **Operator Quality Control**

Operation quality control existed before the 19th century. During that period, each worker or group of workers was responsible for the manufacture of products. In this way, the quality of a product could be better controlled because the workers focused on their work only.

- **Foreman Quality Control**

Mass production was the main reason for the emergence of the foreman quality control, which was developed between 1900 and 1918. Mass production is characterised by the division of labour, specialisation of skills and standardisation. The classical management approach known as the scientific management method was initiated by Fredrick Taylor and became very popular. The foreman grouped the workers performing similar tasks under his/her supervision and he/she took full responsibility for the quality of all works done by the group.

- **Inspection Quality Control**

The phase of inspection or testing quality control was developed during the World War I. By World War II, the manufacturing system had become more complex and large numbers of workers were reporting to each foreman who could quite easily have lost control of the work. As a result, it was necessary to engage full-time quality inspectors. Quality inspection was adopted to separate non-conforming parts, and so the term ‘quality’ meant inspection, and usually quality was inspected during the production process itself.

In this era of mass production, all finished products were examined for defects to ensure quality. Kanji and Asher (1993) stated that quality management started with simple inspection-based systems in which the product is inspected and compared with specified requirements to check its conformity. This means quality measurement at that time focused on the inspection process by eliminating bad products, and it depended on random inspection.

- **Statistical Quality Control**

During the period between 1937 and 1960, statistical quality control reached its peak. There became an increased need for quality inspection in the late mass production era because the volume and variety of components increased dramatically. Owing to the huge costs involved in quality inspection, Taylor's scientific management approach became inappropriate. Statistical quality control concentrated on statistical tools and made the quality inspection department more efficient, contributing most in sampling inspection rather than in complete inspection.

- **Total Quality Control (TQC)**

The TQC phase started in the 1960. Feigenbaum was the first expert who used the TQC term. He considered that "…control must start with the design of the product and end when the product has been placed in the hands of customers who remain satisfied". There are many elements such as supplier development relationships, people empowerment and teamwork that are considered as a part of the TQM concept, but are not included in TQC.

- **TQM**

TQM evolved in the 1980s and began to have a major impact on management and engineering approaches to long-term success through customer satisfaction. It is based on the participation of all members of an organisation in improving processes, products, service and the culture in which they work. Garvin (1984) outlined the evolution of TQM as the outcome of four major eras of development. He described the evolutionary process where quality has moved from an initial stage of inspecting, sorting and correcting standards to an era of developing quality manuals and controlling process performance. The third stage concerns comprehensive manuals including areas of an organisation other than production, and the use of standard techniques such as statistical process control (SPC). Martinez-Lorente et al. (1998) summarized the chronology of TQM development as in Table (5.1).

Table 5.1: Important Events in the Development of TQM

Year	Events
1924-1932	Hawthorn's studies demonstrated the importance of the social and psychological climate in work.
1924	Shewhart developed statistical process control (SPC).
1926	Bell Telephone began to apply statistical process control methods.
1940s	US army pushed the use of sampling methods during World War II.
1950s	Many attempts at work improvement undertaken (e.g. job enrichment, work re-design, participative management, quality of work life, worker involvement).
1950	Deming's first visit to Japan.
1951	Creation of Deming Application Prize in Japan. First edition of Juran's *Quality Control Handbook* published.
1954	Juran's first visit to Japan. Maslow's theories about human needs.
1960	Liberalisation of economy in Japan with pressure to improve quality to compete with foreign companies. McGregor's X and Y theories.
1961	First edition of Feigenbaum's *Total Quality Control* published.
1962	The idea of quality circles appeared in the first issue of the *Japanese Journal Quality Control for the Foreman.*
1970s	The pressure of Japanese companies began to be felt in US companies.
1972	QFD was developed at Mitsubishi's Kobe shipyard.
1973	After the 1973 oil crisis the JIT system was adopted by a vast number of Japanese companies. A small number of US and European companies began to apply this system in the 1980s.
1974	Quality circles began to be widely introduced in the USA; the first quality circle programme was launched in Lockheed in 1974 and in the UK Rolls-Royce introduced the concept in 1979.

1979	First edition of Crosby's *Quality is Free* published. Xerox Corp. started to apply benchmarking concept to processes. Publication of the BS5750 quality management series.
1980	An NBC television documentary about the "Japanese miracle" proposed Deming as a key element in this miracle.
1981	Ouchi's Z theory
1982	First edition of Deming's *Quality, Productivity and Competitive Position* published.
1983	*Quality on the L*ine, published by Garvin in Harvard Business Review, analysed the differences between Japanese and US companies, showing some of the reasons for the better performance of the Japanese. A paper about Taguchi's design of experiments was published in *Harvard Business Review*.
1985	Navel System Command named its Japanese-style management approach "TQM".
1986	First edition of Deming's *Out of the Crisis* published. It became a best seller.
1987	First edition of ISO 9000 quality management system series. Publication of the Malcolm Baldrige National Quality Award.

Source: Martinez-Lorente, Dewhurst and Dale (1998)

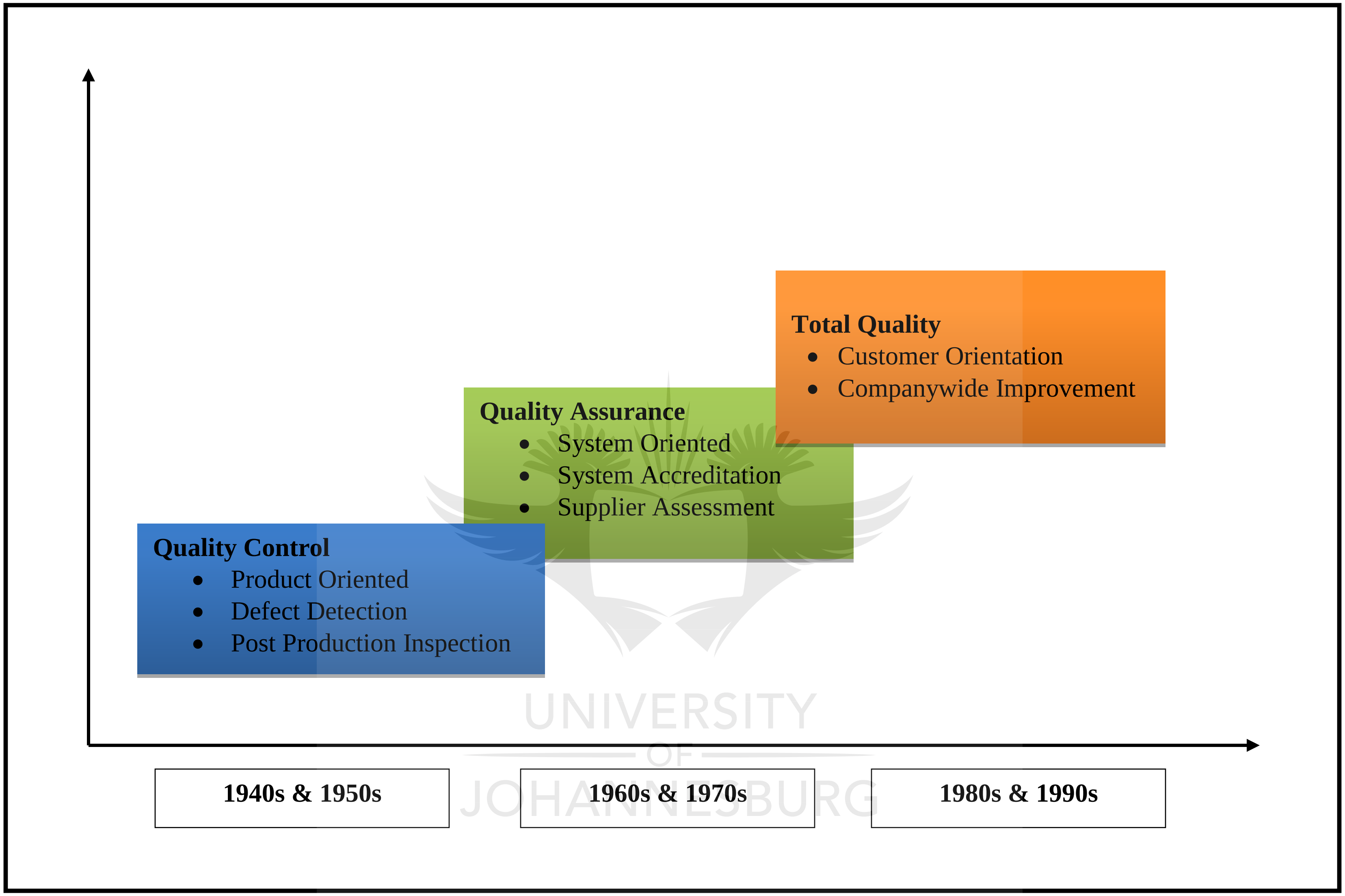

Figure 5.1: Evolution of Quality Management (Source: Himanshu, 1999)

5.3 QUALITY PIONEERS IN DEVELOPED COUNTRIES AND THEIR CONTRIBUTIONS TOWARDS TOTAL QUALITY MANAGEMENT CONCEPT

5.3.1 Contribution by Dr. Joseph Juran

Dr. Joseph Juran originally worked in the quality programme at Western Electric. He became well known in 1951 after the publication of his book *Quality Control Handbook*. Juran (1988) introduced the management dimensions of planning, organizing, and controlling and focused on the responsibility of management to achieve quality and the need for setting goals. Juran defined quality as fitness for use rather than simply conformance to specifications. He was a pioneer in teaching the Japanese on quality management improvement and believed in top management commitment, support and involvement in the quality effort. Juran's ten steps to quality management are the following: i.) Build awareness of opportunity to improve, ii.) Set goals for improvement; iii.) Organize to reach goals; iv.) Provide training; v.) Carry out projects to solve problems; vi.) Report progress; vii.) Give recognition; viii.) Communicate results; ix.) Keep score; and x.) Maintain momentum by making annual improvement part of the regular systems and processes of the company.

Juran (1973) considered quality management as three basic processes (Juran Trilogy), namely quality control, quality improvement, and quality planning. In his view, the approach to managing for quality consists of three steps: i) The sporadic problem is detected and acted upon by the process of quality control; ii) the chronic problem requires a different process, namely quality improvement; and iii) such chronic problems are traceable to an inadequate quality planning process. Juran defined a universal sequence of activities for the three quality processes which is listed in Table 5.2.

Juran defined four broad categories of quality costs which can be used to evaluate the firm's costs related to quality. Such information is valuable to quality improvement. The four quality costs are listed as follows:

- Internal failure costs (scrap, rework, failure analysis), associated with defects found prior to transfer of the product to the customer;

- External failure costs (warranty charges, complaint adjustment, returned material, allowances), associated with defects found after product has been shipped to the customer;
- Appraisal costs (incoming, in-process, and final inspection and testing, product quality audits, maintaining accuracy of testing equipment), incurred in determining the degree of conformance to quality requirements; and
- Prevention costs (quality planning, new product review, quality audits, supplier quality evaluation, training), incurred in keeping failure and appraisal costs to a minimum (Zhang, 2000).

Table 5.2: Universal Processes for Managing Quality

Quality Planning	**Quality Control**	**Quality Improvement**
Establish quality goals	Choose control subjects	Prove the need
Identify customers	Choose units of measure	Identify projects
Discover customer needs	Set goals	Organize project teams
Develop product features	Create a sensor	Diagnose the causes
Develop process features	Measure actual performance	Provide remedies, prove remedies are effective
Establish process controls, transfer to operations	Interpret the difference	Deal with resistance to change
	Take action on the difference	Control to hold the gains

Source: Zhang (2000)

5.3.2 Contributions by Prof. Edwards Deming

Prof. Edwards Deming is often referred to as the ‘father of quality control. He was a Statistics Professor at New York University in the 1940s. Deming (1986) stressed the responsibilities of top management to take the lead in changing processes and systems. He also insisted management’s responsibility is to build good systems that promote good quality management (Deming, 1986). He emphasized that employees cannot produce quality goods that exceed what the system was capable of producing. He therefore proposed 14 points as the principles of TQM or steps for implementing TQM to help companies improve on quality and productivity. These points are listed below:

- Create constancy of purpose for improving products and services.
- Adopt the new philosophy.
- Cease dependence on inspection to achieve quality.
- End the practice of awarding business on price alone; instead, minimize total cost by working with a single supplier.
- Improve constantly and forever every process for planning, production and service.
- Institute training on the job.
- Adopt and institute leadership.
- Drive out fear.
- Break down barriers between staff areas.
- Eliminate slogans, exhortations and targets for the workforce.
- Eliminate numerical quotas for the workforce and numerical goals for management.
- Remove barriers that rob people of pride of workmanship, and eliminate the annual rating or merit system.
- Institute a vigorous programme of education and self-improvement for everyone.
- Put everybody in the company to work accomplishing the transformation.

5.3.3 Contributions by Philip B. Crosby

Philip B. Crosby is another recognized western guru in the area of TQM. He developed the phrase, "Do it right the first time" and the notion of zero defects, arguing that no amount of defects should be considered acceptable. Crosby (1979) coined the term "zero defects" and stated there is absolutely no reason for having errors or defects in any product or service. He said the cost of quality is understated in comparison with the cost of improving quality. Cosby concluded that the cost of quality included all things that are not included in getting it right the first time.

Crosby (1979) identified a number of important principles and practices for a successful quality improvement programme which include, for example, management participation, management responsibility for quality, employee recognition, education, reduction of the cost of quality (prevention costs, appraisal costs, and failure costs), emphasis on prevention rather than after-the-event inspection, doing things right the first time, and zero defects. Crosby claimed that mistakes are caused by two reasons: Lack of knowledge and lack of attention. Education and training can eliminate the first cause and a personal commitment to excellence (zero defects) and attention to detail will cure the second (Crosby, 1979).

Crosby offered a 14-step programme that can guide firms in pursuing quality improvement. These steps are listed as follows:

(i) Management commitment: To make it clear where management stands on quality.

(ii) Quality improvement team: To run the quality improvement programme.

(iii) Quality measurement: To provide a display of current and potential nonconformance problems in a manner that permits objective evaluation and corrective action.

(iv) Cost of quality: To define the ingredients of the cost of quality, and explain its use as a management tool.

(v) Quality awareness: To provide a method of raising the personal concern felt by all personnel in the company toward the conformance of the product or service and the quality reputation of the company.

(vi) Corrective action: To provide a systematic method of resolving forever the problems that are identical through previous action steps.

(vii) Zero defects planning: To investigate the various activities that must be conducted in preparation for formally launching the Zero Defects programme.

(viii) Supervisor training: To define the type of training those supervisors need in order to actively carry out their part of the quality improvement programme.

(ix) Zero defects day: To create an event that will make all employees realize, through a personal experience, that there has been a change.

(x) Goal setting: To turn pledges and commitment into actions by encouraging individuals to establish improvement goals for themselves and their groups.

(xi) Error causal removal: To give the individual employee a method of communicating to management the situation that makes it difficult for the employee to meet the pledge to improve.

(xii) Recognition: To appreciate those who participate.

(xiii) Quality councils: To bring together the professional quality people for planned communication on a regular basis.

(ixv) Do it over again: To emphasize that the quality improvement programme never ends (Crosby, 1979)..

5.3.4 Contributions by Dr. Kaoru Ishikawa

Dr. Kaoru Ishikawa was the first Japanese quality guru to emphasize the importance of the 'internal customer', the next person in the production process. He was also one of the first to stress the importance of total company quality control, rather than just focusing on products and services. Ishikawa (1985) promoted the use of teams or quality circles and the seven tools of quality in performance improvement. He developed the Cause-Effect diagram known as Fishbone Diagram.

Ishikawa defined quality as the development, design, production and service of products that are most economical, most useful, and always satisfactory to the customer. He emphasized the importance of training, and use of cause-effect diagrams for problem solving, and quality circles as a way to achieve continuous improvement (Ishikawa, 1985).

Ishikawa (1985) argued that quality management extends beyond the product and encompasses after-sales service, the quality of management, the quality of individuals and the firm itself. He claimed that the success of a firm is highly dependent on treating quality improvement as a never-ending quest. A commitment to continuous improvement can ensure that people will never stop learning. He advocated employee participation as the key to the successful implementation of TQM. Quality circles, he believed, are an important vehicle to achieve this. Like all other gurus he emphasized the importance of education, stating that quality begins and ends with it.

Ishikawa's concept of TQM contains the following six fundamental principles:

- Quality first; not short-term profits first;
- Customer orientation; not producer orientation;
- Customer breaking down the barrier of sectionalism;
- Using facts and data to make presentations-utilization of statistical methods;
- Respect for humanity as a management philosophy, full participatory management; and
- Cross-functional management (Ishikawa, 1985).

5.3.5 Contributions by Armand V. Feigenbaum

Feigenbaum (1991) defined TQM as an effective system for integrating the quality development, quality maintenance, and quality improvement efforts of the various groups in a firm so as to enable marketing, engineering, production, and service at the most economical levels which allow for full customer satisfaction. He claimed that effective quality management consists of four main stages, described as follows:

- Setting quality standards;
- Appraising conformance to these standards;
- Acting when standards are not met;
- Planning for improvement in these standards (Feigenbaum, 1991).

Feigenbaum considered top management commitment, employee participation, supplier quality management, information system, evaluation, communication, the use of quality costs, and the use of statistical technology to be essential components of TQM. He argued that employees should be rewarded for their quality improvement suggestions since quality is everybody's job. He stated that effective employee training and education should focus on the following three main aspects, namely quality attitudes, quality knowledge, and quality skills (Feigenbaum, 1991).

5.3.6 Summary of Contributions by Quality Pioneers towards TQM Concept

After the approaches to TQM of the five quality gurus from developed countries have been reviewed, it has become evident that each has his own distinctive approach. Nevertheless, the principles and practices of TQM proposed by these quality gurus provide the author with a better understanding of the concept of TQM in developed countries. Although their approaches to TQM are not totally the same, they do share some common points which are summarized as follows:

(i) It is management's responsibility to provide commitment, leadership, empowerment, encouragement, and the appropriate support to technical and human processes. It is top management's responsibility to determine the environment and framework of operations within a firm. It is imperative that management should foster the participation of the employees in quality improvement, and develop a quality culture by changing perception and attitudes toward quality.

(ii) The strategy, policy, and firm-wide evaluation activities are emphasized.

(iii) The importance of employee education and training is emphasized in changing employees' beliefs, behaviour, and attitudes, thereby enhancing employees' abilities in carrying out their duties.

(iv) Employees should be recognized and rewarded for their quality improvement efforts.

(v) It is important to control the processes and improve quality system and product design. The emphasis is on prevention of product defects, not inspection after the event.

(vi) Quality is a systematic firm-wide activity from suppliers to customers. All functional activities, such as marketing, design, engineering, purchasing, manufacturing, inspection, shipping, accounting, installation and service, should be involved in quality improvement efforts.

According to Zairi (1991), W. E. Deming was the first western scientist invited to give seminars to Japanese workers and managers on effective quality management. His main interest was in the application of statistical techniques. He came up with the Deming Cycle: Plan, Do, Check, Action (PDCA). Deming proposed that the purpose of using quality management techniques is to help companies stay in business and that quality improvement has to be led by management. Deming came up with fourteen points for total transformation that are based on a company-wide quality improvement philosophy (Zairi, 1991).

Deming's fourteen points highlight the need for a change in approach in terms of quality management from the aims (point 1), to thoughts (point 2), to action (points 3 and 4), improving (point 5), incorporating new approach (points 6,7,13 and 14) and eliminating acts that negatively affect quality (points 8 to 12). Building quality into the product in the first place (point 3) has significant implications on the operational costs of projects. There will be a reduction in the cost of maintenance if the product is produced to the required quality (Zairi, 1991).

Deming's approach to quality management emphasizes that the purpose of using quality management techniques is to help companies stay in business. This can be achieved when there is quality improvement which leads to higher productivity and this lowers costs. The prices will be lower because of lower production costs and this invariably attracts more customers to the product with good quality and reduced price – getting value for their money. When there is an increase in the number of customers for a product at a reasonable profit for the producer, the producing company stays in business (Zairi, 1991).

Deming's approach to TQM is quite different from *management by objectives* because he argues that the management has two main areas of responsibilities, as mentioned earlier, and quality management is a duty of everyone in the organization. Meanwhile, the *management by objectives* concept requires all managers to participate in strategic planning processes and implement performance systems to help the organization back on track. Managerial focus of *management by objectives* is the final result and not the set of activities that produce the result while Deming's approach encourages the definition of a detailed roadmap for implementation (Zhang, 2000).

Deming's quality philosophy highlights the continuous improvement of the process for which management is responsible. They also state that there are three types of quality that management must understand. These include:

i. Quality of design/redesign;

ii. Quality of conformance; and

iii. Quality of performance

According to Zairi (1991: 21), Juran contributed as much to total quality as Deming did. Juran was invited to speak to Japanese senior managers in 1954 on the importance of planning, organising and managing quality programmes (Zairi, 1991: 21; Ishikawa, 1885: 19). Juran's approach to quality control and management was twofold:

- Company's mission; and
- Senior managers' role.

Juran proposed that quality has to be controlled at each stage of the process and should be aimed at controlling the following:

- Sporadic problems/avoidable costs (defects and product failure, scrapped materials, labour wasted usage for re-work, repair, dealing with customer complaints); and
- Unavoidable costs dealing with chronic problems (prevention and control).

Sporadic problems can be solved easily using quality control techniques such as standard statistical techniques, charts and diagrams; while unavoidable costs require introduction of a new culture which is intended to change attitudes and increase companywide knowledge. Planning, implementing and controlling quality according to the mission of a business determines how lasting a business will be. Juran also argued that managerial processes are necessary for the structured implementation of a total quality programme: planning, control and improvement. He argued that the planning process is crucial for improvement to become a continuous activity (Zairi, 1991: 23). Planning therefore has to be conducted with a long-term view rather than on a project-by-project basis.

According to Zairi (1991: 23) and Wadsworth, Stephens and Godfrey (1986: 19), Crosby's quality drive is prevention and he argued that quality is free. The costs are only related to the various obstacles for the first time. According to Crosby, the major objectives of organizations implementing total quality should be Zero Defect. He proposed that acceptable quality levels should be forbidden because they compromise the commitment towards the achievement of Zero Defect. He also identified the following two major problems which are causes of poor quality in the industry:

- Those which are due to employees poor awareness and knowledge; and
- Others which are due to carelessness and lack of attention.

The first problem can be easily identified, measured and solved but the second needs a long-term management effort in changing culture and attitude. Crosby argued that if a company is serious about achieving Zero Defect, they have to be serious about prevention. He also proposed four steps for managers and fourteen steps to improve quality. Crosby's fourteen steps differ from Deming's because they facilitate the introduction of continuous improvement. Crosby's approach to total quality is to change the culture and attitudes within the organizations to implement continuous improvement. This approach is more management oriented since it does not refer to the control of quality predominantly by the use of various statistical techniques (Zairi, 1991).

These 'pioneers' of quality have their different approaches to quality. Deming's approach is more one of transformation, based on a company-wide quality improvement philosophy; Juran's approach is the company's mission in relation to the customer's specification and the role of senior managers in providing leadership and resources in awareness of developing systems for quality; and Crosby's approach produces guidelines for managers and gives room for corrective actions despite the fact that he preached zero defect.

Zairi (1991: 32) concluded that there is no doubt that TQM ideas and concepts would be developed in the future to facilitate meeting the requirements of a business market which is always changing. Despite the constant change in the construction industry, the TQM approach allows flexibility in the achievement of quality on projects.

5.4 TQM IMPLEMENTATION IN CHINA

This section presents brief review results on TQM implementation in China.

5.4.1 Why China was Chosen for the Study

Over the past years, China has become a focus of interest for Western organizations and management researchers, along with the awareness of the important role it has played in the global economy. Accordingly, more and more researchers have been involved in conducting research projects in relation to China in various fields, such as culture (e.g. Adler & Ziglio, 1996), organizational studies (e.g. Shenkar & Von Glinow, 1994), technology transfer (e.g. Tackaberry, 1998), marketing (e.g. Fock & Woo, 1998) and TQM (e.g. Zhang, 2000). According to Zhang (2000) the existing Chinese literatures related to the TQM showed that, a number of articles were published dealing with institutional policies. Such articles mainly discussed what kinds of governmental quality policies should be drawn up in order to encourage Chinese firms to emphasize quality management, implement TQM, and improve product quality. Secondly, some articles reported the specific experiences of implementing TQM in firms. These articles generally discussed the benefits, importance, and methods of implementing TQM in firms.

5.4.2 Evolution of TQM Implementation in China

According to Zhang (2000), TQM has been introduced in China from 1978 onwards. In order to encourage firms in implementing TQM, great efforts have been made by the Chinese government. As a result, an increasing number of firms implemented TQM. In a survey conducted by Yu et al. (1998), 96% of responding firms reported that they had done so. Therefore, it can be said that the rate of TQM implementation is very high in Chinese manufacturing firms.

In 1978, the Beijing Internal Combustion Engine Factory and the Qinghe Woollen Mill started to implement TQM through cooperating with their foreign partners. In the meantime, a number of experts and scholars began to disseminate the knowledge of TQM to firms. In September 1978, some firms began to introduce QC circle activities. On 24 August 1979, the excellent QC circles' reports were presented in Beijing. On 31 August 1979, the China Quality Control Association was established. One of its duties was to cooperate with relevant governmental agencies to promote TQM in the country. Because of the significant effects of TQM implementation in the Beijing Internal Combustion Engine Factory, it was concluded that TQM could be effectively implemented in China. Thus, the experiences of TQM implementation were then popularized and disseminated to other firms. In order to encourage firms in implementing TQM, the State Economic Commission issued the Provisional Regulations on TQM Implementation in Industrial Firms in March 1980. The provisional regulations, which integrated TQM theory with Chinese national specific conditions, stipulated the significance, role, and implementation method of TQM. In order to help firms implement TQM, a large number of training courses and seminars were organized by the quality control associations at various levels. The statistical data in 1985 showed that 38,000 firms implemented TQM while 500,000 QC circles were established in various firms. Today, there are tens of thousands of firms that have implemented TQM, which has been implemented not only in state-owned firms but also in collective and township firms, and not only in industrial firms but also in service firms.

The major TQM implementation practices in Chinese manufacturing firms could be summarized as using various kinds of quality management tools such as the QC seven tools and statistical process control in practice, implementing QC circles activities, analyzing and identifying quality-related costs, emphasizing quality inspection, establishing quality bodies (e.g. TQM implementation offices) in manufacturing firms, conducting quality audits, and strengthening process control and improvement, product design, and after sales services.

5.5 LESSON LEARNT FROM DEVELOPED COUNTRIES ON TQM IMPLEMENTATION

The historical development of quality as a management concept demonstrates that its evolution did not occur abruptly in sudden changes in management philosophy, but gradually through stable consistent improvement. This reflects a series of management innovations that were created during the twentieth century. Therefore, the TQM movement was not formulated as a separate philosophy, but derived from previously established scientific management concepts.

5.6 CONCLUSION

The chapter discussed TQM implementation in developed countries. Among the issues discussed in the chapter is the evolution of TQM in developed countries. The historical development of quality as a management concept demonstrates that its evolution did not occur abruptly in sudden changes in management philosophy, but gradually through stable consistent improvement. This reflects a series of management innovations that were created during the twentieth century. Therefore, the TQM movement was not formulated as a separate philosophy, but was derived from previously established scientific management concepts.

The views of quality pioneers in developed countries and their contributions towards the TQM concept were also highlighted in the chapter. After the approaches to TQM of the five quality gurus from developed countries have been reviewed, it has become evident that each has his own distinctive approach. Although their approaches to TQM are not totally the same, they do share some common points.

CHAPTER SIX

6 TOTAL QUALITY MANAGEMENT IMPLEMENTATION IN DEVELOPING COUNTRIES

6.1 INTRODUCTION

This chapter discusses TQM implementation in developing countries. The chapter looks into the construction industry in Nigeria and South Africa and how the TQM concept has been accepted in these countries. An evaluation of policies and government intervention with regard to TQM implementation is also presented. In addition, the philosophical basis for TQM implementation in Nigeria and South Africa is discussed. Also explored in this chapter are the challenges facing TQM implementation in the Nigerian and South Africa construction industries.

6.2 THE SITUATION OF NIGERIA CONSTRUCTION INDUSTRY

6.2.1 Construction Industry in Nigeria

The Nigerian construction industry is beset with many problems such as uncompleted project resulting from delay and cash flow problems leading to time and cost overruns, poor quality (defects and rework) and low levels of productivity, especially in projects handled by indigenous construction firms (Saad & Dahiru, 2015). Above all, the Nigerian construction industry has long been associated with poor quality end products and the industry has not changed over the years (Mohammed & Rotimi, 2002). Furhermore, the industry has made little progress in reducing the cost of reworks and defects prevalent in the sector. As clients have also become more aware of the quality standards required in the structure commissioned, the public at large believe that the industry fails to offer value for money, and projects take too long to complete and are too prone to failure (Bamisile, 2004).

Concern over the global decline in the construction quality prompted Kubal (1994) to cite a report of the USACE Blue Ribbon (1993) that explicit solicitude has been reported about the decline in construction quality in the past decade in addition to concerns regarding the decrease in customer satisfaction in the construction industry, despite the programmes developed to improve the process and the products of construction. However, such concern in Nigeria goes beyond customer satisfaction. In the Nigerian context, the issue of quality and standard has been the subject of concern in the country's construction industry in recent times following the frequent collapse of building structures around the nation (Abiodun & Afangadem, 2007). A report of the Lagos State Physical and Development Authority (2006) indicated that out of 61 reported cases of building collapse, 13% were directly attributed to faulty designs, while 53% of the recorded deaths were attributed to faulty designs.

According to Uduak (2006), the construction firms in Nigeria can be classified as follows:

i. Large firms: These are firms whose annual turnover range from 500 million naira and above and have over fifty workers on their payroll. They undertake the erecting of a wide range of buildings from housing estate to offices, hospitals and factories. They also undertake both national and regional works. These firms occupy less than 3% of the contracting firms in Nigeria.

ii. Medium sized firms: These represent hose whose annual turnover is between 100 and 500 million naira and have between 20 to 50 people on their payroll. The regional firms undertake regional work such as real estate schemes and they constitute about 23% of the total number of contracting firms in Nigeria.

iii. Small sized firms: These are firms whose annual turnover is less than 10 million naira to 100 million naira and have fewer than 20 people on their pay roll. They undertake small works, industry minor repairs and maintenance works and they constitute almost 74% of contracting firms in Nigeria.

6.2.2 Implementation of TQM in the Nigerian Construction Industry

There are several project quality management techniques, standards, policies, systems, procedures, audits, manuals, planning, records, and surveillance systems but they are seldom applied during project execution in Nigeria. This leads to poor project quality, high maintenance/running costs, reduced building performance and a high probability of occupants' discomfort.

Quality is conformance to standards that represents the products or services basic characteristics, and is based on customer needs and expectations (Aubrey, 2005). The quality of a product should meet the desired requirements at the lowest cost (Sharma, 2006). Dodo (2008) in Saad and Dahiru (2015) opined that the quest to achieving optimal quality entails the effective functioning and integration of informed clients, skillful designers, knowledgeable suppliers/component manufacturers, and competent contractors. Ozaki (2003) stated that quality management has a three-fold meaning in construction, namely getting the job done on time, ensuring that the basic characteristics of the final project fall within the required specifications, and getting the job done within budget. Poor quality impacts companies in two ways, namely higher cost and lower customer satisfaction (Pyzdek, 2003). Quality can be defined as the totality of features and characteristics of an entity that bear on its ability to satisfy stated or implied needs (ISO 9000:2000) where an entity can be a product, a component, a service, or a process. Quality management has developed from product-related quality control to company-related TQM, aiming for continuous process improvement (Seaver, 2003). According to Mohammed (2011), TQM is an umbrella term for continuous improvement and incorporates quality assurance (QA), quality control (QC) and quality inspection (QI). Harris and McCaffer (2005) defined TQM as a management approach that tries to achieve and sustain long-term organization success by encouraging employee feedback and participation, satisfying customer needs and expectations, respecting societal values and benefits, and obeying government's statutes and regulation. It is a senior management-led process to obtain the involvement of all employees in the continuous improvement of the performance of all activities, as part of normal business, to meet the needs and satisfaction of the customer, whether internal or external.

Previous research indicates that TQM has been in use since the 1980s. In Nigeria, studies have shown little usage of TQM despite its potential benefits to the industry. Although TQM is not fully implemented, there is the Standard Organization of Nigeria (SON), the activities of which are similar to that of the British Standard Institution (BSI) and ISO. SON has officially adopted ISO 9000 series for quality management in Nigeria. The organization was established by Enabling Act No. 56 of 1971 which has three amendments - Act No. 20 of 1976, Act No. 32 of 1984 and Act No. 18 of 1990. The activities of SON are similar to those of BSI and ISO. In fact, SON has officially adopted ISO 9000 series for quality management in Nigeria (Bamisile, 2004).

There are three (3) main standards covered by the ISO 9000 family of standards and they collectively provide guidance for quality management and the general requirements for quality assurance. These families are the ISO 9000, 9001, 9002 and 9003. The requirements of this standard primarily aim at achieving client/customer satisfaction by preventing non-conformity at all stages, from design through to servicing.

The ISO 9000 series is a framework for improving quality in the construction industry (Kumaraswamy & Dissanayaka, 2000). The ISO 9000 standard was developed to move away from the original 'prescriptiveness' approach of its predecessors to achieve a more flexible framework which allows organizations to develop their own policies and procedures (Harris & McCaffer, 2005). The ISO 9000 family of standards operates on the assumption that the following factors can have an influence on the quality of a product or service provided by an organization:

i. Design, purchasing and management
ii. Work patterns, job description, inspection and testing
iii. Reporting relationships, policies and procedures
iv. Record keeping systems, inventory control and training
v. Customers, technologies, resources and planning methods
vi. Production processes, transportation services and communication patterns
vii. Service delivery practices, employee knowledge and skills

According to Nee (1996), the ISO was founded in 1946. Its function then was to establish worldwide common standards for manufacturing, communication and trade. The best known series and recognised quality standards are the ISO 9000 series or families of standards, (Pyzdek, 2003; Harris & McCaffer, 2005). The development of the ISO series started with the formation of a Technical Committee 176 (TC176) in 1979. The ISO series was first issued in 1987. The ISO standard embodies comprehensive quality management concepts and provides guidance for implementing its principles. The concept which underlies the ISO 9000 standards is that consistently high quality is best achieved by a combination of technical product specification and management systems standards. The standard allows more flexible framework to be achieved which allows organizations to develop their own policies and procedures. It is necessary to mention some of the requirements of ISO series. For instance, ISO 9001 (2008) requires that a quality organization shall continually improve effectiveness of the quality of management system through the use of the quality policy, quality objectives, and audits results, analysis of data, corrective actions and management review. Similarly, ISO 9000 (2005) highlighted that the aim of continual improvement of QMS is to increase the probability of enhancing the satisfaction of customers and other interested parties.

Saad and Dahiru (2015) conducted research on multinational and indigenous construction firms in Nigeria to determine how the concept of project quality management is employed and implemented in their firms as well as its effects on construction processes and the quality of the finished product. In their study, a total of one hundred (100) construction firms were selected out of which 50 are multinationals whereas the other 50 are indigenous. The results are as follows (See figures 6.1 to 6.3):

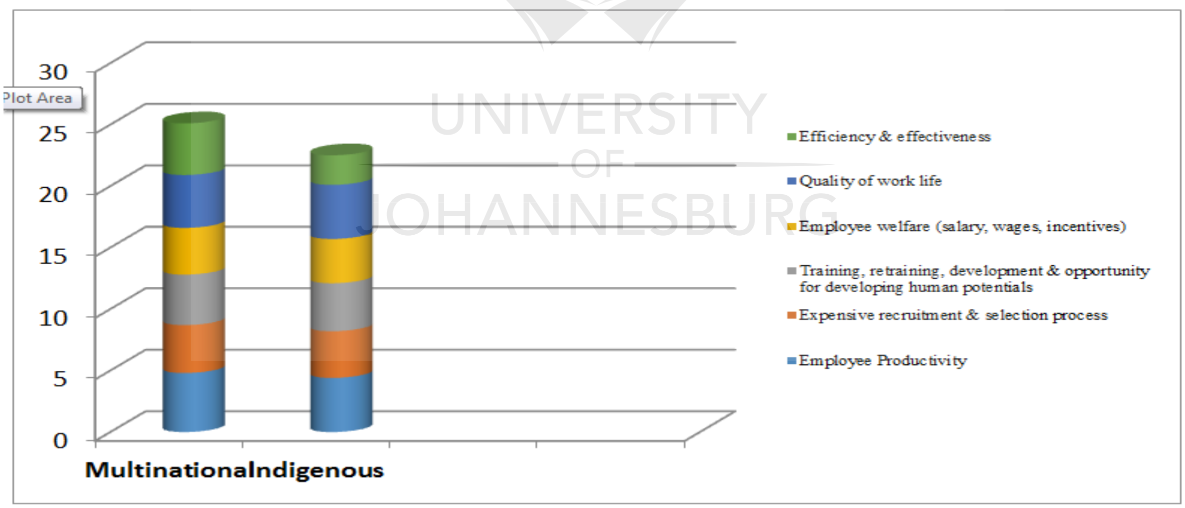

Figure 6.1: Comparison of efforts made in achieving quality between multinational & indigenous construction firms

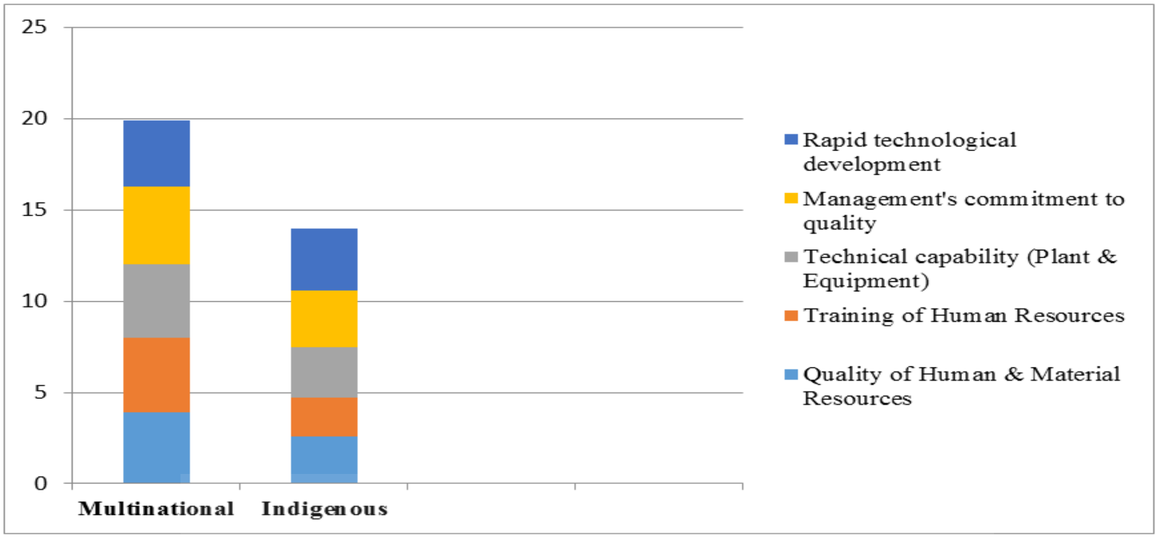

Figure 6.2: Comparison of the factors affecting quality achievement by multinational & indigenous construction firms

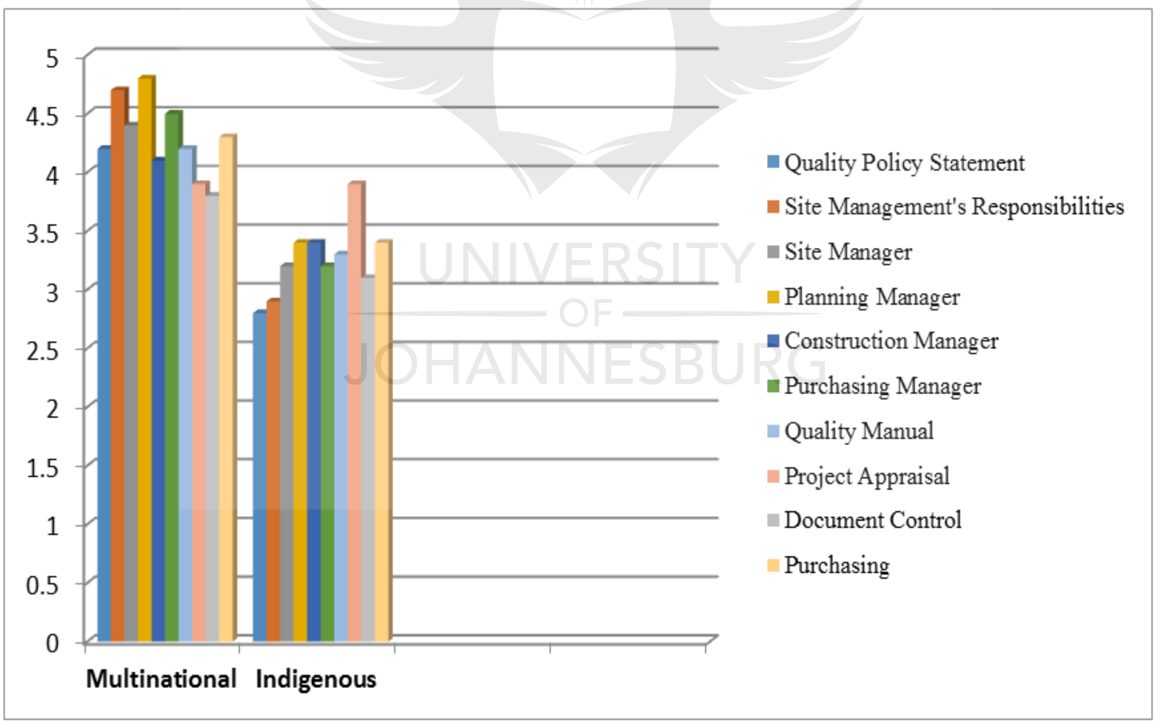

Figure 6.3: Comparison of the level of adherence to project quality management plan by both firms

From the study of Saad and Dahiru (2015) it can be concluded that:

i. There is disparity in terms of project quality delivery between multinational and indigenous firms;

ii. An uncompromising attitude towards the stipulations of the contract documents in terms of design and specifications by the multinationals puts them a step ahead, thus a preference over their indigenous counterparts;

iii. Quality can be achieved when firms can invest in quality management which cost far less than the cost of correcting defects and rework; and

iv. There are Quality Officers or Quality Managers in multinational construction firms whereas they are absent in indigenous construction firms.

6.2.3 Lessons Learnt from Nigeria TQM

In construction industry, the aim of all professionals and consultants is to strive to provide the owner or client with a product or service that will meet the standard that is intended for; properly built with satisfactory performance and value for money. In furtherance to this aim, the Standard Organization of Nigeria (SON) was put in place by the Federal Government to ensure good quality of both materials and finished goods/products that are produced in the country. In other words, SON is an organization charged with the responsibility of formulating a national standard for a Quality Management System in Nigeria. In this regard, many multinational construction firms in Nigeria have gone to a great extent in introducing a quality management system such as TQM as an integral part of construction management while most of these firms have chosen to structure their quality systems in accordance with the standards contained in the ISO 9000 series.

It was realized that most of the construction firms in Nigeria are aware of the benefits of TQM and the factors enhancing its implementation. However, the levels of adoption of the TQM principles are very low, especially in indigenous construction firms. The principal factors which prevent contracting organizations from adopting TQM in Nigeria is the perception that it takes a long time to yield the desired benefits and that TQM involves unnecessary extra cost. Other factors are lack of adequate training, lack of commitment to change, and a poor cultural attitude. Furthermore, TQM is a new concept in Nigeria construction industry and this may explain why though there is some level of familiarity with it, it is yet to be widely adopted. It was therefore suggested that an extensive enlightenment campaign on the importance of TQM in construction will be required in Nigeria to further encourage its use. It was also recommended that government, being the major client of the construction industry, should come up with an award for excellence for quality construction to deserving organisations and a penalty for organizations which refuse to adopt TQM. This will serve as an incentive for conformity to standards in various areas of the industry as well as a deterrent to defaulters.

6.3 THE SOUTH AFRICAN CONSTRUCTION INDUSTRY

The construction industry was considered as one of the foundations of the country's plan for transformation (Bowen, Pearl & Akintoye, 2007). Compared to many other industries, the construction industry plays a vital role in South Africa's economy and is a significant contributor to economic growth (Construction Industry Development Board [CIDB], 2012; Statistics South Africa [Stats SA], 2010). The South African construction industry has been a key driving force behind the nation's economic growth ever since it was targeted for reformation at the beginning of the post-apartheid era of the 1990s. In other words, construction makes a significant contribution to the national economy; it creates employment (especially for the least skilled members of society); it plays a role in the development and transfer of technology, it creates many opportunities for enterprises, and it contributes directly to improving the quality of life of the users of its products. According to the Department of Public Works (1999), the industry contributes 35% to the total gross domestic fixed investment and employs approximately 230,000 employees. The South African Government is the single biggest construction client, making up between 40% and 50% of the entire domestic construction expenditure.

However, the sudden rise in interest rates in the late 1990s and the global economic meltdown of 2008 had a significant impact on the construction sector of the South African economy and many construction organizations did not survive the effect of these periods (cidb, 2004; Joubert, Cruywagen & Basson, 2005; South African Reserve Bank, 2009). Several challenges have also been identified as confronting and influencing the performance, development and growth of the South African construction industry (Luus, 2003; Van Wyk, 2003, 2004; CIDB, 2004, 2007; Lewis, 2007; Boshoff, 2010; Mbande, 2010; Milford, 2010; Tomlinson, 2010). According to the Department of Public Works (1999) reports, among other industry challenges are a sharp decline in employment, a steep decline in gross domestic fixed investment (GDFI), slow delivery of public sector projects due to poor capacity in public sector institutions and the contractors, low productivity and poor quality workmanship, and low profit margins for contractors. Compounding these challenges has been the rapid globalization of the South African economy. In this regard, large South African contractors in particular are increasingly expanding into offshore markets to grow revenues and to survive the economic recession affecting the South African construction industry. This has meant that South African contractors need to be more competitive to match the level of performance of their counterparts operating in international markets.

The construction organizations that survived the recessive periods found themselves in a highly competitive construction business environment with other foreign organizations (Joubert et al., 2005). Competition was further exacerbated by the fragmented nature of the construction industry, the *modus operandi*, as well as its structural features. In order to confront the resultant challenges of uncertainties and fierce competition posed by the business environment, it is essential that organizations recognize and establish a strategic position that will integrate with their business undertakings and decisions (Dikmen & Birgonul, 2003; Phua, 2006).

In order to improve the construction industry situation in South Africa, a government department, The National Department of Public Works (NDPW), was tasked to develop a remedial strategy. The launch of the framework document in 1999 (DPW, 1999) was among the first decisive interventions aimed at addressing the situation, and set the tone for government's intention. Subsequently a Construction Industry Development Board (CIDB)

Act was passed in 2000, thus establishing a statutory body aimed at driving an integrated Construction Industry Development strategy. The CIDB has established the construction industry development strategy, performance targets and key performance indicators. The promotion of best practice standards constitutes a critical component of the industry development strategy. In strong support of the industry development strategy, the Council for Scientific and Industrial Research's (CSIR) Building and Construction Technology Division has developed a model for assessing the overall performance of contractors with a view to promoting best practice standards.

6.3.1 South African Policies on Construction

After the apartheid era, the South African Government put programmes in place to empower previously marginalized citizens and improve the economy. This has given rise to several pieces of legislation and policy documents that can be grouped under the heading of Black Economic Empowerment. In response to a history dominated by colonialism, racism, apartheid, sexism and repressive labour policies, the South African government came up with a programme - the Reconstruction and Development Programme (RDP).

McCutcheon and Taylor Parkins (2003: 16) noted six aspects of employment that have been disturbing in South Africa. These are summarized below:

i. The unemployment level is high and rising – in both formal and informal sectors; unemployment grew from 7% in 1980 to between 27% and 37% in 2001.

ii. The formal employment sector was able to absorb 81% annual net additions to the labour force in the 1960s but this shrank to under 10% in the 1990s.

iii. Unemployment varies geographically – some villages may have over 70% while others may be about 30%.

iv. The level of unemployment amongst the uneducated between the ages of 16-19 is about 70%.

v. There are deleterious effects on people who are unemployed which lead to violence and extreme stress.

vi. Because the South African economy has become more capital intensive, less than half the additional employment was created between 1986 and 1990 compared to between 1971 and 1980.

The country's major policy document, the Reconstruction and Development Programme (RDP), was drawn up by the African National Congress (ANC) and the key objectives were meeting basic needs, developing human resources, building the economy, democratising the state and society, and implementing the RDP (ANC, 1994). The RDP is an integral, coherent socio-economic policy framework that seeks to mobilize South Africans and the nation's resources towards the final eradication of apartheid and the building of a democratic, non-racial and non-sexist future (ANC, 1994).

Developing human resources as defined by the ANC means involving South Africans in decision-making processes, implementation, new job opportunities requiring new skills, and managing and governing society (ANC, 1994). This gave birth to the Expanded Public Works Programme (EPWP) which is aimed at providing poverty and income relief through temporary work for the unemployed to carry out socially useful activities. The immediate goal of the Expanded Public Works Programme Phase 1 was to help alleviate unemployment by creating at least one (1) million work opportunities, of which at least 40% of beneficiaries would be women, 30% youth and two % people with disabilities.

The EPWP Phase 2 was launched in April 2009 at the University of the Western Cape. The goal of EPWP phase 2 is to create two (2) million full-time equivalent (FTE) jobs for poor and unemployed people in South Africa so as to contribute to halving unemployment by 2014 through the delivery of public and community services.

The EPWP has exceeded its aimed target that was set when the programme was launched in May 1994. According to the South African Government Information (2009), at the end of April 2008, the EPWP had already created 1 077 801 job opportunities ahead of its scheduled 31 March 2009 time limit. The EPWP is managed by the Department of Public Works which manages and provides the accommodation, housing, land and infrastructure needs of national departments. The EPWP optimizes employment, growth and transformation in the construction and property industries (South African Government Information, 2009).

Two fundamental strategies underpin the government's approach to reducing unemployment: firstly, to increase economic growth so that the number of net new jobs being created starts to exceed the number of new entrants into the labour market; and secondly, to improve the education system such that the workforce is able to take up largely skilled work opportunities which economic growth will generate (South African Government Information, 2009). Short- to medium-term strategies have been put in place to contribute towards these strategies, of which the EPWP is one. This has required the various tiers and departments of Government to embark on labour-intensive projects and insist that labour-intensive methods be considered on the major projects.

Not only does the Department of Public Works take steps to reduce unemployment in the country, they also support and empower women-owned construction enterprises through contractor development programmes such as the Emerging Contractor Development Programme (ECDP). As part of the ECDP, the Contractor Incubator Programme (CIP) was inaugurated with the intention of providing support to existing small- to medium-size construction enterprises to enable them to become sustainable. By August 2008, a total of 136 contractors were registered on the CIP, of whom 62 were women-owned contracting businesses (South African Government Information, 2009). The figures show that women contractors owned about 46% of the total local companies in South Africa. This is a noteworthy performance of the ECDP.

Another state entity that has contributed to the reduction in unemployment, poverty and inequality through policies and programmes is the Department of Labour. The policies and programmes of the Department of Labour are aimed at the following:

- Improved economic efficiency and productivity;
- Skills development and employment creation;

- Sound labour relations;
- Eliminating inequality and discrimination in the workplace;
- Alleviating poverty in employment;
- Enhancing occupational health and safety awareness and compliance in the workplace; and
- Nurturing the culture of acceptance that worker rights are human rights. (South African Government Information, 2009).

The Employment and Skills Development Services (ESDS) is a unit under the Department of Labour that helps to achieve one of the focuses of the South African Government – skills development. There is also a Human Resource Development strategy, which has given rise to a framework that stands on the following four pillars of strategic intervention:

- Capacity-development initiatives – developing human capital for high performance and enhanced service delivery;
- Organizational support initiatives – enhancing organizational capacity and support to maximize the productivity of human capital;
- Governance and institutional support initiatives – ensuring that the Human Resource Development in the Public Service is effective;
- Economic growth and development initiatives – ensuring that the Human Resource Development plans, strategies and activities seek to integrate, promote and respond to the economic growth and development initiatives of government (South African Government Information, 2009).

The Human Resource Development strategy helps in increasing the sustainable capacity development for the low-income level citizens of South Africa.

The Sector Education and Training Authority (SETA) is another sub-department under the Department of Labour that contributes to the raising the level of skills, to bring skills to the employed, and assisting those wanting to be employed in their sector. They help to implement the National Skills Development Strategy through ensuring that people learn the skills that are needed by communities and employers. In most developing countries construction skills are still mainly acquired through an informal apprenticeship system (ILO 2001: 38). The EPWP encourages formal training for all levels of the employees working under the programme. This assists in ensuring that things are done right the first time to reduce price and costs during execution (South African Government Information, 2009).

Aggressive affirmative action (AAA) policies were the first step taken to move black employees quickly into the corporate ranks where they can be trained and developed. Two basic arguments have been made in favour of such aggressive strategies (McFarlin, Coster &Mogale-Pretorius, 1999: 65). The first is that the positive effects of economic growth will take too long to filter down to affect corporate practices. If South Africa fails to redress apartheid‟s inequalities quickly, it risks a level of racial polarization that could tear the country apart. The second argument is that aggressive affirmative action is simply good business since black consumers will dominate the South African economy in the future. Moreover, affirmative action will help the business environment by lowering unemployment and crime (McFarlin et al., 1999: 65).

However, despite the large government programmes since 1994 to eradicate the inequalities of apartheid, almost 50% of the country’s population lives under the poverty line defined as R1400 (or US$140). In South Africa, the poorest 10% of the population receives only 1.4% of the total income, while the richest 10% receives 47.3% of the total income (Du Plessis, Irurah &Scholes 2003: 242). The poverty level in South Africa has induced the government to embark on development projects with all forms of programmes and policies to ensure that the there is poverty reduction, growth and development in South Africa. These programmes have been relatively effective in growing the economy of this developing country.

6.3.2 Poor Contractor Performance and its Causes in South Africa

Many problems are faced by contractors when delivering construction projects. As a result poor contractor performance, as characterized by poor work quality and low productivity, is common in the industry. In a survey conducted among members of the South African Property Owners Association (SAPOA) to investigate the clients' perception relative to contractors' performance, Smallwood (2000) found the predominant problems to be rework, poor productivity and poor quality. Smallwood concluded that the causes of poor contractor performance, as perceived by clients, were a lack of concern for the environment, late information, inadequate or poor planning, poor management of the design activities, poor management and low skills levels among the workers. Other writers (Allens, 1994; Henry, 1994; Lobelo, 1996) strongly concur with Smallwood's analysis. Furthermore, they identified additional problems to be cost over-runs, rework, late completion, an unacceptably high accident rate, insensitivity to environmental considerations, poor work practices and adversarial relationships. A common thread running through all these cases is the failure of many contractors to fully acknowledge the significance of some key construction issues that seriously affect contractor performance, such as integration of the design and construction process, as well as the quality management process.

Ambrose and Claasen (2004) conducted a survey in South Africa and concluded the following:

- Most of the projects were completed late for various reasons: some due to an increase in work scope, others due to design deficiencies and others due to poor site management on the part of the contractor executing the work.
- Many projects were characterized by adversarial sentiment, especially between the consultant (project manager) and the contractor.
- Many projects experienced cost overruns due mainly to the time elapsed between business plan formulations and funding approval, with inflation taking its toll on costs. In other cases, unknown elements such as excess rock encountered caused the cost overrun, while in a few cases, cost overruns was due to design deficiencies.

- The tender evaluations showed that many contractors are disqualified because they lack the expertise and experience to carry out the work tendered for. In some cases, tender committees appointed such contractors with alarming results.

6.3.3 Problems pertaining to Poor Quality in the South African Construction Industry

Verster (1998) argued that, although the principles of producing quality are universal, the construction industry differs in many aspects from the manufacturing industry. Much research has been conducted on the management of quality and the implementation of TQM in construction in South Africa. Some of the biggest problems identified are the following:

6.3.3.1 Commitment by Top Management

Ngowi (2001) state that top management of construction companies, both in South Africa and Botswana, does not show commitment to quality or TQM and that the focus of companies is more towards maximizing profit and saving time. Furthermore, management's commitment is either not clearly communicated to workers or workers do not have access to the quality policy and quality goals of the company and therefore do not have the motivation to deliver a quality product.

6.3.3.2 Training of Skilled and Unskilled Workers

One of the main reasons for poor quality in the South African construction industry is that the workers who are responsible for the physical execution of projects, and therefore also for the quality thereof, do not have sufficient training to deliver the expected results (Ngowi 2001). Companies either do not have the time to invest in workers' training, or they are unwilling to do so because the workers are contracted on a project-to-project basis and therefore it is uncertain how long the workers are going to be in employment. According to Ngowi (2001), the cost to train workers may be considered an unnecessary expense. Also in South Africa there is very little, if any, correlation between the performance of workers and their remuneration and this also contributes to the fact that workers do not strive to produce a product of high quality.

6.3.3.3 The Use of Subcontractors

Joubert et al. (2005) mentioned that main contractors found that the increasing use of subcontractors leads to fragmentation of the process, with the result that such subcontractors perform their tasks almost in isolation. A subcontractor's aim is to complete his part of the work as quickly as possible, to use as little expensive labour as possible and to receive remuneration as soon as possible. This is not conducive to good quality.

6.3.3.4 Monitoring and Supervision

Ngowi (2001) found that a shortage of trained and experienced supervising personnel results in a situation where monitoring and supervision do not take place on a regular basis and therefore defects are not identified at an early stage. This leads to the continuous rectification of defective work.

6.3.3.5 Tenders

In their study, Joubert et al. (2005) found that the practice where tenders are awarded solely on price also has an influence on the quality of projects.

6.3.3.6 Culture

Ngowi (2001) conducted a study on the application of TQM in the construction industry in Botswana. As a result of Botswana's proximity to South Africa, many of the following findings in this study are applicable to the South African construction industry.

Ngowi (2001) found that society in Botswana tends to be fatalistic rather than deterministic. As a result of this, a culture exists which is largely contrary to a TQM culture. The following are characteristics of the prevailing Botswanan culture:

- Workers do not take responsibility for their own actions as dictated by TQM principles and tend to believe all responsibility rests with management.
- Where TQM places emphasis on prevention rather than detection, Botswana workers leave initiatives towards preventive measures to higher authorities.

- Societies in Botswana (traditionally administrated by chiefs) are more prescriptive than achievement orientated and therefore workers do not aspire to achieve awards – one of the aspects strongly emphasized by TQM.
- Also because of their fatalistic nature, workers feel that problems such as quality are beyond their ability and should be solved by management.
- Most workers on construction projects are recruited on a project basis and therefore do not spend much time with one company. This hampers another important element of TQM, namely that of employee empowerment to make decisions at their level of operation.

6.3.4 Implementation of TQM in South Africa Construction Industry

The international community has gone past quality management as a control system to TQM as a management system and a culture. Theories and full methodologies for implementing quality systems are available, both internationally and locally. Previous research indicates that TQM has been in use since the 1980s. In the South African context, Smallwood (2000) identified only three contractors that use strategies close to TQM but not TQM itself. However, "…although the strategies do not constitute a formal TQM strategy per se in terms of principles, supporting elements and steps, they do incorporate aspects of the aforementioned" (Smallwood, 2000:5). Smallwood (2000) concluded that such lack of quality management systems in South African construction companies is among the causes of poor contractor performance. The findings by Smallwood (2000) are similar to the findings by Ahmed et al. (2002) that the method and techniques to implement quality management in the construction industry are still to be developed. The lack of quality management systems in South African construction companies can be attributed to the construction industry in South Africa being regulated by the Construction Industry Development Board (CIDB). Within the CIDB structures, there are Construction Industry Indicators (CIIs) that measure performance in terms of client satisfaction, health and safety, quality of work delivered, and quality of tender documents and specifications used, among others (CIDB, 2010).

The failure or successful implementation of TQM largely depends on the deep understanding of the philosophy behind its origins and how it is integrated in the organisation as a whole. TQM originated in Japan and it harbours the Japanese philosophy of a holistic, integrated approach to quality management which in itself is a cultural foundation. Implementing TQM in organisations which do not share the cultural values upon which it was founded can result in failure (Ngowi, 2000).

A survey conducted in South Africa by Ambrose and Claasen (2004) indicated the following:

- No formal TQM system is applied by any of the construction industry stakeholders in South Africa. Some see it as not practical for this industry, but more suited to manufacture.
- All the stakeholders identified a need for skills training of personnel involved in projects to equip them to produce quality work. Furthermore, a need was also identified for formal TQM education for construction personnel, and for TQM courses to be included in tertiary qualifications offered.
- The implementation of TQM in the project process from initiation to handover must have a principal/champion for it to work. This would in most cases be the project manager (usually the consultant).
- The main factors that make production of quality construction work problematic are:
    - Inexperience of the site management team – stakeholder representatives are often ill-equipped for the on-site management task;
    - There are too few barriers to the entry of unqualified participants;
    - Personnel are not adequately trained and in many cases not suitably qualified; and
    - There is no inherent pride in producing quality work.
- An autocratic approach is still prevalent – this needs to change to a participative and preventative approach. Anticipation of possible problem situations and appropriate action will enable the prevention of mistakes. Further measures to prevent problems that

were identified are the employment of suitably qualified staff and the implementation of a good quality control system.

- Confrontational and adversarial relations mostly develop during the construction stage. This inevitably occurs when the quality standards have to be enforced, rather than where the project team takes collective responsibility for quality control. Human ego is a major stumbling block, and a culture needs to be developed where people welcome having their work scrutinized.
- The focus of control must move from outside the individual to within so that project team members can accept accountability for their actions.
- The customers' needs must be accurately ascertained at project inception, and meeting these needs must be a primary focus throughout the project process.
- All individuals interviewed agreed that implementing a TQM system would be beneficial to any project, as well as to the individual organizations involved. These benefits include enhanced reputation and minimized rework.
- The project process flow can only be effective if at each customer-supplier interface a customer-supplier relationship exists, and meeting the customers' needs is of primary importance (the quality chain effect).

6.3.5 Lessons Learnt from the South African Construction Industry

The theories and full methodologies for implementing quality systems are available, both internationally and locally. Although most of the construction companies in South Africa do not have a formal quality management system in place, they believe that a formal quality management system will ensure better quality on building sites. The failure or successful implementation of TQM largely depends on the deep understanding of the philosophy behind its origins and how it is integrated in the organization as a whole. It was realized that the traditional tender system contributes to poor quality in South Africa construction industry. Lack of training, lack of site supervision and the culture of labour also have a negative impact on quality on local building sites in South Africa.

6.4 CONCLUSION

This chapter discussed TQM implementation in developing countries. The chapter looks into the construction industry in Nigeria and South Africa and how the TQM concept has been accepted in these countries. An evaluation of policies and government intervention with regard to TQM implementation was also presented. The philosophical basis for TQM implementation in Nigeria and South Africa were discussed. Also explored in this chapter are the challenges facing TQM implementation in the Nigerian and South African construction industries.

CHAPTER SEVEN

7 TOTAL QUALITY MANAGEMENT IMPLEMENTATION IN THE GHANAIAN CONSTRUCTION INDUSTRY

7.1 INTRODUCTION

This chapter discusses TQM implementation in the Ghanaian construction industry. The chapter also examines how the TQM concept has been accepted by Ghana as a country. An evaluation of policies and government intervention with regard to quality management implementation is also presented. Furthermore, the philosophical basis for TQM implementation in Ghana is discussed. Also explored in this chapter are the challenges facing TQM implementation in the Ghanaian construction industry.

7.2 GENERAL OVERVIEW OF GHANA

The modern day Ghana was created from the British Gold Coast Colony, established in 1874, and the UK-administered Trusteeship Territory of Togoland, incorporated in 1956 following a referendum. Anxiety for independence grew strongly after the Second World War. From the early 1950s, self-government was introduced with elections in 1951, 1954 and 1956. In 1957, Ghana became the first sub-Saharan country in colonial Africa to gain its independence. Before independence on March 6, 1957 Ghana was called the Gold Coast. The earliest Europeans to arrive here were the Portuguese in the 15th century. Upon their arrival, they found so much gold between the River Ankobra and the Volta, they subsequently named it ‘da Mina’, meaning ‘The Mine’ (Republic of Ghana, 2011).

The Republic of Ghana is a country located in West Africa Coast. It is a country (sovereign state) located on the Gulf of Guinea and Atlantic Ocean in the sub-Saharan Africa frontier, only a few degrees north of the Equator; therefore it has a warm climate. The country covers an area of 238,500 square kilometers (92,085 square meters). Ghana consists of ten territorial administrative regions bordered by the Ivory Coast to the west, Burkina Faso to the north, Togo to the east and the Gulf of Guinea and Atlantic Ocean to the south. Map 1 shows the Republic of Ghana with the neighbouring countries and internal sub-division.

Map 7.1: Map of Ghana

Source: CIA Factbook, 2012

The regional capitals and land area are as shown in Table 7.1. The national census conducted in Ghana recorded a population of 24,658,823 in 2010. The population was 6,726,815 in 1960 and increased to 18,912,079 in 2000 as shown in Table 7.2.

Table 7.1: Regions showing Land Area

Regions of Ghana	**Area (km²)**	**Regions of Ghana Capital**	**Regions of Ghana**	**Area (km²)**	**Regions of Ghana capital**
Ashanti Region	24,389	Kumasi	Northern Region	70,384	Tamale
Brong-Ahafo Region	39,557	Sunyani	Upper East Region	8,842	Bolgatanga
Central Region	9,826	Cape Coast	Upper West Region	18,476	Wa
Eastern Region	19,323	Koforidua	Volta Region	20,570	Ho

Greater Accra Region	3,245	Accra	Western Region	23,941	Sekondi-Takoradi

Source: Ghana Statistical Service (2013)

Table 7.2: Population Size

Year	**Population**
1960	6,726,815
1970	8,559,313
1984	12,296,081
2000	18,912,079
2010	24,658,823

Source: Ghana Statistical Service (2013)

Most of the country's larger cities are in the south, which has a relatively high population density and low poverty rates whilst the north is sparsely populated but with a very high incidence of poverty. This population pattern also reflects the underlying economic activity and hence the distribution of infrastructure in Ghana. Nevertheless, unlike many other African countries, Ghana's infrastructure backbones cover the entire national territory and help to integrate the different regions. Two road corridors linking north and south, a national power grid, and an ICT backbone interconnect all major population centres (Foster & Pushak, 2011). According to Vision 2020, Ghana intends to maintain the 'middle income' status by 2020 by UN/World Bank definition (Adusa-Poku, 2014).

Studies show that construction contributes between five % and 10% to the gross domestic product (GDP) in all countries, employs up to 10% of the working population, and is responsible for about half of the gross fixed capital formation (Hillebrandt, 2000). In Ghana, the construction industry contributes 10.5% of the GDP and employs about 6% of the population (GSS, 2013).

Developmental projects in the transport, water and sanitation, energy, health, education and agricultural sectors in the economy are undertaken by the construction industry. For this reason, developing a competitive construction industry should be an important objective of government policy (World Bank, 1984). It is no wonder that the Government of Ghana had the theme Infrastructural Development for Accelerated Growth and Job Creation in the 2012 National Budget. The aim of the government was to provide infrastructural activities in various sectors of the economy to stimulate growth and support the private sector in job generation, thus improving the wealth and health of the general population. Therefore, construction sector plays an important role in the realization of these objectives.

7.2.1 Political Overview

In Ghana, the Ministry of Water Resources, Works and Housing and the Ministry of Roads and Transport are responsible for the regulation and certification of onstruction contractors. Although these two (2) Ministries issue certificates to contractors, this does not ensure the sustainability and development of the construction industry.

The construction sector has two main classes of product. One is building which is associated with housing, offices, hospitals, and factories, and the other is civil works involving the infrastructure for water supply, transport, irrigation, and power generation. The informal sector deals mainly with individuals in the construction of less complex buildings with minimal skilled labour required. Such construction work does not undergo strict adherence to standards. The formal sector is responsible for mostly infrastructural works with the Government of Ghana, public institutions and multi-national companies as the clients. The contractors in this formal sector are normally registered and have a large capital base.

Housing and construction are generally accepted as potential game-changers to Ghana's developmental prospects but these sectors appear to be quietly slipping out of the hands of local entrepreneurs. Generally, Ghana's housing conditions are poor in nearly all areas including poor access to improved water sources, poor or non-existent drainage and poor sanitation reflected in inadequate, cooking, bathing and toilet facilities (GSS, 2013).

Although there is a deficit in housing stock, there is no clear-cut policy to support the local contractors. However, the government initiates policies such as tax rebates and free land as in the failed STX deal proposed by the government in 2011.

At a West Africa Building and Construction Exhibition and Seminar, a former Finance and Economic Planning Minister, Dr Kwabena Duffuor, explained that the 120 local contractors listed in the Ministry's database do not have the financial muscle required to handle big projects such as major road construction, bridges and housing. This inadequate financial position therefore inhibits the growth of the construction industry (Adusa-Poku, 2014).

Ofori (2012) recommended the formation of a central agency to regulate and develop the construction industry. He concluded that the absence of a regulatory body negatively affects the standards and practices of this important industry. If the government fails in regulating the industry and does not institute pragmatic measures to grow this industry, foreigners will take advantage and win most government lucrative jobs. As in all industries, there are standards that should govern the industry to ensure specifications and quality is achieved. Thus, countries such as the UK and Hong Kong adopted ISO 9000 as an international standard for certification of quality management systems (QMS).

In order to develop GCI strategically, politicians should initiate appropriate policies and reforms to improve the standards and financial and regulatory status of the construction business environment.

7.2.2 Economic Overview

Construction is the key sector for every economy. It is known that construction contributes to the national socio-economic development by providing significant employment opportunities at non-skilled and skilled levels.

Ghana's economic history dates back to the days when the economy was dependent on agriculture, trade and industry. Agriculture was booming during those pre-colonial days when citizens were involved in some form of agriculture (planting or rearing of livestock). Currently, Ghana is the second leading exporter of cocoa, a crop Tetteh Quarshie brought from Fernado Po in 1878 (Adusa-Poku, 2014).

Before independence, the industries flourished in terms of mining, pottery, cloth weaving and carving activities. The industries produced exports in which the Europeans traded. There was active trading in gold, ornaments and cloth as the Europeans were involved in the trade activities along the coast. After colonization the economy has grown steadfastly under different governments depending on their ideological orientations. Various policies initiated by the International Monitory Fund (IMF), and the World Bank have been introduced to increase productivity and help boost the economy of the nation.

The major contributors to the GDP in Ghana in 2012 were services, followed by industry and then agriculture as shown in Table 2.3. The GDP in Ghana was worth 40.71 billion US dollars in 2012. The GDP value of Ghana represents 0.07% of the world economy. Construction contributed the most to the GDP in the industry sector, as shown in table 7.4.

Table 7.3: Gross Domestic Product (GDP) at Current Market Prices by Economic Activities (Gh¢ Million)

Economic Activity	**2008**	**2009**	**2010**	**2011**	**2012**
Services	13,934.6	17,543.5	22,183.6	27,422.7	33,962.5
Industry	5,854.5	6,775.7	8,294.5	14,274.4	18,580.5
Agriculture	8,875.0	11,342.8	12,909.6	14,154.8	15,399.1

Source: Ghana Statistical Service (2013)

Table 7.4: Gross Domestic Product (GDP) at Current Market Prices by Economic Activities

Economic Activity	**2008**	**2009**	**2010**	**2011**	**2012**
INDUSTRY	***5,854.5***	***6,775.7***	***8,294.5***	***14,274.4***	***18,580.5***
Mining and Quarrying	693.2	740.0	1012.7	4,689.9	5,956.1
Crude Oil	0.0	0.0	0 177.5	3,746.3	4,645.4
Manufacturing	2,276.7	2,478.4	2,941.5	3,842.5	4,680.1
Electricity	155.2	166.9	266.0	279.7	329.3
Water and Sewerage	228.9	246.4	368.3	467.4	505.3
Construction	2,500.5	3,144.0	3,706.0	4,994.9	7,109.6

Source: Ghana Statistical Service (2013)

According to the World Bank country classifications, the country moved from low-income to lower middle-income status on July 1, 2011. To improve on this economic status, the government intends to improve its infrastructure development especially in the rural and northern sectors of the country where poverty rates are high when compared to the southern sector. Foster and Pushak (2011) encouraged the country to maintain its middle income status since raising the country's infrastructure endowment to that of the region's middle-income countries could boost the annual growth by more than 2.7 percentage points.

Thus, the Minister of Finance stated that the establishment of the Ghana Infrastructure Fund (GIF) as a quasi-fiscal body to deal with the huge infrastructure deficit and to focus on strategic infrastructure will lead to job creation and growth of the economy (Terkper, 2013). This confirms the assertion that construction is seen as a vehicle for dispersing economic activity and raising income levels of the citizenry (Ofori, 2012).

One major challenge facing the GCI is access to finance to enable local contractors to compete with foreign partners. In this regard, the Chairman for the Ghana branch of the Chartered Institute of Building (CIOB), Rockson Dogbegah, is advocating setting up a bank solely for the construction industry. He said this has become necessary owing to the high financial cost involved in any construction project.

7.2.3 Sociological Overview

Education and employment are the factors that affect the social state of the country. People with no formal education and those with primary and middle school (basic) education dominate the working population of the country. Thus, nearly 70% of the workforce has no formal or only basic education (GSS, 2013). The GSS report (2013) also stated that about 67% of the population were self-employed without employees, implying small-scale enterprises dominate the economy with few avenues for employing other people.

The construction industry employs about six % of the population (GSS, 2013). This industry has the capability of generating employment especially for the labour-intensive activities. Apart from the labour directly linked to the project, other employment is generated for food sellers, suppliers of goods such as electrical, plumbing, and the financial sector (loans).

7.2.4 Technological Overview

Technology is the application of an existing body of knowledge to the production of goods and services (Henderson & Ruiker, 2010). It embraces tools, equipment, techniques, materials, systems, the products and their use (Adusa-Poku, 2014). There is a general agreement that technology is critical to the development of a nation.

Technological advancement is introduced in the construction industry to increase productivity and cost reduction leading to more profit. Studies have proved that technology growth in the manufacturing industry has greatly improved profit margins. However, the CI is slow in adapting new technologies to improve profit. After studying strategies in improving technology implementation in the construction industry, Henderson and Ruiker (2010) concluded that the degree of technology implementation success depends on the degree to which changes are planned, managed and evaluated. Therefore, technology implementation within construction organizations is not so much a technological problem as it is a human behavioural one.

The development of the Ghanaian construction industry (GCI) is critical for improving the economic state of the country since it is responsible for the provision of the infrastructural development in the country. Moreover, the construction industry generates a great deal of employment in both the private and public sectors. The main contributors to the Ghanaian industry sector were the construction industry, which recorded a growth of 19.2%, mining and quarrying contributed 5.2% and water and sewerage activities, which contributed 0.6% (GSS, 2012). It is therefore imperative that the construction industry is developed and improved to produce quality works in order to enhance the growth of the national economy.

Ofori (2012) stated that although the GCI has much strength, there are a myriad of problems that have persisted for a long time. He suggested that an agency should be set up to survey and develops comprehensive policy guidelines for the industry. In an article titled‘ Construction and the Internet’ in *The Economist* (2000), it was noted that up to 30% of construction costs are due to inefficiencies, mistakes, delays, and poor communication. It is obvious that the GCI is affected by factors such as globalization, information communication technology (ICT), increasing knowledge development and the ever-increasing innovative products delivered daily to the market.

A typical construction project consists of the interaction between a client, consultant and a contractor. In construction project management, where the objective is to meet clients' needs and expectations, one must have knowledge of the management of time, quality, human resources, and risk to ensure a successful completion. Lad and Beck (2009) noted that construction quality management is the key to a successful project. They explained that the selection of a Construction Quality Manager (CQM) early in a project gives the overall project a better chance of delivery on time, to budget, with zero defects as well as high availability and reliability. However, CQM effort can be a cultural change and a challenge for contractors. It requires attention to detail, tracking of issues and accountability (Lad & Beck, 2009). One of the means of achieving this feat is by applying the principles of TQMTQM in construction.

7.3 IMPLEMENTATION OF TOTAL QUALITY MANAGEMENT IN THE GHANAIAN CONSTRUCTION INDUSTRY

There are several project quality management techniques, standards, policies, systems, procedures, audits, manuals, planning, records, and surveillance systems but they are seldom applied during project execution in Ghana. This leads to low quality works, high construction costs and dissatisfied clients (Ansah et al., 2015). With the country attaining a middle-income status in addition to the oil production which started in the year 2010, there is an increased demand for infrastructural work with its accompanying standard quality requirements. Also, considering the influx of foreign construction companies in Ghana and the increasing competitiveness in the construction sector, it is important that Ghanaian contractors deploy appropriate quality management strategies such as TQM to reduce cost and increase value and quality.

Previous researches indicate that TQM has been in use since the 1980s but in Ghana, studies have shown little usage of TQM despite its potential benefits to the industry. Although TQM is not fully implemented in Ghana, there are the National Building Regulations (NBR) (L.I. 1630) which was enacted in 1996 to ensure building work satisfies minimum constructional standards, energy conservation requirements and also the health and safety of people occupying the building. The requirements of this standard primarily aim at achieving client/customer satisfaction by preventing non-conformity at all stages, from design through to servicing.

7.3.1 Overview of Building Regulation and Building Codes for Regulating Construction Project Activities in Ghana

Building regulations had been in use by various municipal administrations from the 1940s and in 1960. By the early 1970s the Code and Building Regulations were obviously out of date and the Building and Road Research Institute (BRRI) of the Council for Scientific and Industrial Research (CSIR) decided to produce a draft document for discussion, modification and use as a basis for a final code to address the redundancy of the earlier documents. The effort was undertaken by Dr. K. Amonoo Neizer and Parts 3 and 4 of the Draft Code were published in 1977, followed by the Parts 1, 2 and 5 by 1988. With changes in land use patterns, materials and construction methods as well as local government structure, the Ministry of Works and Housing produced a document, the National Building Regulations (NBR), 1996 which was gazetted as LI 1630. This document was to improve upon the building regulations of the colonial times and to complement the BRRI Draft Building Code.

The NBR (L.I. 1630) is a legislative instrument promulgated on 27 September 1996. This regulation is set of rules and standards that must be followed to satisfy the minimum acceptable levels of safety for buildings and non-building structures. The NBR is applicable to the erection, alteration or extension of any building. L.I. 1630 consists of nineteen (19) parts and one hundred and eighty-seven (187) regulations. The District Planning Authority (DPA) is mandated by L.I. 1630 to implement the regulations on behalf of every local authority. The DPA comprises heads of relevant departments of the local authority e.g. District Town and Country Planning Manager, Head of District Works Department, District Environmental Health Officer, District Fire Officer, Electricity Company of Ghana District Manager, and the Ghana Water Company Ltd District Manager. The DPA appoints a qualified building inspector who oversees and inspects daily work on buildings, erections and installations to ensure compliance with the requirements of these regulations. The nineteen parts of the regulations involve application of regulations and building plans; plot development; site preparation and landscape; materials for building; structural stability; structural fire precautions; access accommodation; air movement and ventilation; thermal insulation; hearths, chimneys and heat-producing appliances; sound insulation; pest control and protection against decay; drainage; sanitary conveniences; refuse disposal; water supply; lighting and electrical installations; special requirements for rural building and miscellaneous provisions (NBR, 1996).

Presently, there is an attempt to produce a Draft Building Code which will include all the requirements of the existing building regulations and the BRRI Draft Building Code and be in tune with requirements of a building code to answer current land use patterns, materials for construction, construction methods, construction management practices, safety, and the energy efficient use of resources. This document, the Draft Ghana Building Code has been compiled under the auspices of the Ministry of Water Resources, Works and Housing (MWRWH) with funding from the UNDP, through the National Disaster Management Organization (NADMO). A technical committee made up of representatives of relevant stake holding institutions in Ghana compiled the document, using the BRRI Draft Building Code and the national Building Codes of India (2005) and Canada as templates (MWRWH, 2012).

This draft Ghana Building Code contains regulations which can be adopted immediately or enacted for use by various departments, metropolitan, municipal and district assemblies, private and public bodies. It lays down a set of minimum regulations designed to protect the safety of the public with regard to structural efficiency, fire hazards and health aspects of buildings. So long as these basic requirements are met, the choice of materials and methods of design and construction is left to the ingenuity of the building professionals (MWRWH, 2012).

Part 11 of the Code covers the constructional planning, management and practices in buildings; the storage, stacking and handling of materials, and the safety of personnel during construction operations for all elements of a building as well as the demolition of buildings. It also covers guidelines relating to maintenance management, repairs, retrofitting and strengthening of buildings. The aspect of the code that deals with quality indicates that the quality of a project should be planned for all activities from inception to completion. It is desirable that the system planning gives adequate assurance and regulates? how it shall meet project quality objectives. The system will cover a review of existing requirements, subcontracting, materials, processes and controls during the process, auditing, training of personnel, final inspection and acceptance. All activities shall be planned and controlled. This development and overall pattern suggest that Ghana may benefit from a systematic framework for regulating the quality of public services (Foster & Pushak, 2011).

7.4 LESSONS LEARNT FROM TOTAL QUALITY MANAGEMENT IMPLEMENTATION IN THE GHANAIAN CONSTRUCTION INDUSTRY

In most developing countries such as Ghana, the principles of TQM are not fully employed in construction, leading to low quality works, high construction costs and dissatisfied clients. Foster and Pushak (2011) stated that despite Ghana's success with increasing access to infrastructural services, the quality of service remains low. Nevertheless, in the construction industry the aim of all professionals/consultants is to strive to provide the owner/client with a product or service that will meet the standard that it is intended for, properly built with satisfactory performance and value for money. In the pursuit of performance excellence in the construction industries and with an increasing awareness of the construction quality, construction firms have no option other than to ensure that clients get value for money. One of the means of achieving this is by fully applying the principles of TQM in the Ghanaian construction industry.

In furtherance of this aim is the effort by the Government of Ghana to produce a Draft Building Code which will include all the requirements of the existing building regulations and the BRRI Draft and be in tune with requirements of a building code to ensure good quality of both materials and finished goods/products that are produced in the country. In other words, this Building Code will help to provide a national standard for a quality management system in Ghana. Lad and Beck (2009) noted that construction quality management is the key to a successful project. A study conducted by Rategan (1992) indicated that a 90% improvement rate in employee relations, operating procedures, customer satisfaction, and financial performance is achieved due to TQM implementation. Studies on TQM further showed a reduction in cost and improved employee satisfaction that ultimately increase client satisfaction (Low & Jasmine 2004). According to Harris et al. (2006), a TQM approach is essential for long-term survival in all business, including the construction industry. Although TQM is not fully implemented in Ghanaian construction industry, there is the National Building Regulations (NBR) (L.I. 1630) which was enacted in 1996 to ensure that building work satisfies minimum constructional standards. The requirements of this standard primarily aim at achieving client/customer satisfaction by preventing non-conformity at all stages, from design through to servicing. It is therefore suggested that an extensive enlightenment campaign on the importance of TQM in construction will be required in Ghana to encourage its use. It was also recommended that government, being the major client of the construction industry, should come up with an award for excellence for quality construction to deserving organisations and a penalty for organizations which refuse to adopt TQM. This will serve as an incentive for conformity to standards in various areas of the industry and as a deterrent to defaulters.

7.5 CONCLUSION

The chapter discussed TQM implementation in the Ghanaian construction industry. The chapter looked into the construction industry in Ghana and how the TQM concept has been accepted in this country. An evaluation of policies with regard to quality management implementation was also presented. Also explored in the chapter are the challenges facing TQM implementation in the Ghanaian construction industry. It was realized that in Ghana, the principles of TQM are not fully employed in construction, leading to low quality works, high construction costs and dissatisfied clients.

CHAPTER EIGHT

8 RESEARCH METHODOLOGY

8.1 INTRODUCTION

This chapter discusses the various steps undertaken by the researcher to explore the objectives of this research. As discussed in the introduction, the aim of this research is to develop a holistic integrated TQM model for the Ghanaian construction industry. Company vision and plan statement, product selection and design management, and company quality system evaluation are new constructs that are peculiar to the present model to be validated as they have not been previously considered in the existing models of TQM whilst other variables have been measured in the majority of the previous studies. This chapter provides details about the methodological research framework for the current study. The chapter consists of the following sections: philosophical consideration in research methodology, the quantitative study and the qualitative study, research design and methodology. The research design and methodology section focuses on the research procedures, including the choice of research methods and the selection of participants. The methodology adopted for this study is based on the ontological and epistemological assumptions. These philosophical underpinnings (epistemology and ontology) provide a guide to the methodology followed in a research process. Hence, this investigation combined quantitative and qualitative methods (mixed method): the Delphi study and a structured questionnaire survey. The use of a mixed-method approach which is rooted in both philosophical and practical reasons, are explained in section 8.3.3.

8.2 PHILOSOPHICAL CONSIDERATION IN RESEARCH METHODOLOGY

As stated above in Section 8.1, the choice of research methodology is usually influenced by a set of assumptions underlying each research methodology (Crotty, 1998). The choice of a method has to be supported by the statement of assumptions that have been brought into the research process and are reflected in the methodology (Crotty (1998). These assumptions, though varied, tend to fall into the philosophical areas of ontology and epistemology. A brief discussion of these considerations follows in Sections 8.2.1 and 8.2.2.

8.2.1 Ontological Considerations

Ontology is concerned with assumptions about the variety of phenomena in the world. It is said to be a theory of the nature of reality (Delanty & Strydom, 2003); it is a theory of being and is concerned with issues of what exists and also refers to the claims that a particular paradigm makes about reality or truth (Hitchcock & Hughes, 1989).

According to Hitchcock and Hughes (1989), "...ontology is about what exists, what it looks like and how is the components interact with each other". Likewise, as with epistemology, these issues can sometimes have a major impact on methodology, and any contrasting ontology of human beings can, in turn, sometimes demand different research methods (Burrell & Morgan, 1979). Ontological assumptions revolve around the question of 'what is' with the nature of reality (Crotty, 1998). In other words, it is an effort to elucidate what reality is and why things happen the way they do. In an attempt to explain reality, Jean (1992) advocates two opposite assumptions of reality, which are objectivity and subjectivity. Jean (1992) viewed the objectivist stance as reality existing out there, intact and tangible, but it is independent of individuals' appreciation and cognition (Crotty, 1998; Jean, 1992). Thus, regardless of whether or not individuals perceive and attach meaning to this reality, it remains unchanged (Burrell & Morgan, 1994). Hence an individual is "...born into and lives within the social world that has its own reality, which cannot be created by that individual" (Burrell & Morgan, 1994:4). Thus, in order to create a better understanding of reality, objectivist researchers propose the need to study the causal relationships among the elements constituting reality (Jean, 1992; Burrell & Morgan1994) which is advanced in the current research.

According to Crotty (1998), "… [the] objectivist view of reality is closely related to a theoretical position called positivism". Positivists postulate that the world exists as a system of observable variables waiting to be discovered (Maguire, 1987). Similarly, positivists believe that the use of scientific methods of inquiry can assist in discovering the true meaning of reality (Maguire, 1987; Crotty, 1998). The results of such investigation generate rules and theories that help to explain and sometimes provide a guide for understanding social behaviour (Maguire, 1987). The current research aims to apply scientific methods in the development of the model. In addition, it aims to devise the social construct that will lead to TQM in the Ghanaian construction industry.

According to subjectivist interpretation, reality is not discovered but it is constructed by human beings as they engage with the world in which they live (Crotty, 1998). In that way understanding and interpretation of reality occur when human beings interact with their environment and others and assign meaning to the world around them (Crotty, 1998). Thus, in research, meaning of anything is "…an expression of the manner in which the researcher as a human being has arbitrarily imposed a personal frame of reference on the world" (Jean, 1992: 89). Section 8.3.2 looked into 'how' reality or knowledge is created as the extension of the discussion of philosophical suppositions that influence researchers' choice of methodology.

8.2.2 Epistemology

Epistemology is theory of knowledge embedded in the theoretical perspective that informs the researcher (e.g. objectivism, subjectivism). Delanty and Strydom (2003) defined epistemology as the study which investigates the possibility, limits, origin, structure, methods and truthfulness of knowledge and how knowledge can be acquired, validated and applied. Walker and Evers (1988) explained that epistemology is concerned with how phenomena can be made known to the researcher. It is an inquiry of what differentiates defensible belief from opinion. Epistemology can sometimes also have a major impact on the data collection choices as well as on the methodology in a research process (Hitchcock & Hughes, 1995: 19). Epistemology provides the grounds for the decision on the kind of knowledge that is considered appropriate, adequate and legitimate for the research at hand (Crotty, 1998). Furthermore, Hill (1995) was of the view that research methodology is applied epistemology, and therefore methodology has to be supported by an epistemology. Therefore, researchers are expected to point out, explain and justify the epistemology that informs their choice of research methodology.

Consequently, the choice of epistemology is widely influenced by the ontological considerations within a particular discipline (Quattrone, 2000). Both dimensions of ontology (objective and subjective) play an important role in the epistemology and ultimately, the methodology chosen for this research. Sections 8.2.1 and 8.2.2 clearly show how ontological dimensions (objective and subjective) and epistemological considerations affect the choice of research methodology.

8.3 QUANTITATIVE VERSUS QUALITATIVE RESEARCH METHODOLOGY

Qualitative research is collecting, analyzing, and interpreting data by observing what people do and say, whereas quantitative research refers to counts and measures of things (Anderson, 2006:3). Quantitative research options have been predetermined, a large number of respondents are involved and measurement must be objective, quantitative and statistically valid. Statisticians use formulas to calculate the sample size to determine how large a sample size will be needed from a given population in order to achieve findings with an acceptable degree of accuracy (Anderson, 2006).

Qualitative research is much more subjective than quantitative research and uses very different methods of collecting information, mainly individual in-depth interviews and focus groups. The nature of this type of research is exploratory and open ended. A small number of people are interviewed in-depth, and a relatively small number of focus groups. Participants are asked to respond to general questions. The interviewer or group moderator probes and explores their responses to identify and define people's perceptions, opinions and feelings about the topic or idea being discussed and to determine the degree of agreement that exists in the group. The quality of the findings from qualitative research is directly dependent upon the skills, experience and sensitivity of the interviewer or group moderator. This type of research is extremely effective in acquiring information about people's communications needs and their responses to and views about the specific question (Anderson, 2006). This chapter explores the methodological options available to undertake research. Therefore, an appropriate research methodology must be considered by the researcher.

The methodology to be adopted is influenced by the research aim, as well as the type of data to be collected. The choice of the different options of methodology is either quantitative or qualitative or both. Any one of the methodologies or a combination of both methodologies can be carried out by the researcher to provide appropriate answers to the research questions. These methodologies are sometimes influenced by the research paradigms (Jean, 1992) despite the influence of the research aim and the type of data to be collected. A paradigm is a set of beliefs that researchers use to make sense of the world or a segment of the world (Crotty, 1998:35). In other words, a paradigm provides insight into the way in which researchers look at and perceive the world (Kuhn, 1996). Paradigms guide the conceptual framework that researchers use in seeking to understand and make sense of reality (Maguire, 1987). Paradigms set boundaries for researchers in terms of the manner in which they can execute the research process with regard to research methods, strategies for inquiry, as well as the purpose and use of knowledge (Crotty, 1998). Thus, paradigms influence what researchers regard as accepted knowledge and ways of doing research (Crotty, 1998) and shape researchers' "…perceptions and practices within their research disciplines" (Maguire, 1987:11).

Sometimes, the choice of method is typically influenced by major philosophical considerations (ontological and epistemological) underlying the research process (discussed in section 8.2). Both quantitative and qualitative research methodologies are based on the epistemological assumptions regarding the nature of knowledge and the methods of abstracting that knowledge, as well as ontological assumptions which relate to the nature of reality or the phenomena being investigated (Jean, 1992). The philosophical considerations which influenced the choice of the research approach for this thesis were discussed briefly in section 8.2.

8.3.1 Quantitative Methodology

Quantitative research is about quantifying the relationships between variables and finally measuring them. Statistical models are constructed to explain the observed variables. Certain characteristics (variables) are searched for and endeavour to show something interesting about how they are distributed within a certain population. The nature of the research determines the variables in which the researcher is interested. A variable needs to be measured for the purpose of quantitative analysis. Data is collected concerning many variables through a questionnaire. The interested variables may be dependent or independent. There are other features present in the problem that may be constant or confounding.

The objectivist view of an integral and independent reality encourages researchers to adopt the epistemology of positivism (Jean, 1992). The objectivist researcher strives to observe measure, analyse and predict relationships between components that comprise reality (Kent, 1999: 11). He further stated that certain principles guide a positivist's search for reality. These principles include the following:

i. Only phenomena that can be observed can be used to validate knowledge;
ii. Scientific knowledge is arrived at through the accumulation of verified facts derived from systematic observation or record-keeping;
iii. Scientific theories are used to describe patterns of relationships between these facts to establish causal connections between them; and
iv. The process is neutral and judgment free. Observations are uncontaminated by the scientist' own prediction. Thus ethical issues can be included only if they are included as part of the research.

The use of a scientifically guided research methodology where the aim explains and predicts causal relations between elements that constitute reality is the positivist epistemology (Jean, 1992; Quattrone, 2000). The current research adopted the positivist epistemology. Data collected should be quantified and analysed using mathematical formulas (Maguire, 1987) and this shows the success of positivist research. The scientific presentation of results follows the views of positivist researchers (Kent, 1999). Statistical rhetoric such as reliability, validity, correlation, causes and effect relationships are used in the current research. However, the presentation of research findings under this methodology follows an approach that emphasises explicit, exact, scientific and formal procedures just as the use of quantitative methodology to explore and explain relationships between variables is advocated by the positivist's researchers (Sarantakos, 2005). This argument makes the entire research process to be considered as highly neutral and judgment free with limited room for personal bias. According to Sarantakos (2005:33), "…the task of the researcher is to discover the scientific laws that explain human behaviour using quantitative methods, similar to those of natural sciences".

A researcher using quantitative methodology has to follow a number of steps in conducting their research which usually include generating the research problem, coming up with expectations based on reality, generating hypothesis, defining variables, sampling, data collection, analysis of data, report of findings and relating findings to the theory (Kent, 1999:11). May (2001) indicates that the researcher and the research process move together. Their perceptions, expectations, experiences and interpretations become part of the research process. According to May (2001), the relationship between the researcher and the research should be a continuous ebb and flow of information. Therefore the researcher's subjectivity is considered as an integral part of the research process. Advocates of subjectivity suggest that it is a better option for undertaking research as opposed to objective quantitative methods (Brieschke, 1992). Sarantakos (2005) asserted that scientific research with the emphasis on explicit, exact, and formal procedures is appropriate for a quantitative methodology. From the given scenarios, quantitative methodology should be supported by qualitative methodology (Tashakkori & Teddlie, 1998).

Section 8.3.3 discusses the advantages of combining qualitative and quantitative methodology in more detail. In the following section qualitative methodology is discussed. The discussion of qualitative methodology in this section focuses on both the advantages and limitations of qualitative methodology.

8.3.2 Qualitative Methodology

Qualitative research allows the subjects being studied to give much 'richer' answers to questions put to them by the researcher, and may give valuable insights that might have been missed by any other method. Not only does it provide valuable information to certain research questions in its right but there is a strong case for using it to complement quantitative research methods. If the area of interest has not been previously investigated then qualitative research may be a vital forerunner to conducting any quantitative research; for example, it is impossible to carry out a meaningful structured questionnaire survey on

TQM. At the other extreme, qualitative research may also help the researcher to understand the findings of quantitative research; for example, it is very easy to discover that some construction firms fail to implement TQM but uncovering the reasons for this can be more difficult and conventional surveys may miss some of the important factors.

According to Jean (1992), "…the subjectivist's view of reality advocates for appreciation of human involvement in the creation and shaping of knowledge". The subjectivist epistemology thus suggests that meaning or reality is not discovered but rather is imposed on the object by the subject, and in a research situation, imposed by the researcher (Crotty, 1998). In other words, with the subjectivist epistemology, the object being studied contributes less to the meaning or reality. Thus, researchers' input in the research process is recognised under subjectivism. The research methodology recommended by subjectivists is qualitative methodology. According to Jean (1992:92), qualitative research is "…a form of social interaction in which the researcher converses with and learns about the phenomenon being studied". It is part of the research process and is actively involved in creating the meaning of reality (Crotty, 1998). Qualitative research is suggested as more applicable to the study of people and their environment (social sciences) than natural sciences (Bryman, 2001). Consequently, advocates of qualitative research advanced the use of qualitative methodology when studying people as it enables the researcher to see through the eyes of the researched (Bryman, 2001). Constructing meaning through engagement with people involves interpretation. Interpretivism is the process by which information is extracted through interpretation as pointed out by Sarantakos (2005). Under interpretivism, researchers seek information relating to people's views, opinions, perceptions and interpretations of the social world (Crotty, 1998), which was also partly utilized in the current research. Subjectivism, constructivism, and interpretivism form part of a broader list of research methods commonly employed in qualitative research.

The qualitative methodology has been criticized for lacking in efficacy owing to its inability to study the relationships between variables with a degree of accuracy (Sarantakos, 2005). The researcher in qualitative research is the main player. He or she decides on what to concentrate on during the data collection. Views may vary among different researchers and it is difficult to replicate and generalize the findings with ease. A small number of cases is studied as compared to the large sample sizes common in quantitative cases (Bryman, 2001). The population under the study may not be representative of the majority. However, advocates of qualitative research argue that generalizations are made on the assumption that the findings and inferences made during the research are supported by sound theoretical reasoning (Mitchel, 1983). Representation in qualitative research is in accordance with the subject of investigation, which is highly subjective and a narrow-minded view of events and what is being observed (Ruyter & Scholl, 1998). The findings of qualitative research are difficult to subject to rigorous quality verification requirements such as reliability and validity (Creswell, 1994). It would be difficult to prove the validity of qualitative research findings through measurement. Validity requires measurement of the object of enquiry and that is not possible in qualitative research because its purpose is not to measure but to generate ideas (Stenbacka, 2001).

On the other hand, reliability is concerned with producing the same result with consistency. This is not possible under qualitative research because of the involvement, influence, subjectiveness and the possibility of the bias of the researcher in qualitative research. Qualitative researchers have, however, argued that quality verification using validity and reliability checks is not necessarily applicable to qualitative research because it owes its origin to scientific rhetoric and positivist paradigms common in quantitative research (Creswell, 1994; Stenbacka, 2001). Stenbacka (2001:555), in further defending the paradigm, suggests that "...new concepts relevant to qualitative research [have] been used instead of quality concepts borrowed from quantitative research".

Nevertheless, both qualitative and quantitative research methodologies can be used in different situations, depending on the aims and objectives of the study. Most research is centered on four primary objectives, namely "exploration, explanation, description and prediction" (Ellram, 1996:98). Research where the objectives are either exploration or explanation, or both, would normally require qualitative research methods. This is because qualitative research has the ability to provide insight and explanation into a phenomenon that was relatively unknown (Ruyter & Scholl, 1998). It provides answers to questions, such as 'how' or 'why' which are common in exploration and explanation of phenomena (Ellram, 1996). Research that is descriptive or predictive, or both, would require quantitative research methods that utilize statistical techniques to predict and describe relationships between variables (Ellram, 1996). The choice between the two methodologies should be based on the aims and objectives of the study, as well as the nature of the study. In some cases the two methods may be used jointly to cover for the weaknesses inherent in each method (Tashakkori & Teddlie, 1998; Amaratunga, Baldry, Sarshar & Newton, 2002). A similar process is known to Tashakkori and Teddlie (2003) as mixed method or pragmatism. The combination of qualitative and quantitative methods is discussed in section 8.3.3.

8.3.3 Combined Quantitative and Qualitative Methods

Mixed-methods research involves both collecting and analyzing quantitative and qualitative data. Quantitative data includes closed-ended information such as that found on attitude, behaviour or performance instruments. The collection of this kind of data might also involve using a closed-ended checklist on which the researcher checks the behaviours seen. The analysis consists of statistically analyzing scores collected on instruments, checklists, or public documents to answer research questions or to test hypotheses. In contrast, qualitative data consists of open-ended information that the researcher gathers through interviews with participants. The general, open-ended questions asked during these interviews allow the participants to supply answers in their words. The analysis of the qualitative data (words or text or images) typically follows the path of aggregating the words or images into categories of information and presenting the diversity of ideas gathered during data collection. The open-ended versus closed-ended nature of the data differentiates between the two types better than the sources of the data (Elliot, 2005).

Several researchers such as Uysal and Crompton (1985), Creswell (1994), Tashakkori and Teddlie (1998), Bryman (2001), and Amaratunga et al (2002) have supported theoretically the combination of qualitative and quantitative methods. Tashakkori and Teddlie (1998) asserted that quantitative and qualitative research methods are not dichotomous but rather complement one another to produce improved research findings.

However, those advocating for the use of combined methods rejected the choice between positivism and constructivism as none of the methods work best in isolation (Tashakkori & Teddlie, (1998). The use of combined methods, often called the mixed method, has been found to alleviate the weaknesses linked with using either of the methods on their own (Tashakkori & Teddlie, 1998; Bryman, 2001; Amaratunga et al., 2002; Mangan, Lalwani, & Gardner, 2004). For example, Bryman (2001:450) suggests that "...in some instances neither qualitative nor quantitative research methods may be adequate on their own, thus researchers cannot rely on just one method and have to use both to support the research process". Quantitative and qualitative methods supplement each other by providing richness and details that are otherwise unavailable if each method were pursued separately (Jack & Raturi, 2006). Combining the methods provides a multidimensional insight into the research problem, and thus assists in getting a broader understanding as well as a true analysis of the situation at hand (Mangan et al., 2004), which is also one of the strong points of consideration for the current research. The use of combined methods compensates for the weakness embedded in each of the research method by "...counter-balancing the strengths of another" (Amaratunga et al., 2002:23). Jack and Raturi (2006) informed that triangulation provides confirmation of the research findings by improving the ability of researchers to draw conclusions from their studies, thereby resulting in more robust and generalizable research findings. The research design used in this research has been discussed in the section. The study adopted a mixed-method methodology in order to counter-balance the strengths and weakness embedded in each of the research methods when used separately, as discussed earlier. Further details on the justification for and explanation of how quantitative and qualitative methods were used to collect data in this thesis are provided.

8.3.4 Mixed-Methods Approach

Mixed-methods research involves the use of more than one approach to or method of design, data collection or data analysis within a single programme of study, with integration of the different approaches or methods occurring during the programme of study, and not just at its concluding point (Johnson et al., 2007:120). Mixed-methods research is a research methodology with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches in many phases in the research process. As a method, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches, in combination, provides a better understanding of research problems than either approach alone (Creswell & Clark, 2007). The mixed-method approach was adopted in this thesis based on the philosophical and practical reasons discussed earlier. A quantitative survey provides a snapshot of phenomena while the qualitative method or interview from the Delphi panelists (Delphi study) provide contextual information and human subjective information to interpret and inform the quantitative results. Creswell, Clark, Gutmann and Hanson (2003) identified six commonly used designs in mixed-methods research. However, the present study uses two of those, namely sequential explanatory and concurrent triangulation design. A visual model of mixed methods, as discussed by Creswell et al (2003) and Teddlie and Tashakkori (2009) is also used in the present study (Figure 8.1) to summarize and clarify the procedure. The quantitative survey is the main driver of this study, complemented by the qualitative study. The use of both methods provides a richer understanding of phenomena, an explanatory account of triangulation and illuminates significant survey findings in what Teddlie and Tashakkori (2009) referred to as crossover track analysis. Although the quantitative and qualitative studies are independent, both sets of data and analyses are used in analysis. The survey (quantitative) examination of the relations and associations between the key variables and the Delphi study (qualitative) are presented in the preceding chapters.

The current study used mixed-methods research, which involved both quantitative and qualitative approaches. According to Tashakkori and Teddlie (2003), mixed-methods research is a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches in many phases of the research process. It focuses on collecting, analysing, and mixing both quantitative and qualitative data in a single study or series of studies. The use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone. The quantitative data in a typical mixed method includes closed-ended information which was also adopted in this thesis. The collection of this kind of data involves using a closed-ended checklist in which the researcher checks the behaviour observed. Sometimes quantitative information is found in documents such as census records or attendance records. The analysis of the qualitative data consists of statistically analysing scores collected on instruments and checklists to answer research questions, to test hypotheses or to answer the research questions (Creswell, 2003). In contrast, qualitative data consists of open-ended information that the researcher gathers through interviews with participants. The general open-ended or closed-ended structured questions asked during interviews allow the participants to supply answers in their own words.

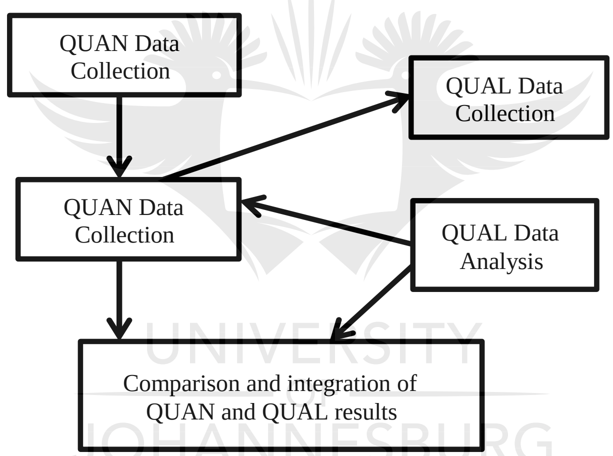

Figure 8.1: Visual Model of Mixed Methods Design

Source: Adapted from Tashakkori and Teddlie (2003); Aigbavboa (2013: 248)

These can be thematically analysis and converted into qualitative data, which can also be transcribed in quantitative data; for instance, when the Delphi technique is used, frequencies of measures of central tendencies are used to draw consensus. Qualitative data may also be collected by observing participants or sites of research, gathering documents from a private or public source, or collecting audio-visual material such as video-tapes or artefacts. The analysis of the qualitative data (words or text or images) typically follows the path of aggregating the words or images into categories of information and presenting the diversity of ideas gathered during data collection. The open- versus closed-ended nature of the data differentiates between the two types better than the sources of the data. Mixed-methods research is commonly used as a strategic research approach that is able "…(a) to demonstrate a particular variable will have a predicted relationship with another variable and (b) to answer exploratory questions about how that predicted (or some other related) relationship actually happens" (Tashakkori & Teddlie 2003:15).

Both qualitative and quantitative methods were used in the current study to identify the factors that are associated with TQM practices. It also indicates the statistical significance of these factors in determining TQM in the Ghanaian construction industry. The current study also looked into the relationship between the identified factors and TQM to be tested (predicted). The impact of the identified independent variables on the TQM implementation was also soughted in this study. The use of qualitative method was employed to explore and gain a comprehensive understanding of the way the selected factors had an influence on TQM. A quantitative method was further used to verify the results in the survey. The factors that bring about TQM in the construction industry were obtained through the use of the mixed-method approach.

The mixed-method approach confirms the findings of both the quantitative and qualitative approaches (Flick, 2009). This implies that the findings of the study could be useful in the establishment of the factors that should be considered for the development of TQM principles. The current study adopted a qualitative method structured through the use of the Delphi technique. The Delphi technique has been elaborated on in section 8.4.3. Findings from the Delphi survey were used to refine the survey tool (structured questionnaire) for the study and to validate the findings. The Delphi findings were used to resolve issues on TQM in the construction industry through consensus. The quantitative method of data collection for the study was the survey method with the use of a structured questionnaire. The analysis was done using SEM with EQS Version 6.2, using SPSS in the development and validation of the TQM model.

8.3.5 Justification of the Mixed-Method Approach

Both quantitative and qualitative methods have their strengths and weaknesses. Quantitative methods have been criticized for being "…sanitized and lacking in contextual realism" (Tashakkori & Teddlie 2003:516). Qualitative methods are suitable for addressing questions of how and why things occur while quantitative methods are more appropriate for answering 'what' and 'how' questions (Yin, 1994). The use of one method is not appropriate in studying the variables that predict TQM in the construction industry and was not enough to explore from the various stakeholders (identified in the qualitative Delphi study as experts). The use of the mixed-method approach that integrated qualitative and quantitative methods was required. According to Tashakkori and Teddle (2003:518), "…one of the merits of a Mixed Method Approach in the current study is that the techniques of the qualitative and quantitative domains, which are interwoven, helped to maximize the knowledge yield of the research endeavour". The mixed-method approach was used by the researcher to discover and justify the model components within one study.

Qualitative research involves people in order to provide the realism and detail needed for the generation of hypotheses and building of theory (Tashakkori & Teddle, 2003). Detail-rich data was collected for this study by using qualitative techniques. The language and context of the stakeholders and the people being studied were captured during the questionnaire survey to collect the required data for the study. The qualitative data gathered in both the first and second stages and the data analysis approach were aligned with the positivist paradigm. The positivist paradigm sought to identify patterns and repetition within each key research issue and also explored the level of impact, influence and agreement through the use of scales. The mixed-method approach was adopted to answer questions that would not have been possible to answer by either qualitative or quantitative approaches alone. The research problem was addressed through the use of the mixed-method approach which enabled the researcher to use both methods. The generalisability of the research result was increased through the use of mixed-method approach which was a major consideration in the present study. It also provided stronger evidence for a conclusion through the convergence and verification of findings. It also added insights and understanding that would have been missed if only a single method was used. In addition, it provided complete knowledge necessary to inform theory, practice and to be able to answer a broader and more complete range of research questions because the researcher was not confined to a single method or approach. Individuals who intend to solve problems using both numbers and words (combination of inductive and deductive thinking) naturally to employ mixed methods research as the preferred mode of understanding the thesis statement.

The Delphi technique was combined with the survey method in the current research to provide the basis for the validation of the conceptual framework for the development of a holistic TQM model for the Ghanaian construction industry and the major cities in Ghana as a case study.

8.4 RESEARCH DESIGN

A research design gives a detailed outline of how an investigation will be carried out. It will typically include how data will be collected, what instruments will be used, how the instruments will be used and the intended means for analyzing data collected. The research design has been defined as the framework for conducting research. It assists the researchers to conduct the study successfully (Churchill, 2001). Usually, the research design is used to justify decisions and choices relating to the research procedure (Sekaran, 2000). This section of the thesis provided the outline of the research design as shown in figure 8.2. The appropriate methodology used in this study is based on the ontological and epistemological assumptions. The choice of research design is influenced largely by the methodology (whether quantitative or qualitative) as well as the philosophical assumptions guiding the research process (ontology and epistemology). Objectivist ontology influences a researcher to adopt a more positivist epistemology. This gives emphasis to the use of quantitative methods in the research process (Sarantakos, 2005) such as the constructivist ontology, which culminates in qualitative methodology. The research design was fixed in line with the requirements of objectivism, which favours a scientific way of abstracting data when objectivist ontology is adopted. The instruments used in collecting data were determined by the research design. In quantitative design, the survey method is used to collect the data. The philosophical underpinnings (epistemology and ontology) provide a guide to the methodology followed in a research process. A decision on the specific research design can be hypothesised in the form of a connection beginning from the philosophical underpinnings (epistemology and ontology).

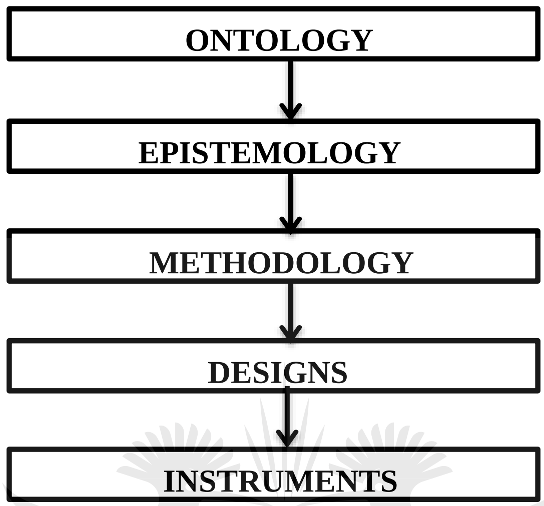

Figure 8.2: Steps in the research design process

Source: Adapted from Sarantakos (2005:29); Aigbavboa (2013: 253)

Following the decision on the methodology, the researcher has to decide on the research design guided by the research questions and aim. The research design influences the the choice of instruments to use in the execution of the research process (Sarantakos, 2005). Figure 8.2 illustrates these connections. The exact justifications for a research design should follow the five aspects - research purpose, theoretical framework, research questions, research methods and sampling strategy – which are appropriately inter-connected, according to Robson (2002). The current study follows these aspects of research design. Hence, the choice of research methods for the current study was influenced by the research aim, sub-questions and objectives.

Three considerations were made for the selection of the research methods to answer the predetermined set of goals for the research. These are:

i. To be able to identify the variety of factors associated with TQM in the construction industry;

ii. To be able to predict the relationship between each of the identified factors and how they can predict TQM in the construction industry; and

iii. To be able to provide in-depth information to be collected and analysed to show how firms identified factors as important (influential) in determining TQM in the construction industry.

The current study adopted the mixed method of research (quantitative and qualitative combined) as stated, discussed and justified in the previous sections. The mixed-method approach was adopted to answer the research questions and meet the research objectives, thus, developing a TQM model that applies to the study area.

The following strategies were adopted to meet the research objectives stated in Chapter 1, Section 1.6.2:

i. The first general objective was to establish the factors that determine TQM in the construction industry. To this end, a literature review was conducted relating to the factors that determine TQM implementation. Published articles, development reports and status reports were reviewed. The expected outcome from this objective was information and a global picture of the determinants of TQM implementation. Both international and national literature was reviewed. The review gave a general overview of how TQM in the construction industry is formed and its relevance to construction firms.

ii. The second general objective was to establish the current theories and literature on TQM implementation as well as to identify the gaps that needed consideration. The constructs that were established were included as part of the theory for the development of the holistic TQM model. Literature review was conducted from a wide source of publications including journals, conference proceedings, books and monographs. Specific theories of TQM studies were reviewed. The second general objective was expected to provide information on the current theories on TQM studies to determine the gaps which other scholars have not yet addressed, to identify common themes and the type of methodologies that have been used in the research and how terms have been defined. This information was necessary as it was the core literature to inform the current research project.

iii. The Delphi method was used to achieve the third and fourth objectives which were to determine the main and sub-attribute(s) that bring about TQM and to examine the similarities in attributes that determine compliance in other cultural contexts as well as Ghana. In addition, the study aimed to evaluates the factors and issues that affect the implementation of TQM in Ghana. Since experts' views were required on the factors that determine TQM, the Delphi Method was the best to use in this instance. Apart from experimental procedures which were not feasible for this study, the Delphi or focus groups, or both, could be used.

The focus groups could have been used except that there was the challenge of assembling all workers and experts to deliberate from 8.00 am to 16.00 pm for a minimum of three days. The focus group was also expensive and beyond the budget for the field work. This might have defeated the purpose of conducting a rigorous process to achieve the objective. This is not the case for a focus group. There was no bias from the experts because they remain completely anonymous to each other and therefore there was no undue influence from peers. A detailed explanation of the Delphi technique is explained in Section 8.4.3 in order to give an idea to the reader of how the Delphi method was conducted and what should be expected. The expected output is an estimation of the extent to which TQM was influenced by the established factors. Also the consensus reached on the critical factors and issues that affect the non-implementation of TQM in the Ghanaian construction industry. The conceptual model was developed for the TQM from the factors and their interrelationships

iv. The fifth general objective was achieved by drawing on the conclusions from the extensive literature review and the results and findings from the qualitative Delphi study.

v. An empirical questionnaire survey was conducted and analysed using SEM to achieve the sixth objectives of the research.

The sixth objective was to test and validate the conceptual model developed from the RO5. Data obtained from the questionnaire sought to establish interrelationships between the factors that determine TQM to establish the relationship produced amongst them and which constructs have a greater influence on the determination of TQM in the construction industry. The aim was to establish the core determinants of TQM in the Ghanaian construction industry. A detailed explanation of the survey concerning population, sampling procedure and analysis of results is presented in Section 8.4.4. The expected output for the sixth objective was information to validate the conceptualized holistic model and based on this, to finalize the best fit model for TQM for the Ghanaian construction industry. Table 8.1 summarises the research methods employed to achieve the objectives of the research. The methods used to achieve the objectives of the research have been explained in the sections that follow.

Table 8.1: Research Procedure

Stage	**Research objective**	**Data collection Method**	**Data analysis method**	**Output**
1.0 Literature review	**RO1**: To establish the factors that determines TQM implementation in the construction industry	Literature review		Information and a global picture of the determinants of TQM in the construction industry.
	RO2: To investigate theories and literature on TQM implementation in the construction industry	Literature review		Information on the current theories on TQM in the construction industry and to determine the gaps which other scholars have not addressed.
				Outline of constructs (factors) associated with TQM implementation in

				the construction industry have not been considered in the previously developed models
2.0 Delphi Technique	**RO3**: To determine the main and sub-attributes of TQM in the Ghanaian construction industry	Delphi Technique	Descriptive statistics	Consensus on the influence and impact level of the various attributes of TQM implementation in the construction industry
	RO4: To evaluate the critical factors that affect construction firms for not implementating TQM in Ghana	Delphi Technique	Descriptive statistics	Consensus on the critical factors and issues that affect construction firms for the implementation of TQM in Ghana .
	RO5: To develop an integrated TQM model to guide construction firms in managing construction projects in Ghana	Desk study; Questionnaire Survey; Delphi Technique	Theory	An integrated TQM model.
3.0 Questionnaire Survey	**RO6**: To determine the validity of the integrated TQM model through a comparative analysis of the Delphi and literature outcome with	Questionnaire Survey	Structural Equation Modeling (SEM); EQS	Information to validate conceptual model; validated best-fit model.

	the field questionnaire survey outcome			

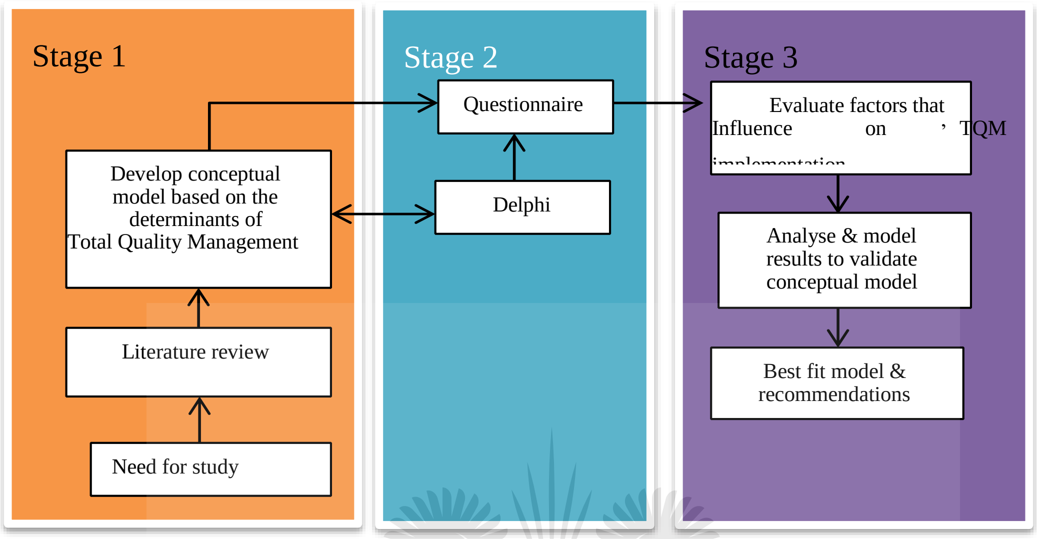

Figure 8.3: Research Design Outline

Source: Manu, Ankrah, Proverbs and Suresh (2010:29), Musonda (2012:91), Aigbavboa (2013:258)

8.4.1 Methods

An overview of the methods to be used to achieve the objectives of the research is given in detail in this section. The methods are a literature review, the Delphi method and the questionnaire survey. A detailed description of each of the methods listed has been given under the analysis (how data were treated) section. An outline of how the study was conducted is given in Table 8.1. The table details the methods (procedures) employed to achieve the objective of the study. Figure 8.3 is also an outline of how the study was conducted and gives a detailed description of the methods described in the next sections.

8.4.2 Stage One: Literature Review

Boote and Beile (2005) asserted that literature is the foundation of research. The most important aspect of developing a study is to review literature on previous works carried out by different researchers as well as the methodologies employed to investigate similar problem in order to establish the trends on the use to solve several problems (Heppner & Heppner, 2004:52).

For the current study it is necessary to know the following:

i. The theoretical and conceptual perspectives of TQM research;
ii. Gaps in TQM implementation in construction industry research;
iii. TQM issues in the construction industry;
iv. TQM implementation in develop countries; and
v. TQM implementation in developing countries, specifically those in Africa.

The literature review on the above aspects was important as it provides the broad context of the study to the reader. It also highlights what has already been done before on the subject under consideration. It further relates the present research to the on-going debate on the subject and provides a framework for comparing the results of the present research with other studies on the subject.

An effort was made to ensure that the literature analysis was thorough and comprehensive to ensure the integrity of the study. Studies reviewed were well integrated and adopted methods have been used in other studies. The reviewed and detailed analysis of the methods used in other studies was not only on report made in the existing literature (Boote & Beile, 2005). Several materials were used for the literature review, such as books, reviews of articles on the subject matter (both published and unpublished), theses and dissertations. Names of leading authors and contributors on the subject matter were sourced from the references of the consulted articles. This helped to obtain their publication history and the search for information focused within research databases. The progression of research on the topic under study was made possible from articles in the mentioned sources. The methods of conducting a literature review as indicated by Boote and Beile (2005) below were strictly followed in the study.

The process of conducting literature review specifically followed, among others the following steps (Boote & Beile, 2005:13):

i. Sourcing a broad range of high-quality, specific articles, books, dissertations and reviews directly related to the study;

ii. Reading and re-reading to establish progressions and trends;
iii. Summarizing the studies read;
iv. Identifying methodologies adopted in the studies;
v. Relating the current study to those reviewed; and
vi. Writing the literature.

The output from the literature review was a clear perspective of the topic and an indication of where the study fits in relation to other studies on the subject matter. This also provided a framework for comparing the results of the study with other studies. According to Boote and Beile (2005), "…good research is good because it advances our collective understanding". A great deal of energy has been expended in the review of literature on the current study. Findings from the literature review have indicated various factors which determine TQM practices in different contexts. Other factors such as key constructs which should bring about TQM should be considered. These factors were not considered in the previous models developed since there are missing universal factors which give assurance on TQM in the Ghanaian construction industry. Theories were developed about the influence of the missing factors and their interrelationships with other factors to determine TQM implementation in the construction industry. A test needed to be carried out to ascertain their influence on TQM in the Ghanaian construction industry. This was achieved by using theDelphi method described below.

8.4.3 Stage Two: Delphi Method

The Delphi technique was first or originally developed by two scientists, Olaf Helmer and Norman Dalkey of the Rand Corporationin in US in the 1950s, and named after the greatest of all Greek oracles (Buckley, 1995). In other words, Delphi technique was named after the ancient Greek temple where the oracle could be found. The technique was developed as a tool for forecasting and problem solving of complex topics at the Rand Corporation. Dalkey and Helmer (1963) identified that the Delphi technique is a procedure to solicit opinions, judgement, and consensus from a group of experts in a given subject field. They added that the process is very interactive and solicits and collates opinions on a particular topic through a set of designed sequential questionnaires interspersed with a summarized feedback of opinions derived from earlier responses (Dalkey & Helmer, 1963). On the other hand, Miller (1993) explained that the Delphi technique is a qualitative methodology seeking to produce consensus of a group of experts on an issue of concern through a survey consisting of rounds. Miller (1993) added that the technique is based on structural surveys and makes use of intuitively available information of the participants (experts) in their various fields. The method provides both qualitative and quantitative results, and has beneath its explorative, predictive and even normative elements (Cuhls, 2003). Hence, there is agreement that Delphi is an expert survey in two or more 'rounds' in which the second and later rounds of the survey (the results) of the previous round are given as feedback. Thus, the experts answer from the second round based on the influence of the other experts' opinions but the panel members have no idea who is involved. The idea is that the joint judgment of experts is a relevant measure of the outcome of the research. The Delphi method was used during the second stage of the current study to identify the main attributes that bring about an understanding of TQM in the construction industry and to examine whether the attributes that determine TQM in other cultural contexts as identified from the literature are the same within the construction industry in Ghana.

The Delphi technique requires knowledgeable and expert contributors individually responding to questions and submitting the results to a central coordinator (researcher). The coordinator (researcher) processes the responses, looking for central and extreme tendencies and their validations (Grisham, 2008). The results are then fed back to the input provided by the coordinator (researcher). The experts are then asked to resubmit their opinions, aided by the input provided by the coordinator (researcher). This process continues until the coordinator sees that consensus has been reached on the questions asked. The method was intended to remove the bias that is possible when diverse groups of experts meet, which is common with other methods of decision making. With the Delphi method, the experts do not know who the other experts are.

Hence, the standard Delphi method is a survey which is directed by a coordinator as already stated and comprises several rounds with a group of experts, who are kept anonymous and for whose subjective-intuitive prognoses a consensus is aimed at (Cuhls, 2003). After each survey round, standard feedback about the statistical group judgment calculated from the median, the percentages and the interquartile range of single projections is given and if possible, the arguments and counter-arguments of the extreme answers are fed back. In the Delphi process, nobody 'loses face' because the study is done anonymously using a questionnaire. Rowe, Wright and Bolger *(*1991) and Häder and Häder (1995) stated that it is commonly assumed that the method makes better use of group interaction whereby the questionnaire is the medium of interaction. The Delphi method is especially useful for long range forecasting, as expert opinions are the only source of information available.

The Delphi technique is part of a group of decision-making (policymaking) techniques that includes the nominal group technique (NGT) and the interacting group method (IGM). The Delphi technique differs in various ways from the NGT and IGM respectively, but primarily due to the fact that Delphi is individual based, anonymous and independent. The element of group interaction is eliminated from the process and feedback to questionnaires is in written format (Loo, 2002). Over time, the Delphi method has gained popularity as a method of inquiry across many scientific disciplines. Czinkota and Ronkainen (1992) cited in Aigbavboa (2013) indicated that the Delphi method has gained considerable approval across disciplines. They further claimed that it has been used as a study instrument in the fields of library and information science (Buckley, 1995), in the medical disciplines (Linstone & Turoff, 1975), in multi-country studies of communications in Europe, and by actuaries to predict economic conditions (SOA, 1999). Czinkota and Ronkainen (1992) cited in Aigbavboa (2013) further report that those experienced with the Delphi technique report that the method produces valuable results which are accepted and supported by the majority of the expert community. Similarly, in the business field, the technique has been highly rated by some as a systematic thinking tool, but has been challenged in its ability to serve as an identifier of strategic issues (Schoemaker, 1993).

The Delphi technique is well suited as a research approach and method for the current study. The technique has not been used in a similar study in Ghana or in any other developing country. The study was aimed to attract a wide spectrum of inputs from various geographically dispersed experts in Ghana. The Delphi method was preferred to common survey methods as the current study was addressing the 'what can - if' kind of questions, as opposed to the 'what is' kind of questions. Delphi is more suited for these kinds of questions to explore concepts that are difficult to measure except through experimental methods. Unfortunately, an experimental survey was not feasible or appropriate for the current study. The Delphi's strength lies in the rounds used, unlike ordinary survey research, which provided an opportunity for initial feedback, collation of feedback, and distribution of collated feedback to participants for further review (Stitt-Gohdes & Crews, 2004:62). Therefore, the Delphi method was also considered to be a robust method of rigorous query of experts. This unique process requiring group communication is central to the strength of the Delphi (Stitt-Gohde & Crews, 2004:62). Also, Loo (2002) opined that the Delphi process should be used when investigating policy-making or policy-evaluation strategies that will set the future direction for the public or private sector respectively. The Delphi method was considered as a useful tool for the current study. The thesis is aimed at future direction for TQM in the Ghanaian construction industry.

However, the Delphi method was alleged to have failed to follow accepted scientific procedures, in particular the lack of psychometric validity (Sackman, 1974). Coates (1975) was of the view that the Delphi technique is of value not in the search for public knowledge but rather in the search for public wisdom; not in the search for individual data but in the search for deliberative judgment. Sackman's (1974) view is not applicable to the current study. However, it should be noted that the approach deals with areas that do not lend themselves to traditional scientific approaches; henceHelmer (1977) argues that the forecasting tendency, one of the major applications of the Delphi, is inevitably conducted in a domain of what might be called 'soft data' and 'soft law'. Helmer (1977) further determines that standard operations and research techniques should be augmented by judgmental information and that the Delphi method cannot be legitimately criticized for using mere opinion and for violating the rules of random sampling in the 'polling of experts'. Such criticism, Helmer (1977) argued, rests on a gross misunderstanding of what the Delphi method is; it should be pointed out that a Delphi inquiry is not an 'opinion poll'. As all the above definitions illustrated, in no instance is reaching a majority opinion the ultimate goal in a typical Delphi study; it is rather the reaching of agreement (consensus). According to Buckley (1995), "Delphi is a tool for discovering agreement and identifying differences rather than forcing consensus". Buckley (1995) further informs that in principle, agreement alone is not a sufficient condition for arguing the acceptance of the Delphi method.

Linestone and Turoff (2002) asserted that majorities of research methods, the method of use and application has an enormous influence on the eventual success of the inquiry. Hence, where no agreement is achieved, the Delphi still helps to clarify the issue being investigated. Linestone and Turoff (2002) asserted that one of the common reasons for failure in a Delphi study is ignoring and not exploring disagreement. The current research is not only about reaching or forcing a consensus but recognizing disagreement and exploring the reason for such.

In addition to the above criticism of the Delphi technique, different authors have pointed out their various views of the weaknesses of the Delphi technique as follows:

i. It has not been shown consistently that the results from the Delphi method are any better than those achieved through other structured judgmental techniques (Rowe, Wright & Bolger, 1991);

ii. There is possibility of biases of the coordinating or monitor team (researcher), who chooses the experts, interprets the returned information and structures the questions for the Delphi study. There is an enormous debate whether the experts should be chosen from within or outside of the organisation initiating the study and whether they should be experienced in the subject area of the study in question (Masini, 1993);

iii. Linstone (1978) disagreed with the process and how the questionnaire was structured, which Linstone (1978) believed can lead to bias (like IQ tests), which assumes a certain cultural background. Hence, the experts may give responses they think the monitoring group wants to hear, or they may not respond at all. Consequently, the cultural background of respondents will have an impact upon the results;

iv. Simmonds (1977) debated that one of the key flaws in the Delphi technique is that certain questions are not asked as they do not seem important when the study begins. Nonetheless, once the study begins, new questions cannot be added, which in turn can weaken the study considerably;

v. Lang (1995) states that the process of choosing the panelists is often not considered seriously enough. Yet, it is the caliber of the panelists that determines the quality of the outcomes of the study (Lang, 1995);

vi. In the process of achieving consensus, extreme points of view run the risk of being suppressed, when in fact they may provide important new information or insights (Lang, 1995);

vii. The flexibility of the technique means it can be adapted to a whole range of situations, which in turn can makes it vulnerable to misrepresentation and sloppy execution (Amara, 1975); and

viii. Garrod (2008) found that the Delphi technique can be extremely sensitive to the level of panelists' expertise, the composition of the panel, the clarity of the questions, the way the research or coordinator reports reasons for outliers, and the administration of the questionnaire.

Despite the limitations noted above from different scholars, Brill, Bishop and Walker (2006) describe the Delphi as a particularly good research method for developing consensus amongst a group of entities having expertise on a particular topic where information required is subjective and where participants are separated by physical distance (Linstone & Turoff, 1975). Brill et al. (2006) further state that the Delphi method has been validated in the literature as a reliable empirical method for reaching consensus in a number of areas. Amongst these areas are distance education (Thach & Murphy, 1995), journalism (Smith, 1997), visual literacy (Brill et al., 2006), electronic commerce (Addison, 2003), health care (Whitman, 1990) and others. Beside these areas, the method has also been used in many other disciplines, such as in information technology (IT) research to identify and rank key issues for management attention (Delbecq, Van de Ven &Gustafson, 1975); scientific study of GIS (Hatzichristos & Giaoutzi, 2005), quality management (Saizarbitoria, 2006), terrorism (Parente, Hiob, Silver, Jenkins, Poe & Mullins, 2005), banking (Beales, 2005), social sciences (Landeta, 2006), the privatization of utilities (Critcher & Gladstone, 1998), and education (Yousuf, 2007). Based on the extensive usage of the method over time, the Delphi method in a research is an accepted practice. However, it may not be appropriate for all research activities.

8.4.3.1 Epistemological Approach towards the Delphi Design

The variance amongst the various group techniques, the definition of the Delphi method as compiled by various scholars and cognisance of the various criticisms form the epistemological foundation for defining the approach towards a typical Delphi study design. Amongst these include reducing the effects of personal bias. This is done by assuring that all expert feedback is anonymous. Through this, the technique captures the opinions, experience, and knowledge of each panel member. Personal knowledge is harvested and interpersonal interaction biases are stripped away. According to Scheele (2002), "…the concreteness of the framework of the Delphi design is vital in researching the overall objective of the study". The basic premises of the Delphi research design towards a typical TQM (TQM) study is entrenched in some form of general agreement and consensus regarding the core ingredients and components of the subsequent framework.

Given the current status of TQM issues in Ghana and the absence of generally agreed TQM implementation principles, the search for consensus and a point of departure in issues on TQM that will better serve the construction industry is therefore justified through the use of the technique. Hence the objective of the Delphi design for this study is to obtain the most reliable consensus of opinion of a group of experts in the specific field being studied, namely TQM in the construction industry. According to Lang (1995), "…the Delphi technique is mostly used to solicit the opinions of experts to determine the timing and possible occurrence of future events". It is a method that is best used where there is little past data available applicable to extrapolate from, and where social, economic, ethical and moral considerations are pre-eminent. Considering the outcome of the literature review of the current research, there is no structured research so far carried out which has adopted the technique with regard to TQM implementation in the Ghanaian construction indusrty. It is therefore justified that the Delphi technique is the best method to explore the subject of the research and to achieve the aim and objectives.

8.4.3.2 When to use Delphi Technique

The Delphi method is mainly used when long-term issues have to be assessed such as the subject of the current research. This is because it is a procedure used to identify statements (topics) that are relevant for the future; it reduces the tacit and complex knowledge to a single statement and makes it possible to judge upon (Cuhls, 2003). Hence the use in combination with other methodologies like survey design can be interesting. It is also suitable if there is the (political) attempt to involve many people in processes (Eto, 2003).

Hence, Linstone and Turoff (2002) argued that one or more of the following properties could lead to the need for the use of the Delphi technique:

i. When the problem of inquiry does not lend itself to precise analytical techniques but can benefit from subjective judgments on a collective basis (Buckley, 1994);

ii. The research needs to contribute to the examination of a broad or complex problem with no history of adequate communication and may represent diverse backgrounds with respect to experience or expertise, which is a major premise of the research;

iii. More individuals are needed than can effectively interact in a face-to-face exchange;

iv. Time and cost to make frequent group meetings is limited;

v. The efficiency of face-to-face meetings can be increased by a supplemental group communication process;

vi. Disagreements among individuals are so severe or politically unpalatable that the communication process must be refereed and anonymity assured; or

vii. The heterogeneity of the participants must be preserved to assure the validity of the results, such as the avoidance of domination by quantity or by strength of personality, called the “bandwagon effect”.

According to Cuhls (2003), "…the Delphi method as a foresight tool seems to possess certain degrees of invariance to survive in the changing challenges of the past 50 years". Hence the process could serve different understandings of predicting or premonition and is probably understood by the users as being relevant for covering technical perspectives organisational perspectives, but also personal perspectives. Cuhls (2003) further emphasises that what the users of the Delphi technique especially like are the sets of data about the future that are collected. Writing down future topics seems to have an immense psychological effect because it transfers implicit tacit knowledge to the more visible and explicit, and therefore transferable knowledge.

8.4.3.3 Components of the Delphi Technique

The main components of the Delphi technique, according to Loo (2002), consist of the following five major characteristics, which were adopted in the study.

i) A study should consist of a panel of carefully selected experts representing a broad spectrum of opinions on the topic or issue being examined;

ii) The participants are usually anonymous;

iii) The coordinator (researcher) constructs a structured questionnaires and feedback reports for the panel over the course of the Delphi;

iv) It is an iterative process often involving three to four iterations called 'rounds' of questionnaires and feedback reports; and

v) There is an output, typically in form of a research report containing the Delphi results, the forecasts, policy and programme options (with their strengths and weaknesses), recommendations to senior management and possibly an action plan for developing and implementing the policies programmes.

Likewise, Hasson, Keeney and McKenna (2000) recommended that the following research guidelines for using the Delphi technique be addressed in designing a Delphi approach, namely research problem identification, understanding the process;, selection of experts, informing or invitation to experts, data analysis, and presentation and interpretation.

i. Research problem identification: Turoff (1970) outlined four objectives that call for the use of the Delphi technique. One of those objectives was to relate informed judgments on a topic that spans a wide range of disciplines. Reid (1988) contended that the decision to use the Delphi technique must centre upon the appropriateness of the available alternatives. Reid (1988) claims that the use of experts in a field of study is a perfectly suited technique if the technique has not been utilized in the past, based upon the research performed, such as the current study that has not employed the Delphi Technique as a tool of investigation in TQM in Ghana.

ii. Understanding the process: The Delphi technique is a multistage process designed to combine opinions into group consensus (McKenna, 1994). The process consists of the following:

- Pilot testing of a small group;
- Initial questionnaire - qualitative comments solicited (not in all cases);
- Initial feedback - quantitative after statistical analysis of the initial opinions;
- Subsequent questionnaire-qualitative comments solicited again; and
- Subsequent feedback - quantitative after statistical analysis. This provides an opportunity for participants to change their opinions.

iii. Selection of experts: It is important to select panel members who are impartial, and are interested in the topic. Some studies have over 60 experts, some as few as fifteen. Selection of people knowledgeable in the field, and their commitment to multiple rounds of questions on the same topic are essential. In the section that provides more details regarding the practical design and execution of the Delphi study for this thesis, further details on how the experts were chosen for the study arepresented.

iv.. Informing or invitation to experts: It is imperative to explain what is required of them, how much time it will require, what they will be required to provide, what the objective of the study is, and what will be done with the information.

v. Data analysis: This is the process where opinions of the experts are solicited. According to Green, Jones, Hughes and Williams, 1999) two or three rounds are preferred. Green et al. (1999) suggest that an 80 per cent consensus should be the goal.

Likewise, Crisp, Pelletier, Duffield, Adams and Nagy (1997) suggest that percentages should not be used, but rather the process should stop when stability of the data occurs. However, percentage estimation was found suitable for this study as one of the means to achieve consensus, hence, a 60 per cent consensus goal was set for the three round Delphi studies. Also, analytical software can be utilised to analyse the responses and provide feedback to the experts on the central tendencies (median and interquartile range) and on the levels of dispersion (standard deviation). Hence, Lincola and Guba (1985) state that the criteria for qualitative studies such as the Delphi technique should be credibility (truthfulness), fittingness (applicability), audit ability (consistency), and confirmatory ability.

vi. Presentation and interpretation: There are a number of methods for presenting the data from a typical Delphi study, with two methods being graphical and statistical. These two methods have been used in the current research.

Therefore, given the nature of the current research, it is further believed that the Delphi technique is well-suited to obtain credible inputs from experts in industry, academia and government to serve as key input in the development of a TQM model for Ghanaian construction industry. The next section provides an overview of how the Delphi technique is used in this thesis.

8.4.3.4 Designing, Constructing and Executing the Delphi Technique Study

Given the rationale behind the Delphi technique and the main features previously explained, the design, construction and execution of the Delphi study for the current research follows a sequential process as suggested by Loo (2002). Four vital planning and execution activities are followed as pointed out by (Loo, 2002):

i. Problem definition;
ii. Panel selection;
iii. Determining the panel size; and
iv. Conduction the Delphi iterations.

Supporting Loo (2002) approach, Delbecq, Van de Ven and Gustafson (1975) suggest a basic Delphi methodology that includes distinct stages such as Delphi question development (objective), expert panel selection, sample size, first questionnaire, first questionnaire analysis and follow-up questionnaires. This methodology forms the basis of the current Delphi research study and is explained in the subsequent sections. Table 8.2 gives a summary of the Delphi design, construction and execution.

Phase 1: Delphi Questionnaire Development

The formulation of the Delphi question is vital to the whole process. It is paramount that the panel of experts should understand the broad context within which the questionnaire is designed. The current research looked at the concept of what determines TQM implementation in the construction industry. Hence the concept had to be broadly clarified. Key questions were asked to achieve the objectives of the Delphi study. The basis of constructing the questions for this current study was the guidelines given in Table 8.2, with corresponding wording and phrasing given for this study.

Table 8.2: Key Delphi Questions and Phrasing for the Study

Key Delphi questions?	Phrasing for this study
Why are you interested in this study?	This study was initiated because of the belief that not all construction firms in Ghana implement TQM. This assumption is concrete because there is lack of understanding of the diverse features that determine TQM implementation in construction industry.
What do you need to know that you do not know now?	Despite the knowledge about the features that brings about TQM implantation in construction industry, Carry on here these have not been put together as a model for the construction industry in Ghana. The attribute that determines TQM in the Ghanaian construction industry emerges the end of this study.
How will the results from the Delphi study influence TQM in construction industry?	The results of the Delphi study enable the development of a conceptual framework for the TQM model to be developed. The attributes which collectively predict and assure TQM implementation in the Ghanaian construction industry are established.

Phase 2 – Delphi Expert Panel Selection

A critical phase in conducting a Delphi interview technique is the selection of the right experts (panellists, participants or respondents). The experts' role is also crucial to the success of the research (Hasson, Keeney & McKenna, 2000). To ensure a high commitment response rate in the subject under examination depends on the selection of the experts, their interests and involvement. According to Hasson et al. (2000), "…controversial debate occurs when a professional becomes an expert". The claim that a group represents valid expert opinion has been criticized as scientifically untenable and overstated. McKenna (1994) defined 'an expert' as a panel of informed individuals (otherwise called experts hereafter). The definition of 'an expert' by McKenna (1994) was supported by Goodman (1987:730) who stated that the Delphi technique "…tends not to advocate a random sample of panellists… instead the use of experts or at least of informed advocates is recommended".

> Delphi inquiry is not an opinion poll, relying on drawing a random sample from the population of experts is not the best approach, rather, once a set of experts has been selected (regardless of how-but, following a predetermined qualifying criteria), it provides a communicative device for them that uses the conductor of the exercise as a filter in order to preserve anonymity of responses', which is the core of the Delphi Technique (Helmer, 1977:18-19).

Therefore, Linstone and Turoff (2002) asserted that the most significant danger in selecting the panel of experts lies in the path of 'least resistance' through the selection of a group of cosy friends and or like-minded individuals, which thus negates the strength of the process. Since panellists form the cornerstone of the Delphi technique, clear inclusion criteria should be applied and outlined as a means of evaluating the results and establishing the study's potential relevance to other settings and populations (Igbal & Pipon-Young, 2009).

The selection of panellists for the study was based on criterion sampling. Panellists were selected for a purpose to apply their knowledge to a concept raised in the study based on the criteria that were developed from the research questions under investigation. A Delphi study does not depend on a statistical sample that attempts to be representative of any population. It is a group decision mechanism requiring qualified experts who have deep understanding of the issues (Okoli & Pawlowski, 2004). Therefore, one of the most critical requirements is the selection of qualified experts as it is the most important step in the entire Delphi process because it directly relates to the quality of the results generated (Hsu & Sandford, 2007). Stitt-Gohdes and Crews (2004:61) argued that careful selection of the panel of experts is the keystone to a successful Delphi study. Dalkey and Helmer (1963) opined that there are detailed criteria for the selection of panel experts, recommending that in a typical Delphi study experts should meet two recommendations. These recommendations were also postulated by Rodgers and Lopez (2002). The two recommendations are as follows:

i. The experts should exhibit a high degree of knowledge of the subject matter. and
ii. They should be representatives of the profession so that their suggestions may be adaptable or transferable to the population.

Adler and Ziglio (1996) stated that the Delphi participants in any study should meet four 'expertise' requirements, namely knowledge and experience with the issues under investigation, capacity and willingness to participate, sufficient time to participate in the Delphi studies, and effective communication skills.

In choosing panellists for this study, each expert was required to meet at least five (5) of the following minimum criteria:

i. Residency: Have lived in any of the Metropolitan/Municipal/Districts in Ghana for at least more than one (1) year;
ii. Knowledge: Has knowledge of TQM in the construction industry;
iii. Academic Qualification: Has been presented an earned degree (National Diploma/Bachelor's degree/Master's degree/Doctor of Philosophy) related to field of study, certification of employment/experience focusing on construction development/project management issues;
iv. Experience: Has a history of or is currently performing consultation services for the government of Ghana, individuals, businesses, agencies, companies, and/or

organizations relating to construction project management. The experts must exhibit a high degree of knowledge of experience in the subject matter as well as extensive theoretical knowledge.

v. Employment: Currently serves (or has previously served) in a professional or voluntary capacity (e.g. at place of employment - institution, business, agency, department, company) as supervisor or manager of establishment that is involved with construction project management construction in Ghana.

vi. Influence and Recognition: Has served/is currently serving as a peer reviewer for one or more manuscripts received from a journal editor prior to its publication in the primary literature, with focus of the manuscript(s) on construction project management.

vii. Authorship: Is an author or co-author of peer-reviewed publications in the field of construction with emphasis on Ghana, has prepared and presented papers at conferences, workshops or professional meetings focusing on construction project management and TQM.

viii. Research: Has submitted one or more proposals to or has received research funds (grant/contract) from national, local government, regional, and/or private sources that support construction project management and studies related to TQM.

ix. Teaching: Has organised, prepared, and successfully presented one or more TQM training workshops focusing on the group for which expertise is sought. The workshop or course must have been on TQM practices. Or, has served as an individual or as a collaborative instructor in the teaching of one or more polytechnic or university courses focusing on TQM or a related field.

x. Membership: Member of a professional body (as listed on the expert questionnaire). Should be the representative of a professional body so that their opinions may be adaptable or transferable to the population.

xi. Willingness: Must be willing to participate fully in the entire Delphi process.

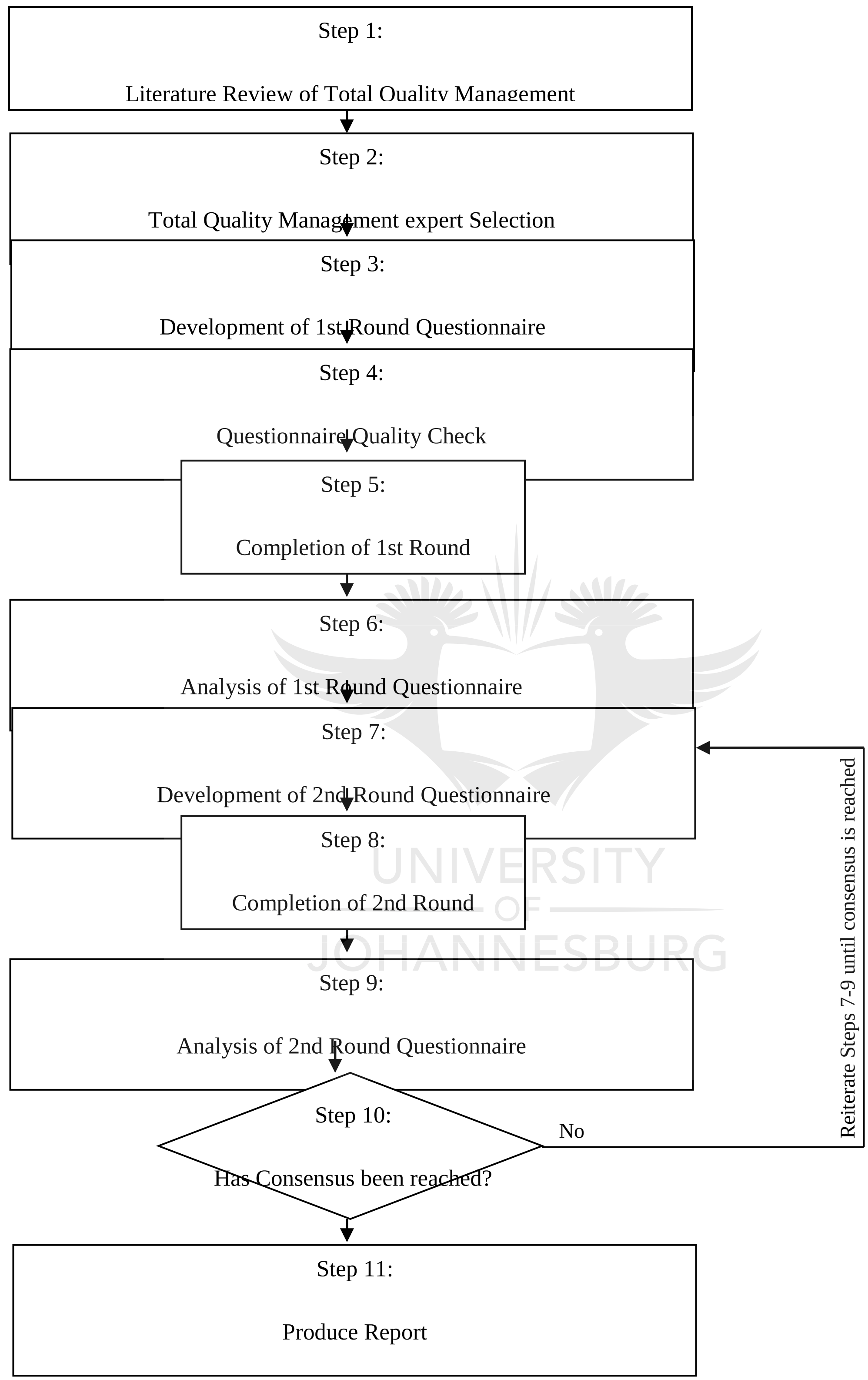

Figure 8.4: The Delphi process

The selected participants should represent a wide variety of backgrounds to guarantee a wide base of knowledge (Rowe, Wright & Bolger, 1991). The recommendations of Rowe et al. (1991) were adopted for the current study. The number of respondents should be large enough to ensure that all perspectives are represented but not so large as to make the analysis of the results unmanageable by the researcher (Linstone & Turoff, 1975). The adoption of five of these criteria was considered more stringent than the recommended number of at least two criteria by Rogers and Lopez (2002) and Dalkey and Helmer (1963). The five minimum criteria were framed after the four recommendations made by Adler and Ziglio (1996), with the inclusion of experts' residency status, which was considered to be compulsory for all selected experts. This was considered significant because experts were required to have a wide-ranging understanding of TQM practices within their locality.

Phase 3 - Determining the Panel Size

The Delphi technique requires a qualitative approach rather than a quantitative approach. The number of participants or experts in a Delphi technique is expected to be fewer than normal quantitative surveys. Various scholars have recommended different sample sizes for determining the minimum number of experts to participate in a typical Delphi survey. Dalkey and Helmer used a panel of seven experts in their original Delphi experiment in 1953 (Helmer, 1983). According to Linstone (1978:296), "…a suitable minimum panel size is seven". Linstone (1978) justified this by indicating that the research runs the risk of accuracy and deteriorates quickly when the numbers increase. The justification given by Linstone (1978) was supported by Cavalli-Sforza and Ortolano (1984:325) who postulated that a "…typical Delphi panel has about eight to twelve members", while Phillips (2000:193) stated that the optimum number of participation should be between seven and twelve. A similar number was cited by Linstone (1978). Miller (1993) was of the view that any additional responses beyond the first thirty responses would not generate new information. Similarly, Dunn (1994) suggested ten to thirty participants, indicating that as the complexity of the policy issue increases, the sample size needs to be larger to include the entire range of participants both for and against the policy issue area. Dunn (1994) further emphasised the inclusion of both formal and informal stakeholders who have an interest in the policy issue in the study. They should also have varying degrees of influence, hold a variety of positions, and be affiliated to different groups.

These requirements are the basis upon which the present Delphi study was based. According to Andranovich (1995), "…if the group of experts is fairly homogeneous (sharing similar opinions) then ten to fifteen panellists will be enough and if there are diverse interests present amongst the experts, then the size of the group will need to be increased to ensure balance (Zami & Lee, 2009). Most community-oriented Delphi studies have a panel of thirty experts. Since the Delphi technique is a labour-intensive procedure, the greater the number of panellists, the greater the information load (Zami & Lee, 2009).

The following are the factors highlighted by Skulmoski, Hartman and Krahn (2007) to be considered in order to determine the sample size for a Delphi technique:

i. Heterogeneous or homogeneous sample: Where the group is homogeneous, then a smaller sample of between ten to fifteen people should yield sufficient results.

Nevertheless, if an unrelated group is involved, for instance in an international study, then a larger sample will most likely be required and several hundred people might participate (Delbeq et al., 1975). However, the researcher needs to exercise caution because heterogeneous groups can greatly increase the complexity and difficulty of collecting data, reaching consensus, conducting analysis, and verifying results.

ii. Decision quality/Delphi manageability trade off: There is a reduction in group error (or an increase in decision quality) as sample size increases (Linstone & Turoff, 2002). However, above a certain threshold, managing the Delphi process and analysing the data becomes cumbersome in return for marginal benefits.

iii. Internal or external verification: The larger the group, the more credibly the results can be said to be verified. However, a smaller sample might be used with result verification conducted through follow-up research. The current research adopted a smaller sample premise and verified through a follow-up questionnaire survey.

However, the selection of an initial respondent panel for the Delphi study varies. It was concluded from the literature review that a typical sample size varies between seven to fifty panellists. There is no agreement on the desired 'typical' number of panellist to be adopted in a Delphi study. Rather, the method can be modified to suit the circumstances and the research question. Owing to time constraints and conflicting schedules of the experts, the current study did not involve a large number of experts. A sample size of a panel of 10 experts was adopted based on the following premise. This was also in conjunction with the qualifying criteria as established in phase two of the Delphi study:

i. Experts should be fairly and practically split between academics and practitioners. The two categories may provide input for various perspectives and balance the theoretical and practical considerations.

ii. Panellists in both categories should have extensive experience relating to TQM and project management in general.

The number of panel of experts also depends on the topic area, as well as the time and resources at the researcher's disposal. The adopted number of panel of experts of nine (9) seems appropriate, considering the data required and subsequent analyses each panel of expert will generate.

Phase 4 – Conducting the Delphi Iterations

Data collection through Delphi

Sequences of questionnaire rounds are used to obtain iterative responses to issues in a Delphi study (Masser & Foley, 1987). According to Woudenberg (1991), "…two to ten rounds is appropriate because accuracy is expected to increase over rounds and the need for repetition of judgment and group pressure for conformity", while Critcher and Gladstone (1998) suggested between two to five rounds. Two rounds of iterative process were used in the current study for the Delphi method. This was done to achieve consensus between the panel members on the influence and impact of TQM in the construction industry. The attached Delphi questionnaire in Appendix D was sent out electronically to all panel experts to respond to the questions according to their ability and expertise. The Delphi questionnaire was developed based on the findings from the literature review and was specifically designed to address and achieve the Delphi-specific objectives defined for the study. The experts took a minimum of two months to complete the questionnaires. A questionnaire was designed for each round based on the responses to the previous one.

However, the Round One questionnaire was designed based on a summary of the comprehensive review of literature highlighting sets of attributes and sub-attributes that are potentially relevant to TQM in the construction industry in Ghana (see Appendix D).. These attributes were structurally and constructively put together to frame the first round of the Delphi survey. Therefore, Round One of the Delphi study was intended to be a brainstorming exercise used to produce a list of empirical attributes that determine TQM implementation in construction industry. Other issues relating to TQM implementation in Ghana and other subsequent issues relating to the objective of the Delphi study were also considered in Round One. Closed-ended questions were used in this round (round one). The responses were analysed and formed the basis of Round Two (see Appendix E) of the study. Frequencies were obtained to measure the degree of consensus reached amongst participants regarding the attributes that determine TQM in the Ghanaian construction industry and for other related questions. The purpose of the second round of the study was to allow experts to review and comment on the attributes that determine TQM and other related issues relating to TQM implementation in Ghana, which were proposed by the panel of experts in Round One. Closed-ended questions were used in this round to investigate participant comments expressing agreement, disagreement or clarification concerning proposed attributes that determine TQM implementation in Ghana. The specific nature of the closed-ended questions stimulated participants' reactions. Frequencies were likewise obtained to measure the degree of consensus reached amongst participants regarding the attributes that determine TQM implementation and for other related questions.

The final Round Two (Appendix E) was specifically aimed at:

i. Informing the experts of the findings of the analysis of responses to the questionnaire of Round One; and

ii. Requesting their final affirmation or comments on attributes and issues that did not receive any consensus in Round One.

The Round Two questionnaire was designed based on the measures of frequency responses to the questionnaire of Round One. Frequencies were obtained to indicate consensus reached amongst experts regarding attributes that determine TQM and TQM issues as presented in the study. Consensus was reached regarding most of the attributes that determine TQM in the Ghanaian construction industry over the two rounds of the Delphi survey.

Based on the findings of the analyses of responses to the Delphi rounds, a list of attributes that determine TQM was prepared, which informs the conceptual framework for the broader study, while issues surrounding TQM implementation were highlighted. The Delphi survey was conducted via electronic mail, and follow-up emails were used to encourage prompt responses to the questionnaires. Using email provides a free and faster means of communication.

With regard to the Delphi questionnaire, a panel of experts were requested to rate the likelihood of an attribute influencing TQM, and the impact of sub-factors in predicting TQM in the Ghanaian construction industry, if they were present. The probability scale ranged from one to ten representing zero to 100%. Interval ranges were set at ten (Table 8.7). The panel of experts were asked to rate the negative impact that would result if a particular TQM attribute were also absent. This was based on a 10-point ordinal scale ranging from 'negligible' to 'very high impact'. This aspect indicated the importance of the TQM as shown on Table 8.8.

Table 8.3: Influence or Likelihood Scale

0-10 %	**11-20 %**	**21-30 %**	**31-40 %**	**41-50 %**	**51-60 %**	**61-70 %**	**71-80 %**	**81-90 %**	**91-100 %**
1	2	3	4	5	6	7	8	9	10
			X				**X**		

Table 8.4: Impact Scale

No impact		**Low impact**		**Medium impact**		**High impact**		**Very high impact**	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
								X	

The panel of experts were also required to state their level of agreement using a 10-point Likert scale with certain statements and to support their choices where necessary with regard to TQM policy issues and TQM practices to arrive at a consensus. Group medians were calculated as a measure of the central tendency for each response on each element. Thus, an indicator of whether consensus had been reached on the questions for each element was determined. The median was deemed to be more suitable for the type of information that was being collected. This is because the median eliminates bias, takes into consideration outlier responses, and makes a consensus notion more reasonable. The mean, on the other hand, may not reflect a reasonable central tendency as it considers only the outlier responses.

Group medians and the absolute deviations from the Delphi First Round were computed for each element. These were then sent back to the expert panel members so that responses in the second round could be made, taking into account the group median. The panel of experts in the second round were asked to either maintain their original responses made in Round One, or to change their initial responses to be more in line with the group median. Panel members, who had responses to units above or below the group median in the second round, were requested to state their reasons for sticking to a response that does not agree with the group median. Group medians and the absolute deviations were again computed for the second round. From these calculations and after two rounds of the Delphi process, it was determined that consensus had been reached. Reasons for other experts who stuck to their ratings were, however, taken into consideration.

Calculations for the second round of the Delphi process indicated that there was no need to proceed to the third round as there was no further value that could be added to the degree of consensus attained at that level. Throughout the entire Delphi process, anonymity of panel members was maintained to avoid undue influence on other members. The aspect of anonymity is crucial to the credibility of the Delphi technique. There was a rigorous establishment of the complex 'what would happen if' kind of questions that ideally should be established from an experimental study. This was in fact extremely difficult and not feasible to do. Figure 8.5 shows an outline of how the Delphi study data was collected.

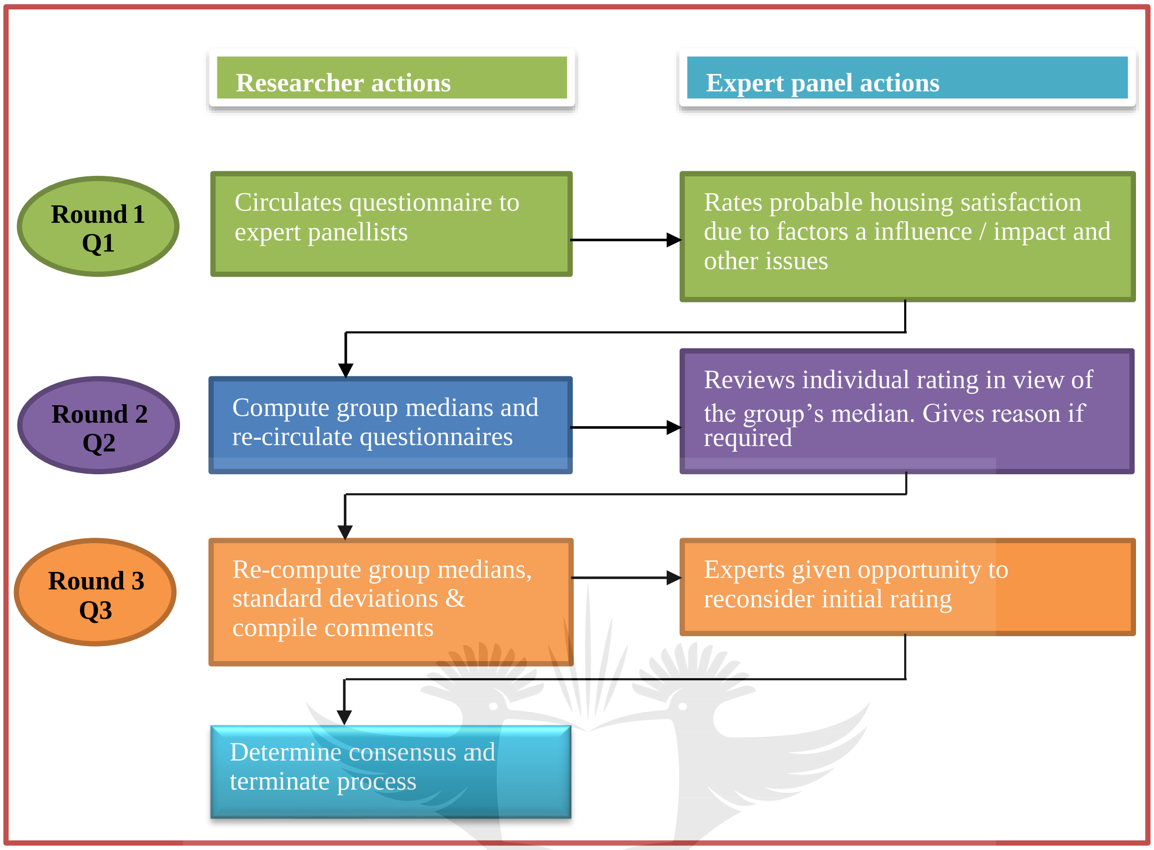

Figure 8.5: Outline of Delphi Process

Source: Adapted from Thangaratinam and Redman (2005:124); Musonda (2012: 102); Aigbavboa (2013: 284)

8.4.3.5 Specific Objectives of the Delphi Study

There are various characteristics and factors which determine TQM in the construction industry from literature, as measured from different TQM theories and categories such as TQM practices. It is not clear from the literature what specific level or extent the identified factors contribute to the TQM implementation in the construction industry. Attempts have been made through various studies to determine the influence of these factors in TQM studies but none has been specifically related to TQM implementation. Various factors determine TQM implementation albeit varied in different cultural and TQM backgrounds and typological settings. Also, previous models have not been adequately organized into a model to form a holistic attribute which determines TQM implementation in Ghana. Based on the foregoing, a more reliable measure of the determinants of TQM was therefore necessary in order to establish not only whether these factors have an influence on TQM implementation but also the extent or level of their influence. In addition, it was necessary to identify which factors have the greatest influence in the Ghanaian context together with the identified gap of factors from the literature. Based on the context of the thesis, this kind of investigation would ordinarily call for an experimental kind of research. However, the experimental method of research was not feasible and practical considering the time frame, ethical issues and the willingness of would-be participants. Hence, the Delphi method was considered the most suitable method to achieve the general objective of determining the influence and impact of the identified factors on TQM in the construction industry.

The broader research aim was to develop an integrated TQM framework for the Ghanaian construction industry. The Delphi method was therefore chosen at the first stage to formulate the conceptual model. This had to be validated later from responses obtained from the questionnaire survey analysed using the SEM Software EQS Version 6.2. At the Delphi stage, factors that were identified from literature that defined and determined TQM were formulated into questions. Experts were asked to give their rating as being influential or having an impact on TQM. The output from the Delphi process was a set of attributes which determine TQM that would be implemented.

The following are the specific objectives for achieving the Delphi survey based on research objectives 3 and 4:

SOD1. To identify the main and sub-attributes that determine TQM implementation in the Ghanaian construction industry;

SOD2. To determine the factors that enables construction companies to implement TQM;

SOD3. To identify the factors that affect construction companies for not implementing TQM in Ghana;

SOD4. To evaluate organizational factors that affect the implementation of TQM; and

SOD5. To identify the effects of implementation of TQM in the construction industry in Ghana

The philosophy behind the above objectives is to do away with the tendency of a non-coherent dialogue on TQM in Ghana. The following are the outcomes in achieving the above objectives:

i. Determining the key factors and constructs that are of critical significance (influence) to determine TQM in the construction industry; and

ii. Developing a holistic conceptual model on TQM for the Ghanaian construction industry.

8.4.3.6 Computation of Data from Delphi Study

Computation of data from the Delphi study was conducted using Microsoft Office Excel, a spreadsheet software program. The first stage involved analysis to determine consensus on responses to the predetermined criteria. This involved determining the group median responses for each question. After the second round of the Delphi, absolute deviations (*Di*) of the group medians (m*(X))* of each rating for the relevant questions as pre-determined were calculated using Equation 1.0 below.

$$Di=[x\ i-m(X)] \quad \text{Equation 1.0}$$

Where *Di =Absolute deviation*

$x\ i$ *=Panel rating*

m *(X) = Measure of central tendency*

A computation of each question element was completed for the likelihood and impact of the attributes in predicting TQM implementation in Ghana. The influence or impact of the absence or presence of a particular TQM practices element on the overall TQM of the other elements is presented. For every round of responses from the experts, besides the group median value computation, their respective interquartile deviation (IQD) were also computed as a measure of the central tendencies to determine consensus. The median value was adopted as a measure of central tendency because of its effect to minimize the effects of potentially biased individuals while the IQD scores were used to summarize the variability in the data. The IQD helped to identify which measures were most appropriate to influence TQM. A clearer picture of the overall data set was provided as the IQD removes or ignores outlying values through the use of the IQD. The inter-quartile range is a measure that indicates the extent to which the central 50% of values within the data set are dispersed. This is based upon, and related to, the median. The median is adopted as a measure of central tendency for studies of this nature, as opposed to the mean and IQD, although it is sometimes used. To compute the variation of the median from the responses for each question in each round, the absolute deviation given in Equation 1.0 was done. This is the absolute difference between a response within a data set and a given point. The point from which the deviation is measured is a measure of central tendency, which is the median. The results from the Delphi analysis will be presented as numbers and percentages in tables in the results (Chapter 9, Section 8.3). The outcomes show the predictions of the influence of TQM factors and other issues in TQM practices in Ghana.

8.4.3.7 Determination of Consensus from the Delphi Process

It is required that consensus should be reached on all questions. Consensus was determined by measuring the central tendency of the various responses on all questions. The group median and the IQD were computed for all responses. In order to achieve consensus, the deviation of all responses about the group median was determined not to be more than one (1) unit, likewise for the IQD. This is considered to be suitable as the scale that was used for both probability (influence) and impact was 1 to 10. The deviation of all responses was calculated using the absolute median (Equation 1.0), while the IQD was calculated based on the recommended statistical process of the absolute value of the difference between the 75^{th} and 25^{th} percentiles. A percentile (or centile) is the value of a variable below which a certain per cent of observations fall. The percentile is often used in the reporting of scores from norm-referenced tests, as in the present situation. The 25^{th} percentile is also known as the first quartile (Q1), the 50^{th} percentile as the median or second quartile (Q2), and the 75^{th} percentile as the third quartile (Q3).

Hence, the deviation between the 75^{th} and 25^{th} percentiles give an absolute value referred to as the interquartile range or deviation. The interquartile range deviation is a robust statistic, having a breakdown point of 25%, and is thus often preferred to the total range, with smaller values indicating higher degrees of agreement (consensus). Smaller values in the inter-quartile range would then indicate higher degrees of consensus. However, consensus is difficult to measure in Delphi studies. The foregoing has been established from literature, namely that there is no consensus on how to determine consensus regarding a set of opinions. Holey, Feeley, Dixon and Whittaker (2007:2) suggested that consensus is the same as agreement and that agreement can be determined by the following:

i. The aggregate of judgments;

ii. A move to a subjective level of central tendency; or

iii. By confirming stability in responses with the consistency of answers between successive rounds of the study.

Other researchers have used frequency distribution to assess agreement and the criterion of at least 51% responding to any given response category being used to determine consensus (McKenna, 1994). Other studies, such as one conducted by Rayens and Hahn (2000), have used means and standard deviations with a decrease in standard deviations between rounds indicating an increase in agreement. Inter-quartile deviation (IQD) has also been used to determine consensus (Rayens & Hahn, 2000), which has also been adopted for the current study. Studies conducted by Rayens and Hahn (2000) have included another criterion to determine consensus in addition to the IQD to achieve stability. The criterion to achieve consensus was that the IQD should equal one (1) unit for which more than 60% of respondents should have answered either generally positive or generally negative. Items which had an IQD $\neq 1$ for which the percentage of generally positive or generally negative responses was between 40% and 60% were determined to indicate a lack of consensus or agreement. An IQD of 1.00 or less was identified by Raskin (1994) as an indicator of consensus. Spinelli (1983) also considered a change of more than 1.00 IQD point in each successive stage as the criterion for convergence of opinion. How to use or interpret IQD as a method of data analysis for the Delphi process to achieve consensus has not been identified in literature review. The potential range of IQD values depends on the number of response choices, with larger IQDs expected as the number of response choices increases. The use of a particular IQD as a cut-off for consensus requires consideration of the number of response choices. The following criteria for determining consensus have been used by Holey et al., (2007):

i. Percentage response;

ii. Percentages for each level of agreement for each question to compensate for varying response rates;

iii. Computation of median, standard deviation and their associated group rankings;

iv. Computation of the means, standard deviation and their associated group rankings using the importance ratings; and

v. Computation of the weighted kappa (k) values to compare the chance eliminated agreement between rounds.

Holey, Feeley, Di and Whittaker (2007) opined that consensus is reached when the following are present:

i. An increase in percentage agreements;

ii. Convergence of importance rakings;

iii. Increase in kappa values;

iv. A decrease in comments as rounds progressed;

v. A smaller range of responses; and

vi. Smaller values of standard deviations.

These studies suggest that there is little agreement on how to measure consensus in a Delphi study. It is however agreed that for consensus to have been achieved, there has to be a convergence of ideas and reasoning towards a subjective central tendency measure. Hence, in the current study, consensus was determined to have been reached if the following were achieved:

i. More than 60% of responses are generally positive or negative with certain questions;

ii. The average of the absolute deviation was not more than one unit. The absolute deviation is calculated from Equation 1.0., and

iii. The IQD was less than 1.00, meaning that items with IQD = 0.00 were considered to have reflected high consensus.

Therefore the scales of consensus adapted for this research are as following:

i. Strong consensus - median 9-10, mean 8-10, interquartile deviation (IQD) ≤1 and ≥80% (8-10);

ii. Good consensus - median 7-8.99, mean 6-7.99, IQD≥1.1≤2 and ≥60%≤79% (6-7.99); and

iii. Weak consensus - median ≤ 6.99, mean ≤5.99 and IQD≥2.1≤3 and ≤ 59% (5.99).

8.4.3.8 Reliability and Validity of the Delphi Process

Reliability is the extent to which a procedure produces similar results under constant conditions at all times (Els & Delarey, 2006:52). This kind of statistical reliability is not possible in a Delphi study because another panel may reach a different conclusion depending on their knowledge of the subject area and interest. Care was taken that credibility showed in truthfulness, fittingness exhibited in applicability, audit ability shown in response consistency and conformability was exhibited in the responses from all participants to reach reliability. Credibility was also assured during the selection of the panel. All panels of experts had distinguished themselves based on the set criteria for the selection of panel of experts and the depth of their knowledge and experience as presented in Section 8.4.3.4 (Phase 2: Delphi expert panel selection). Validity was boosted by the removal of preconception or influence from other members by keeping all members completely anonymous from each other and hence eliminating the 'bandwagon' effect, which is one of the strengths of the Delphi method. Furthermore, the number of iterations that were implemented in the Delphi study also enhanced the internal validity. Thus, expert panellists were given a chance to change their opinion or maintain it with a written explanation or argument for dissenting views.

Feedback to the researcher and constant communication between the researcher and the panellists individually was another way of ensuring internal validity of the study. The external validity of a study deals with the extent the results from the study can be generalised to a larger population. This is usually determined by how participants are selected to be part of the study. However, this process was not necessary as the validation process of the conceptual model had been done using the questionnaire survey. The selection of participants for the Delphi study guaranteed external validity as scientific criteria as predetermined (Section 8.2.3) based on previous scholarly works were adopted. The panel comprised members from varied sectors, all with in-depth knowledge on project management. All the panel of experts reside in one of the major cities in Ghana. They were highly experienced with sound working experience. The study therefore fulfilled the requirements for external validity in line with standard research ethics.

8.4.4 Stage Three (Questionnaire Survey)

Phase Three of the research involved collecting data from the field through the use of questionnaires in order to meet the general objective RO6 of the overall research respectively. Phase Three formed the pinnacle of the research. The Delphi study findings were that TQM is a multidimensional construct, which consists of the Leadership and Top Management, Company Supplier Quality Management, Company Quality System Evaluation, Client Focus and Involvement, Company Vision and Plan Statement, Product Selection and Design Management, Construction Process Management and Improvement, and Construction Employees' Involvement and Motivation. These factors have been collectively considered for the development of a holistic integrated TQM model in this study. Five of the factors have been previously considered in the development of a TQM (TQM) model in other cultural contexts. None of the existing models to date have included Company Vision and Plan Statement, Product Selection and Design Management, and Company Quality System Evaluation as factors to develop a model that will help construction companies in Ghana produce quality project. The following specific objectives of the questionnaire survey were used to validate the findings from Delphi study:

QS1. Identify the factors that are more influential regarding TQM implementation in the Ghanaian construction industry;

QS2. Establish the effects of implementation of TQM in the construction industry;

QS3. Identify the factors that are more influential and affecting construction companies' for not implementing TQM in the Ghanaian construction industry;

QS4. Determine the factors that are more influential to enable construction companies to implement TQM;

QS5. Determine the goodness-of-fit of the hypothesized integrated TQM model to the data sampled.

The previous models of TQM established in the developed countries cannot be relied on in developing countries. The findings of what determines TQM in the construction in developing countries are rarely known from the previously conducted research. There is a lack of research into the overall impact on and influence of the direct and holistic active involvement of TQM constructs. Owing to the absence of an integrated TQM model, the achievement of TQM implementation in the Ghanaian construction industry is unlikely.

The integrated conceptual model shown in Figure 10.1 (Model 1.0; page 257) was made up of the following interrelationships:

1. Leadership and Top Management features have an impact on TQM in the construction industry and greatly influence its determination;
2. Company Supplier Quality Management features have an impact on TQM in the construction industry and greatly influence its determination;
3. Company Quality System Evaluation features have an impact on TQM in the construction industry and greatly influence its determination;
4. Client Focus and Involvement have an impact on TQM in the construction industry and greatly influence its determination;
5. Company Vision and Plan Statement have an impact on TQM in the construction industry and greatly influence its determination;
6. Product Selection and Design Management features have an impact of TQM in the construction industry and greatly influence its determination;
7. Construction Process Management and Improvement features have an impact of TQM in the construction industry and greatly influence its determination;
8. Construction Employees' Involvement and Motivation features have an impact of TQM in the construction industry and greatly influence its determination; and
9. The integrated holistic TQM model describes the determinant (constructs) which determine TQM implementation in the Ghanaian construction industry.

As a result of the objectives of the study, it was obvious that collecting facts would involve professionals and top management employees in the building construction industry. A field survey was considered the most suitable method of collecting the required data. A complete biographical section that related to the building construction industry was required. Data relating to Leadership and Top Management, Company Supplier Quality Management, Company Quality System Evaluation, Client Focus and Involvement, Company Vision and Plan Statement, Product Selection and Design Management, Construction Process Management and Improvement, and Construction Employees Involvement and Motivation were required. Other data required were factors that have an influence on TQM and factors that have an influence on TQM implementation in the Ghanaian construction industry. These types of information could not be obtained through other means of data collection except a field survey. This is because other means of data collection would not give an adequate representation of the above stated relationships. Also, the decision to choose a survey method was based on a number of factors. The factors included the sampling technique to be adopted, the type of population, the question form, the question content, the response rate, and the duration of data collection. The most appropriate survey method for this research was a personally administered questionnaire.

This method was chosen for the following reasons:

i. The questions could be answered by crossing the proper response. Respondents could seek clarity on any question in order to meet consistent question objectives (Sekaran, 2000; Aaker, Kumar & George, 2009);

ii. A higher response rate of almost 100% can be assured since the questionnaires were not left with the respondents but collected once they had been completed (Malhotra, 1999; Sekaran, 2000);

iii. Higher levels of anonymity of respondents were assured because respondents were not required to disclose their identities (Sekaran, 2000; Burns & Bush 2002).

Apart from the above reasons for adopting a personally administered questionnaire survey method, the following reasons justify the use of the questionnaire survey method:

1. The philosophy underpinning the research is based on the positivist theory as discussed above, which uses quantitative methods and collection of data by the use of questionnaires;
2. Validation of the conceptual model developed at Phase One (literature review) and Two (Delphi) entailed using an alternative method to the previous two to validate the findings. This therefore eliminated the use of methods similar to the Delphi and its derivatives. Hence, this called for collection of data on the TQM in the construction industry through a questionnaire survey;
2. The field survey was considered to be more descriptive in that most of construction firms are located in the regional capitals of Ghana;
3. Likewise, the interpretation and presentation of the data can easily be done and understood by various readers when adopting a positivist philosophy of research as it follows a logical explanation of the method;
4. A large number of research questions can be asked in a questionnaire to target many respondents within a stipulated time frame;
5. A questionnaire requires minimal investment and is relatively easy to obtain generalizations from (Bell, 1996);
6. Specific information about views, attitudes and perceptions of a group of respondents, which are difficult to measure using observational technique, can be easily elicited via a questionnaire (McIntyre, 1999; Yuen, 2007);
7. Another reason for choosing a questionnaire was because data collected through a questionnaire can be analysed easily; and
8. Data entry and analysis for the questionnaire can be easily done using computer software packages, such as the SPSS and EQS (Bell, 1996; Hishamuddin, 2007; Yuen, 2007).

8.4.4.1 Questionnaire Survey Instrument

Pinsonneault and Kraemer (1993) defined a questionnaire as a method used to gather information related to the opinions of a large group of people. A standardised questionnaire exposes each respondent to same set of questions (Brace, 2008). This study applies a formal standardised questionnaire in order to achieve the research objectives. A structured questionnaire was used to collect data during the field survey. The questionnaire was based on the literature review conducted in the first stage of the research, as well as the findings from the Delphi study in stage two. The questionnaire consisted of six sections. The first section was designed to collect information about the profiles of the respondents and firms. This information included biographical, socio-economic and other information, as deemed necessary to meet the research objectives.

Section Two of the questionnaire included questions on the TQM in the construction industry as related to Leadership and Top Management, Company Supplier Quality Management, Company Quality System Evaluation, Client Focus and Involvement, Company Vision and Plan Statement, Product Selection and Design Management, Construction Process Management and Improvement, and Construction Employees' Involvement and Motivation. This section was meant to collect information on the extent of the TQM for each sub-attribute variable as provided. The questionnaire was designed to assess the influence of the identified constructs on TQM. The first section had fourteen questions relating to the profiles of the respondents and firms. Section Two had nine sub-headings with different numbers of questions in each section. The respondents were asked to rate each of the items on a five-point Likert scale regarding the extent to which they agreed or disagreed with factors that determine TQM in the construction industry. The length of the questionnaire was ten pages, including the cover letter (see Appendix F). This was in line with the recommended length of between five (5) to 12 pages.

To avoid bias resulting from the questionnaire design, the questions were constructed in such a way that they were direct, short, comprehensible, avoided ambiguity, not vague, no generalizations, not leading, not double-barrelled, presumptuous questions, but simple and familiar to the respondents. Instructions for the questionnaire were kept simple with no technical or specialized words being used. However, it was recognised that this type of questionnaire has a few weaknesses as follows:

i. There is an absence of probing beyond the answer given;

ii. There is a lack of control over who answers the questionnaire; and

iii. They can be characterized by a low response rate because of cost.

The above weaknesses were addressed by refining the questions and keeping them simple but care was taken not to deviate from the objectives of the instrument, keeping the overall questionnaire within the recommended limits and ensuring that only the right person(s) completed the questionnaire by the lead researcher constantly communicating with the fieldworkers. The absence of further probing is characteristic of this type of questionnaire. This aspect was not a major concern as the data to be collected was meant to validate the integrated conceptual model initially developed in the previous phase of the study.

One type of response format was used, namely close-ended. To obtain the respondents' extent of agreement and disagreement towards the model's identified constructs; a labelled scale response format was used. Apart from the simplicity of administering and coding in further statistical analysis (Burns & Bush, 2000), a labelled scale response format is appropriate for TQM, as it allows the respondent to respond to questions to varying degrees that describe the dimensions being studied (Aaker, Kumar & George, 2009). Labelled Likert scales were appropriate to measure the responses for this study. This scale was adopted based on the following reasons:

i. It yields higher reliability coefficients with fewer items than the scales developed using other methods (Hayes, 1998);

ii. This scale is widely used in TQM research and has been extensively tested in both marketing and social science studies (Garland, 1991);

iii. It offers a high likelihood of responses that accurately reflect respondent opinion under study (Zikmund, 2000; Burns & Bush, 2002); and

iv. It helps to increase the spread of variance of responses, which in turn provide stronger measures of association (Aaker et al., 2009; Wong, 1999).

8.4.4.2 Variables

The research instrument was designed to measure the exogenous variables, namely Leadership and Top Management (LTM), Company Supplier Quality Management (CSQM), Company Quality System Evaluation (CQSE), Client Focus and Involvement (CFI), Company Vision and Plan Statement (CVPS), Product Selection and Design Management (PSDM), Construction Process Management and Improvement (CPMI), Construction Employees' Involvement and Motivation (CEIM), and Endogenous Variables (TQM Implementation). These variables were hypothesised to be characterised by indicator variables, which collectively constituted the questionnaire items. Factors influencing construction firms for the implementation and non-implementation of TQM in the Ghanaian construction industry were also measured by the questionnaire. Table 8.5 gives a comprehensive summation of the latent and indicator variables.

Table 8.5: Conceptual Model Indicator Variables

Latent Variable Construct	**Measurement Variables**
Leadership and Top Management (TML)	Leadership style Leadership ability in solving quality problem Leadership skills Leadership initiatives Leadership and top management knowledge in TQM Top management commitment in TQM Top management interaction with workers Top management participation Top management learning Top management empowerment Top management encouragement Top management's role model
Company Supplier Quality Management (CSQM)	Partnership with suppliers Supplier selection criteria Participation in suppliers Supplier performance evaluation Supplier quality audit Supplier communication

	Supplier knowledge of TQM Location of supplier Suppliers' past records Suppliers' commitment Cooperation from suppliers Suppliers' orientation
Client Focus and Involvement (CFI)	Client brief/ input Client complaint information/feedback Market investigation Client satisfaction survey Quality warranty Client information system Client services Client cooperation Client orientation
Company Quality System Evaluation (CQSE)	Evaluation of strategy Evaluation of overall company performance Evaluation of departments' performance Evaluation of employee performance Evaluation of quality costs Evaluation of quality manual Evaluation of quality control system Evaluation of quality system procedures

	Evaluation of end results Quality audit Quality benchmarking Quality information system
Company Vision and Plan Statement (CVPS)	Vision statement Quality policy Overall business performance plan Product quality goal Quality improvement plan Formulation of vision and plan Concreteness of future plan Employee contribution to the vision Involvement of employees in the development of vision statement
Product Selection and Design Management (PSDM)	Client brief/input Cost implication Environmental issues Socio cultural issues Appearance/finishes required Strength of required Intended purpose of the material Where the material to be used Design methods/techniques Design detailing

	Concurrent engineering Design experiments/testing Quality function deployment Value engineering Computer-aided design
Construction Process Management and Improvement (CPMI)	Project monitoring and control improvement Equipment maintenance and innovation Inventory management Use of quality materials Use of quality tools Use of quality manual Understanding of work instructions/quality manual Quality system procedures improvement Obtaining ISO 9000 certification for operation Understanding of quality control system Continuity of quality control circle activities Appropriate use of system structure and standards Targets and priority measures Safe working environment Utilization of analysis results

Construction Employees Involvement and Motivation (CEIM)	Education and training Salary promotion Position promotion Employee rewards Bonus scheme Conducive working environment Involvement of employees within-functional team Employee participation Employee suggestion Improving employee commitment Job rotation Involvement in quality control circle Employee involvement in cross-functional team Employee recognition

TQM Implementation (TQMI)	Greater reduction of construction costs Higher product quality Improved schedule performance Elimination of reworks Defect-free product at first attempt Higher safety standards Higher productivity Good methods of working Higher profitability Higher reduction of construction waste

8.4.4.3 Population

Cooper and Schindler (2006) and Neuman (2006) defined a study population as the entire group of items in which the researcher has an interest. The population for this study is made up of the small to large (D4K4 to D1K1) construction companies in Ghana. The majority of these construction companies are located in the ten regional capitals of Ghana (Accra, Kumasi, Takoradi, Cape Coast, Koforidua, Ho, Sunyani, Tamale, Bolgataga and Wa).

8.4.4.4 Sample Frame

The sample frame was established by obtaining a list of registered construction companies in good standing from the Association of Building and Civil Engineering Contractors of Ghana (ABCECG). There were 1 282 construction companies in good standing which were registered with the ABCECG as at March 2017. The selection of the number of construction companies in the list was made possible based on a probability sampling technique (discussed in the next section). The construction companies selected from the list were instructed as in the cover letter of the questionnaire (see Appendix F) that their responses were of utmost importance to the researcher.

8.4.4.5 Sampling Method

Sampling is the process of selecting a sample consisting of units such as people, or organisations from a population of interest. By studying the sample we may answer the questions posed regarding some aspects of the population from which they were chosen (Trochim & Donnelly, 2007). The two general sampling methods are probability and non-probability sampling, which are usually differentiated by their randomness. A non-probability sample is also known as a non-random sample whereby samples are selected in some way not suggested by probability theory but using something other than a mathematically random process (Neuman,). On the other hand, probability sampling allows each segment of the population to be represented in the sample. Probability sampling is also known as random sampling, hence Cooper and Schindler (2006) state that a probability sample is one based on the concept of random selection – a controlled procedure that assures each population element is given a known non-zero or allows each member of the population to have an equal chance of being selected.

In this case the samples were chosen from a larger population by a process known as random selection. The various sampling techniques employed in the selection of a probability sample are simple random, stratified random, systematic, and cluster sampling. Simple random sampling allows the sample to be chosen by simple random selection where every member of the population has an equal chance of being selected while stratified random sampling occurs in populations which consist of different strata or groups. In order to have equal representation in a stratified sample, the researcher selects samples equally from each one of the strata or group whereas cluster sampling sub-divides an expansive area into smaller units, for instance, a country could be sub-divided into regions, and further into towns. The clusters must be as similar to one another as possible, with each cluster containing an equally heterogeneous mix of individuals and a subset of the identified clusters is randomly selected.

The current study used the probability sampling method, which allows all segments of the construction companies as defined above to be represented in the sample, making sure that a representative sample of companies was selected for this study. Therefore, a simple random sampling technique was used which allows each member of the population to have an equal chance of being selected (Kerlinger & Lee, 2000). The rationale for selecting this method of sampling was based on the nature and composition of the companies in Ghana. The selection of a representative sample for this study was also based on the justification by Smith (2004) who informed that random sampling must be used for a study of this nature, hence it was adopted.

8.4.4.6 Sample Size

A sample is a subset of items a researcher selects from a specific population (Neuman, 2006). Sample size is therefore an important feature of any empirical study in which the goal is to make inferences about a population from a sample, as in the case of the current study. Sample size, in other words, is the number of observations or replicates to be included in a statistical sample. The sample size used in the study was determined based on the expense of data collection and the need to have sufficient statistical power to validate the conceptual model. The sample size for the current study was not based on the entire population of the study; therefore the sample size was not equal to the population size. The sample size was based on the number of respondents from 250 to 500 or more using the required number under SEM. The question of how large a sample should be depends on the following: the kind of data analysis the researcher plans to use; how accurate the sample has to be for the researcher's purposes and the population characteristics (Neuman, 2006).

Malhotra (1999) indicated that the determination of sample size depends on the proposed data analysis techniques, financial and access to sampling frame. The proposed data analysis technique for this research is SEM utilizing EQS software, which is very sensitive to sample size and less stable when estimated from small samples (Tabachnick & Fidell, 2001). As a general rule of thumb, at least 300 cases is deemed comfortable, 500 as very good and 1000 as excellent (Comrey & Lee, 1992; Tabachnick & Fidell, 2001), thus for this study it was decided to target a sample size of 50% from the entire population of the study. This decision was based on the assertion by Leedy and Ormrod (2005) that if the population size is around 500, 50% of the population should be sampled and if the population size is around 1500, 20% should be sampled. Therefore because the entire population of the study is 1282, a sample size 50% (641) chosen from the population was deemed adequate for the study. Neuman (2006) informs that a large sample size alone does not guarantee a representative sample. This is because a large sample size without random sampling or with a poor sampling frame is less representative than a smaller one with random sampling and an excellent sampling frame. However, the larger the size of the sample, the more likely its mean and standard deviation will be representative of the population's mean and standard deviation. A larger sample also makes it less likely that the researcher will obtain negative results or fail to determine the truth.

Hence, Leedy and Ormrod (2005) opined that researchers should endeavour to maximize the sample size and provide the following guidelines for selecting a sample size:

i. For small populations with fewer than 100 people or other units, there is little point in sampling; therefore the entire population should be sampled;

ii. If the population size is around 500, 50% of the population should be sampled;

iii. If the population size is around 1500, 20% should be sampled, and

iv. Beyond a certain point (at about 5000 units or more), the population size is almost irrelevant and a sample size of 400 should be adequate.

Neuman (2006) recommended that for small populations, a researcher needs a large sampling size and for moderately large populations, a smaller sample size of about 10 per cent is needed to be equally accurate. However, Cooper and Emory (1995) and Cooper and Schindler (2006) disagree on the 10 per cent sample size recommendation for smaller populations. Cooper and Schindler (2006) inform that a sample size does not have to be large for it to be representative of the population. They state that the absolute size of a sample is much more important than its size compared to the population, and how large a sample should be is a function of the variation in the population parameters under study and the estimating precision needed by the researcher. They suggested that a sample of 400 may be appropriate sometimes, while more than 2 000 are required in other circumstances; and in another case, perhaps only 40 are called for.

Furthermore, Smith (2004) simplified the process of sampling size by recommending that one may use 20 cases or 5 per cent, whichever is greater for the population. Schiller further informed that the sample size should vary with the type of study, and that a routine review study would require 5 per cent or 30 observations; a query review study would require 10 per cent or 40 cases, whichever is greater; an intensive review study would require a sample size of 15 per cent or 60 cases and a sentinel event would require a 100 per cent of the observations. Hence, given the kind of data analysis method (SEM) used in this study and the avoidance of negative results which would jeopardize the model goodness-of-fit, thus failing to establish the truth with regard to the constructs which predict TQM in the construction industry, a large sample size of 641 was considered. This is because the role of sample size is crucial in SEM analysis (Lucko & Rojas, 2010). Therefore the sample size requirement in this thesis was a function of the model framework development consideration. Harris and Schaubroeck (1990) proposed a sample size of 200 at least to guarantee robust SEM. Kline (2010) suggested that a very complicated path model needs a sample size of 200 or more, while Bagozzi and Yi (2012) proposed that the sample size should be above 200. Also, based on Smith's (2004) research classification, the study is both a query and an intensive review; hence the selection of the sample size demanded a 10 per cent or 40 cases and 15 per cent or 60 cases, whichever is greater. The study sample size also agrees with Neuman's (2006) recommendation of a 10 per cent sampling size. Therefore, the total sample size of the respondents from the entire population of the study was 641, which aligned perfectly with the analysis of covariance structure estimation requirement.

8.4.4.7 Sample Selection

This step required a detailed specification of all the steps discussed above (Malhotra, 1999). A total of 641 respondents were chosen for the research, which was equivalent to the sample size. The names of construction companies (entire population) were assigned with codes and entered into a computer and the 641 sample for study was generated randomly from the computer. This process was essential in obtaining true representativeness of the entire sample.

8.4.4.8 Fieldworkers

Fieldworkers were recruited prior to the actual survey to assist with the administering of the questionnaires. A fieldworker is defined as an objective collector of data. He or she may or may not have formal qualifications but is perceived to have access to a particular community. Maart and Soal (1996:1) determined that a fieldworker primarily mediates or facilitates the learning of individuals and groups to create an environment in which people can participate. Tamblyn and Shelton (1996) defined in a comprehensive market research manual the data collection skills that fieldworkers should possess, and thus recommended that fieldworkers must be selected with great care and be trained for a stipulated minimum of four hours before undertaking quantitative data collection. They concluded that it is essential for fieldworkers to have a good understanding of the area and the respondents and to be trained in the skills necessary for relating to people, analysing situations and designing strategies.

For this study, fieldworkers were recruited from the Bachelor of Technology students of the Department of Building Technology at the Cape Coast Technical University. They were selected based on the researcher's working knowledge of their ability and competence in construction management issues. Their resident status in the survey areas was also taken into consideration. The fieldworkers were trained by the researcher on the use (administering) of the questionnaire. Five hours of an intensive training workshop was organised for the fieldworkers. The selection and training of the fieldworkers took place after determining the sample size for the study. During the collection of data, a total of six (6) fieldworkers were used. This was based on the sample size (641) and number of days (60) available for the data collection. The researcher helped the fieldworkers to identify and reach the selected construction firms for the study through contact telephone numbers and email addresses of the firms. The researcher conducted the first day survey with the fieldworkers to ensure that the fieldworkers followed instructions as stipulated on the survey instrument. He controlled the data quality by checking for errors during the survey and after each survey, checked whether the questionnaires had been completed fully and correctly. Following this procedure ensured that all the respondents answered the questions fully and correctly and identified problem areas, which were adequately resolved.

8.4.4.9 Data Collection

The questionnaire was personally administered to the companies by the researcher and six selected trained fieldworkers. A personally administered or face-to-face structured questionnaire for data collection was the preferable option (Fowler, 1993) used for the current study. It took approximately 25 minutes to complete each questionnaire, although respondents were informed in the cover letter that it would take 20 minutes to complete. The process of data collection took two months, from the third week of the month of January 2018 to third week of March 2018. Most of the questionnaires were completed immediately by the respondents and where necessary, they were given clarity. Other respondents who were busy at the time when the questionnaire was administered and could not complete the questionnaire at the time requested to complete the questionnaire in their leisure time. The data collection process took a long time because of this process. Out of 641questionnaires administered, 536 were fully completed and retrieved. All the 536 questionnaires collected were sent for data capturing by the Statistics Department of the University of Johannesburg.

8.4.4.10 Data Analysis from the Questionnaire Survey

Coding the responses, cleaning, screening the data and selecting the appropriate data analysis strategy are steps involved in data analysis. Coding of the questionnaire involved identifying, classifying and assigning a numeric or character symbol to data, which may be done in two ways: pre-coded and post-coded (Wong, 1999). The aspect of data analysis from the questionnaire survey has been elaborated in Chapter 11. Taken from the list of responses, a number corresponding to a particular selection was given. This process was applied to every question that needed this treatment. Upon completion, the data was then entered onto a Statistical Analysis Software Package (SPSS) for the next analysis steps. In choosing the appropriate statistical analysis technique, the following were research elements considered, namely the research problem, objectives, characteristics of data and the underlying properties of the statistical techniques (Malhotra, 1999). To meet the purposes of this study, descriptive and inferential analyses and the measures of goodness-of-fit of model were applied where necessary. The data analysis involved the use of multiple analytical techniques to facilitate ease of communicating the results, while at the same time improving its validity. Hence, the researcher chose to use SEM utilizing EQS software. Raw data from the questionnaire was entered into the SPSS software and was later exported to the SEM software EQS Version 6.2 for analysis. The motivation for the choice of the SEM and particularly the use of the software EQS is explained in the next session.

Inferential analysis refers to the cause-effect relationships between variables which the current study hopes to establish between the identified model constructs. Inferential statistics use the results obtained from samples to generalize about a population (Forzano, 2008). Inferential statistics used for this research were correlations, exploratory factor analysis (EFA) confirmatory factor analysis (CFA) and SEM. SEM was used for the development and validation of the TQM model. The statistical significance of the constructs was evaluated. The result's statistical significance was expressed by *p-value* (Forzano, 2008). When the *p-value* is high, there is less possibility of an association between two variables (McClave, Benson & Sincich, 2008), while a smaller *p-value* gives a better likelihood of association. The *p-value* chosen in the present study is 0.05, which implies a 95 per cent chance that the population mean is within a listed range of values (McClave et al., 2008). SEM is currently the most inclusive statistical procedure in social and scientific research catering for all operations of the general linear modelling (GLM) group of statistics such as analysis of variance (ANOVA), multivariate analysis of variance (MANOVA) and multiple regression (Kline, 2005:14). Though there are many ways to describe SEM, it is most commonly thought of as a hybrid between some form of ANOVA or regression and some form of factor analysis. In general, it can be said that SEM allows one to perform some type of multilevel regression or ANOVA on factors. SEM is conceptually used to answer any research question involving the indirect or direct observation of one or more independent variables or one or more dependent variables.

However, the primary goal of SEM is to determine and validate a proposed causal process or model, or both. In the current study, the conceptualized holistically integrated TQM model for Ghanaian construction industry is being validated. SEM takes a confirmatory approach to the analysis of a structural theory bearing on some phenomenon (Byrne, 2010).

However, Dion (2008:365) claims that SEM simultaneously estimates all coefficients in the model and therefore it is able to assess the significance and strength of a relationship in the context of the entire postulated model. Hence, considering the conceptualized model in this thesis of unobserved (exogenous) variables which had to be estimated from the observable variables, methods of analysis such as ANOVA could not be used as they lack a direct way of distinguishing between observed measures and the underlying constructs (Kline, 2005:14). A clear distinction is made in SEM between true variance and error variance, which implies that model parameters are estimated by taking measurement error into consideration. CFA was carried out on each exogenous variable to determine the best fit for the model before the SEM was performed.

The choice of the software EQS for analysis was enhanced by the benefit of utilizing the Satorra-Bentler scaled statistics ($S - B\chi 2$), which provide an adjusted, more robust measure of fit for non-normal data. This approach is more accurate than the normal chi-square test statistics ($\chi 2$)(Byrne, 2006:22). Likewise Kline (2005:83), Musonda (2012) and Aigbavboa (2013) inform that EQS offers several different estimation methods for non-normal data as well, including the robust maximum likelihood (RML). EQS Version 6.2, a software package, was used for SEM as it is user-friendly software that provides a graphical user interface, which is easy to understand. EQS also enables data to be imported directly from SPSS. Other reasons why the researcher adopted EQS 6.2 and SPSS 20.0 software include first, the software is available at the University's Postgraduate and Statistics Centre. It was easier for a postgraduate research student to access the software; second, as revealed from the literature, EQS had seldom been used by previous researchers to enhance conceptual understanding of TQM research as compared to other techniques, such as AMOS and LISREL (Tong, 2007). Being a user-friendly graphically modelling interface, EQS offers a wider variety of goodness-of-fit measures (Tong, 2007).

8.4.4.11 Data Screening and Preliminary Analysis

The use of the SPSS program version 20.0 was to ensure consistency in data and provide meaningful interpretation of results. Screening of data was carried out during the preliminary analyses. This includes data cleaning, the handling of missing data, the normality test and the outliers. The screened data were further analysed using more complex analyses including EFA, CFA and the SEM.

8.4.4.12 Data Cleaning

To ensure the accuracy of the data being coded and entered into the data file, a verification procedure was carried out. In this process, data were examined using descriptive statistics and graphic representations of the variables (Tabachnick & Fidell, 2007). Data cleaning can be achieved by frequency tables, histograms, bar stem-and-leaf displays, and box plots (Pallant, 2007). Summaries of the values for the respondents' profiles and firms were obtained in frequency tables. Percentages and graphic displays were used for the descriptive methods to simplify and characterize the data.

8.4.4.13 Normality

According to Hair et al. (1998), sample size affects a study's findings where the outcome of smaller samples has too little statistical power for the test to realistically identify significant results. Sample size can also be easily 'over-fitting' to the data in that they fit the sample very well, but yet have no generalizability. Large sample sizes of more than 200 to 400 respondents have disadvantages due to making the statistical tests overly sensitive as a result of the increased statistical power from the sample size (Hair et al., 1998) which such data can incur non-normality. Therefore, the data obtained were analyzed for normality to ensure their suitability using standard multivariate analysis. Normality of data can be examined through statistical approaches such as skewness and kurtosis, the Kolmogorov-Smirnov test and graphical approaches, for example, histograms and box plots (Pallant, 2007). The variable's frequency value distribution should approximate the bell-shaped curve or a straight diagonal line to attain normality of the data (Pallant, 2007; Hair et al., 1998). The skewness and kurtosis were used for this study and established that the data was slightly non-normal. To overcome the non-normality of the data, maximum likelihood estimation with robust standard errors and chi-square (MLR) EQS program version 6.2 was used in this study when the CFA and SEM were analyzed. This estimator method rectifies non-normal data.

8.4.4.14 Treatment of Outliers

Outliers are cases with extreme values on a single variable (univariate) or on a combination of variables (multivariate) (Pallant, 2007). Some causes of outliers are data entry errors, unusual events, unexplainable observations, and unusual or unique combined patterns (Hair et al., 1998). Univariate outliers were identified by examining the box plot of each variable (Tabachnick & Fidell, 2001). Few outliers were identified in the current study, therefore the items were removed.

8.4.4.15 Criteria for Determining Reliability and Validity

The content validity is the extent to which a constituent variable belongs to its corresponding construct (Pallant, 2007; Leedy & Ormrod, 2010). Since content validity cannot be tested using statistical tools, an in-depth literature survey was necessary to specify the variables and define the latent variables in order to keep the researcher's judgment on the right track. An exploratory study with TQM experts using the Delphi method was conducted. The finalized variables are indicated in Appendix D deriving the achievement of content validity.

8.4.4.16 Content Validity

The content validity is the extent to which a constituent variable belongs to its corresponding construct (Pallant, 2007; Leedy & Ormrod, 2010). Since content validity cannot be tested using statistical tools, an in-depth literature survey was necessary to specify the variables and define the latent variables in order to keep the researche's judgment on the right track. An exploratory study with TQM experts using the Delphi method was conducted. The finalized variables are indicated in Appendix D deriving the achievement of content validity.

8.4.4.17 Reliability

Reliability tests were conducted after establishing the content validity and preliminary data analyses. Scale reliability is the correlation between two scores ranging from 0 to 1.00 where the Cronbach's alpha is the most common form of internal consistency reliability coefficient. A lenient cut-off of 0.60 is common in exploratory research. The generally agreed upon lower limit for alpha is 0.70 (Hair et al., 1998) and a cut-off of 0.80 for a good scale (Lingard et al., 2011). The adopted cut-off alpha for this study is 0.70 and measures below 0.70 were eliminated. Composite or construct reliability for CFA was calculated after the re-specification of the measurement model. Composite reliability represents a better choice; it draws on standardized loadings and measurement error for each item; however, it was reported that only 20% of SEM studies reported composite reliability to exceed 0.60 (Shook et al., 2004). This was calculated as follows: {(Sum of standardized loadings)^2} / {(sum of standardized loadings)^2 + (sum of indicator measurement error)}.

8.4.4.18 Convergent Validity

The analysis of convergent validity was carried out after the establishment of the content validity and preliminary data analyses. Convergent validity was tested by determining whether the scores of items in one scale correlate with the scores on the other scales and converge or load together on a single construct in the measurement model (Hair et al., 2006). Furthermore, Hair et al. (2006) opined that factor loadings of 0.30 and 0.40 are considered significant for sample sizes of 350 and 200 respectively. No factor loadings were less than 0.30 in the current study. This would have been considered not to be significant (Field, 2005; Hair, et al., 2006). The current study used a cut-off value of 0.30 to retain the variables as suggested by Hair et al. (2006).

8.4.4.19 Discriminant Validity

The analysis of discriminant validity was carried out after the establishment of the content validity and preliminary data analyses. Discriminant validity is the extent to which items representing a latent variable are unique and capture some phenomena that other measures do not (Hair et al., 2006). Items on one construct should not load or converge too closely with items from other scales. Different latent variables that correlate too highly may indeed measure the same construct instead of different constructs. Hair et al. (1998) indicated that items in a construct attaining inter-correlations below 0.90 suggest that there is no multicollinearity, but that the construct has discriminant validity. Another method of attaining discriminant validity as indicated by Fornell and Larcker (1981) is the average variance estimate (AVE). The AVE was calculated as follows: {(Sum of squared standardized loadings)} / {(sum of squared standardized loadings) + (sum of indicator measurement error)}. Despite the two methods of analyzing discriminant validity, the inter-correlation of the items in a construct-element was used for this study.

8.4.5 Methods of Data Analysis of the Quantitative Survey

Descriptive and multivariate correlation data analyses were conducted after screening the data. Three major steps were carried out in the multivariate correlation analysis: EFA, SEM which includes CFA and structural model testing. Analyses were conducted on selected respondents' profiles and firm variables with the elements of the TQM model.

8.4.5.1 Exploratory Factor Analysis

EFA was performed to gather information about the unidimensionality of the factors to yield their factor analysability. The EFA was conducted using SPSS version 20. Seo, Torabi, Blair and Ellis (2004) asserted that EFA is a precursor to the SEM. EFA was used in the current study to confirm the validity and reliability of the eight element-constructs of the proposed construction TQM model in the construction industry. The maximum likelihood, with a minimum eigenvalue of one, together with principal axis factoring with Oblimin Kaiser normalization was specified as the analysis method for this study. A bivariate correlation was performed to assess the strength among the research elements of the TQM model.

8.4.5.2 Structural Equation Modelling

SEM was performed immediately after EFA. The development of the methods of analysis involving SEM with latent variables has provided researchers with considerable means to construct test and modify theories (Anderson & Gerbing, 1982). SEM represents a component of the methodological instrument of the social sciences. It is a comprehensive statistical approach for testing hypotheses about relationships among observed and latent variables (Kline, 2005; Molenaar, Park & Washington, 2009). It assesses whether the sample covariance matrix is consistent with hypothesised model (Sweeny, 2009). In comparison to other statistical analytical techniques such as factor and regression analysis, SEM is a relatively young field. The cradle of SEM was pioneered in the 1920s, when Sewell Wright attempted to solve simultaneous equations to disentangle genetic influences across generations (Murayama, 1998). The increasing complexity of research questions in the social and behavioural sciences and appearance of flexible user-friendly computer software programs, especially with the advent of windows applications (Marcoulides & Hershberger, 1999), has increased the interest in SEM (Kelloway, 1998). It has been argued to be the most important multivariate correlational analysis technique (Byrne, 2010). SEM can also be used to analyse and test theoretical models (Schumacker & Lomax, 2004). Recent research has shown that SEM has become increasingly popular in the construction industry literature. For example, Molenaar et al. (2009), Mohamed (2002), Chinda and Mohamed (2008), Musonda (2012), and Agumba (2013) used SEM to develop models in the construction industry. Therefore SEM was considered the most suitable method of analysis for the third phase of the current study in testing the conceptualised model.

8.4.6 Structural Equation Modelling Analysis

A two-step process was followed after the EFA to test the structural model. Anderson and Gerbing's (1988) recommended two approaches which included CFA and structural model testing. Firstly, it is vital to confirm the measurement model before the structural model can be finalized. Tabachnick and Fidell (2007) indicated that measurement models test relationships which are paths between the measures, also known as manifests or observed variables, and constructs, also termed latent variables, whilst the structural model clarifies the casual relationships, as well as the degrees of influence.

8.4.6.1 Structural Equation Modelling (SEM) Process

Structural model testing can be carried out through five basic steps involved in SEM analysis, namely model specification, model identification, model estimation, model testing and model modification (Schumacker & Lomax, 2004). The study adopted the Schumacker and Lomax (2004) process. However, Hair et al. (1998) proposed a seven-step process for SEM analysis which included developing a theoretical model, constructing a path diagram of causal relationships, converting the path diagram into a set of structural equations and measurement models, choosing the input matrix type (correlation matrix or covariance matrix) and estimating the proposed model, assessing the identification equations and measurement models, choosing the input matrix type (correlation matrix or covariance matrix) and estimating the proposed model, assessing the identification of model equations, evaluating the results of goodness-of-fit and making the indicated modifications to the model if theoretically justified.

8.4.6.1.1 Step 1: Model Specification

Model specification is the first vital step in SEM. It involves developing a theoretical model (Schumacker & Lomax, 2004). This process must be guided by a combination of theory and empirical results from previous research (Hair et al., 2006), although the role of informed judgement, hunches and dogmatic statements of belief should not be discounted (Kelloway, 1998). This was the first step performed in this study. In particular, attention must be paid to include all relevant variables and only those variables that are relevant. If the theoretical model is not consistent with the true model, the theoretical model is said to be mis-specified and lacks validity. This may occur if the researcher fails to include an important variable or an important parameter or alternatively, if an unimportant parameter or variable was included in error (Schumacker & Lomax, 2004).

Having developed the theoretical framework of the model, the next step is to illustrate this in a path diagram, which is a pictorial representation of all relationships in the model (Hair et al., 1998). This is a graphical representation of how the various constructs of the model relate to one another (Byrne, 2010). This is essentially the first step in the SEM process (Byrne, 2010; Kline, 2005). While it is not a formal requirement of SEM, construction of a path diagram offers important benefits. Specifically, the hypotheses contained in the model are much more easily comprehended in visual form than in either verbal or mathematical terms. It may also help improve the conceptualization of the model by drawing attention to omitted links or excluded variables (Diamantopoulos, 1994), therefore decreasing the possibility of specification error (Kline, 2005). Path diagrams not only enhance the understanding of structural models, but substantially contribute to the creation of the correct input files (Raykov & Marcoulides, 2000).

Path models adhere to common drawing specifications that are utilized in SEM models. The observed variables are enclosed by boxes or rectangles. The relationships between the latent variables and their corresponding indicators are represented by arrows which originate at the latent variable and end at the indicators. Each indicator is also associated with an error term representing the errors in measurement. The error terms associated with the endogenous variables represent error in equations and indicate that the dependent variables in the model are not perfectly explained by the independent variables. A curved double headed line between two independent variables indicates covariance (Byrne, 2010; Kline, 2005).

8.4.6.1.2 Step 2: Model Identification

The second step of SEM is model identification. This is crucial because identification problems should be resolved prior to the estimation of parameters (Schumacker & Lomax, 2004; Kline, 2005). Identification revolves around the question of whether one has sufficient information to obtain a unique solution for the parameters to be estimated by the model (Byrne, 2010). Identification determines whether it is possible to find unique values for the parameters of the specified model (Kline, 2005). It concerns the correspondence between the information to be estimated (the free parameters) and the information from which it is to be estimated (the observed variances and covariances) (Hoyle, 1995).

Models can be under-identified, just-identified or over-identified. A model is considered *just-identified* if it has only one estimate for each parameter and generates zero degrees of freedom and therefore cannot be rejected (Byrne, 2010). A just-identified model will always provide one unique solution that will be able to perfectly reproduce the correlation matrix (Kline, 2005). However, the solution is uninteresting because it has no generalizability (Hair et al., 2006). An *under-identified* model is obtained when one or more parameters are not uniquely determined; that is the number of unknowns exceeds the number of equations, therefore there is no much empirical information to allow its unique estimation (Schumacker & Lomax, 2004; Kline 2005) and therefore its estimation should not be relied upon (Kline, 2005). The most accepted situation is one in which there are more indicators than unknown variables and the model is *over-identified* and has positive degrees of freedom (Byrne, 2010). Only models that are identified can be estimated (Kline, 2005). In an over-identified model, there are a number of possible solutions, and the task is to select the one that comes closest to explaining the observed data within some margin of error (Kelloway, 1998).

Hoyle (1995) cautions that determining the identification status of a model can be difficult. Providing some guidance, Raykov and Marcoulides (2000) urge researchers to simply count the number of parameters in the model and subtract this from the number of non-redundant elements in the sample correlation matrix, determined as follows:
$N (N + 1) / 2$, [where N = the number of observed variables in the model]. The resulting difference is referred to as the degrees of freedom. If positive, the model is considered to be identified (Hair et al., 2006). The current structural and measurement models were *over-identified* and were therefore appropriate for testing.

8.4.6.1.3 Step 3: Model Estimation

The third step is model estimation. The purpose of estimation is to generate numerical values for free parameters within the model that produces the implied matrix Σ so that the parameter values yield a matrix as close as possible to the sample covariance matrix S. The estimation process involves the selection of a particular fitting function to minimise the difference between Σ and S (Schumacker & Lomax, 2004; Kline, 2005) and this can be achieved by use of EQations (EQS). EQS can estimate both structural equation models and path models for a single or multiple groups. In addition, EQS can estimate models with regressions among combinations of continuous latent variables and observed variables. It can also estimate factor indicators and other observed dependent variables when they are all continuous. Several fitting functions or estimation procedures are available to be used. EQS can use different estimator choices: maximum likelihood (ML), maximum likelihood with robust standard errors and chi-square (MLR), generalized least squares (GLS), and weighted least squares (WLS) (Muthèn & Muthèn, 2007). This study adopted MLR in EQS program because of slight non-normal data identified in the process of data screening and its robustness to rectify non-normality.

8.4.6.1.4 Step 4: Model Testing

Once the parameter estimates are obtained for a SEM model, the fourth step is to determine how well the data fit the model (Schumacker & Lomax, 2004). Assessing whether a specified model fits the data is an important step of SEM (Yuan, 2005) as it determines whether the model being tested should be accepted or rejected. Model fit refers to the extent to which a hypothesized model is consistent with the data (Schumacker & Lomax, 2004). Goodness-of-fit under SEM is defined by Hair et al. (2006) as the degree to which the actual/observed input matrix is predicted by the estimation model. A model is said to fit the observed data to the extent that the covariance matrix it implies is equivalent to the observed covariance matrix (Hoyle, 1995). The process of estimation results in an implied covariance matrix Σ which is as close as possible to sample covariance matrix S; the closer Σ is to S, the better the fit of the model (Schumacker & Lomax, 2004). Model fit represents one of the most controversial areas of SEM as indicated by Barrett (2007).

If the model does not fit the data in such a way that the observed covariance matrix is statistically different from the covariance structure of the model, either the model or the data should be rejected (Fornell, 1983). The issue of model fit assessment has been a real problem (Barrett, 2007). It represents a major challenge facing theory developers and researchers as different indexes and values are reported (Kline, 2005; Barrett, 2007), unlike many statistical procedures that have a single, powerful fit index, for example, F-test in analysis of variance (ANOVA). In SEM there is an increasingly large number of model fit indices (Schumacker & Lomax, 2004). Determining the tests that best suit the model is a matter of discretion. As such, there is a possibility that only those fit measures that fall within the acceptable range and support the proposed model are reported (Kline, 2005). Model fit indices provide no guarantee that a model is useful. Fit indices provide information on a model's lack of fit and do not reflect the extent to which the model is plausible (Kline, 2005). Even if a model fits well, data can never confirm a model. They can only fail to disconfirm. Other equal or better fitting models may exist (Maruyama, 1998).

Discussion of the Selected Fit Indices

Assessment of model fit under SEM is an important process (Yuan, 2005; Kline 2005) as fit measures are continually evolving (Kline, 2005). It determines whether the proposed model should be accepted or rejected (Hu & Bentler, 1999). It is unnecessary and unrealistic to include every index included in the program's output (Hooper, Coughlan & Mullen 2008). Similarly the cut-off criteria for fit-indexes vary in different publications. According to Hu and Bentler (1999), it is difficult to designate a specific cut-off value for each fit index because it does not work equally well with various conditions. Similarly, Schumacker and Lomax (2004) highlighted the controversy and discussion on subjective interpretation and appropriateness under specific modelling conditions used. It is now common practice to use multiple tests when evaluating and reporting overall model fit (Hu & Bentler, 1999). Although there is not an agreed and strict list of fit indexes to be examined and criteria to be met while evaluating the model fit, Hooper et al. (2008) indicated the following three types of goodness of fit measures used:

i. *Absolute fit measures or accurate fit measures*, which measure the overall model fit of ?both measurement and structural models, with no adjustment for the degree of over-fitting that might occur using root mean square error of approximation (RMSEA) and standardised root mean squared residual (SRMR);

ii. *Incremental fit measures*, that compare the proposed model to a baseline model specified by the researcher using the Tucker-Lewis fit index (TLI) and comparative fit index (CFI); and

iii. *Parsimonious fit measures*, which adjust the measures of fit to provide comparison between models with differing numbers of estimated coefficient using chi square divided by degree of freedom x^2/df.

Based on the aforementioned discussions the following model fit indices were selected to be used for this study. The most common model fit index is the *chi-square* (x^2) goodness-of-fit test (Kline, 2005). It has been reported in previous SEM studies (Agumba, 2013; Molenaar et al., 2009; Chinda & Mohamed, 2008). A significant chi-square indicates the rejection of the null hypothesis, suggesting that the model is not plausible in the population. Goodness-of-fit indices usually represent indexes ranging from zero to one, with zero indicating a complete lack of fit and one indicating perfect fit. However, with regard to the chi-square test, zero indicates perfect fit and large numbers indicate extreme lack of fit; as such the chi-square test has been referred to as a *lack of fit* test (Mulaik, James, Van Alstine, Bennet, Lind & Stilwell, 1989).

However, goodness-of-fit tests tend to be quite sensitive to sample size. This is especially true for the chi-square test (Hair et al., 2006). When the sample size becomes very large, the chi-square test increases in sensitivity and becomes impractical (Kelloway, 1998). Similarly, a poor fit based on a small sample may result in a non-significant chi square, implying one should accept the model (Kline, 2005). Based on the sensitivity of the chi-square index to sample size (Schumacker & Lomax, 2004; Kelloway, 1998), a number of fit indices were chosen for this study to supplement the chi-square index. The *normed chi-square* was used as a supplement index to the chi-square. The normed chi-square reduces the sensitivity of the sample size. Its value is achieved when the value of chi-square (x^2), is divided by the degrees of freedom (df), (x^2/df), which results in a lower value called the normed-chi-square. The minimal acceptable cut-off value has not been clearly established (Kline, 2005). In a recent study by Hsu et al. (2012), they proposed values of less than 2 or 3 to be standard and applicable. However, some studies in construction industry have used cut-off values of less than 5 as acceptable to data fit (Chinda & Mohamed, 2008; Agumba, 2013).

A cut-off value less than 5 was adopted in this study. The *root mean square error of approximation* (RMSEA) focuses on the discrepancy between the model and population covariance matrices per degree of freedom. It is generally regarded as one of the most informative fit indices (Kline, 2005). RMSEA has been reported in previous structural equation modelling studies (Agumba, 2013; Molenaar et al., 2009; Chinda & Mohamed, 2008; Fernandez-Muniz et al., 2007). An RMSEA value of 0.05 or less is indicative of good fit. Values between 0.05 and 0.08 are considered reasonable. Values between 0.08 and 0.10 are considered moderate fit while values greater than 0.10 indicate poor fit (Hsu et al., 2012). Furthermore, Steiger (2007) argued that a cut-off value of 0.07 is considered acceptable. A cut-off value of less than 0.05 was adopted for this study. *Standardised root mean squared residual (SRMR)* has a lower bound of zero and an upper bound of one. Generally values below 0.05 are interpreted as indicating good model fit (Hair et al., 2006; Hsu et al., 2012) whereas values ranging from 0.05 to 0.09 are considered acceptable fit (Hu & Bentler, 1998). Kline (2005) postulates that values less than 0.10 are favourable. This index was therefore adopted for this study.

However, the CFI is the revised form of the normed fit index (NFI) which takes into account the sample size (Byrne, 2010). CFI performs well even with small samples (Tabachnick & Fidell 2007). In1990 Bentler introduced the CFI and subsequently included it as part of the EQS program (Kline, 2005). The CFI assumes that all latent variables are uncorrelated (null/independence model) and compares the sample covariance matrix with the null model. The statistical values for CFI range between 0.00 and 1.00 with values closer to 1.00 indicating good fit. A cut-off value for CFI greater than or equal to 0.90 (Hsu et al., 2012) was initially accepted as good fit. However, recent studies have shown that a value greater than 0.90 is needed in order to ensure that misspecified models are not accepted (Hu & Bentler, 1999). The CFI greater than or equal to 0.95 is presently recognized as indicative of good fit (Hu & Bentler, 1999).

The CFI index has been reported in previous studies by Fernandez-Muniz et al (2007), Chinda and Mohammed (2008), Larsson et al. (2008), Martinez-Corcoles et al (2012), and Agumba (2013) and was therefore adopted for this study. A cut-off value of greater than 0.80 was adopted for this study. The Tucker-Lewis index (TLI), also known as non-normed fit index (Schreiber, Stage, King, Nora & Barlow, 2006), penalises model complexity. The TLI is one of the indexes that are less affected by sample size. TLI greater than or equal to 0.90 (Hsu et al., 2012) indicates acceptable model fit. Some authors have used the cut-off values of 0.80 since TLI tends to run lower than the goodness-of fit-index (GFI) (Sweeny, 2009). Hu and Bentler (1999) support the use of TLI because it is relatively insensitive to sample size, sensitive to model misspecifications, relatively insensitive to violations of assumptions of multivariate normality, and is relative insensitive to estimation method. Previous studies in construction industry have reported on this index (Chinda & Mohamed, 2008; Molenaar et al., 2009; Agumba, 20132013). Therefore this index was adopted for this current study because of its benefits. A cut-off value of 0.80 was used for this study.

8.4.6.1.5 Step 5: Model Modification

In the final step of SEM, if the fit of the implied theoretical model is not as strong as desired (which is often the case with initial models) then the next step is to modify the model and subsequently evaluate this modified model (Schumacker & Lomax, 2004). Modifications can be made by linking the indicators to the latent variable from fixed to free or vice versa, allowing or constraining correlations among measurement errors or allowing or constraining correlations among latent variables (Hair et al., 2006). This process is known as model modification (Kline, 2005). This is done to improve the model. It implies a better fitting model and/or more parsimonious model that are substantively more interpretable. To assist in the process most SEM software provides modification indices for each fixed parameter. This value indicates the minimum improvement that could be obtained in the chi-square value if that parameter were fixed for estimation (Kline, 2005; Schumacker & Lomax, 2004).

Providing a slightly different approach, the Wald index indicates how much a proposed model's chi-square would increase if a particular parameter were fixed to zero (Raykov & Marcoulides, 2000). Another method is to examine the residual matrix, the differences between the observed covariance matrix S and the model implied covariance matrix Σ. They should be small in magnitude and should not be larger for one variable than another. Large values overall signify general model misspecification whereas large values for single variables indicate misspecification for that variable only (Schumacker & Lomax, 2004). Testing and revising of models should not become a procedure completely determined by statistical results and devoid of theoretical underpinnings. Theoretical considerations must guide model modifications (Kline, 2005) because adjusting a model after initial testing increases the chance of making a Type I error. Blind use of modification indices can lead researchers astray from their original goal (Raykov & Marcoulides, 2000). In this current study, the structural model was not modified, but some of the measurement models were.

8.4.7 Ethical Considerations

It is relevant to consider the proper conduct of this research. This research has taken the responsibility to protect the interests of the survey respondents. With regard to the survey respondents, no one was forced to respond to this survey. Respondents were asked to participate of their own free will. They were told of their rights not to participate or to end their participation if they so wished. In addition, they were briefed about the purpose of the study and how or why they were chosen. As such they were free from deception or stress that might arise from their participation in this research. The respondents were also guaranteed protection through anonymity and all information that may reveal their identities, which are held in strict confidence.

8.5 CONCLUSION

This chapter presented the methodology adopted for the conduct of this research. It also provided the justifications for the philosophical position and methods of data collection. The research design described in this chapter has linked three important elements of the research methodology, namely the underlying philosophical assumptions, the research methods/approach, and the process followed in the questionnaire administration, as well as an introduction to the data analysis. In testing the theoretical model proposed for this study, the survey method was discussed. The descriptive and multivariate correlation data analyses were also discussed. Furthermore, the methodology for analysing the proposed conceptual model was discussed, including the process to be followed when using SEM. The three main steps were discussed for conducting the multivariate correlation analysis, namely EFA, CFA and SEM.

Moreover, ethical considerations pertaining to the collection of data were discussed. Finally, issues relating to validity and reliability were also discussed. The next chapter presents the results of the data analysis from the Delphi study.

CHAPTER NINE

9 RESULTS FROM THE DELPHI STUDY

9.1 INTRODUCTION

The influence (probability) and factors affecting TQM in the construction industry were determined by soliciting experts' views through a Delphi study. Thus, the study identified the main and sub-attributes that bring about the understanding of TQM in the Ghanaian construction industry. Two rounds of the Delphi process were conducted to seek experts' views on TQM in the Ghanaian construction industry. Consensus was reached by the experts on various questions asked after the second round. The summary of the results from the consensus reached by the experts after the second round is presented in this section. The analysis of the results from the questions on the influence (probability) and impact of the attributes that predict TQM in the Ghanaian construction industry were computed and presented in the preceding sections. The preceding sections also provided a description and general background to the Delphi study. This section of the study describes the composition of the selected panel of experts' and the findings of the study. The discussion of the summary of the findings based on the objectives of the Delphi study has also been provided in this section.

9.2 OBJECTIVES OF DELPHI STUDY

Delphi study was conducted to meet the following objectives:

DSO1. To identify the main and sub-attributes that determine TQM implementation in Ghanaian construction industry;

DSO2. To determine the factors that enable construction companies to implement TQM;

DSO3. To identify the factors that affect construction companies for not implementing TQM in Ghana;

DSO4. To evaluate organizational factors that affect the implementation of TQM; and

DSO5. To identify the effects of implementation of TQM on the construction industry

The above Delphi study objectives were set to:

i. determine key factors and constructs that are of critical significance (influence) to determine TQM in construction industry and

ii. develop a holistically integrated conceptual model on TQM for the Ghanaian construction industry.

9.3 EXPERT PANEL SELECTED FOR THE DELPHI STUDY

The involvement of experts in the Delphi process was a key consideration for this study. Panel members (experts) for the study were identified from three sources. They comprised professionals in construction firms, academicians and consultants with a construction project management background. Some of the selected experts were authors identified from conference proceedings of the West African Built Environment Research (WABER) and Association of Researchers in Construction Management (ARCOM) held in Ghana. The selected participants represented a wide variety of backgrounds to guarantee a wide base of knowledge as recommended by Rowe, Wright and Bolger (1991). Panellists were recruited via e-mail, with a brief overview of the study objective included therein. Thereafter, those that consented to the preliminary invitation were sent a letter inviting them to participate with a detailed description of the Delphi study (see Appendix C). Experts were asked to send their curriculum vitae in order to confirm their areas of expertise and to ascertain whether they meet the qualifying criteria. Seventeen (17) invitations were sent out based on the set criteria. The five criteria set for the study were met by all experts selected for the current study. A panel of fourteen (14) experts agreed to participate but only ten (10) completed the first round and remained as panellists throughout the study. In other words, the eventual withdrawal of four (4) experts during the first round of the study led to the completion of the study with ten (10) experts.

This number of panellists was considered adequate based on literature recommendations from scholars which have employed the technique previously. Ten (10) to fifteen (15) panellists as suggested by Delbecq et al. (1975) could be sufficient if the background of the panellists is homogenous, which was achieved in the current study. Rowe and Wright

(1999) indicated that the size of a Delphi panel ranges from three (3) to eighty (80) in peer reviewed studies. Okoli and Pawlowski (2004) and Skulmoski, Krahn and Hartman (2007) also indicated a panel size of about ten (10) to eighteen (18) members whilst Hallowell and Gambatese (2010) suggested that since most studies incorporate between eight (8) and sixteen (16) panellists, a minimum of eight (8) is suggested. Hallowell and Gambatese (2010) further argued that the size of a panel should be dictated by the study characteristics, the number of available experts, the desired geographical representation and the capacity of the facilitator. Therefore a panel of ten (10) experts for this study was considered adequate based on the fact that the Delphi method does not depend on statistical power but rather on group dynamics for arriving at consensus amongst experts. Most of the potential experts who agreed to participate during the initial stage withdrew from the study, probably owing to the rigorous nature and time required of the Delphi method.

The selected experts' were required to have a thorough understanding of TQM in their respective locations. The residence of the experts' was considered as compulsory for the selection of participants owing to the importance of the study. Hence, the setting for the study was based on five metropolitans in Ghana (Cape Coast, Accra, Takoradi, Koforidua and Kumasi). It is therefore means that all the panel members were Ghanaians. Three of the experts are currently working in Cape Coast and one of the experts each are in Koforidua, Takoradi and Kumasi respectively. Four of the remaining experts are in Accra (Table 9.1).

Table 9.1: Residential location of experts

Regional Capitals /Cities	**Number of Experts**
Cape Coast	3
Koforidua	1
Kumasi	1
Takoradi	1
Accra	4
Total	10

The highest qualifications held by the experts are tabulated in Table 9.2 below. Three of the experts had a Doctor of Philosophy (PhD) degree and the remaining seven experts had a Master of Science (MSc). All experts were involved in construction project quality management.

Table 9.2: Qualification of Panel of Experts

Highest qualification	Number of experts
Doctor of Philosophy (PhD)	3
Master of Science degree (MSc)	7
Total	10

Table 9.3 shows that one panel of experts had 1-5 years of experience, four had 6-10 years of experience, four had 11-16 years of experience, and one had 16-20 years of experience. All experts were professionally registered at the highest level with various professional regulating bodies such as the Ghana Institute of Construction (GIOC), the Ghana Institute of Engineers, and the Ghana Institute of Surveyors. Others are the Institute of Engineers and Technology, the Royal Institute of Chartered Surveyors, the Chartered Institute of Marketing, and the International Association of Valuators, Consultants and Analysts.

Table 9.3: Panel of Experts' Years of Experience

Years of experience	Number of experts
1-5	1
6-10	4
11-15	4
16-20	1
Total	10

Consideration was also given to the selection of the panel of the experts to achieve a balance between professionals and academicians in the fields of TQM in the construction industry. In terms of their current occupations, seven (7) of the selected experts were employed by construction firms in Ghana as project managers and directors and the remaining three (3) experts were employed by technical universities (Coast Technical University -2 and Koforidua Technical University – 1). All three (3) panel experts from the technical universities were Senior Lecturers and held senior positions in the technical universities. They also handle project management-related courses in their institutions. The seven (7) experts employed by construction firms held the highest positions at their various firms (Project Managers – 5, Quality Control Manager – 1, Consultant/Director - 1) and were involved in TQM. Their curriculum vitae analysis shows that all the experts were involved in both construction works and related fields (Table 9.4).

Table 9.4: Panel of Experts' Fields of Specialization

Field of specialization	**Number of experts**
Construction Project Management	8
Construction Health and Safety Management	1
Civil Engineering (Structural Engineering).	1
Total	10

9.4 FINDINGS FROM THE DELPHI STUDY

Frequencies were obtained to measure the degree of consensus reached amongst participants regarding the attributes that determine TQM implementation in the Ghanaian construction industry. The results of each Delphi round were reviewed and compiled by the researcher. The median, mean, standard deviation, percentages and IQD scores of each question were calculated. All statements were examined individually for consensus. In other words, the quantitative results were statistically analysed after each round of questionnaires to determine whether consensus had been reached for each question or statement using the provided scale for each question or statement. Consensus is achieved with 100% of the participants in agreement but two-thirds in the agreement is considered a common consent (Stitt-Gohdes & Crews, 2004). The goal for this study was that each question or statement should have consensus but common consent would be acceptable. Common consent was obtained if 60% of the experts agreed on each statement that was achieved in the study. If consensus was reached prior to the final round that question or statement was no longer required (asked/required) in the next rounds. After the second round Delphi survey, consensus was reached regarding most of the attributes that determine TQM implementation in the construction industry in Ghana. If consensus had not been reached at the second round, the data from this second round would have been analysed again by calculations for median, mean, standard deviation and percentages scores and sent to the experts for consideration in responding to a third round. The researcher predicted the use of three rounds to achieve consensus but this prediction was incorrect. A third round was not needed, and the participants were informed of this when the second round questionnaires were sent out.

Based on the findings of the analyses of responses from the Delphi rounds, a list of attributes that determine TQM implementation in the construction industry was prepared which inform the conceptual framework for the broader study. Issues relating to TQM implementation in the construction industry in Ghana were highlighted, which responded accordingly to the set objectives of the Delphi study. The results of the Delphi study about the specific objectives of the Delphi are presented below.

DSO 1: To identify the main and sub-attributes that determine TQM implementation in Ghanaian construction industry

A set of main attributes and sub-attributes that are relevant to TQM were emphasised through a comprehensive review of literature. Although the reviewed literature was based on studies from the developed countries, they were collectively used to examine the attributes that determine TQM in the Ghanaian construction industry. The influence of the attributes on TQM was obtained as a product of the impact on the construction industry in Ghana. The main attributes were based on the level of influence as categorized on the questionnaire. This was established by assessing the extent to which the listed attributes will determine the TQM implementation in Ghanaian construction industry. The impact of the sub-attributes in determining TQM was assessed if they were present or lacking. The rating was based on an ordinal scale of one to ten with one being 'low influence' or 'no impact' and ten being 'high influence' or 'very high impact'. The levels of influence and impact were obtained as a product of the consensus achieved as detailed in Chapter 8, Section 8.4.3.7.

By applying the interquartile deviation (IQD) to determine whether an attribute reached consensus or not, four (4) attributes, namely Leadership and Top Management, Company Quality System Evaluation, Product Selection and Design Management, Construction Process Management and Improvement reached consensus with the IQD cut-off (IQD ≤1) score set to reach consensus (Table 9.5).. Six (6) of the attributes had strong consensus, with the exception of Client Focus and Involvement, and Product Selection and Design Management, which had good consensus (Table 9.5). Seven (7) attributes from the eight (8) identified main attributes that determine TQM in the construction industry were considered by the experts to have a very high influence, with the exception of one (1) attribute (Product Selection and Design Management) which had a high influence.

Table 9.5: Total Quality Management (TQM) in the Construction Industry Main Attributes

Total Quality Management in the Construction Industry Main Attributes	$\bar{x}$	M	SD	IQD
Leadership and Top Management (LTM)	9.10	10.00	1.85	1.00
Company Supplier Quality Management (CSQM)	8.40	9.00	1.43	1.25
Client Focus and Involvement (CFI)	8.30	8.00	1.06	1.50
Company Quality System Evaluation (CQSE)	9.10	9.00	0.57	0.25
Company Vision and Plan Statement (CVPS)	8.40	9.00	1.43	1.25
Product Selection and Design Management (PSDM)	7.80	8.00	0.79	0.25
Construction Process Management and Improvement (CPMI)	8.60	9.00	0.84	0.50
Construction Employees' Involvement and Motivation (CEIM)	9.00	10.00	2.21	1.25

M=Median; $\bar{x}$=Mean; σ_x=Standard Deviation (SD); IQD=Interquartile Deviation

Twelve (12) attributes were identified from the first sub-attribute (Leadership and Top Management). By applying the interquartile deviation (IQD) to determine whether an attribute reached consensus or not, the experts reached consensus on six attributes with the IQD cut-off (IQD ≤ 1) score set to reach consensus (Table 9.6). Eight (8) attributes had strong consensus, with the remaining four (4) having good consensus. The outcome of these results has been depicted in Table 9.2. The experts considered eight (8) attributes out of twelve (12) attributes to have very high influence on the attributes that determine TQM in the construction industry. The experts considered the remaining four attributes to have high influence. Eight (8) out of the twelve (12) attributes had a very high impact (VHI -9-10) on TQM in the construction industry, while the remaining four (4) attributes had a high impact (HI-7-8.99) on TQM in the construction industry (Table 9.6).

Table 9.6: Leadership and Top Management

Leadership and Top Management	$\bar{x}$	M	SD	IQD
Leadership style	8.78	9.00	1.09	0.00
Leadership ability in solving quality problem	8.70	9.00	0.95	0.00
Leadership skills	8.20	8.50	0.92	2.00
Leadership initiatives	8.89	9.00	0.33	0.00
Leadership and top management knowledge of TQM	9.30	10.00	1.34	1.25
Top management commitment in TQM	9.00	9.00	0.67	0.50
Top management interaction with workers	8.50	9.00	1.18	1.25
Top management participation	8.56	9.00	1.24	2.50
Top management learning	7.70	8.00	0.95	1.25
Top management empowerment	7.90	8.00	1.10	1.25
Top management encouragement	8.80	9.00	0.63	1.00
Top management's role model	7.70	8.00	1.25	0.75

M=Median; $\bar{x}$=Mean; σ_x=Standard Deviation (SD; IQD=Interquartile Deviation

From the twelve (12) identified attributes under the second sub-attribute (Company Supplier Quality Management), the experts reached consensus on seven attributes with IQD cut-off (IQD ≤1) score set to achieve consensus (Table 9.7). Five (5) attributes had strong consensus, while six (6) had good consensus and the remaining one (1) (Location of supplier) had weak consensus in determining TQM in the construction industry. The representation of all the attributes is shown in Table 9.7.

Table 9.7: Company Supplier Quality Management

Company Supplier Quality Management	$\bar{x}$	M	SD	MAD	IQD
Partnership with suppliers	7.80	8.00	1.03	0.40	0.00
Supplier selection criteria	8.10	8.00	0.74	0.30	0.00
Participation in suppliers	7.90	8.00	0.32	0.10	0.00
Supplier performance evaluation	8.80	9.00	0.42	0.20	0.25
Supplier quality audit	8.60	9.00	0.70	0.40	1.00
Supplier communication	8.30	9.00	1.34	0.70	1.25
Supplier knowledge in TQM	8.40	9.00	1.43	0.80	1.25
Location of supplier	6.00	6.00	1.63	1.00	1.50

Suppliers' past records	8.00	8.50	1.33	1.00	2.00
Suppliers' commitment	8.30	8.00	0.48	0.30	1.00
Cooperation from suppliers	8.20	9.00	1.32	0.80	1.25
Suppliers' orientation	7.30	7.00	0.82	0.50	1.00

M=Median; $\bar{x}$=Mean; σ_x=Standard Deviation (SD); IQD=Interquartile Deviation

From the nine (9) identified attributes under the third sub-attribute (Client Focus and Involvement), the experts reached consensus on five attributes with IQD cut-off (IQD ≤1) score set to achieve consensus (Table 9.8). Five (5) attributes had strong consensus, while the remaining five (5) had good consensus. Two (2) of the attributes had a very high impact (VHI: 9-10). The remaining seven (7) other attributes had a high impact (HI: 7-8.99) on TQM in the construction industry (Table 9.8).

Table 9.8: Client Focus and Involvement

Client Focus and Involvement	$\bar{x}$	M	SD	IQD
Client brief/ input	8.50	8.50	1.08	1.50
Client complaint information/feedback	8.70	9.00	0.82	1.00
Market investigation	7.90	8.00	0.32	0.00
Client satisfaction survey	8.70	9.00	0.82	1.00
Quality warranty	8.00	8.00	1.15	2.00
Client information system	7.50	7.00	0.97	1.25
Client services	7.30	7.00	0.95	0.50
Client cooperation	8.00	8.00	0.82	2.00
Client orientation	7.00	7.00	0.82	0.25

M=Median; $\bar{x}$=Mean; σ_x=Standard Deviation (SD); IQD=Interquartile Deviation

Experts reached consensus on all twelve attributes identified under the fourth sub-attribute (Company Quality System Evaluation) with IQD cut-off (IQD ≤1) score set to achieve consensus (Table 9.9). Eight (8) attributes had strong consensus and other four had good consensus (Table 9.9). The eight (8) attributes had a very high impact (VHI: 9-10), while the remaining four (4) of the attributes had a high impact (HI: 7-8.99).

Table 9.9: Company Quality System Evaluation

Company Quality System Evaluation	$\bar{x}$	M	SD	IQD
Evaluation of strategy	8.20	8.00	0.79	0.25
Evaluation of overall company performance	8.70	9.00	0.67	0.25
Evaluation of departments' performance	8.50	9.00	0.71	1.00
Evaluation of employees' performance	7.90	8.00	0.57	0.25
Evaluation of quality costs	7.90	8.00	0.57	0.25
Evaluation of quality manual	8.20	8.00	0.63	1.00
Evaluation of quality control system	8.70	9.00	0.67	0.25
Evaluation of quality system procedures	8.70	9.00	0.82	1.00
Evaluation of end results	8.60	9.00	0.70	1.00
Quality audit	9.00	9.00	0.47	0.00
Quality benchmarking	8.80	9.00	0.42	0.25
Quality information system	8.70	9.00	0.48	1.00

M=Median; $\bar{x}$=Mean; σ_x=Standard Deviation (SD);; IQD=Interquartile Deviation

Experts reached consensus on five (5) attributes from the fifth sub-attribute **(**Company Vision and Plan Statement) identified with IQD cut-off (IQD ≤1) score set to achieve consensus (Table 9.10). One (1) of the nine (9) attributes had strong consensus, while the remaining eight (8) had good consensus (Table 9.10). One (1) of the nine (9) attributes (Quality Improvement Plan) had a very high impact (VHI: 9-10), while the remaining eight (8) had a high impact (HI: 7-8.99). These representations are given in Table 9.10.

Table 9.10: Company Vision and Plan Statement

Company Vision and Plan Statement	$\bar{x}$	M	SD	MAD	IQD
Vision statement	7.50	8.00	0.97	0.70	1.25
Quality policy	8.30	8.50	1.06	0.90	2.00
Overall business performance plan	7.70	8.00	0.82	0.50	1.00
Product quality goal	8.10	8.00	0.88	0.50	1.00
Quality improvement plan	8.80	9.00	0.63	0.20	0.00
Formulation of vision and plan	7.60	8.00	1.07	0.80	1.50
Concreteness of future plan	7.40	8.00	1.35	1.00	2.25
Employees' contribution to the vision	7.80	8.00	0.63	0.20	0.00
Involvement of employees in the development of vision statement	7.50	8.00	0.97	0.50	1.00

M=Median; $\bar{x}$=Mean; σ_x=Standard Deviation (SD); IQD=Interquartile Deviation

From the fifteen (15) attributes under the sixth sub-attribute (Product Selection and Design Management) identified, the experts reached consensus on eleven attributes with IQD cut-off (IQD ≤1) score set to achieve consensus (Table 9.11). Seven (7) of the attributes were considered by the experts to have a very high impact (VHI: 9-10) under the median score. The remaining eight (8) attributes were considered by the experts to have a high impact (HI: 7-8.99) on TQM in the construction industry (Table 9.11).

Table 9.11: Product Selection and Design Management

Product Selection and Design Management	$\bar{x}$	M	SD	IQD
Client brief/input	8.90	9.00	0.88	0.50
Cost implication	8.00	8.00	0.82	0.25
Environmental issues	6.56	7.00	2.07	2.50
Socio cultural issues	7.40	8.00	2.37	0.25
Appearance/finishes required	8.40	9.00	1.17	1.25
Strength required	8.20	9.00	1.69	1.25
Intended purpose of the material	7.60	9.00	2.55	2.25
Where the material to be used	7.20	7.00	0.42	0.25
Design methods/techniques	8.10	8.00	0.99	0.25
Design detailing	8.60	9.00	0.84	1.00
Concurrent engineering	7.90	8.00	0.99	0.25
Design experiments/testing	7.90	8.00	0.99	0.25
Quality function deployment	8.70	9.00	1.06	0.25
Value engineering	8.70	9.00	1.06	0.25
Computer-aided design	7.00	7.00	1.49	0.50

M=Median; $\bar{x}$=Mean; σ_x=Standard Deviation (SD); IQD=Interquartile Deviation

From the fifteen (15) attributes under the seventh sub-attribute (Construction Process Management and Improvement) identified, the experts reached consensus on twelve attributes with IQD cut-off (IQD ≤1) score set to achieve consensus (Table 9.12). Twelve (12) attributes had strong consensus, with the remaining three (3) having good consensus. Four (4) of the attributes were considered by the experts to have a very high impact (VHI: 9-10) under the median score. The remaining eleven (11) of the attributes were considered by the experts to have a high impact (HI: 7-8.99) on TQM in the construction industry (Table 9.12).

Table 9.12: Construction Process Management and Improvement

Construction Process Management and Improvement	$\bar{x}$	M	SD	IQD
Project monitoring and control improvement	8.90	9.00	0.74	0.00
Equipment maintenance and innovation	8.10	8.00	0.88	0.50
Inventory management	7.30	7.00	0.67	0.25
Use of quality materials	8.70	9.00	1.06	1.50
Use of quality tools	8.00	8.00	1.05	0.50
Use of quality manual	8.00	8.00	0.94	0.00
Understanding of work instructions/quality manual	8.70	9.00	1.16	1.25
Quality system procedures improvement	8.20	8.00	0.79	0.25
Obtaining ISO 9000 certification for operation	8.00	8.00	0.82	0.25
Understanding of quality control system	8.20	8.00	0.63	0.00
Continuity of quality control circle activities	8.60	9.00	0.84	1.00
Appropriate use of system structure and standards	8.00	8.00	0.94	0.00
Targets and priority measures	7.80	8.00	0.79	0.25
Safe working environment	8.30	8.50	1.16	1.25
Utilization of analysis results	7.90	8.00	0.74	0.00

M=Median; $\bar{x}$=Mean; σ_x=Standard Deviation (SD); IQD=Interquartile Deviation

From the fourteen (14) attributes under the eighth sub-attribute (Construction Employees Involvement and Motivation) identified, the experts reached consensus on thirteen attributes with IQD cut-off (IQD ≤1) score set to achieve consensus (Table 9.13). Thirteen (12) attributes had strong consensus, with the remaining one (1) having good consensus. Only one (1) of the attributes was considered by the experts to have a very high impact (VHI: 9-10) under the median score. The remaining thirteen (13) of the attributes were considered by the experts to have a high impact (HI: 7-8.99) on TQM in the construction industry (Table 9.13).

Table 9.13: Construction Employees' Involvement and Motivation

Construction Employees Involvement and Motivation	$\bar{x}$	M	SD	IQD
Education and training	8.70	9.00	0.48	1.00
Salary promotion	7.70	8.00	0.67	0.25
Position promotion	7.50	8.00	0.97	1.25
Employee rewards	7.60	8.00	0.70	1.00
Bonus scheme	7.80	8.00	0.79	0.25
Conducive working environment	7.89	8.00	0.78	0.00
Involvement of employees within-functional team	8.10	8.00	0.57	0.25
Employee participation	8.20	8.00	0.42	0.25
Employees' suggestion	8.10	8.00	0.32	0.00
Improving employee commitment	8.20	8.00	0.42	0.25
Job rotation	7.90	8.00	0.88	0.50
Involvement in quality control circle	7.90	8.00	0.74	0.00
Employee involvement in cross-functional team	7.80	8.00	0.42	0.25
Employee recognition	8.10	8.00	0.32	0.00

M=Median; $\bar{x}$=Mean; σ_x=Standard Deviation (SD); IQD=Interquartile Deviation

DSO 2: To determine the factors that enable construction companies to implement TQM

From the twenty-two (22) identified factors that were considered to enable construction companies to implement TQM, the experts reached consensus on sixteen factors with an IQD cut-off (IQD ≤1) score on TQM in the construction industry (Table 9.14). Eight (8) of the factors had a very high impact (VHI: 9-10), while the remaining fourteen (14) of the factors had a high impact (HI: 7-8.99) on TQM in the construction industry (Table 9.14).

Table 9.14: Factors that Enable Construction Companies to Implement TQM

Factors that enable Construction Companies to Implement TQM	$\bar{x}$	M	SD	IQR
Top management support	9.10	9.00	0.74	1.25
Good quality driven agenda	8.90	9.00	0.57	0.25
Commitment to people	8.30	8.00	0.48	1.00
Training and re-training of staff	8.70	9.00	0.67	0.25
Institution of continuous improvement	8.60	9.00	0.70	1.00

process within the company				
Systematic TQM framework	8.20	8.00	0.42	0.25
Efficient management system	8.50	9.00	0.71	1.00
Proper understanding of TQM among construction professionals	8.80	9.00	0.79	0.25
Availability of resources	7.50	8.00	1.51	1.00
Good communication in organisation	7.60	8.00	1.26	1.50
Good quality policy	7.90	8.00	0.74	0.00
Changes in company structure	7.40	8.00	1.26	1.00
Good organizational and quality culture	8.60	9.00	0.70	1.00
Teamwork	8.00	8.00	0.47	0.00
Availability of quality information	8.10	8.00	0.57	0.25
Employee involvement	7.70	8.00	0.67	1.00
Good climatic condition	6.80	7.00	0.42	0.25
Good socio-economic environment	6.50	7.00	1.90	1.50
Proper project conceptualization	6.60	7.00	1.71	0.50
Project manager competence	7.20	8.00	1.62	1.25
Clarity of goals and objectives	8.00	9.00	1.49	2.25
Adequate TQM experts	7.50	8.00	0.85	1.25

M=Median; $\bar{x}$=Mean; σ_x=Standard Deviation (SD); IQR=Interquartile Deviation

DSO 3: To Identify the Factors that Affect Construction Companies for not Implementing TQM in Ghana

From the twenty (20) identified factors that were considered to affect construction companies in Ghana for not implementing TQM, the experts reached consensus on only nine factors with an IQD cut-off (IQD ≤1) score on TQM in construction (Table 9.15). Eleven (11) of the factors had a very high impact (VHI: 9-10) on TQM in the construction industry. Nine (9) factor had a medium impact (HI: 7-8.99) on TQM in the construction industry (Table 9.15).

Table 9.15: Factors that Affect Construction Companies for not Implementing TQM in Ghana

Factors that Affect Construction Companies if not Implementing TQM	$\bar{x}$	M	SD	IQR
Lack of efficient TQM management system	8.50	9.00	1.08	2.00
Lack of or limited company resources	7.30	8.00	2.06	1.00
Unavailable TQM policy	8.50	9.00	1.08	2.00

Lack of or limited knowledge of TQM	8.50	9.00	0.85	1.25
Inability to employ TQM personnel	7.20	8.00	1.87	1.00
Absent of systematic TQM framework	8.10	8.00	0.57	0.25
Lack of and inability to train and educate employees on TQM	8.30	9.00	1.70	1.25
Lack of understanding among construction professionals in applying TQM	8.40	9.00	0.84	1.25
Lack of coordination of the implementation of TQM policy within the organisation	8.40	9.00	1.17	1.25
Limited access to body responsible for the implementation of TQM policy	7.40	8.00	2.32	0.50
Lack of TQM expert	8.00	9.00	1.89	1.25
Reluctance to change old management technique	8.90	9.00	0.57	0.25
Complex nature of TQM technique	7.50	8.00	2.37	1.25
Lack of commitment from management	9.22	9.00	0.67	1.00
Perception that TQM may not yield any better results	7.10	8.00	2.33	1.50
TQM technique is time consuming	8.00	8.00	1.05	0.50
TQM technique is costly	8.10	8.00	0.74	1.25
Lack of finance in the management of TQM experts	8.10	8.00	0.57	0.25
Lack of enforcement from the legislative bodies overseeing the implementation of TQM	7.90	9.00	2.18	1.25
Lack of interest in the application of TQM	8.80	9.00	1.14	0.50

M=Median; $\bar{x}$=Mean; σ_x=Standard Deviation (SD); IQR=Interquartile Deviation

DSO 4: To evaluate organizational factors and issues that affects the implementation of TQM

From the twenty (20) organizational factors and issues that affect the implementation of TQM, the experts reached consensus on twelve factors with IQD cut-off (IQD ≤1) score on TQM implementation in the construction industry (Table 9.16). Six (6) of the factors had a very high impact (VHI: 9-10) on TQM implementation in the construction industry. The remaining fourteen (14) factors had a high impact (HI: 7-8.99) on TQM implementation in the construction industry (Table 9.16).

Table 9.16: Organizational Factors that Affect Construction Companies in the Implementation of TQM

Organizational Factors that Affect Construction Companies in the Implementation of TQM	$\bar{x}$	M	SD	IQR
Leadership and top management commitment	9.40	9.00	0.52	1.00
Top management support	9.30	9.00	0.48	1.00
Project manager competence	8.80	9.00	0.79	0.25
Quality policy	8.90	9.00	0.88	0.50
Supplier management	8.00	8.00	0.82	0.25
Limited cash flow to manage TQM	7.70	8.00	1.64	0.75
Change in management behaviour/attitude	7.90	8.00	1.73	1.50
Change in status quo	7.80	8.00	1.69	1.50
Personnel to manage and monitor TQM application	7.50	8.00	1.58	1.25
Education and training	9.00	9.00	0.94	1.25
Employee relations	8.20	8.00	0.92	1.25
Employee involvement	8.78	9.00	0.83	0.50
Lack of interest in the application of TQM	8.30	8.00	1.25	1.50
Client involvement	8.30	8.00	0.82	1.00
Teamwork	8.50	8.00	1.08	2.00
Feedback by project participants	8.50	8.00	0.71	1.00
Design quality management	8.30	8.00	0.82	1.00
Strategic quality management	8.30	8.00	0.82	1.00
Quality data and reporting	8.40	8.00	0.84	1.00
Analysis of quality information	8.50	8.00	0.97	1.25

M=Median; $\bar{x}$=Mean; σ_x=Standard Deviation (SD); IQR=Interquartile Deviation

DSO5. To identify the effects of implementation of TQM in the construction industry

From the seventeen (17) identified effects of implementation of TQM in the construction industry, the experts reached consensus on fourteen of the effects with IQD cut-off (IQD ≤1) score on TQM in the construction industry (Table 9.17). Eleven (11) of the effects had a very high impact (VHI: 9-10) on TQM in the construction industry. The remaining six (6) effects had a high impact (HI: 7-8.99) on TQM in the construction industry (Table 9.17).

Table 9.17: Effects of Implementing TQM in the Construction Industry

Effects of Implementing TQM in the Construction Industry	$\bar{x}$	M	SD	MAD	IQR
Reduction in construction costs	9.20	9.00	0.63	0.40	1.00
Higher client satisfaction	9.20	9.00	0.63	0.40	1.00
Improve employee job satisfaction	9.10	9.00	0.57	0.30	0.25
Improve schedule performance	8.60	9.00	0.84	0.60	1.00
Elimination/Reduction of reworks	9.80	10.00	0.42	0.20	0.25
Defect-free product at first attempt	8.90	9.00	0.74	0.30	0.00
Improve safety	8.40	8.00	0.70	0.40	1.00
Higher productivity	9.00	9.00	0.47	0.20	0.00
Lower employee turnover	8.30	8.00	0.95	0.70	1.25
Speed up construction work	8.30	8.00	0.82	0.50	1.00
Improved relationships with subcontractors	8.20	8.00	0.79	0.40	0.25
Improved methods of working	8.20	8.00	0.79	0.40	0.25
Better control over the construction process	8.70	9.00	0.82	0.50	1.00
Increased profitability	9.00	9.00	0.82	0.60	2.00
Gaining competitive advantage over other companies	9.30	9.00	0.67	0.50	1.00
Decreasing waste	8.70	9.00	0.95	0.70	1.25
Better coordination of activities	8.20	8.00	0.79	0.40	0.25

M=Median; $\bar{x}$=Mean; σ_x=Standard Deviation (SD); IQR=Interquartile Deviation

9.5 DISCUSSIONS FROM THE DELPHI STUDY RESULTS

DSO 1: To identify the main and sub-attributes that determine TQM implementation in Ghanaian construction industry.

A set of main attributes and sub-attributes that are relevant to TQM was emphasised through a comprehensive review of literature. Although the reviewed literature was based on studies from the developed countries, they were collectively used to examine the attributes that determine TQM in the Ghanaian construction industry. The influence of the attributes on TQM was obtained as a product of the impact on the construction industry in Ghana. The main attributes were based on the level of influence as categorized on the questionnaire. This was established by assessing the extent to which the listed attributes will determine the TQM implementation in Ghanaian construction industry. The impact of the sub-attributes in determining TQM was assessed if they were present or lacking. The rating was based on an ordinal scale of one to ten with one being 'low influence' or 'no impact' and ten being 'high influence' or 'very high impact'. The levels of influence and impact were obtained as a product of the consensus achieved.

The first objective of the Delphi study was to identify the main and sub-attributes that determine TQM in the Ghanaian construction industry. Findings emanating from the survey revealed that the attributes that bring about TQM in the Ghanaian construction industry are similar to those in other cultural contexts. In determining whether an attribute reached consensus or not, consensus was reached on four (4) attributes (Leadership and Top Management, Company Quality System Evaluation, Product Selection and Design Management, Construction Process Management and Improvement) under the main attributes that determine TQM in the Ghanaian construction industry, with an IQD score of 1.00. Six (6) of the attributes had strong consensus, with the exception of Client Focus and Involvement, and Product Selection and Design Management, which had good consensus. Seven (7) attributes from the eight (8) identified main attributes that determine TQM in the construction industry were considered by the experts to have a very high influence (VHI: 9-10), with the exception of one (1) attribute (Product Selection and Design Management) which had a high influence (HI: 7-8.99). These indicate that all the attributes have high levels of influence on TQM implementation in the Ghanaian construction industry.

The assessment of the sub-attributes of eight (8) major determinants of TQM in the construction industry showed that the sub-attributes that determine TQM in the Ghanaian construction industry are identical to other cultural contexts. From the ninety-eight (98) sub-attributes identified under the (8) major determinants, only thirty-six (36), were found to be strong determinants of TQM in the construction industry in Ghana. Among these sub-attributes which were determined by the experts to have reached strong consensus are Leadership style, Leadership ability in solving quality problem, Leadership initiatives, Leadership and top management knowledge in TQM, Top management commitment in TQM, Top management interaction with workers, Top management participation, Top management encouragement, Supplier performance Evaluation, Supplier quality audit, Supplier Communication, Supplier knowledge in TQM, Cooperation from suppliers, Client complaint information/feedback, Client satisfaction survey, Evaluation of overall company performance, Evaluation of departments' performance Evaluation of quality control system, Evaluation of quality system procedures, Evaluation of end results, Quality audit, Quality benchmarking, and Quality information systems. Other sub-attributes which were considered by the experts to be strong determinants of total quality in the construction industry are Quality improvement plan, Client brief/input, Appearance/finishes required, Strength required, Intended purpose of the material, Design detailing, Quality function Deployment, Value engineering, Project monitoring and control improvement, Use of quality materials, Understanding of work instructions/quality manual, Continuity of quality control circle activities, and Education and training.

The assessment of the sub-attributes findings replicated the results of the majority of studies on TQM in the construction industry in relation to adequate Training and education, Supplier quality management and in general Leadership and top management commitment (Saraph et al., 1989; Flynn et al., 1994; Ahire et al., 1996; Imbeah & Dansoh framework, 2011; Adusa-Poku framework, 2014) upon which the current study's sub-attributes were also based. Leadership style, Leadership ability in solving quality problem, Leadership initiatives, Leadership and top management knowledge in TQM, Top management commitment in TQM, Top management interaction with workers, Top management participation, Top management encouragement were rated as variables with a very high impact as these impact on the quality of leadership and top management. Project monitoring and control improvement, Use of quality materials, Understanding of work instructions/quality manual, and Continuity of quality control circle activities also have a very high impact in relation to Construction Process Management and Improvement. These findings agree with previous findings from the studies done by Saraph et al. (1989), Flynn et al. (1994), and Ahire et al. (1996). Further findings as related to Supplier performance Evaluation, Supplier quality audit, Supplier Communication, Supplier knowledge in TQM, Cooperation from suppliers, Client complaint information/feedback, Client satisfaction survey, Evaluation of overall company performance, Evaluation of departments' performance Evaluation of quality control system, Evaluation of quality system procedures, Evaluation of end results, Quality audit, Quality benchmarking, Quality information system, Quality improvement plan, Client brief/input, Appearance/finishes required, Strength required, Intended purpose of the material, Design detailing, Quality function Deployment, and Value engineering imply that the sub-variables play a vital role in TQM in the construction industry.

In conclusion, the results seem to suggest that the attributes that bring about TQM in the Ghanaian construction industry are similar to the determinants in other cultural contexts. Furthermore, TQM in the construction industry is assured if more attention is given to these attributes in the development of an integrated TQM model for the construction industry in Ghana. Particular attention should be given to the thirty-six (36) sub-attributes determined by the experts who have all been described as having a significant influence and very high impact on determining TQM in the Ghanaian construction industry.

Objective DSO2

The second objective of the Delphi study was to determine the factors that enable construction ompanies to implement TQM in the construction industry. The assessment of the twenty two (22) factors of major determinants of TQM in the construction industry showed that the experts reached consensus on sixteen (16) factors with an IQD score between 0.00 and one (1). Eight (8) of the enable factors (Top management support, Good quality driven agenda, Training and re-training of staff, Institution of continuous improvement process within the company, Efficient management system, Proper understanding of TQM among construction professionals, Good organizational and quality culture, Clarity of goals and objectives) had a very high impact (VHI: 9-10) on TQM in the construction industry. The remaining fourteen (14) of the enable factors had a high impact (HI: 7-8.99) on TQM in the construction industry. These indicate that all the enabling factors have a high level of influence on TQM implementation in the Ghanaian construction industry.

Objective DSO3

The third objective of the Delphi study was to identify the factors that affect construction companies for not implementing TQM in Ghana. Construction companies' inability to implement TQM in the Ghanaian construction industry might be due to several factors, some of which may be beyond their control and others out of their reach owing to limited resources. The assessment of the twenty (20) factors of major determinants of TQM in the construction industry showed that experts reached consensus on nine (9) factors with IQD less or equal to one (1). Eleven (11) of the factors (Lack of efficient TQM management system, Unavailable TQM policy, Lack of or limited knowledge of TQM, Lack of and inability to train and educate employees on TQM, Lack of understanding among construction professionals in applying TQM, Lack of coordination of the implementation of TQM policy within the organisation, Lack of TQM experts, Reluctance to change old management technique, Lack of commitment from management, Lack of enforcement from the legislative bodies overseeing the implementation of TQM, and Lack of interest in the application of TQM) had a very high impact (VHI: 9-10) on TQM in the construction industry. The remaining nine (9) of the factors had a high impact (HI: 7-8.99) on TQM in the construction industry. These indicate that most of the factors have a very high level of influence on construction companies in Ghana which do not implement TQM.

Objective DSO4

The fourth objective of the Delphi study was to evaluate the organizational factors and issues that affect the implementation of TQM in the construction industry. The assessment of the twenty (20) organizational factors and issues as considered by the experts to be the major determinants of TQM in the construction industry showed that the experts reached consensus on twelve (12) factors (Leadership and top management commitment, Top management support, Project manager competence, Quality policy, Supplier management, Limited cash flow to manage TQM, Employee involvement, Client involvement, Feedback by project participants, Design quality management, Strategic quality management, Quality data and reporting) were considered by the experts to have achieved consensus with IQD less or equal to one (1). Six (6) of the organizational factors and issues (Leadership and top management commitment, Top management support, Project manager competence, Quality policy, Education and training, Employee involvement) to have a very high influence (VHI: 9-10) on TQM in the construction industry. The experts reached consensus on the remaining fourteen (14) of the organizational factors and issues as having a high influence

(HI: 7-8.99) on TQM in the construction industry. Their SD ranges from 0.48-1.73 and their mean ranges from 7.50 – 9.40. These indicate how significant organizational factors and issues are regarding the TQM implementation in the construction industry.

Objective DSO5

The fifth objective of the Delphi study was to identify the effects of implementation of TQM in the construction industry. The assessment of the seventeen (17) major effects of the implementation of TQM in the construction industry showed that the experts reached consensus on fourteen (14) of the effects with an IQD less or equal to one (1). Eleven (11) of the effects (Elimination/Reduction of reworks, Reduction in construction costs, Higher client satisfaction, Improve employee job satisfaction, Improve schedule performance, Defect-free product at first attempt, Higher productivity, Better control over the construction process, Increase profitability, Gaining competitive advantage over other companies, Decreasing waste) had a very high influence (VHI: 9-10) on TQM in the construction industry, while the remaining six (6) of the effects had a high influence (HI: 7-8.99). Their SD ranged from 0.42-0.95 and their mean ranged from 8.20 – 9.30. These indicate how important and influential these effects are on the TQM implementation in the construction industry.

From all of the above, a number of factors that were considered to be important in determining TQM in the Ghanaian construction industry have been identified and amplified by the Delphi study. The factors considered to be paramount determinants of TQM in the Ghanaian construction industry include Leadership and Top Management, Company Supplier Quality Management, Client Focus and Involvement, Company Quality System Evaluation, Company Vision and Plan Statement, Product Selection and Design Management, Construction Process Management and Improvement, and Construction Employees' Involvement and Motivation. These factors have been collectively considered for the development of a holistic TQM model in this study. Five of the factors have been previously considered in the development of TQM model in other cultural contexts, but none of the existing models to date have included Vision and Plan Statement, Product selection and Design Management, and Company Quality System Evaluation as inclusive factors to develop a model to guide professionals in the construction industry in making decisions about the criteria to be given priority in TQM issues.

9.6 CONCLUSION

This chapter presented a summary of results and discussions of the results of both the Delphi rounds (first to the second round). Computation for each question element was made for the influence and impact of the attributes in determining TQM in the construction industry and how this will contribute to the improvement of project performance in the construction industry in Ghana. The influence or impact of the absence or presence of a particular TQM element on the overall TQM of the other elements was presented. The chapter concluded with a summative discussion of the findings based on the objectives of the Delphi study. The findings from the expert participants revealed a consistent discussion on TQM in Ghanaian construction industry with consensus being reached in most cases and in others with a discrete conclusion. The result of the Delphi study assisted in the determination of key factors and constructs that are of critical significance (influence) to determine TQM in the construction industry. The outcome led to the development of the holistically integrated TQM conceptual model for the construction industry in Ghana. Chapter 10 provides the evaluation of these factors and their interrelationships.

CHAPTER TEN

10 THE CONCEPTUAL INTEGRATED TOTAL QUALITY MANAGEMENT MODEL

10.1 INTRODUCTION

This chapter presents a discussion of the findings from the review of the literature. The conceptual model theory forms the basis of the discussion. Based on an in-depth review of the previous models as presented in Chapter 2 of this thesis, the hypothesised integrated holistic TQM model is presented in this chapter. The five constructs (Leadership and Top Management, Company Supplier Quality Management, Client Focus and Involvement, Construction Process Management and Improvement, and Construction Employee Involvement and Motivation) that influence the implementation of TQM in the construction industry are explained in detail and presented in this chapter. The additional three constructs (Company Vision and Plan Statement, Product Selection and Design Management, and Company Quality System Evaluation) which were identified as gaps in TQM research have already been explained and discussed in detail in Chapter 3 of this thesis. Detailed discussions of the holistic integrated model and the variables of the model, the identification of the model and justification for the selected variables are all given in this chapter.

10.2 SELECTION OF VARIABLES FOR TQM IMPLEMENTATION

Both objective and subjective attributes have been combined in the TQM study models. For the assessment of TQM implementation, the research by Sila and Ebrahimpour (2002) identified twenty-five TQM elements which are commonly used by researchers to measure TQM implementation. Their research discovered eight common cores of the factors, namely leadership and top management commitment, employee training, customer focus and satisfaction, teamwork, employee involvement, continuous improvement and innovation, and quality information and performance. Literature also discloses that different countries have adopted related TQM constructs as criteria for quality awards under different titles (Metri, 2005).

The selection of the variables for this study is anchored around system theory in that it takes all the organizations’ systems for successful implementation of TQM and the organization performance is largely dependent on its ability to continuously improve on the management of its systems. Also system theory is based on the principle that each organization is composed of a system of interrelated processes and people which make up the system’s components. The system theory was updated by the Deming theory (Deming, 1986). Hackman and Wageman (1995) systematically reviewed Deming’s theory and proposition relating to TQM. Their review indicated the following five interventions as the core of TQM: Explicit identification and measurement of customer needs and wants, the creation of supplier partnership, the use of functional teams to identify and resolve quality problems, the use of scientific methods to monitor performance and identify points of high leverage for performance improvement, and the use of process management heuristics to improve team effectiveness.

Comparing the conceptual frameworks of Saraph, Benson and Schroeder (1989), Flynn, Schroeder and Sakakibara (1994), Ahire, Golhar and Waller (1996); Adusa–Poku, (2014) and that of quality award models i.e the European Quality Award Model (1994), the Deming Prize Quality Award model (1996), and the Malcolm Baldrige National Quality Award model (1999), it was found that most of the research findings relating to TQM implementation shared a similar view with the Deming theory of profound knowledge which is a management philosophy grounded in systems theory (Deming, 1986).

These frameworks and the three quality award models helped to identify a range of intangible and tangible processes that influence the firm’s TQM implementation and the end results. It was obvious that there are some similarities and dissimilarities in their conceptual frameworks. This study integrated the identified TQM constructs as much as possible and came up with the following five constructs: Leadership and Top Management, Company Supplier Quality Management, Client Focus and Involvement, Construction Process Management and Improvement, and Construction Employee Involvement and Motivation.

Hence, the existing TQM model contains leadership and top management with twelve variables; Company Supplier Quality Management with twelve variables; Client Focus and Involvement with nine variables; Construction Process Management and Improvement with fifteen variables; and Construction Employee Involvement and Motivation with fourteen variables.

Almost all the TQM studies have these constructs conceptualized on a frequent basis. However, the current study brings into focus company vision and plan statement which has nine variables, product selection and design management which has fifteen variables, and company quality system evaluation which has twelve variables. These three additional constructs were not found in the identified model and frameworks. The gaps identified in the literature review are these three additions and were found to be peculiar to both developed and developing countries.

The five constructs that influence the implementation of TQM in the construction industry are explained in detail and presented in this chapter. The additional three constructs have been presented and discussed in detail under a section in Chapter 3 (observed gaps in the TQM litereature).

10.2.1 Leadership and Top Management (LTM)

Leadership is the capability to inspire confidence and support among those needed to accomplish organizational objectives (DuBrin, 1995). Anderson et al. (1994a) explained the concept of leadership as the ability of top management to establish, practise, and lead a long-term vision for the company, driven by changing customer requirements as opposed to an internal management control role. Leadership is therefore exemplified by clarity of vision, long-term orientation, coaching management style, participative change, employee empowerment, and planning and implementing organizational change. Juran and Gryna (1993) mentioned that certain roles of top management can be recognized as establishing quality policies, establishing and deploying quality objectives, providing resources, providing problem-oriented training, and stimulating improvement. The European Quality

Award (1994) and the Malcolm Baldrige Quality Award (1999), on the other hand, recognize the vital role of leadership in creating the goals, values and systems that guide the pursuit of continuous performance improvement. Recognition of the crucial role of leadership and its responsibility in quest of continuous quality improvement supports the arguments put forward by quality gurus such as Deming (1986), Juran (Juran & Gryna, 1993), and Crosby (1979). Hence, the concept of leadership in this study can be defined as the ability of top management to lead the company in continuously pursuing long-term overall business success. This is demonstrated by top management participation, top management encouragement, employee empowerment, top management learning, top management commitment to employee education and training, and top management pursuit of product quality and long-term business success.

A predominant theme in quality management literature is that strong commitment from top management is very important. Indicating such commitment is therefore a prime leadership principle for realizing TQM. Brown, Pearl and Akintoye (1994) stated that a lack of top management commitment is one of the causes for the failure of TQM initiatives. However, top management commitment itself is not enough. It is more important that top management personally participates in various quality management activities. Furthermore, it should strongly encourage employee involvement in quality management activities. DuBrin (1995) stressed that an important leadership practice is to encourage people to assess the level of quality.

To become a successful leader in most modern firms, the top manager must continue to develop and learn. Knowledge of the business and constant learning are important requirements of efficient leadership (DuBrin, 1995). In order to lead the company effectively, top management must encourage workers to fix the problems they face. Thus, workers must have the ability to solve problems and prevent their further occurrence. Also in order to effectively lead the company, top management must be dedicated to providing adequate resources for employees' education and training, building trustworthy relationships with employees, and regarding them as precious resources of the company. Top management must be dedicated to assigning adequate resources to prevent, as well as repair, quality problems. Top management should discuss quality frequently, for example, by giving speeches on the topic and asking questions about quality at every staff meeting. In fact, people make things happen. Therefore, top management must train and coach workers to assess, analyze, and improve work processes (Dale & Plunkett, 1990; Deming, 1986).

The research study carried out by Garvin (1986) recommended that high levels of quality performance were always accompanied by an organizational dedication to that goal; high product quality did not exist without strong top management commitment. Many such scientific studies have also found that top management support for quality was a key factor in quality enhancement. Hence, it is important that top management should focus on product quality rather than yields only. More significantly, it is essential for the company to engage long-term business success. Seeking short-term business success places quality behind yield, costs, and meeting delivery schedules (Zhang, 2000b). This present study looks at leadership/management that has been hypothesised for the development of a holistic TQM model and is summarised in Table 10.1.

10.2.2 Company Supplier Quality Management (CSQM)

Supplier quality management can be defined as the set of supplier-related quality management practices for improving suppliers' quality of products and services. This is exemplified by firm-supplier partnerships, product quality as the criterion for supplier selection, participation in suppliers, communication with suppliers, understanding of supplier performance, and supplier quality audits (Mann, 1992; Zhang, 2000a).

In modern industrial production, the interdependence of buyers and suppliers has increased considerably. The supplier becomes an extension of the buyer's organization to a certain extent. A revolution in the link between customers and providers appeared in the form of supplier collaboration (Juran & Gryna, 1993). Hackman and Wageman (1995) stated that building relationships with suppliers is one of the main TQM implementation practices. Anderson et al. (1994a) also pointed out that external collaboration between a company and its suppliers has benefits in the just-in-time buying systems. Working collaboratively with suppliers on a long-term basis is helpful. Deming (1986) strongly suggested working with the supplier as a partner in a long-term relationship of loyalty and trust to enhance the quality of incoming materials and decrease costs. A long-term relationship between buyer and supplier is essential for the best economy.

Deming (1986) and Ishikawa (1985) recommended that companies choose their suppliers on the basis of quality, rather than solely on price. Deming (1986) added that price has no meaning without a measure of the quality being bought. Without sufficient measures of quality, business drifts to the lowest bidder, low quality and high cost being the inevitable outcomes. The company therefore must change its focus from lowest initial cost of material bought to lowest total cost. Companies should take part directly in suppliers' activities related to quality (Mann, 1992; Zhang, 2000a). Deming (1986) and Ishikawa (1985) therefore suggested that companies work directly with suppliers to ensure that their materials are of the highest possible quality. Incoming material control is extremely important for supplier quality management. Specifications and standards should be recognized as requirements for approval of raw materials, parts, and components. Techniques such as acceptance sampling inspection and 100% inspection can be used to provide acceptance at most economical levels (Feigenbaum, 1991).

Evaluating suppliers is an essential activity to ensure areliable high quality of incoming materials in the company (Feigenbaum, 1991). Each supplier is measured against another specific supplier or group of suppliers for price, quality, delivery, and other important performance measures. Supplier performance evaluation includes objective assessment of one supplier's performance, which can feed back to that supplier. In the case of a poor quality situation, such information can be used by the supplier to come up with corrective action. Supplier quality evaluation also provides a quantitative summary of supplier quality over a period of time (Juran & Gryna, 1993).

Companies need to have detailed information about supplier quality information such as drawings, specifications, and other necessary information. It is also essential to establish a supplier information feedback system which can be used for giving feedback to suppliers about their products (Feigenbaum, 1991; Juran & Gryna, 1993).

Supplier quality audit, an organized evaluation of supplier abilities to provide materials of the necessary quality and quantity, is an essential basis for initial supplier selection and ongoing supplier quality surveillance (Feigenbaum, 1991). Surveillance can take several forms: Inspection of product, meetings with suppliers to review quality status, audits of elements of the supplier, review of SPC data, and witnessing of specific operations or tests (Juran & Gryna, 1993). The supplier quality management that is considered for the present study is summarised in Table 10.1.

10.2.3 Client Focus and Involvement (CFI)

Client focus can be defined as the extent to which a company continuously satisfies client or customer desires and expectations. A successful company recognizes the need to put the customer first in every decision taken (Philips Quality, 1995). The key to quality management is keeping a close association with the customer in order to fully establish the customer's needs, as well as to receive feedback on the degree to which those needs are being met. The customer should take part in the product design and development process; with input at every point so that there is less probability of quality problems once full production begins (Flynn et al., 1994). Deming (1986) recommended that the customer is the most essential part of the production line and that the product should be aimed at the needs of the customer.

Receiving customer complaint information is to seek opportunities to improve product and service quality. Quality complaints have different problems that require different actions. Based on customer complaint information, it is important to identify the "vital few" serious complaints that demand in-depth study in order to discover the basic causes and to remedy those causes (Juran & Gryna, 1993). To improve customer focus efforts, customer complaints should therefore be treated with top priority. Records and analyses of customer complaint reports from the field furnish useful product-control information. Such information reflects the effectiveness of control programmes and highlights those nonconformities for which more aggressive corrective action must be initiated (Feigenbaum, 1991).

Obtaining customer satisfaction information is essential for pursuing customer focus efforts. Intensive examination of finished products from the viewpoint of the customer can be a useful predictor of customer satisfaction. Such information includes data on field failures and service-call rates, and analysis and reporting of customer attitude trends regarding product quality. Such information is valuable for new product development (Feigenbaum, 1991). The results of customer satisfaction surveys can be used to take immediate action on customer complaints, identify problems requiring generic corrective action, and provide a quantitative measurement of customer satisfaction (Juran & Gryna, 1993). Customer satisfaction may very well predict the future success or failure of a firm (Kanji & Asher, 1993). Thus, it is very important to achieve customer satisfaction and their perception of quality. The insights gained can clearly help the firm improve quality.

In-depth marketing research can identify suddenly arising customer needs. The attainment of quality requires the performance of a wide variety of identification activities of quality tasks such as the study of customers' quality needs, design review, and field complaint analysis (Juran & Gryna, 1993). To achieve quality, it is essential to know what customers need and then provide products that meet their requirements (Ishikawa, 1985). According to the review results from Hackman and Wageman (1995), obtaining data about customers is one of the most commonly used TQM implementation practices. Deming (1986) suggested that firms understand what the customer needs and wishes now and in the future so that products and services can be designed to satisfy those needs and wishes.

In order to pursue customer focus, firms should always provide warranties on their products sold to customers. Thus, customers will reduce their risk in buying products. In addition, firms should pay sufficient attention to customer services. In a word, pursuing customer focus efforts should be a long-term business strategy; it is never ending (Juran & Gryna, 1993). The consideration of customer focus and involvement for the present study is summarised in Table 10.1.

10.2.4 Construction Process Management and Improvement (CPMI)

Process refers to certain unique combinations of tools, machines, methods, materials, and people employed in production. Process control and improvement indicates a set of methodological and behavioral practices, which are implemented to control and improve processes that produce products and services (Juran & Gryna, 1993). In fact, process control and improvement can enable the manufacturing process to function as anticipated, without breakdowns, missing materials, fixtures, tools, and the like and regardless of workforce variability (Flynn et al., 1994). A set of practices of process control and improvement is described in the following paragraphs.

An essential issue in process control and improvement is the maintenance of process capability to meet production requirements. Process capability is mostly independent of specification tolerances for parts to be manufactured within the process. It is essential to establish these capabilities as elemental to product-control standards setting (Feigenbaum, 1991). Process capability study gives a basis for this determination and its associated assignment of parts to those facilities that can economically maintain the required tolerances (Gitlow et al., 1989).

Juran and Gryna (1993) stated that another aspect of process control and improvement is equipment maintenance, which enables variation to be kept within satisfactory limits and keeps the manufacturing process running efficiently. Feigenbaum (1991) asserted that manufacturing equipment inevitably wears under continuous usage which would result in poor-quality products. Hence, a programme of preventive maintenance is an essential quality management practice since it ensures a frequently scheduled examination of processing facilities before they break down.

A company should endeavour to design its process to be “foolproof” in order to reduce the possibility of worker mistake. Foolproofing explains methods, such as poka-yoke, which enable activities or operations to be carried out in the proper means. Foolproofing techniques can be divided into two types: Alarms and controls. Alarm devices may light a red lamp, sound a buzzer, or flash an alarm light if a mistake is detected. Control devices may interrupt work by activating a clamp, stopping a machine, or halting a conveyor if an error happens so that a defect does not shift on to the next process (Slack et al., 1995).

A number of quality techniques and tools can be applied to control and improve processes. These techniques comprise the seven QC tools and Plan, Do, Check, and Act (PDCA) cycle. The PDCA cycle is fundamentally the scientific technique applied to continuous process improvement (Dale, 1999; Deming, 1986; Mann, 1992). According to Dale (1999), statistical process control can also be applied to attain process stability and offer guidance on how the process may be improved. Statistical process control is the application of statistical techniques to the measurement and analysis of variation in any process (Juran & Gryna, 1993). Deming (1986) asserted that without statistical control, the process is in chaos, the noise of which will mask the effect of any effort to bring improvement.

Construction Process Management and Improvement for the current study should also consider quality system procedures improvement. Quality system procedures improvement is defined as the organizational structure, procedures, processes and resources required to apply quality management (ISO 8402, 1994). In 1987, the International Standardization Organization published the ISO 9000 standards series on quality management and quality assurance. Applying ISO 9000 is a way in seeking quality system improvement in a company. In this study, quality system improvement means to set up a quality system according to the specifications of ISO 9000. Through the execution of ISO 9000, a quality manual, quality system procedures, and work instructions are established. In the end, a firm may apply to be registered as having an ISO 9001 (9002 or 9003) quality certificate (Mirams & McElheron, 1995; Randall, 1995).

A quality manual is a document stating the quality policy and describing the quality system of an organization (ISO 8402, 1994), and should cover all the applicable elements of the quality system standard required for an organization. Guidelines for developing quality manuals (ISO 10013, 1995) can be used for drawing up a quality manual.

A procedure is a specified way to perform an activity. A written procedure contains the reasons and scope of an activity; what shall be done and by whom; when, where and how it should be done; what materials, equipment and documents shall be used; and how it shall be managed and documented. Documented quality system documents explain the activities of individual functional units required to apply the quality system elements (ISO 8402, 1994; ISO 10013, 1995). Work instructions include detailed work documents, which can guide individuals in performing specific work. It should be noted that drawing up various work instructions should be based on the existing documents and characteristics of the firm, and should be presented to different individuals for extensive review. Thus, these work instructions can be effectively implemented in practice (Mirams & McElheron, 1995; Randall, 1995).

It should be noted that a quality system should be consistently improved. Quality system documents should be consistently modified with the change of quality activities within the firm. It is essential to maintain the quality system's conformance with the ISO 9000 requirements at the same time (Randall, 1995). With an ISO 9000 quality system in place, a company may consider becoming ISO 9000 certified. This present study looks at Construction Process Management and Improvement that has been hypothesised for the development of a holistic TQM model and are summarised in Table 10.1.

10.2.5 Construction Employee Involvement and Motivation (CEIM)

Every organization is concerned with what should be done to achieve sustained high levels of performance through its workforce. This means giving close attention to how individuals can best be motivated through means such as incentives, rewards, and promotions, among others and the organizational context within which they carry out the work (Armstrong, 2006). The study of motivation is concerned with why people behave in a certain way. In general it can be described as the direction and persistence of action. Hence, motivation is defined as the set of processes that determine the choices people make about their behaviours. It is concerned with why people choose a particular course of action in preference to others, and why they continue with chosen action, often over a long period, and in the face of difficulties and problems (Mullins, 2005). Motivation can therefore be said to be at the heart of how innovative and productive things get done within an organization (Bloisi et al., 2003). Motivation is an abstract term. It imparts incentives that require a response on the part of someone else to achieve a defined goal. In business, motivation is not synonymous with salaries; money is a means for accommodating the economic needs of workers. Motivation means an inner wholesome desire to exert effort without the external stimulus of money.

Motivating is the ability of indoctrinating the personnel with a unity of purpose and maintaining a continuing, harmonious relationship among all people. It is a force which encourages and promotes a willingness of every employee to cooperate with every member of the team. To maintain it is to create and perpetuate the climate which brings harmony and equilibrium into the entire work group for the benefit of all who are involved – the company as a whole. It has been established that motivation is concerned with the factors that influence people to behave in certain ways. Arnold et al. (1991) established the following three components of motivation:

Direction: what the person is trying to do,

Effort: how hard a person is trying, and

Persistence: how long a person keeps on trying (Armstrong, 2006).

Since the effective motivation comes from within, by motivating others the manager can do more than create conducive conditions that cause people to do their work with willingness and enthusiasm. Motivating is the work managers perform to inspire, encourage and impel people to take action (Allen, 1986). To motivate the employee, the employee must be reached; to reach him there must be a completed understanding of the complexity his make-up (Allen, 1986). Motivation efforts must be directed towards improving company operations. To be effective, however, they must also be designed to show benefits to the employee. In fact, motivation can best be accomplished when workers are able to merge their personal ambitions with those of the company. According to Robin and DeCenzo (1995; 271) motivation is defined as "…the willingness to exert a high level of effort to reach organizational goals, conditioned by the effort's ability to satisfy some individual need". Campbell and Pritchard (1976) define motivation as a set of independent and dependant relationships that explain the direction, amplitude and persistence of an individual's behaviour, holding constant the effects of aptitude, skills, understanding of a task and the constraints operating in the work environment.

Schrader (1972) linked construction workers' needs to motivation, and it was subsequently concluded by Thomas et al. (1990) that there is evidence supporting the existence of a linkage between employees' motivational level and their individual performance. Atkinson (1964) defines it as the contemporary immediate influence on the direction, vigour, and persistence of action.

The relationship between the employer and employee must be one of understanding in order for the employee to identify himself with his work and with the business he is working for. Lack of motivation in return affects TQM. A number of symptoms may point to low morale: declining productivity, high employee turnover, increasing number of grievances, higher incidence of absenteeism and tardiness, increasing number of defective products, higher number of accidents or a higher level of waste materials and scrap (Day, 1978). A motivated employee is a loyal employee and to be loyal implies that the employee supports the actions and objectives of the firm. The appearance of the job as a whole has a bearing on the willingness and quality of an employee's performance (Bruce, 1962).

According to McClelland (1961), individuals tend to develop certain motivational drives on the cultural environment in which they live and these drives affect the way people view their jobs. McClelland suggests that achievement, affiliation, competence and power are four types of motivational drives that are found in individuals that are self-motivated and this may be the case for many construction workers. Motivation plays a part in enhancing construction labour productivity (Smithers & Walker, 2000) and forms the basis for the identification of the work environment factors. For example, Laufer and Moore (1983) advocated the use of financial incentive programmes to improve construction labour productivity, reinforcing Maloney's (1982) thesis of driving forces that lead to productivity improvements.

Autonomy and comradeship (Edwards & Eckblad, 1984) are also found to be important aspects that add to the way construction workers are self-motivated about their work. However, much work in linking motivation and productivity relied on Hertzberg's sample involving mainly white-collar professionals (Mullins, 1996). Furthermore Hofstede, (1980) decried such motivational theories as merely points made about the ad nauseam emphasis on the managerial perspective in the quest to improve productivity. John Borcherding and Clarkson Oglesby (1978) posited that a productive job creates high levels of job satisfaction while a non-productive job (one which falls behind schedule) produces dissatisfaction at all levels of the management/worker chain. The relationship is believed to be due to the very nature of construction, thus different from the one found in an office or factory setting where high levels of job satisfaction lead to greater productivity.

In construction, a worker, through his own efforts, produces a highly visible, physical structure in which great satisfaction comes from completion. Therefore, jobs that are well-planned and run smoothly produce great satisfaction while jobs with poor management (with scheduling and planning problems) create dissatisfaction. This illustrates the relationship between job satisfaction and productivity since well-managed jobs are generally more productive. A close review of all theories of human motivation reveals a common driving principle that people do what they are rewarded for doing. In general, the theories on motivation can be classified as employees need motivation through goal-setting, employee reward/incentives and reinforcement.

In order to keep construction workers motivated, their needs must be addressed as project goals are reached. Satisfying workers' needs can be viewed as distributing incentives when certain objectives are achieved. Employees have needs that they want met and employers have goals that they reach and they can work together as a team to satisfy the wants of both the employees and their employers (McKenzie & Lee, 1998). Workers who are motivated to help reach the goal of the employer and do so should be recognized with an incentive or reward. When considering what type of incentives to use there are two types to be aware of, namely extrinsic and intrinsic. Extrinsic rewards are external rewards that occur apart from work, such as money and other material things. On the other hand, intrinsic rewards are internal rewards that a person feels when performing a job so that there is a direct and immediate connection between work and reward.

The power of incentives is immense and pervasive, which is all the more reason they require careful management (McKenzie & Lee, 1998). Heap (1987) presented a summarized list of advantages and disadvantages associated with financial incentives. Many construction companies have already considered that there can be advantages and disadvantages of developing an incentive programme. A study by Sanders and Thompson (1999) showed that those companies that keep their programmes simple with the main objective of the programe in mind (to benefit the project in reference to cost, schedule, customer service, environment and quality) are also assured of the success of any incentive programme. Incentives are usually defined as tangible rewards that are given to those who perform at a given level. Such rewards may be available to workers, supervisors, or top managers. Whether the incentive is linked directly to such items as safety, quality or absenteeism, the reward follows successful performance (MaKenzie & Lee, 1998). Many companies feel that pocket money is no longer a good motivator. Others contend that small rewards such as toasters and blenders do not motivate. Many companies therefore offer profit-sharing plans. Some companies have abandoned monetary rewards and instead offer lavish trips to such places as Europe and some Caribbean islands. Because of the expense, these programmes require careful monitoring. Some companies merely reward good producers with an extra day off with pay (MaKenzie & Lee, 1998). Other concerns reward top performers with better working conditions. Since incentive programmes aim to increase workers' performance levels, the measure used to decide whether a reward has been earned should be carefully set. The performance level must be attainable or workers will not try to reach the goal. That fact underscores the usefulness of having workers themselves contribute their ideas about what constitutes a reasonable level of performance.

An incentive scheme may also fail if the measure of success ignores quality or safety. An obvious problem exists when an incentive is applied to work that is machine paced. Incentives should be clearly linked to performance, but not all incentives can be clearly tied to objective criteria (MaKenzie & Lee, 1998). Some incentive rewards are issued on the basis of a subjective assessment by a superior on the merit of particular workers. This method in particular may cause conflicts among workers, especially those who do not win rewards. This present study looks at construction employee involvement and motivation that has been hypothesised for the development of a holistic TQM model as is summarised in Table 10.1.

Table 110.1: Conceptual Model Latent Features

Latent Variable Construct	**Measurement Variables**
Leadership and Top Management (TML)	Leadership style Leadership ability in solving quality problems Leadership skills Leadership initiatives Leadership and top management knowledge in TQM Top management commitment in TQM Top management interaction with workers Top management participation Top management learning Top management empowerment Top management encouragement Top management's role model
Company Supplier Quality Management (CSQM)	Partnership with suppliers Supplier selection criteria Participation with suppliers Supplier performance evaluation Supplier quality audit Supplier communication Supplier knowledge of TQM Location of supplier Suppliers past records Suppliers commitment Cooperation from suppliers

	Suppliers orientation
Client Focus and Involvement (CFI)	Client brief/ input Client complaint information/feedback Market investigation Client satisfaction survey Quality warranty Client information system Client services Client cooperation Client orientation
Company Quality System Evaluation (CQSE)	Evaluation of strategy Evaluation of overall company performance Evaluation of departments' performance Evaluation of employee performance Evaluation of quality costs Evaluation of quality manual Evaluation of quality control system Evaluation of quality system procedures Evaluation of end results Quality audit Quality benchmarking Quality information system

Company Vision and Plan Statement (CVPS)	Vision statement Quality policy Overall business performance plan Product quality goal Quality improvement plan Formulation of vision and plan Concreteness of future plan Employee contribution to the vision Involvement of employees in the development of vision statement
Product Selection and Design Management (PSDM)	Client brief/input Cost implication Environmental issues Socio cultural issues Appearance/finishes required Strength of required Intended purpose of the material Where the material to be used Design methods/techniques Design detailing Concurrent engineering Design experiments/testing Quality function deployment

	Value engineering Computer-aided design
Construction Process Management and Improvement (CPMI)	Project monitoring and control improvement Equipment maintenance and innovation Inventory management Use of quality materials Use of quality tools Use of quality manual Understanding of work instructions/quality manual Quality system procedures improvement Obtaining ISO 9000 certification for operation Understanding of quality control system Continuity of quality control circle activities Appropriate use of system structure and standards Targets and priority measures Safe working environment Utilization of analysis results
Construction Employees' Involvement and Motivation (CEIM)	Education and training Salary promotion Position promotion Employee rewards

	Bonus scheme Conducive working environment Involvement of employees within-functional team Employee participation Employee suggestions Improving employee commitment Job rotation Involvement in quality control circle Employee involvement in cross-functional team Employee recognition
TQM Outcomes (TQMO)	Greater reduction of construction costs Higher product quality Improved schedule performance Elimination of reworks Defect-free product at first attempt Higher safety standards Higher productivity Good methods of working Higher profitability Higher reduction of construction waste

10.3 MODEL SPECIFICATION AND JUSTIFICATION

This thesis aims to build a conceptual TQM model. The theoretical conceptual framework for the current research is built on the work of Saraph et al. (1989), Flynn et al. (1994), Ahire et al. (1996) and Adusa–Poku (2014) whose works were also built on the previous Deming theory and that of quality award models, as discussed in Chapter 2 (Section 2.6.1 – 2.6.2). The theoretical essence of the Deming (1986) approach to TQM concerns the creation of an organizational system that fosters cooperation and learning for facilitating the implementation of process management practices, which, in turn, lead to continuous improvement of processes, products, and services as well as to employee fulfillment, both of which are critical to customer satisfaction, and ultimately, to firm survival. Adusa-Poku (2014) shared a similar view with Deming (1986). Adusa-Poku emphasised that process management, continuous improvement, employees' satisfaction/empowerment, supplier chain management, customer focus, management/leadership, and training are the set of basic factors forming the building blocks of the proposed TQM framework (Adusa-Poku, 2014). The proposed framework by Adusa-Poku (2014) is based on six criteria which are also based on European Foundation for Quality Management (EFQM). EFQM is also a quality model based on nine (9) elements; five (5) enablers and the four (4) elements are Results as explained in Chapter 2 (refer to section 2.6.1.2). It was argued that three basic criteria needed for a successful implementation of a TQM framework are process management, leadership commitment, and customer focus (Adusa-Poku, 2014). These three basic criteria are the triangular pillars on which TQM derives its support. Process Management is at the top of the triangle, indicating that without process management the framework will fail. Customer Focus and Management are the Human Resources who play their role effectively in managing all necessary processes. The customers include the internal and external customers. Any one of these criteria that fails leads to a failure of TQM. Adusa-Poku (2014) further stated that Continuous Improvement, Training, and Supplier Management are the connectors to the main pillars for an effective and efficient TQM implementation in the construction industry.

Saraph et al. (1989), Flynn et al. (1994), Ahire et al. (1996) as well as Adusa–Poku (2014) conceptualised TQM models which consists of the following common basic components:

leadership/management, supplier quality management, evaluation, process control and improvement, product design, employee participation, recognition and reward, education and training, and customer focus and involvement. The fundamental underpinning of four models, and the incorporated theoretical perspectives which have been adopted in other similar studies are therefore useful for conceptualizing the present study as a variety of TQM studies and TQM being conceptualized within the broader theoretical framework. Therefore, the conceptual framework for this thesis is primarily based on the approach used by Saraph et al. (1989), Flynn et al. (1994), Ahire et al. (1996) as well as Adusa–Poku, (2014). Based on the fundamental factors and constructs associated with all the previous models as revealed in Table 10.1, the present model or conceptual framework for the study looks at the leadership and top management, company supplier quality management, client focus and involvement, construction process management and improvement, and construction employee involvement and motivation. These factors have been measured in the majority of the previous studies, but consideration has not been given to company vision and plan statement, product selection and design management, and company quality system evaluation which have been classified as the exogenous variables and their role in predicting overall TQM, which is the endogenous variable. These will in turn, predict the construction industry implementation of TQM. The study aims to forecast the relative predictive power of these different variables for TQM in order to test or determine whether TQM implementation depends on the supposed features of the variables as indicated in the other frameworks, taking into account the needs of the construction industry in Ghana. It is apparent that some of the variables discussed above should be measured by objective means, some by subjective means and some include both forms of measurement. The reason for combining both objective and subjective indicators within the proposed model is supported by Campbell, Converse and Rogers (1976) and Falah, Al-Abed and Stan (1995) who stated that by themselves, objective indicators are often misleading and will remain so until indicators that human beings attached to them are obtained. Likewise, by themselves, subjective indicators are insufficient as guides to policy. The conceptual model theorises that TQM is established by the relationship that exists between the exogenous variables which include the basic elements by which the subjective and objective measurements are linked. These variables identified from the review of the literature are considered to be the major determinants of TQM. The determinants identified have been adopted to fit into the TQM implementation in the Ghanaian construction industry.

10.4 STRUCTURAL COMPONENT OF THE MODEL

The integrated TQM model for the Ghanaian construction industry in the case of developing countries is derived from Leadership and Top Management (LTM), Company Supplier Quality Management (CSQM), Company Quality System Evaluation (CQSE), Client Focus and Involvement (CFI), Company Vision and Plan Statement (CVPS), Product Selection and Design Management (PSDM), Construction Process Management and Improvement (CPMI), and Construction Employees' Involvement and Motivation (CEIM), in the process of achieving TQM in the construction industry. The TQM model to be tested in the postulated hypothesis not based on prior study or any examination is composed of LTM, CSQM, CQSE, CFI, CVPS, PSDM, CPMI, CEIM, and it is a multidimensional structure. The postulated model is presented in Figure 10.1 (Model 1.0). The conceptualized model is the notion that TQM implementation is related to the evaluation of many variables, such as LTM, CSQM, CQSE, CFI, CVPS, PSDM, CPMI, and CEIM. It is therefore difficult to discuss the principal variable without reference to variables of company vision and plan statement, product selection and design management, and company quality system evaluation and the inclusion of the other exogenous variables. In this study, the objective evaluation of TQM was assessed by measuring the actual condition of the construction industry that is an exogenous variable in the model.

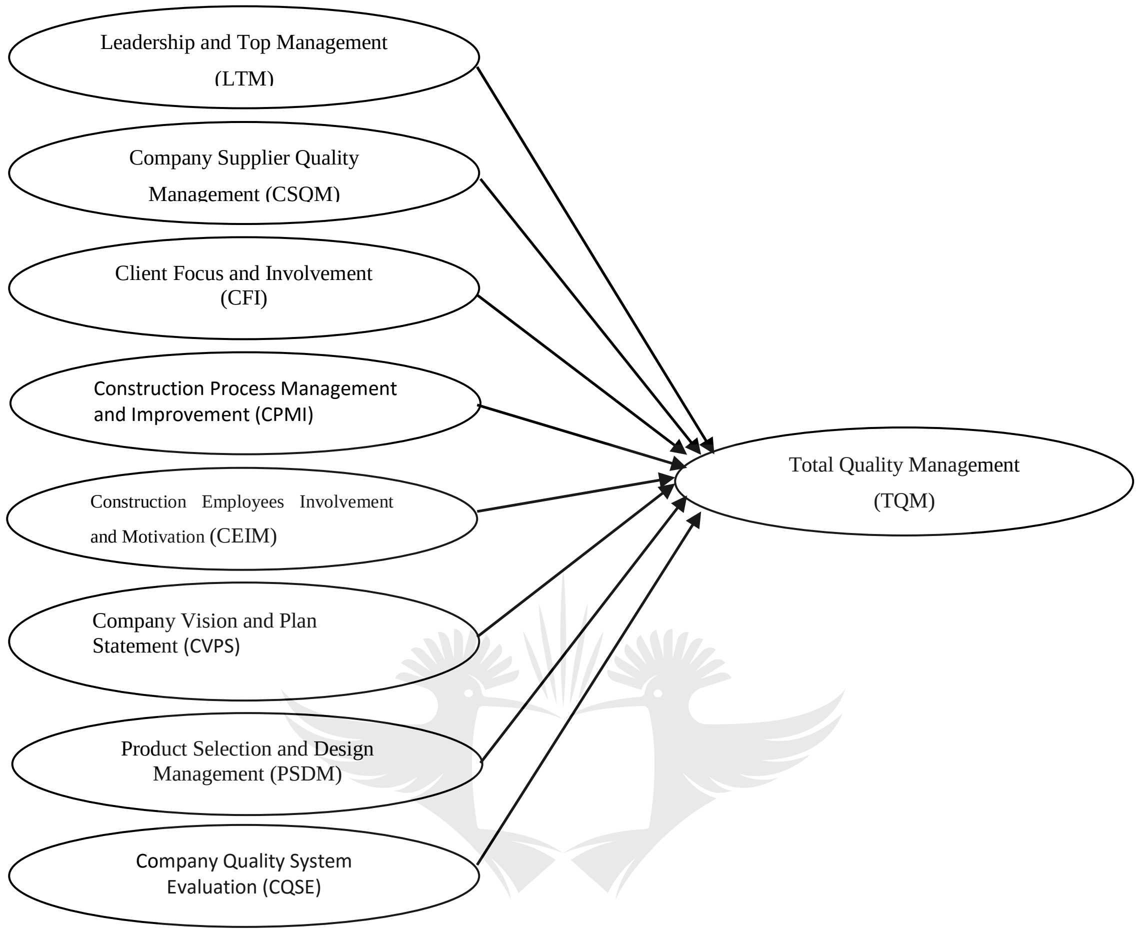

Figure 110.1: Integrated TQM Conceptualised Model (Model 1.0)

10.5 MEASUREMENT COMPONENT OF THE MODEL DYNAMIC

The measurement component of the hypothesized model comprises the following TQM implementation factors: LTM = 12 measurement variables; CSQM = 12 measurement variables; CFI = 9 measurement variables; CEIM = 14 measurement variables; CVPS = 9 measurement variables; PSDM = 15 measurement variables; CPMI = 15 measurement variables; CQSE = 12 measurement variables and TQMO = 10 manifest measurement variables. The success for the consideration of TQM implementation for the benefit of the construction industry has been theorised in the present model.

10.6 CONCLUSION

The theorised conceptual model given in this chapter is a multidimensional structure composed of eight latent variables of Leadership and Top Management, Company Supplier Quality Management, Client Focus and Involvement, Construction Process Management and Improvement, Construction Employees' Involvement and Motivation, Company Vision and Plan Statement, Product Selection and Design Management, and Company Quality System Evaluation. These factors were derived from the literature review. The explanation of the selected variables for the construction of the integrated TQM model has been highlighted in the theoretical framework in this chapter. Chapter 11 present the discussion of the survey results.

CHAPTER ELEVEN

11 SURVEY ANALYSIS

11.1 INTRODUCTION

The theoretical conceptual model is presented in Figure 10.1 (Model 1.0). The hypothesized integrated holistic TQM model theory is based on literature and the views of experts obtained during the Delphi study. The views of the experts have been described in detail Chapter 8. This chapter presents the descriptive statistics, inferential statistics and hypotheses testing results based on the questionnaire analysis. Statistical analyses techniques used to test the validity and reliability of the measuring instrument have been discussed in this chapter. Other statistical techniques used are the empirically testing of the proposed conceptual model presented in Chapter 10. The results obtained from the quantitative survey are provided and discussed. The data analysis was conducted in two stages:

i. Descriptive data analysis, and

ii. Multivariate correlational data analysis including exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and structural equation modelling (SEM) software EQations (EQS) Version 6.2 for analysis (Bentler, 1999).

A sample size of 536 questionnaires were answered by respondents and returned at the end of the survey. Greater model fit bias as indicated by Tong (2007) has been attributed to sample size which will affect the model fit. Therefore, the sample size obtained for the current study is considered as large (Kline, 2005:15). Harris and Schaubroeck (1990) indicated that a sample size of fewer than 100 cases will be difficult to analyse when the analytical tool to be used is SEM. A similar view has been shared by Kline (2005:15). Sometimes, appropriate sample size may depend on observed variables as indicated by Tong (2007) and supported by MacCallum, Browne and Sugawara (1996). The minimum sample of 200 for SEM analysis was used by Bentler and Chou in 1987. The variable ratio of an ideal SEM model has been suggested by Tong (2007) to be at least 5:1. This implies that a SEM model with 10 observed variables should have more than 50 respondents. For the purpose of this study the researcher collected 536 responses. There are 74 hypothesized observed variables and the ratio to sample size for the current study is 7.24:1. Therefore, the variable ratio to sample size meets the requirement recommendation in literature by Tong (2007). The sample data (536) was finally taken through random sampling before carrying out the EFA and CFA. A total of 275 samples were realized for the EFA analysis and 261 samples for the CAF analysis.

11.2 DESCRITIVE STATISTICS

This section provides demographic information on the individual respondents. The analyzed results for the descriptive data were the respondents' background information including their individual information and the company information. Descriptive statistics such as percentages, means and standard deviation were used in the analysis.

11.2.1 Demographic Profile of the Respondents and Firms

A total of 536 samples were realized for the study. The responses represent 85.1 per cent (N = 456) males and 14.9 per cent (N = 80) females, as shown in Table 11.1.

Table 11.1: Gender

Gender	Frequency	Percentage
Male	456	85.1
Female	80	14.9
Total	536	100.0

Source: Fieldwork (2018)

Table 11.2 shows that the majority of the respondents in the age group of 26 to30 years and 36 to 40 years constituted (26.9%; N=144) each of the sample, followed by the age group of 21 to 25 years (20.5%; N=110), 31 to 35years (17.2%; N=92), 41 to 45 years (6.0%: N=32), 15 to 20years (1.7%; N=9) and the age range 46 years and above which constituted (0.9%; N=5) of the sample.

Table11.2: Age Category

Age Category	Frequency	Percentage
15-20 years	9	1.7
21-25 years	110	20.5
26-30 years	144	26.9
31-35 years	92	17.2
36-40 years	144	26.9
41-45 years	32	6.0
46 years and above	5	0.9
Total	536	100.0

Source: Fieldwork (2018)

The highest education level of the majority of the sample respondents was a bachelor's degree (first degree) certificate (42.2%; N = 226), followed by postgraduate master's degree (MSc., MPhil.) (31.5; N = 169), a national/national certificate (25.45; N = 136) and the least number of the sample respondents held doctoral (PhD) degrees (0.9%; N=5) as shown in Table 11.3.

Table 11.3: Highest Qualification

Qualification	Frequency	Percentage
National/National Certificate	136	25.4
Bachelor's degree (first degree)	226	42.2
Postgraduate – Master's degree (MSc., MPhil.)	169	31.5
Doctoral degree (PhD)	5	0.9
Total	536	100.0

Source: Fieldwork (2018)

Table 11.4 shows that a large number of the respondents (30.0% ; N-161) have worked in the construction industry for between one to five years, followed by a group with six to ten years of service (25.2%; N = 135), eleven to fifteen years (23.3%; N = 125) , sixteen to twenty years (10.3%; N = 55), twenty-one to twenty-five years (6.7%; N = 36), twenty-six to thirty years (3.2%; N = 17) and the year range 31years and above constituted the least number of years of work experience in the construction industry, namely 1.3 per cent of the sample.

Table 11.4: Work Experience in the Construction Industry

Work experience	Frequency	Percentage
1-5 years	161	30.0
6-10 years	135	25.2
11-15 years	125	23.3
16-20 years	55	10.3
21-25 years	36	6.7
26-30 years	17	3.2
31 years and above	7	1.3
Total	536	100.0

Source: Fieldwork (2018)

The majority of the respondents (40.91%; N= 219) held the position of Site Engineer in their firm, followed by the Site Supervisor position (28.0%; N=150). The position of Quality Control Officer constituted the least (2.4 %; N=13) of the sample as shown in Table 11.5.

Table 11.5: Position Held in the Firm

Position	Frequency	Percentage
Project Manager	87	16.2
Site Engineer	219	40.9
Quality Control Officer	13	2.4
Supervisor	150	28.0
Foreman	27	5.0
Others	40	7.5
Total	536	100.0

Source: Fieldwork (2018)

Table 11.6 shows that a large number of the respondents (56.0%; N=300) have worked in their current firm for between one to five years, followed by a group with six to ten years, 11-15 years, 16-20 years, 21-25 years, and 26-30years representing (19.6%; N=105), (14.6%; N=78), (5.4%; N=29), (4.3%; N=23), (0.2%: N=1) respectively of the sample. The ranges of year thirty-one years and above constituted 0.0%.

Table 11.6: Tenure of Current Position

Tenure	Frequency	Percentage
1-5 years	300	56.0
6-10 years	105	19.6
11-15 years	78	14.6
16-20 years	29	5.4
21-25 years	23	4.3
26-30 years	1	0.2
31 or more years	0	0.0
Total	536	100.0

Source: Fieldwork (2018)

The majority of the respondents (29.3%; N=157) indicated their firms have been in existence in the range of six to ten years, followed by the range of eleven to fifteen years (17.4%; N=93). The firms with the year range of sixteen to twenty years constituted the least (5.6 %; N=30) of the sample as shown in Table 11.7.

Table 11.7: Existence of Firm

Firm Existence	Frequency	Percentage
1-5 years	85	15.9
6-10 years	157	29.3
11-15 years	93	17.4
16-20 years	30	5.6
21-25 years	64	11.9
26-30 years	35	6.5
31 or more years	72	13.4
Total	536	100.0

Source: Fieldwork

The majority of the construction projects currently undertaken by the firms were building construction projects (65.9%; N=353), followed by civil engineering projects (29.1%; N=156) while both building and civil construction projects constituted the least (5.0%; N=27) of the sample as shown in Table 11.8.

Table 11.8: Type of Current Construction Projects

Type of construction project	Frequency	Percentage
Building construction	353	65.9
Civil engineering	156	29.1
Both building and civil works	27	5.0
Total	536	100.0

Source: Fieldwork (2018)

Table 11.9 shows that a large number of the respondents (44.0%; N=236) worked with the D2/K2 class of contractors, followed by the D1/K1 class (32.6 %; N=175) and the D4/K4 class constituted the least (10.8%; N=58) of the sample.

Table 11.9: Classification of Firm

Classification	Frequency	Percentage
D1/K1	175	32.6
D2/K2	236	44.0
D3/K3	67	12.5
D4/K4	58	10.8
Total	536	100.0

Source: Fieldwork (2018)

11.2.2 Level of TQM Implementation in the Ghanaian Construction Industry

Table 11.10 indicates the level of TQM implementation in the Ghanaian construction industry in terms of percentage responses. The respondents were asked to choose between the following statements; ‘To no extent’, ‘To a small extent’, ‘To a moderate extent’, ‘To a large extent’, ‘Completely’ to indicate the level of TQM implementation in their firm. The majority of the respondents (38.1%; N=204) indicated that their firms have implemented TQM to a moderate extent, followed by 30.4%; N=163 indicating that their firms have implemented TQM to a large extent and the statement ‘To no extent’ constituted the least level TQM implementation by the firms, namely 2.4 per cent of the sample. This suggests that not all the firms under study have implemented TQM.

Table 11.10: TQM Implementation in the Ghanaian Construction Industry

Extent of TQM implementation	**Frequency**	**Percentage**
To no extent	13	2.4
To a small extent	106	19.8
To a moderate extent	204	38.1
To a large extent	163	30.4
Completely	50	9.3
Total	536	100.0

Source: Fieldwork (2018)

11.2.3 Attributes Influencing the Implementation of TQM in the Ghanaian Construction Industry

Table 11.11 indicates the Leadership and Top management features in terms of percentage responses on a scale of 1 (Not at all influential) to 5 (Extremely influential), and a MS ranging between 1.00 and 5.00. All the MSs are above the midpoint score of 3.00, which indicates that the respondents agreed with the Leadership and Top Management features of TQM implementation. It is notable that all the Leadership and Top Management features have a MS $> 4.00 \leq 5.00$, which indicates that the respondents perceive the Leadership and Top Management features to be between 'very influential' and 'extremely influential'. The relatively high MS = 4.02- 4.24 achieved suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana.

Table 11.11: Leadership and Top Management features

Attributes	Not at all influential……..Extremely					MS	SD	Rank
	1	2	3	4	5			
Top management participation in TQM	0.00	2.24	15.86	37.69	44.22	4.24	0.80	1
Top management support of TQM	0.00	4.85	19.96	27.43	47.76	4.18	0.92	2
Top management commitment to TQM	1.12	3.36	21.27	27.05	47.20	4.16	0.95	3
Leadership ability in solving quality-related problems	1.31	1.68	19.22	36.38	41.42	4.15	0.88	4
Top management knowledge and proper understanding of TQM	1.12	4.66	19.40	32.65	42.16	4.10	0.95	5
Leadership style of managing employees	0.00	4.29	18.84	39.55	37.31	4.10	0.85	5
Top management interaction with workers	0.19	2.24	20.34	42.16	35.07	4.10	0.81	5
Leadership initiatives towards TQM	0.00	3.54	23.13	35.82	37.50	4.07	0.86	6
Top management empowerment of employees	0.00	3.54	25.37	36.38	34.70	4.02	0.86	7

Source: Fieldwork (2018)

Table 11.12 indicates the Company Supplier Quality Management features in terms of percentage responses on a scale of 1 (Not at all influential) to 5 (Extremely influential), and a MS ranging between 1.00 and 5.00. All the MSs are above the midpoint score of 3.00, which indicates that the respondents agreed with the Company Supplier Quality Management features of TQM implementation. It is notable that all the Company Supplier Quality Management features have a MS $> 3.50 \leq 5.00$, which indicates that the respondents perceive the Company Supplier Quality Management features to be ‘very influential'. The relatively high MS = 3.88 - 4.13 achieved suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana.

Table 11.12: Company Supplier Quality Management Features

Attributes	**Not at all influential……..Extremely**					**MS**	**SD**	**Rank**
	1	2	3	4	5			
Supplier quality audit	0.19	2.80	19.40	38.99	38.62	4.13	0.83	1
Supplier knowledge of TQM	0.19	4.29	23.51	29.29	42.72	4.10	0.92	2
Supplier communication	0.19	2.43	21.83	39.37	36.19	4.09	0.83	3
Supplier performance evaluation	0.56	5.22	22.20	29.66	42.35	4.08	0.95	4
Participation of suppliers in TQM activities	0.19	8.40	16.23	35.07	40.11	4.07	0.96	5
Suppliers' commitment to TQM	0.56	4.48	24.81	28.92	41.23	4.06	0.94	6
Supplier selection criteria	0.00	6.53	16.79	44.22	32.46	4.03	0.87	7
Suppliers' orientation on TQM	0.19	3.73	26.49	38.06	31.53	3.97	0.86	8
Partnership with suppliers	0.00	4.66	30.41	37.50	27.43	3.88	0.87	9

Source: Fieldwork (2018)

Table 11.13 indicates the Client Focus and Involvement features in terms of percentage responses on a scale of 1 (Not at all influential) to 5 (Extremely influential), and a MS ranging between 1.00 and 5.00. All the MSs are above the midpoint score of 3.00, which indicates that the respondents agreed with the Client Focus and Involvement features of TQM implementation. It is notable that all the Client Focus and Involvement features have a MS > 4.00 ≤ 5.00, which indicates that the respondents perceive the Client Focus and Involvement features to be between 'very influential' and 'extremely influential'. The relatively high MS = 4.01- 4.29 achieved suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana.

Table 11.13: Client Focus and Involvement Features

Attributes	Not at all influential……..Extremely					MS	SD	Rank
	1	2	3	4	5			
Client cooperation	0.37	.19	15.86	37.50	46.08	4.29	0.76	1
Client information system	0.00	5.22	18.28	28.73	47.76	4.19	0.91	2
Quality warrant to client	0.00	1.87	18.10	41.23	38.81	4.17	0.78	3
Client services	0.00	3.54	19.59	39.18	37.69	4.11	0.84	4
Market investigation	0.19	2.99	19.03	41.42	36.38	4.11	0.82	4
Client satisfaction survey	0.00	7.09	15.49	41.42	36.01	4.06	0.89	5
Client compliant information/feedback	0.00	2.24	25.37	39.18	33.21	4.03	0.82	6
Client brief/input	0.00	3.36	24.25	40.11	32.28	4.01	0.84	7

Source: Fieldwork (2018)

Table 11.14 indicates the Company Quality System Evaluation features in terms of percentage responses on a scale of 1 (Not at all influential) to 5 (Extremely influential), and a MS ranging between 1.00 and 5.00. All the MSs are above the midpoint score of 3.00, which indicates that the respondents agreed with the Company Quality System Evaluation features of TQM implementation. It is notable that all the Company Quality System Evaluation features have a MS $> 4.00 \leq 5.00$, which indicates that the respondents perceive the Company Quality System Evaluation features to be between 'very influential' and 'extremely influential'. The relatively high MS = 4.11- 4.29 achieved suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana.

Table 11.14: Company Quality System Evaluation Features

Attributes	Not at all influential……..Extremely					MS	SD	Rank
	1	2	3	4	5			
Evaluation of overall company performance	0.00	2.43	11.57	40.86	45.15	4.29	0.76	1
Evaluation of the quality strategy framework	0.00	2.61	12.13	42.16	43.10	4.26	0.77	2
Evaluation of quality system procedures	0.00	2.99	15.30	37.69	44.03	4.23	0.81	3
Evaluation of the quality control system	1.12	1.49	18.47	35.82	43.10	4.18	0.86	4
Evaluation of the quality manual	0.37	1.87	20.15	34.51	43.10	4.18	0.84	4
Evaluation of the quality information system	0.00	5.22	12.50	41.42	40.86	4.18	0.84	4
Evaluation of end results	0.00	1.49	19.78	38.62	40.11	4.17	0.79	5
Evaluation of employee performance	0.19	4.29	14.93	40.30	40.30	4.16	0.85	6
Evaluation of quality costs	0.00	2.80	18.84	42.54	35.82	4.11	0.80	7

Source: Fieldwork (2018)

Table 11.15 indicates the Company Vision and Plan Statement features in terms of percentage responses on a scale of 1 (Not at all influential) to 5 (Extremely influential), and a MS ranging between 1.00 and 5.00. All the MSs are above the midpoint score of 3.00, which indicates that the respondents agreed with the Company Vision and Plan Statement features of TQM implementation. It is notable that all the Company Vision and Plan Statement features have a MS > 4.00 ≤ 5.00, which indicates that the respondents perceive the Company Vision and Plan Statement features to be between ‘very influential’ and ‘extremely influential’. The relatively high MS = 4.05- 4.28 achieved suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana.

Table 11.15: Company Vision and Plan Statement Features

Attributes	Not at all influential……..Extremely					MS	SD	Rank
	1	2	3	4	5			
Good quality policy and driven agenda	0.00	1.12	13.25	42.54	43.10	4.28	0.73	1
Involvement of employees in the development of the	0.00	2.80	18.47	34.89	43.84	4.20	0.84	2
Quality improvement plan	0.00	2.61	19.96	34.70	42.72	4.18	0.84	3
Clarity of vision and plan statement	0.00	4.66	18.10	38.81	38.43	4.11	0.86	4
Employee contribution to the vision	0.00	5.97	23.32	27.43	43.28	4.08	0.95	5
Concreteness of the future plan	0.00	6.34	21.08	33.77	38.81	4.05	0.92	6
Formulation of vision and plan	0.00	5.04	20.15	39.74	35.07	4.05	0.87	6

Source: Fieldwork (2018)

Table 11.16 indicates the Product Selection and Design Management features in terms of percentage responses on a scale of 1 (Not at all influential) to 5 (Extremely influential), and a MS ranging between 1.00 and 5.00. All the MSs are above the midpoint score of 3.00, which indicates that the respondents agreed with the Product Selection and Design Management features of TQM implementation. It is notable that all the Product Selection and Design Management features have a MS > 3.50 ≤ 5.00, which indicates that the respondents perceive the Product Selection and Design Management features to be ‘very influential’. The relatively high MS = 3.83- 4.23 achieved suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana.

Table 11.16: Product Selection and Design Management Features

Attributes	Not at all influential……..Extremely					MS	SD	Rank
	1	2	3	4	5			
Design methods/techniques	0.00	1.49	15.49	41.98	41.04	4.23	0.76	1
Strength required for the end product	0.00	1.12	19.40	36.94	42.54	4.21	0.79	2
Appearance/finishes required	0.00	3.17	17.72	39.37	39.74	4.16	0.82	3
Intended purpose of the material	0.00	2.80	19.22	37.87	40.11	4.15	0.83	4
Design detailing	0.00	.19	22.39	39.93	37.50	4.15	0.77	4
Where the material to be used	0.00	2.99	16.04	45.71	35.26	4.13	0.78	5
Environmental issues	0.00	5.97	16.04	36.75	41.23	4.13	0.89	5
Cost of selection and design of the product	0.00	5.41	15.11	42.54	36.94	4.11	0.85	6
Client brief/input	1.87	4.85	15.67	39.93	37.69	4.07	0.94	7
Socio-cultural issues	0.19	5.04	28.73	44.03	22.01	3.83	0.83	8

Source: Fieldwork (2018)

Table 11.17 indicates the Construction Process Management and Improvement features in terms of percentage responses on a scale of 1 (Not at all influential) to 5 (Extremely influential), and a MS ranging between 1.00 and 5.00. All the MSs are above the midpoint score of 3.00, which indicates that the respondents agreed with the Construction Process Management and Improvement features of TQM implementation. It is notable that all the Construction Process Management and Improvement features have a MS > 4.00 ≤ 5.00, which indicates that the respondents perceive the Construction Process Management and Improvement features to be between 'very influential' and 'extremely influential'. The relatively high MS = 4.02 - 4.33 achieved suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana.

Table 11.17: Construction Process Management and Improvement Features

Attributes	Not at all influential……..Extremely					MS	SD	Rank
	1	2	3	4	5			
Understanding of work instructions/quality manual	0.19	.56	18.66	26.87	53.73	4.33	0.81	1
Project monitoring and control improvement	0.00	4.10	13.43	36.19	46.27	4.25	0.84	2
Use of a quality tools	0.00	.19	17.54	39.93	42.35	4.24	0.74	3
Efficient management system	0.00	3.17	15.86	35.26	45.71	4.24	0.83	3
Use of quality materials	0.00	3.54	14.37	39.37	42.72	4.21	0.82	4
Equipment maintenance and innovation	0.00	.93	15.86	44.40	38.81	4.21	0.74	4
Quality control system	0.19	2.80	17.16	36.75	43.10	4.20	0.83	5
Use of quality manual	0.00	5.04	13.43	41.60	39.93	4.16	0.84	6
Appropriate use of system structure and standards	0.00	2.24	19.03	39.93	38.81	4.15	0.80	7
Institution of a continuous improvement process within	0.00	3.36	20.15	38.81	37.69	4.11	0.84	8
Inventory management	0.00	5.22	17.16	43.47	34.14	4.07	0.85	9
Obtaining ISO 9000 certification for operation	2.05	6.34	17.54	35.26	38.81	4.02	1.00	10

Source: Fieldwork (2018)

Table 11.18 indicates the Construction Employees Involvement and Motivation features in terms of percentage responses on a scale of 1 (Not at all influential) to 5 (Extremely influential), and a MS ranging between 1.00 and 5.00. All the MSs are above the midpoint score of 3.00, which indicates that the respondents agreed with the Construction Employees Involvement and Motivation features of TQM implementation. It is notable that all the Construction Employees Involvement and Motivation features have a MS > 4.00 ≤ 5.00, which indicates that the respondents perceive the Construction Employees Involvement and

Motivation features to be between 'very influential' and 'extremely influential'. The relatively high MS = 4.04- 4.29 achieved suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana.

Table 11.18: Construction Employees' Involvement and Motivation Features

Attributes	Not at all influential……. ……………Extremely influential					MS	SD	Rank
	1	2	3	4	5			
Teamwork	0.00	.75	12.13	44.78	42.35	4.29	0.70	1
Recognition of employees	0.19	1.31	20.34	34.33	43.84	4.20	0.82	2
Conducive working environment	0.00	3.92	17.54	37.13	41.42	4.16	0.85	3
Employee involvement in TQM activities	0.00	3.17	18.10	38.25	40.49	4.16	0.83	3
Education and training/re-training of staff	3.36	5.78	12.50	28.17	50.19	4.16	1.07	3
Salary/position promotion	0.00	4.48	16.98	39.74	38.81	4.13	0.85	4
Bonus scheme	0.19	7.84	15.11	33.40	43.47	4.12	0.95	5
Employee commitment	0.00	2.80	20.90	39.37	36.94	4.10	0.83	6
Employee reward	1.31	6.16	13.81	38.99	39.74	4.10	0.94	6
Availability of a suggestion forum for employees	0.19	2.24	26.31	35.82	35.45	4.04	0.85	7

Source: Fieldwork (2018)

11.2.4 Project Outcomes that Motivate Construction Companies to Implement TQM

Table 11.19 indicates the project outcomes that motivate firms to implement TQM in the Ghanaian construction industry in terms of percentage responses on a scale of 1 (Not a motivating factor) to 5 (Very high motivating), and a MS ranging between 1.00 and 5.00. All the MSs are above the midpoint score of 3.00, which indicates that the respondents agreed with the project outcomes that motivate firms to implement TQM in the Ghanaian construction industry. It is notable that all the ten ranked motivating factors influencing the implementation of TQM in the construction industry have a MS > 4.00 ≤ 5.00, which indicates that the respondents perceive the motivating factors influencing the implementation of TQM in the construction industry to be between ‘high motivating factor’ and ‘very high motivating factor’. All the rankings of motivating factors that motivate the implementation of TQM in the construction industry indicate MS> 4.08 - 4.35. The relatively high MS achieved suggests that all the motivating factors that motivate the implementation of TQM in the construction industry are very significant in driving TQM implementation among construction firms in Ghana.

Table 11.19: Project Outcomes that Motivate Construction Companies to Implement TQM

Project Outcomes	**Not a motivating factor…Very high motivating**					**MS**	**SD**	**Rank**
	1	2	3	4	5			
Higher productivity	0.00	.93	10.07	41.79	47.20	4.35	0.70	1
Good methods of working	0.00	.75	11.01	46.27	41.98	4.29	0.69	2
Higher product quality	0.00	1.12	15.49	37.50	45.90	4.28	0.76	3
Higher reduction of construction waste	1.12	1.31	10.82	42.35	44.40	4.28	0.79	3
Higher safety standards	0.00	.93	14.18	42.72	42.16	4.26	0.73	4
Higher profitability	0.00	.19	15.49	42.54	41.79	4.26	0.72	4
Defect-free product at first attempt	0.00	1.87	23.88	28.73	45.52	4.18	0.86	5
Elimination of reworks	1.12	3.54	17.54	39.18	38.62	4.11	0.89	6
Greater reduction of construction costs	3.54	3.17	18.66	30.04	44.59	4.09	1.04	7
Improvement schedule performance	0.00	3.73	20.90	39.37	36.01	4.08	0.84	8

Source: Fieldwork (2018)

11.2.5 Reasons for Non-Implementation (Non-Adoption) of TQM in Ghanaian Construction Industry

Table 11.20 indicates the factors influencing firms' non-implementation of TQM in the Ghanaian construction industry in terms of percentage responses on a scale of 1 (strongly disagree) to 5 (strongly agree), and a MS ranging between 1.00 and 5.00. All the MSs are above the midpoint score of 3.00, which indicates that the respondents agreed with the factors influencing firms' non-implementation of TQM in the Ghanaian construction industry. It is notable that all the sixteen ranked factors influencing firms' non-implementation of TQM in the Ghanaian construction industry have a MS $> 3.50 \leq 5.00$, which indicates that the respondents perceive the factors influencing firms' non-implementation of TQM in the Ghanaian construction industry to be between 'neutral' and 'agree'. All the rankings of factors influencing firms' non-implementation of TQM in the Ghanaian construction industry indicate MS> 3.79 - 4.33. The relatively high MS achieved suggests that these variables are the most common reasons why construction companies in Ghana do not implement or adopt TQM.

Table 11.20: Reasons for Non-Implementation (Non-Adoption) of TQM

Reasons/Factors	Strongly disagree…Strongly agree					MS	SD	Rank
	1	2	3	4	5			
Lack or limited knowledge of TQM	0.00	3.54	12.87	30.60	52.99	4.33	0.83	1
Lack of enforcement from the legislative bodies overseeing the implementation of TQM	0.00	2.43	18.47	33.96	45.15	4.22	0.83	2
Lack of efficient TQM management system	0.93	4.48	15.49	35.63	43.47	4.16	0.91	3
Lack of interest in the application of TQM	0.37	4.10	16.23	41.23	38.06	4.13	0.85	4
Absent of TQM policy	0.56	6.16	20.15	30.04	43.10	4.09	0.96	5

Reasons/Factors	Strongly disagree…Strongly agree					MS	SD	Rank
	1	2	3	4	5			
Lack of commitment from management	0.37	6.90	17.72	33.40	41.60	4.09	0.95	5
Reluctance to change old management technique	1.87	3.73	18.66	36.19	39.55	4.08	0.95	6
Lack of coordination of the implementation of TQM policy within the organization	0.00	9.33	13.62	38.25	38.81	4.07	0.95	7
Lack of training and inability to train and educate employees on TQM	2.05	2.24	19.59	39.74	36.38	4.06	0.91	8
Complex nature of TQM technique	0.19	3.54	23.13	36.57	36.57	4.06	0.87	8
Lack of TQM experts	0.00	7.46	21.08	32.09	39.37	4.03	0.95	9
Lack of finance in the management of TQM	1.12	8.21	20.52	33.77	36.38	3.96	1.00	10
Lack of understanding among construction professionals in applying	0.00	5.78	24.81	38.99	30.41	3.94	0.88	11
Perception that TQM may not yield any better results	3.92	5.41	23.32	34.70	32.65	3.87	1.06	12
TQM technique is costly	1.87	8.21	24.81	32.65	32.46	3.86	1.02	13
TQM technique is time consuming	0.37	10.07	28.17	33.40	27.99	3.79	0.98	14

Source: Fieldwork (2018)

11.2.6 PERFORMANCE OF CONSTRUCTION COMPANIES IN GHANA

Table 11.21 indicates the performance of construction companies in Ghana with performance indicators in terms of percentage responses on a scale of 1 (very poor) to 5 (excellent), and a MS ranging between 1.00 and 5.00. All the MSs are above the midpoint score of 3.00, which indicates that the respondents agreed with the performance indicators which determine the performance of construction companies in Ghana. It is notable that all the ten ranked performance indicators which determine the performance of construction companies in Ghana have a MS > 3.50 ≤ 4.50, which indicates that the respondents perceive the performance indicators which determine the performance of construction companies in Ghana to be between 'average' and 'good'. All the rankings of performance indicators which determine the performance of construction companies in Ghana indicate MS> 3.82 - 4.12. The relatively high MS achieved suggests that the performance of construction companies in Ghana is good.

Table 11.21: Performance of Construction Companies in Ghana

Performance indicators	**Very poor…………………Excellent**					**MS**	**SD**	**Rank**
	1	2	3	4	5			
Product quality	0.00	0.19	15.67	55.78	28.36	4.12	0.66	1
Productivity levels	0.00	0.37	20.15	49.44	30.04	4.09	0.71	2
Amount of waste produced	0.00	5.78	16.42	45.34	32.46	4.04	0.85	3
Degree of control over the construction process	0.00	2.61	16.79	55.60	25.00	4.03	0.72	4
Construction cost	0.00	2.24	26.12	40.86	30.78	4.00	0.81	5
Safety standards	0.56	5.97	19.40	41.42	32.65	4.00	0.90	5
Methods of working	0.56	2.61	16.98	61.75	18.10	3.94	0.71	6
Schedule performance	0.00	2.80	24.81	48.51	23.88	3.93	0.77	7
Defect-free product at first attempt	0.00	2.99	32.46	39.74	24.81	3.86	0.82	8
Reworks elimination	0.00	8.40	25.00	42.91	23.69	3.82	0.89	9

Source: Fieldwork (2018)

11.3 INFERENTIAL STATISTICS

11.3.1 Conceptual TQM Model Indicator Variables obtained after Exploratory Factor Analysis

A total of 536 samples were realized for the Exploratory Factor Analysis (EFA). Eight (8) factors including their indicator variables were presented for the EFA based on the 536 cases as shown in Table 11.22. The factors are as follows: Factor one (F 1) with nine (9) indicator variables, Factor two (F 2) with nine (9) indicator variables, Factor three (F 3) with eight (8) indicator variables, Factor four (F 4) with nine (9) indicator variables, Factor five (F 5) with seven (7) indicator variables, Factor six (F 6) with ten (10) indicator variables, Factor seven (F 7) with twelve (12) indicator variables, and Factor eight (F 8) with ten (10) indicator variables.

Table 11.22: Conceptual Model Indicator Variables

Indicator Variable	Measurement Variable
F1 LTM1	Leadership style of managing employees
F1 LTM2	Leadership ability in solving quality-related problems
F1 LTM3	Leadership initiatives towards TQM
F1 LTM4	Top management knowledge and proper understanding of TQM
F1LTM5	Top management commitment to TQM
F1 LTM6	Top management interaction with workers
F1 LTM7	Top management participation in TQM activities
F1 LTM8	Top management empowerment of employees to solve quality problems
F1 LTM9	

Indicator Variable	**Measurement Variable**
F2 CSQM1	Partnership with suppliers
F2 CSQM2	Supplier selection criteria
F2 CSQM3	Participation of suppliers in TQM activities
F2 CSQM4	Supplier performance evaluation
F2 CSQM5	Supplier quality audit
F2 CSQM6	Supplier communication
F2 CSQM7	Supplier knowledge of TQM
F2 CSQM8	Suppliers' commitment to TQM
F2 CSQM9	Suppliers' orientation on TQM
F3 CFI 1	Client brief/input
F3 CFI 2	Client compliant information/feedback
F3 CFI 3	
F3 CFI 4	Market investigation
F3 CFI 5	Client satisfaction survey
F3 CFI 6	
F3 CFI 7	Quality warrant to client
F3 CFI 8	Client information system
F4 CQSE1	Evaluation of overall company performance
F4 CQSE2	Evaluation of the quality strategy framework
F4 CQSE3	Evaluation of quality system procedures
F4 CQSE4	Evaluation of the quality control system
F4 CQSE5	Evaluation of the quality manual
F4 CQSE6	Evaluation of the quality information system
F4 CQSE7	Evaluation of end results
F4 CQSE8	Evaluation of employee performance

Indicator Variable	Measurement Variable
F5 CVPS	Clarity of vision and plan statement
F5 CVPS	Good quality policy and driven agenda
F5 CVPS	Quality improvement plan
F5 CVPS	Formulation of vision and plan
F5 CVPS	Concreteness of the future plan
F5 CVPS	Employee contribution to the vision
F5 C VPS	Involvement of employees in the development of the vision statement
F6 PSDM1	Client brief/input
F6 PSDM2	Cost of selection and design of the product
F6 PSDM3	Environmental issues
F6 PSDM4	Socio-cultural issues
F6 PSDM5	Appearance/finishes required
F6 PSDM6	Strength required for the end product
F6 PSDM7	Intended purpose of the material
F6 PSDM8	Where the material to be used
F6 PSDM9	Design methods/techniques
F6 PSDM10	

F7 CPMI1	Project monitoring and control improvement
F7 CPMI2	Equipment maintenance and innovation
F7 CPMI3	Inventory management
F7 CPMI4	Use of quality materials
F7CPMI5	Use of a quality tools
F7CPMI6	Use of quality manual
F7CPMI7	Understanding of work instructions/quality manual
F7CPMI8	Obtaining ISO 9000 certification for operation
F7CPMI9	Quality control system
F7CPMI10	Institution of a continuous improvement process within the company
F7CPMI11	Appropriate use of system structure and standards
F7CPMI12	Efficient management system
F8 CEIM1	Education and training/re-training of staff
F8 CEIM2	Teamwork
F8 CEIM3	Salary/position promotion
F8 CEIM4	Employee reward
F8 CEIM5	Bonus scheme
F8 CEIM6	Conducive working environment
F8 CEIM7	Employee involvement in TQM activities
F8 CEIM8	Availability of a suggestion forum for employees
F8 CEIM9	Employee commitment
F8 CEIM10	Recognition of employees

Source: Fieldwork (2018)

11.3.2 Results of Exploratory Factor Analysis Data

The theoretical conceptual model elements were analyzed using EFA. The Social Sciences (SPSS) version 20 software Package was used to evaluate the reliability, discriminant validity and convergent validity of the instrument. Principal axis factoring with oblimin rotation (PAF Oblimin) was the method of factor extraction used to determine the unidimensionality of the elements. The Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was based on the method used by Farrington (2009) to assess the factor analysability of data. Tabachnick and Fidell (2007) posit that the KMO should range from 0 to 1 and a minimum value of 0.60 was suggested as good for factor analysis. A value greater than 0.50 as a minimum cut-off value and a desirable cut-off value of 0.80 or higher was recommended. Furthermore, Hair et al. (1998) suggested a cut off value of KMO greater than or equal to 0.70. For the purpose of this study, data with KMOs of ≥0.70 ($p<0.05$) was considered factor analysable. In addition, eigenvalue was computed to establish the factors within the items proposed. Minimum eigenvalue 1 was considered significant and used to explain the variance captured by a factor. Eigenvalues of less than 1 were considered insignificant and therefore excluded (Hair et al., 1998).

Exploratory Factor Analysis: Dimensionality of TQM Elements

In the following section, the measures of reliability, convergent and discriminant validity for each of the factors realized through EFA (Table 11.22) are discussed.

Factor one (F1)

EFA was conducted to assess the unidimensionality and reliability of TQM. PAF Oblimin was specified as the extraction and rotation method. There were nine items measuring factor one (F1). The result of F1 is reported in Table 11.23. The corrected item-total correlation was greater than the suggested cut-off value of 0.30, suggesting that the items were good measures of the element and the Cronbach's alpha was greater than 0.700 at 0.930, indicating acceptable internal reliability (Nanually & Bernstein, 1994). The KMO of 0.919 with Bartlett's test of sphericity of $p<0.000$ was also obtained, indicating consistency with the recommended KMO cut-off value of 0.70 and Bartlett's test of sphericity of $p<0.05$ suggested by Hair et al. (2010). These results suggested that factor analysis could be conducted with the data. All the nine items (LTM1, LTM2, LTM3, LTM4, LTM5, LTM6, LTM7, LTM8 and LTM9) are expected to measure TQM loaded together on this factor. The factor loadings for all items were greater than 0.705 reported in Table 11.23, which were greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al. (1998).

Table 11.23: Factor one (F 1)

Item	Questions	Factor Loading	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
LTM1	Leadership style of managing employees	0.858	0.823	0.917
LTM2	Leadership ability in solving quality-related problems	0.755	0.726	0.923
LTM3	Leadership initiatives towards TQM	0.752	0.725	0.923
LTM4	Top management knowledge and proper understanding of TQM	0.831	0.797	0.919
LTM5	Top management commitment to TQM	0.780	0.750	0.922
LTM6	Top management interaction with workers	0.705	0.676	0.926
LTM7	Top management participation in TQM activities	0.707	0.682	0.926
LTM8	Top management empowerment of employees to solve quality problems	0.786	0.755	0.921
LTM9	Top management support of TQM	0.779	0.748	0.922

Source: Fieldwork (2018)

Factor two (F 2)

EFA was conducted to assess the unidimensionality and reliability of TQM. PAF Oblimin was specified as the extraction and rotation method. There were nine items measuring factor two (F2). The result of F2 is reported in Table 11.24. The corrected item-total correlation was greater than the suggested cut-off value of 0.30, suggesting that the items were good measures of the element and the Cronbach's alpha was greater than 0.700 at 0.911, indicating acceptable internal reliability (Nanually & Bernstein, 1994). The KMO of 0.891 with Bartlett's test of sphericity of $p<0.000$ was also obtained, indicating consistency with the recommended KMO cut-off value of 0.70 and Bartlett's test of sphericity of $p<0.05$ suggested by Hair et al. (2010). These results suggested that factor analysis could be conducted with the data. All the nine items (CSQM1, CSQM2, CSQM3, CSQM4, CSQM5, CSQM6, CSQM7, CSQM8 and CSQM9) are expected to measure TQM loaded together on this factor. The factor loadings for all items were greater than 0.585 reported in Table 11.24, which were greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al. (1998).

Table 11.24: Factor two (F 2)

Item	**Questions**	**Factor Loading**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
CSQM1	Partnership with suppliers	0.697	0.666	0.903
CSQM2	Supplier selection criteria	0.675	0.648	0.905
CSQM3	Participation of suppliers in TQM activities	0.773	0.734	0.899
CSQM4	Supplier performance evaluation	0.834	0.791	0.894
CSQM5	Supplier quality audit	0.585	0.560	0.910
CSQM6	Supplier communication	0.686	0.655	0.904
CSQM7	Supplier knowledge of TQM	0.810	0.764	0.896
CSQM8	Suppliers' commitment to TQM	0.773	0.717	0.900
CSQM9	Suppliers' orientation on TQM	0.739	0.702	0.901

Source: Fieldwork (2018)

Factor three (F 3)

EFA was conducted to assess the unidimensionality and reliability of TQM. PAF Oblimin was specified as the extraction and rotation method. There were eight items measuring factor three (F3). The result of F3 is reported in Table 11.25. The corrected item-total correlation was greater than the suggested cut-off value of 0.30, suggesting that the items were good measures of the element and the Cronbach's alpha was greater than 0.700 at 0.891, indicating acceptable internal reliability (Nanually & Bernstein, 1994). The KMO of 0.894 with Bartlett's test of sphericity of $p<0.000$ was also obtained, indicating consistency with the recommended KMO cut-off value of 0.70 and Bartlett's test of sphericity of $p<0.05$ suggested by Hair et al. (2010). These results suggested that factor analysis could be conducted with the data. All the eight items (CFI1, CFI2, CFI3, CFI4, CFI5, CFI6, CFI7, and CFI8) are expected to measure TQM loaded together on this factor. The factor loadings for all items were greater than 0.603 reported in Table 11.25, which were greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al. (1998).

Table 11.25: Factor three (F 3)

Item	**Questions**	**Factor Loading**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
CFI1	Client brief/input	0.768	0.716	0.872
CFI2	Client compliant information/feedback	0.763	0.711	0.873
CFI3	Market investigation	0.728	0.688	0.875
CFI4	Client satisfaction survey	0.723	0.674	0.877
CFI5	Quality warrant to client	0.651	0.610	0.882
CFI6	Client information system	0.776	0.728	0.871
CFI7	Client services	0.603	0.567	0.887
CFI8	Client cooperation	0.676	0.638	0.880

Source: Fieldwork (2018)

Factor four (F 4)

EFA was conducted to assess the unidimensionality and reliability of TQM. PAF Oblimin was specified as the extraction and rotation method. There were nine items measuring factor four (F4). The result of F4 is reported in Table 11.26. The corrected item-total correlation was greater than the suggested cut-off value of 0.30, suggesting that the items were good measures of the element and the Cronbach's alpha was greater than 0.700 at 0.915, indicating acceptable internal reliability (Nanually & Bernstein, 1994). The KMO of 0.914 with Bartlett's test of sphericity of $p<0.000$ was also obtained, indicating consistency with the recommended KMO cut-off value of 0.70 and Bartlett's test of sphericity of $p<0.05$ suggested by Hair et al. (2010). These results suggested that factor analysis could be conducted with the data. All the nine items (CQSE1, CQSE2, CQSE3, CQSE4, CQSE5, CQSE6, CQSE7, CQSE8 and CQSE9) are expected to measure TQM loaded together on this factor. The factor loadings for all items were greater than 0.676 reported in Table 11.26, which were greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al. (1998).

Table 11.26: Factor four (F4)

Item	**Questions**	**Factor Loading**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
CQSE1	Evaluation of the quality strategy framework	0.721	0.684	0.906
CQSE2	Evaluation of overall company performance	0.739	0.702	0.905
CQSE3	Evaluation of employee performance	0.772	0.732	0.903
CQSE4	Evaluation of quality costs	0.744	0.709	0.904
CQSE5	Evaluation of the quality manual	0.785	0.746	0.902
CQSE6	Evaluation of the quality control system	0.787	0.749	0.901
CQSE7	Evaluation of quality system procedures	0.724	0.692	0.906

CQSE8	Evaluation of end results	0.676	0.646	0.909
CQSE9	Evaluation of the quality information system	0.687	0.656	0.908

Source: Fieldwork (2018)

Factor five (F5)

EFA was conducted to assess the unidimensionality and reliability of TQM. PAF Oblimin was specified as the extraction and rotation method. There were seven items measuring factor five (F 5). The result of F 5 is reported in Table 11.27. The corrected item-total correlation was greater than the suggested cut-off value of 0.30, suggesting that the items were good measures of the element and the Cronbach's alpha was greater than 0.700 at 0.897, indicating acceptable internal reliability (Nanually & Bernstein, 1994). The KMO of 0.875 with Bartlett's test of sphericity of $p<0.000$ was also obtained, indicating consistency with the recommended KMO cut-off value of 0.70 and Bartlett's test of sphericity of $p<0.05$ suggested by Hair et al. (2010). These results suggested that factor analysis could be conducted with the data. All the seven items (CVPS1, CVPS2, CVPS3, CVPS4, CVPS5, CVPS6 and CVPS7) are expected to measure TQM loaded together on this factor. The factor loadings for all items were greater than 0.673 reported in Table 11.27, which were greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al. (1998).

Table 11.27: Factor five (F 5)

Item	Questions	Factor Loading	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
CVPS1	Clarity of vision and plan statement	0.787	0.737	0.878
CVPS2	Good quality policy and driven agenda	0.691	0.651	0.888
CVPS3	Quality improvement plan	0.673	0.632	0.890
CVPS4	Formulation of vision and plan	0.703	0.666	0.886

CVPS5	Concreteness of the future plan	0.779	0.734	0.878
CVPS6	Employee contribution to the vision	0.829	0.777	0.873
CVPS7	Involvement of employees in the development of the vision statement	0.755	0.710	0.881

Source: Fieldwork (2018)

Factor six (F6)

EFA was conducted to assess the unidimensionality and reliability of TQM. PAF Oblimin was specified as the extraction and rotation method. At the end of the EFA, F6 had two factor loadings which were relabelled as F6A – Product Design Management (PDM) and F6 B – Product Selection Management (PSM). There were six and four items measuring F6 A and F6 B respectively.

Factor six A (F6 A)

The result of F 6A is reported in Table 11.28. The corrected item-total correlation was greater than the suggested cut-off value of 0.30, suggesting that the items were good measures of the element and the Cronbach's alpha was greater than 0.700 at 0.849, indicating acceptable internal reliability (Nanually & Bernstein, 1994). The KMO of 0.882 with Bartlett's test of sphericity of $p<0.000$ was also obtained, indicating consistency with the recommended KMO cut-off value of 0.70 and Bartlett's test of sphericity of $p<0.05$ suggested by Hair et al. (2010). These results suggested that factor analysis could be conducted with the data. All the six items (PDM1, PDM2, PDM3, PDM4, PDM5 and PDM6) are expected to measure TQM loaded together on this factor. The factor loadings for all items were greater than 0.460 reported in Table 11.28, which were greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al. (1998).

Table 11.28: Product Design Management (PDM) - Factor six (F6A)

Item	Relabeled item	Questions	Factor Loading	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
PSDM4	PDM1	Socio-cultural issues	0.460	0.541	0.842
PSDM6	PDM2	Strength required for the end product	0.755	0.693	0.812
PSDM7	PDM3	Intended purpose of the material	0.659	0.651	0.820
PSDM8	PDM4	Where the material to be used	0.740	0.613	0.828
PSDM9	PDM5	Design methods/techniques	0.680	0.632	0.824
PSDM10	PDM6	Design detailing	0.728	0.668	0.817

Source: Fieldwork (2018)

Factor six B (F6 B)

The result of F6 B is reported in Table 11.29. The corrected item-total correlation was greater than the suggested cut-off value of 0.30, suggesting that the items were good measures of the element and the Cronbach's alpha was greater than 0.700 at 0.858, indicating acceptable internal reliability (Nanually & Bernstein, 1994). The KMO of 0.882 with Bartlett's test of sphericity of $p<0.000$ was also obtained, indicating consistency with the recommended KMO cut-off value of 0.70 and Bartlett's test of sphericity of $p<0.05$ suggested by Hair et al. (2010). These results suggested that factor analysis could be conducted with the data. All the four items (PSM1, PSM2, PSM3 and PSM4) are expected to measure TQM loaded together on this factor. The factor loadings for all items were greater than 0.624 reported in Table 11.29, which were greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al. (1998) except item PSM3 (Environmental issues) which recorded factor loading of 0.384 below the recommended value of 0.40.

Table 11.29: Product Selection Management (PSM) - Factor six (F6B)

Item	Relabeled item	Questions	Factor Loading	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
PSDM1	PSM1	Client brief/input	0.910	0.744	0.802
PSDM2	PSM2	Cost of selection and design of the product	0.839	0.776	0.789
PSDM3	PSM3	Environmental issues	0.384	0.572	0.872
PSDM5	PSM4	Appearance/finishes required	0.624	0.733	0.808

Source: Fieldwork (2018)

Factor seven (F7)

EFA was conducted to assess the unidimensionality and reliability of TQM. PAF Oblimin was specified as the extraction and rotation method. There were twelve items measuring factor eight (F8). The result of F 8 is reported in Table 11.30. The corrected item-total correlation was greater than the suggested cut-off value of 0.30, suggesting that the items were good measures of the element and the Cronbach's alpha was greater than 0.700 at 0.930, indicating acceptable internal reliability (Nanually & Bernstein, 1994). The KMO of 0.902 with Bartlett's test of sphericity of $p<0.000$ was also obtained, indicating consistency with the recommended KMO cut-off value of 0.70 and Bartlett's test of sphericity of $p<0.05$ suggested by Hair et al. (2010). These results suggested that factor analysis could be conducted with the data. All the twelve items (CPMI1, CPMI2, CPMI3, CPMI4, CPMI5, CPMI6, CPMI7, CPMI8, CPMI9, CPMI10, CPMI11 and CPMI12) are expected to measure TQM loaded together on this factor. The factor loadings for all items were greater than 0.645 reported in Table 11.30, which were greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al. (1998).

Table 11.30: Factor seven (F7)

Item	Questions	Factor Loading	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
CPMI1	Project monitoring and control improvement	0.719	0.689	0.924
CPMI2	Equipment maintenance and innovation	0.645	0.622	0.926
CPMI3	Inventory management	0.663	0.638	0.926
CPMI4	Use of quality materials	0.739	0.709	0.923
CPMI5	Use of a quality tools	0.675	0.653	0.925
CPMI6	Use of quality manual	0.708	0.684	0.924
CPMI7	Understanding of work instructions/quality manual	0.762	0.732	0.922
CPMI8	Obtaining ISO 9000 certification for operation	0.718	0.688	0.925
CPMI9	Quality control system	0.804	0.774	0.921
CPMI10	Institution of a continuous improvement process within the company	0.754	0.725	0.922
CPMI11	Appropriate use of system structure and standards	0.766	0.737	0.922
CPMI12	Efficient management system	0.752	0.721	0.923

Source: Fieldwork (2018)

Factor eight (F8)

EFA was conducted to assess the unidimensionality and reliability of TQM. PAF Oblimin was specified as the extraction and rotation method. There were ten items measuring factor nine (F8). The result of F 8 is reported in Table 11.31. The corrected item-total correlation was greater than the suggested cut-off value of 0.30, suggesting that the items were good measures of the element and the Cronbach's alpha was greater than 0.700 at 0.909, indicating acceptable internal reliability (Nanually & Bernstein, 1994). The KMO of 0.871 with Bartlett's test of sphericity of p<0.000 was also obtained, indicating consistency with the recommended KMO cut-off value of 0.70 and Bartlett's test of sphericity of $p<0.05$ suggested by Hair et al. (2010). These results suggested that factor analysis could be conducted with the data. All the ten items (CEIM1, CEIM2, CEIM3, CEIM4, CEIM5, CEIM6, CEIM7, CEIM8, CEIM9 and CEIM10) are expected to measure TQM loaded together on this factor. The factor loadings for all items were greater than 0.660 reported in Table 11.31, which were greater than the recommended value of 0.40 as suggested by Field (2005) and Hair et al. (1998).

Table 11.31: Factor eight (F8)

Item	**Questions**	**Factor Loading**	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
CEIM1	Education and training/re-training of staff	0.694	0.653	0.902
CEIM2	Teamwork	0.715	0.683	0.900
CEIM3	Salary/position promotion	0.709	0.674	0.900
CEIM4	Employee reward	0.826	0.789	0.892
CEIM5	Bonus scheme	0.688	0.656	0.901
CEIM6	Conducive working environment	0.737	0.705	0.898
CEIM7	Employee involvement in TQM activities	0.663	0.627	0.902
CEIM8	Availability of a suggestion forum for employees	0.691	0.654	0.901
CEIM9	Employee commitment	0.725	0.685	0.899
CEIM10	Recognition of employees	0.660	0.623	0.903

Source: Fieldwork (2018)

11.4 THE STRUCTURAL EQUATION MODELING (SEM)

The reason why SEM is preferred to other statistical approaches such as ANOVA and regression is because it displays better conditions to demonstrate causality. Three conditions to demonstrate causality are association, isolation and directionality (Hoyle, 1995:10). SEM is not distinctive in the first aspect for isolating and putative causes, it is more flexible and comprehensive than any univariate or multivariate modelling approaches, and SEM provides a means of controlling not only for extraneous or confounding variables, but for measurement error as well. Directionality is often greatly misunderstood. SEM can be shown with many statistical procedures because it comes from theory (research design) and sample logic. In the case of a model as a whole, SEM produces a good-fit and the result greatly supports the individual causal relationships within the model. The current research has clearly shown that measuring TQM is a complex construct. Therefore, in order to examine the factors that determine TQM in the Ghanaian construction industry, EQS Version 6.2 software was used to investigate the measurement model adequacy and structural model goodness-of-fit.

11.4.1 Structural Equation Modelling Analytic Strategy

This study aims to test a model of TQM for the Ghanaian construction industry. Three steps were conducted in the analysis which includes EFA, CFA and SEM using EQS software Version 6.2 for analysis. First, a series of CFA was used to test for the measurement equivalency for each of the nine latent constructs in Table 11.33 and the manifest or composite variables of TQM in the hypothesized model of TQM. The CFA results defined the relations between the observed and unobserved variables. The CFA provided the link between scores on a measuring instrument and the underlying constructs they are designed to measure. The CFA was carried out to reaffirm the factor structure of the observed and unobserved variables, hence the construct validity. Secondly, the fit of the entire measurement model underlying the hypothesized structural model was tested. The structural model defined the relationship amongst the different exogenous variables and specified the manner by which each exogenous variable directly or indirectly influences the changes in the values of other exogenous constructs in the model.

Thus, the endogenous variables were defined (TQM outcomes). All analyses were performed using Eqations software (EQS), including the testing of the hypothesized SEM. In SEM, a covariance matrix generated from a particular sample is compared with the covariance matrix generated from the hypothesized model and fit statistics are used to determine the acceptability of the solution obtained. Hu and Bentler (1999) have recommended using a combination of fit statistics to evaluate the fit of models (Table 11.34) as adopted for the current study.

11.4.2 Conceptual TQM Model Indicator Variables obtained after CFA

Table 11.33 gives details of the selected model after series of CFA on the nine (9) factors realized from the EFA. The model was realized during the CFA through the process of removing cases to achieve stronger models fit statistics. At the conclusion of the stated process, a nine-factor model was realized. All the eight original conceptual TQM latent constructs' names from Figure 10.1 (Model 1.0) were retained except that the latent construct with the name 'Product Selection and Design Management (PSDM)' had two factor loadings during EFA and was therefore separated with the following assigned names:

i. Product Selection Management (PSM)
ii. Product Design Management (PDM)

Substituted 'Product Selection and Design Management (PSDM)' with the two new latent constructs ('Product Selection Management' and 'Product Design Management'), the number of the latent constructs of the original conceptual TQM model in Figure 10.1 (Model 1.0) increased from eight to nine, hence a nine-factor model was realized. The nine-factor model therefore was deemed fit for the current study and presented in Table 11.32.

Table 11.32: Conceptual Model Indicator Variables

Latent Construct	Indicator Variable	Measurement Variable	Label
Leadership and Top Management (LTM)	F1 LTM1	Leadership style of managing employees	LTM1
	F1LTM4	Top management knowledge and proper understanding of TQM	LTM4
	F1LTM8	Top management empowerment of employees to solve quality problems	LTM8
	F1LTM9	Top management support of TQM	LTM9

Latent Construct	Indicator Variable	Measurement Variable	Label
Company Supplier Quality Management (CSQM)	F2CSQM4	Supplier performance evaluation	CSQM4
	F2CSQM7	Supplier knowledge of TQM	CSQM7
	F2CSQM8	Suppliers' commitment to TQM	CSQM8
Client Focus and Involvement (CFI)	F3CFI1	Client brief/input	CFI1
	F3CFI2	Client complaint information/feedback	CFI2
	F3CFI4	Client satisfaction survey	CFI4
Company Quality System Evaluation (CQSE)	F4CQSE1	Evaluation of the quality strategy framework	CQSE1
	F4CQSE2	Evaluation of overall company performance	CQSE2
	F4CQSE3	Evaluation of employee performance	CQSE3
Company Vision and Plan Statement (CVPS)	F5CVPS5	Concreteness of the future plan	CVPS5
	F5CVPS6	Employee contribution to the vision	CVPS6
	F5CVPS7	Involvement of employees in the development of the vision statement	CVPS7
Product Design Management (PDM)	F6A PDM2	Strength required for the end product	PDM2
	F6A PDM3	Intended purpose of the material	PDM3
	F6A PDM6	Design detailing	PDM6
Product Selection Management (PSM)	F6B PSM1	Client brief/input	PSM1
	F6B PSM2	Cost of selection and design of the product	PSM2
	F6B PSM4	Appearance/finishes required	PSM4

Construction Process Management and Improvement (CPMI)	F7CPMI9 F7CPMI10 F7CPMI11 F7CPMI12	Quality control system Institution of a continuous improvement process within the company Appropriate use of system structure and standards Efficient management system	CPMI9 CPMI10 CPMI11 CPMI12
Construction Employees' Involvement and Motivation	F8CEIM3 F8CEIM4 F8CEIM5	Salary/Position promotion Employee rewards Bonus scheme	CEIM3 CEIM4 CEIM5
TQM Outcomes (TQMO)	F9TQMO1 F9TQMO4 F9TQMO5 F9TQMO6	Greater reduction of construction costs Elimination of reworks Defect-free product at first attempt Higher safety standards	TQMO1 TQMO4 TQMO5 TQMO6

Source: Fieldwork (2018)

11.4.3 The Measurement Model Confirmatory Factor Analysis

After the constructs had demonstrated sufficient evidence of unidimensionality and reliability using EFA, a CFA was then administered. EQS version 6.2 with maximum likelihood robust estimator was used to analyze the construct validity of the measurement models. The types of goodness-of-fit indices and their acceptable cut-off values selected for this study are shown in Table 11.33.

Table 11.33: Cut-off Criteria for Fit Indices

Fit index	Acronym	Acceptable thresholds for continuous data	Reference
Chi-square test	x^2 test	Low x^2 relative *df* with an insignificant *p*-	Hooper et al. (2008); Hsu et al. (2012)
Normed chi-square	x^2/df ratio	Ratio of (x^2) to *df ≤2 or 3 good fit* Ratio of (x^2) to *df ≤5 acceptable*	Hsu et al., (2012) Kline (2005)
Root-mean squared-error of approximation	RMSEA	Values less than 0.05 with confidence interval (CI) 0.00-0.05 "good fit" Values greater than 0.06 to 0.08 with confidence interval 0.00-0.05 "acceptable fit" Values greater than 0.08 to 1.00 with confidence interval 0.00-0.05 "mediocre fit"	Schreiber et al. (2006); Hsu et al. (2012

Fit index	Acronym	Acceptable thresholds for continuous data	Reference
Comparative fit index	CFI	Equal or greater than 0.95 "good fit" Equal or greater than 0.90 "acceptable fit"	Schreiber et al. (2006) Hu & Bentler (1999)
Tucker-Lewis index	TLI/ NNFI	Equal or greater than 0.95 "good fit" or Equal or greater than 0.90 "acceptable fit"	Schreiber et al. (2006) Hu & Bentler (1999)
Standardized root mean square residual	SRMR	Equal or less than 0.05 "good fit" Equal or less than 0.08 "acceptable fit"	Schreiber et al.(2006) Hu & Bentler (1999)
Normed fit index	NFI	Greater than 0.90 "good fit"	Bentler and Bonnet (1980)

Source: Fieldwork (2018)

Statistics on SEM Assumptions - Outliers and Missing Data

Data sets investigation revealed that some data sets had missing values. A detailed examination of the pattern of missing data revealed that the missing data was missing at random (MAR) and not missing completely at random (MCAR). "The condition that data was missing completely at random is a situation where the presence or absence of the observation is independent of other observed variables and the variable itself" (McDonald & Ho, 2002:70). The condition of MCAR is a very strict assumption that may be difficult to justify in practice as suggested by McDonald and Ho (2002). Therefore, the assumption of the condition of MAR was adopted. Hence, the robust maximum likelihood estimation solution in EQS was used to address the problem. This method produces better results compared to other methods (Kline, 2005). The assumption in this method was that the means, variances and covariances were sufficient statistics. Consequently, cases with missing variables were skipped and not included in the analysis. Further examination of the data set revealed that there were a few outliers in the data. The EQS result output included case numbers with the largest contribution to Yuan, Lambert and Fouladi's normalized multivariate kurtosis. Examination of these case numbers showed the case numbers that include outliers and it was upon these inspections that the conclusion was based. It was concluded that there were a few outliers in the data. The robust maximum likelihood (RML) was adopted for estimation and it happened to be adequate in addressing the problems of outliers.

Statistics on SEM Assumptions – Data Distribution Characteristics

The model analysis began after the distribution characteristics of the data had been established through the maximum likelihood estimation. This method assumes multivariate normality. The EQS result output included univariate statistics such as mean, skewness, kurtosis and the respective standard deviations. Similarly, the multivariate kurtosis formed part of the result output. Analysis of the univariate statistics and Yuan, Lambert and Fouladi based on normalized multivariate kurtosis suggested non-normality in the sample data set. The result shows that all the Yuan, Lambert and Fouladi estimates of normalized multivariate kurtosis were greater than the upper limit value of 3.0 (DeCarlo, 1997:292). The outcome of the results led to descriptions of the data being highly kurtotic. However, the adoption of the robust maximum likelihood estimation method of the postulated model was due to the non-normality of the data. The results in the preceding sections as indicated by Satorra- Bentler scaled statistics (Satorra & Bentler, 1988) are reported using robust statistics for the chi-square. The first item of each factor is fixed to establish the factors' scale in the models. Yuan, Lambert and Fouladi's coefficient and other univariate statistics are presented in Table 11.34.

Statistics on SEM Assumptions – Identifiability of the Model

According to Boomsma (2000:466), "…the researcher has the responsibility of examining a model to ascertain whether it is theoretically identified or not". Therefore, a SEM analysis was conducted to identify the structural model. In addition to this, it must fulfill the conditions of model identification.

Table 11.34: Univariate Statistics and Yuan, Lambert and Fouladi's Normalized Multivariate Estimates

Latent Construct	Indicator Variable	Mean (x)	Skewness (G1)	Kurtosis (G2)	SD (σx)	Yuan, Lambert and Fouladi's
Leadership and Top Management (LTM)	LTM1	4.10	-0.608	-0.414	0.851	
	LTM4	4.10	-0.852	0.141	0.946	
	LTM8	4.02	-0.376	-0.844	0.862	
	LTM9	4.18	-0.744	-0.581	0.917	
Company Supplier Quality Management	CSQM4	4.08	-0.686	-0.414	0.949	
	CSQM7	4.10	-0.592	-0.689	0.918	
	CSQM8	4.06	-0.598	-0.547	.0.942	
Client Focus and Involvement (CFI)	CFI1	4.01	-0.369	-0.725	0.837	
	CFI2	4.03	-0.305	-0.884	0.822	
	CFI4	4.06	-0.725	-0.211	0.892	
Company Quality System Evaluation (CQSE)	CQSE1	4.26	-0.821	0.197	0.769	
	CQSE2	4.29	-0.864	0.254	0.763	
	CQSE3	4.16	-0.815	0.127	0.846	

Company Vision and Plan Statement (CVPS)	CVPS5 CVPS6 CVPS7	4.05 4.08 4.20	-0.585 -0.581 -0.673	-0.657 -0.838 -0.491	0.923 0.949 0.835	
Product Design Management (PDM)	PDM 2 PDM 3 PDM 6	4.21 4.15 4.15	-0.524 -0.589 -0.281	-0.797 -0.531 -1.168	0.788 0.826 0.765	
Product Selection Management (PSM)	PSM 1 PSM 2 PSM 4	4.07 4.11 4.16	-1.012 -0.738 -0.639	0.811 -0.081 -0.371	0.945 0.852 0.824	
Construction Process Management and Improvement (CPMI)	CPMI9 CPMI10 CPMI11 CPMI12	4.20 4.11 4.15 4.24	-0.752 -0.549 -0.543 -0.795	-0.119 -0.546 -0.551 -0.21	0.833 0.838 0.804 0.830	
Construction Employees' Involvement and Motivation (CEIM	CEIM3 CEIM4 CEIM5	4.13 4.10 4.12	-0.687 -1.008 -0.845	-0.266 0.607 -0.216	0.850 0.944 0.950	
TQM outcomes (TQMO)	TQMO1 TQMO4 TQMO5 TQMO6	4.09 4.11 4.18 4.26	-1.120 -0.891 -0.529 -0.592	0.844 0.578 -0.992 -0.425	1.036 0.891 0.859 0.730	

Source: Fieldwork (2018)

A model can be analysed when it has been identified. Therefore, it is necessary to carry out such an identification process. The section meant for results shows the identification (property of the model) test. As argued by Kline (2005:105), a model is said to be identified if it is theoretically possible to derive a unique estimate for each parameter. Kline (2005) further argued that the sample size does not matter if a model is not identified and it will be difficult to analyze it. A model can then be said to be identified if it has at least as many observations as free model parameters (namely, the degree of freedom ≥ 0) and that every unobserved variable must be assigned a scale (Kline, 2005:105). However, a model could be just-identified, over-identified or under-identified (Byrne, 2006:31). According to Byrne (2006:31), "…an over-identified model is one in which the number of parameters to be estimated is less than the number of data variances and covariances of the observed variables and therefore results in a positive degree of freedom". Kline (2005:31) posits that the significance of an over-identified model is that it allows for a model to be rejected, thereby rendering it of scientific value. A just-identified model cannot be rejected and it is not possible to obtain a solution for an under-identified model. The EQS result outputs showed that the lowest value for the degree of freedom was 0.0 and the highest value was 2.0 for the current study. These results show an over-identified model because the scores showed a positive value of degree of freedom.

11.4.4 Confirmatory Factor Analysis of the Latent Construct

The first step in assessing measurement invariance as indicated by Byrne (2006) is to conduct separate CFAs of the latent constructs. Therefore, a CFA was carried out on the exogenous variables (Leadership and Top Management, Company Supplier Quality Management, Client Focus and Involvement, Company Quality System Evaluation, Company Vision and Plan Statement, Product Selection Management, Product Design Management, Construction Process Management and Improvement and Construction Employees' Involvement and Motivation) and the endogenous variable (TQM Outcomes) to determine whether the measures used were sufficient indicators, to assess the coefficients and to reaffirm the factor structure of each construct. The fit of the items to the latent variables was further conducted with EQS 6.2 Statistical Software to explore the measurement model. If the fit of each of these models is good and the item loading is acceptable, it can be assumed that the indicators underlying the factor are tapping into the construct at hand in each of the latent constructs. This is in line with the practice established by McDonald and Ho (2002) and supported by the SEM experts' recommendations. The evaluation of models as attested by the experts should be derived from a large number of criteria rather than a single "magic index" (Kline, 2005; Byrne, 2006). Various goodness-of-fit indices were considered in the study to determine the goodness-of fit.

11.4.4.1 Fit Statistics on Measurement Models (CFA)

11.4.4.1.1 Measurement Model for Leadership and Top Management Features (LTM) Construct

A unidimensional model for Leadership and Top Management (LTM) features is presented (Table 11.33). From the 536 cases analyzed for this construct, four (4) indicator variables (F1LTM1, F1LTM4, F1LTM8, and F1LTM9) made up of the same factor were realized and the name LTM was maintained (Table 11.33). All four (4) indicator variables obtained were used for the CFA (Byrne, 2006:94; Joreskog & Sorbom, 1988). In order for a variable to be included in a CFA, thus enabling the model to be described as well-fitting, the distribution of residuals covariance matrix should be symmetrical and centred around zero (Byrne, 2006:94; Joreskog & Sorbom, 1988). The four-indicator model provides good measures of residual matrix and evidence of convergent validity.

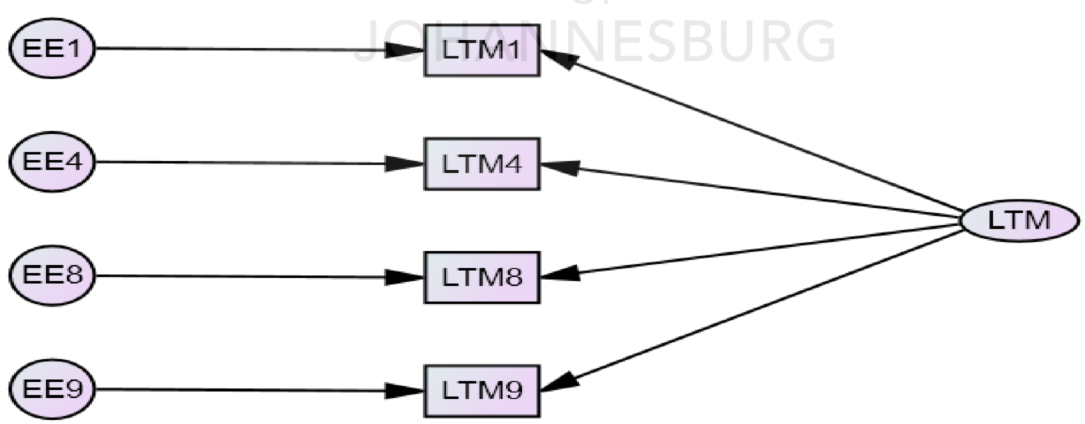

Figure 11.1: Measurement Model of Leadership and Top Management

The CFA results further revealed that the Leadership and Top Management features had four (4) dependent variables, five (5) independent variables and eight (8) free parameters. The number of fixed non-zero parameters was five (5). These are the four (4) dependent indicator variables for the Leadership and Top Management: Leadership style of managing employees, Top management knowledge and proper understanding of TQM, Top management empowerment of employees to solve quality problems, and Top management support of TQM**.** These indicator variables are presented in Table 11.36. The Leadership and Top Management features measurement model shown in Figure 11.1 was analyzed before it could be included in the full latent variable model. In order to establish how well the model fit the sample data and the strength of the hypothesized relationship between the variables, results on residual covariance matrix (unstandardized and standardized), distribution of standardized residuals, fit statistics and statistical significance at a probability level of 5 per cent were examined. In addition, the Cronbach's alpha and the rho coefficient of internal consistency were examined to determine the score reliability. Results of these statistics are presented in the next section for the Leadership and Top Management features.

Table 11.35: Postulated Leadership and Top Management Features Model

Latent constructs	**Indicator variables**	**Label**
Leadership and Top Management (LTM)	Leadership style of managing employees	LTM1
	Top management knowledge and proper understanding of TQM	LTM4
	Top management empowerment of employees to solve quality problems	LTM8
	Top management support of TQM	LTM9

Source: Fieldwork (2018)

Diagnostic Fit analysis: Analysis of Residual Covariance Estimate

The unstandardized and standardized absolute residual matrix values of the Leadership and Top Management features are presented in Table 11.36 and 11.37. The result reveals that all the absolute residual values and the average off-diagonal absolute residual values were close to zero. The unstandardized average off-diagonal residual was 0.0002 while the standardized average off diagonal residual was found to be 0.0015. A residual value greater than 2.58 is described as large (Byrne, 2006:94). The results obtained for the Leadership and Top Management features measurement model suggested a fairly acceptable fit to the sample data because the absolute residual were all less than 2.58. In order for a model to be described as well-fitting, the distribution of standardized residuals should be symmetrical and centred around zero (Byrne, 2006:94).

Table 11.36: Residual Covariance Matrix for Leadership and Top Management Model (Unstandardized)

Unstandardized Residual Covariance Matrix				
	LTM4	LTM9	LTM8	LTM1
LTM4	0.000			
LTM9	-0.019	0.000		
LTM8	0.008	0.008	0.000	
LTM1	0.005	0.01	-0.013	0.000
Average absolute residual = **0.0400**				
Average off-diagonal absolute residual = **0.0002**				
% falling between -0.1 +0.1 = 99.99%				

Source: Fieldwork (2018)

Further review of the frequency distribution reveals most residual values (99.99%) fall between -0.1 and +0.1, which is in the acceptable range. Of the remaining residuals, 0.01% fell outside the -0.1 to 0.1 ranges.

Table 11.37: Residual Covariance Matrix for Leadership and Top Management Model

Standardized Residual Covariance Matrix				
	LTM4	LTM9	LTM8	LTM1
LTM4	0.000			
LTM9	0.053	0.000		
LTM8	0.007	0.021	0.000	
LTM1	-0.019	-0.021	-0.007	0.000
Average absolute residual = **0.0009**				
Average off-diagonal absolute residual = **0.0015**				
% falling between -0.1 +0.1 = 99.99%				

Source: Fieldwork (2018)

From this information, the results suggested a measurement model that was well fitting despite a minimal discrepancy in fit between the hypothesized model and the sample data. Therefore, since this diagnostic fit analysis indicated a good fit, further tests of goodness-of-fit were possible to make a conclusive decision on the fit and appropriateness of the measurement model.

Goodness-of-fit Statistics – Robust Maximum Likelihood (RML)

The analysis strategy of goodness-of-fit for the Leadership and Top Management followed a three-statistics strategy of fit indexes as recommended by Hu and Bentler (1999). The sample data on Leadership and Top Management measurement model yielded the $S - B\chi 2$ of 6.827 with 2 degrees of freedom (*df*) with a probability of $p = 0.033$. This chi-square value indicated that the departure of the sample data from the postulated measurement model was significant and hence indicative of good fit. The chi-square test is very sensitive to sample size and is used more as a descriptive index of fit rather than as a statistical test (Kline, 2005:136). The normed chi-square value is usually adopted by most researchers. The normed chi-square is the procedure of dividing the chi-square by the degrees of freedom. The normed values of up to 3.0 or even 5.0 are recommended (Kline, 2005:137). Values for NFI range between 0 and 1 with Bentler and Bonnet (1980) recommended values greater than 0.90 indicating a good fit. Hu and Bentler

(1999) have given cut-off criteria of NFI ≥ 0.95. This index is sensitive to sample size, underestimating fit for samples less than 200 (Mulaik et al., 1989; Bentler, 1990) and is thus not recommended to be solely relied on (Kline, 2005). The non-normed fit index (NNFI, also known as the Tucker-Lewis index), is an index that prefers simpler models. The value of the NNFI can indicate poor fit despite other statistics pointing towards good fit if small samples are used (Bentler, 1990; Kline, 2005; Tabachnick & Fidell, 2007). Owing to the non-normed nature, NNFI values can go above 1.0 and can thus be difficult to interpret (Byrne, 1998). The chi-square and degrees of freedom were found to be 3.414. This ratio was within the limit of 3.00 or 5.0 advocated for by some authors (Kline, 2005:137). The CFI value was found to be 0.996 which was higher than the cut-off limit of 0.95 so the model is described to have a good fit. The NFI value was 0.995 which is above the given cut-off value of NFI ≥ 0.95 and is shown in Table 11.39. Therefore, the model is acceptable. The NNFI value obtained is 0.988 which is also above the cut-off value of 0.80. These fit indexes for the Leadership and Top Management model suggested that the postulated model adequately describes the sample data and could therefore be included in the full latent variable model analysis (Table 11.38).

Table 11.38: Robust Fit Indexes for Leadership and Top Management Features Construct

Fit Index	**Cut-off value**	**Estimate**	**Comment**
$S - B\chi^2$		6.827	
df	0≥	2	Good fit
Normed chi-square = x^2/df ratio	*≤2 or 3 good fit* *≤5 acceptable*	3.414	Good fit
CFI	0.90≥ acceptable 0.95≥ good fit	0.996	Good fit
RMSEA	Less than 0.05 with confidence interval (CI) 0.00-0.05 "good fit"	0.067	Acceptable

NFI	Greater than 0.90 "good fit"	0.995	Good fit
NNFI	Greater than 0.80. "good fit"	0.988	Good fit
RMSEA 95% CI		0.016: 0.125	Slightly out of range
SRMR	Equal or less than 0.05 "good fit" Equal or less than 0.08 "acceptable fit"	0.009	Good fit

Source: Fieldwork (2018)

Statistical Significance of Parameter Estimates

Table 11.39 shows the correlation values, standard errors and the test of statistics. All the correlation values were less than 1.00 and all the *Z*-statistics were greater than 1.96 and show appropriate signs. The estimates were therefore deemed reasonable as well as statistically significant. The parameter with the highest standardized coefficient was the indicator with variable LTM1 and LTM4 (Leadership style of managing employees and Top management knowledge and proper understanding of TQM) and its parameter coefficient was 0.847.

Table 11.39: Factor Loading and Z-statistics of Leadership and Top Management Measurement

Indicator Variable	Unstandardized Coefficient (λ)	Standardized Coefficient (λ)	*Z*-Statistics	R^2	Significant at 5% level?
LTM1	1.000	0.847	4.132	0.717	Yes
LTM4	1.111	0.847	3.361	0.718	Yes
LTM8	0.988	0.826	3.500	0.682	Yes
LTM9	0.995	0.783	2.417	0.613	Yes

(Robust Statistical Significance at 5% level)

Source: Fieldwork (2018)

Most of the parameter estimates had high correlation values close to 1.00. The high correlation values suggest a high degree of linear association between the indicator variables and the unobserved variable (Leadership and Top Management features). In addition, the R^2 values were also close to the desired value of 1.00, indicating that the factors explained more of the variance in the indicator variables. The results therefore suggest that the indicator variables significantly predict the unobserved construct because all the measured variables are significantly associated with the Leadership and Top Management features.

Internal Reliability and Validity of Scores

The internal consistency and reliability of scores for the Leadership and Top Management features construct were determined from the rho and the Cronbach's alpha coefficient. According to Kline (2005:59), the reliability coefficient should fall between zero and 1.00. Values close to 1.00 are desired. The rho coefficient of internal consistency was found to be 0.801. This value was above the minimum required value of 0.70. Likewise, the Cronbach's alpha was above the minimum acceptable value of 0.70. The Cronbach's alpha was found to be 0.895 (Table 11.40).

Both of these values revealed a high level of internal consistency and therefore reliability, suggesting that the indicator variables represent the same latent construct (Leadership and Top Management).

Table 11.40: Reliability and Construct Validity of Leadership and Top Management Feature Model

Factor	Indicator Variable	Factor Loading	Cronbach's Alpha	Rho Coefficient
Leadership and Top Management	LTM1	0.847	0.895	0.801
	LTM4	0.847		
	LTM8	0.826		
	LTM9	0.783		

*Parameter estimates are based on standardized solutions

Source: Fieldwork (2018)

Further, construct validity was determined from the magnitude and reasonableness of the parameter coefficients (factor loading). The parameter coefficients represent the magnitude of correlation or covariance between an item and a construct. Higher parameter coefficients show that the indicator variables have a stronger relationship with a construct and thus converge at a common point. Parameter coefficients of greater than 0.5 indicate a close relationship between the construct and an indicator variable. A parameter coefficient of 0.5 is interpreted as 25 per cent of the total variance in the indicator variable being explained by the latent variable (factor). Hence, a parameter coefficient should be 0.5 or higher, and ideally 0.7 or greater to explain about 50 per cent of the variance in an indicator variable (Hair et al., 1998:111). The standardized parameter coefficient presented in Table 11.40 revealed that all coefficients were significantly higher with the lowest being 0.783 for Leadership and Top Management features. The magnitude of the parameter estimate was above the 50 per cent minimum. This indicates a strong relationship between the indicator variables and the factors of the Leadership and Top

Management features construct. Therefore the Leadership and Top Management features satisfied both internal reliability and the construct criteria. The rho value was above the minimum value of 0.70 and the magnitude, signs and statistical significance of the parameter estimates were appropriate (Table 11.41).

Summary on Leadership and Top Management Feature Measurement Model

The CFA revealed that the residual covariance estimates fell within the acceptable range. Likewise, the robust fit indices met the cut-off index criteria and all the parameter estimates were statistically significant and feasible. Considering these criteria, the measurement model for the Leadership and Top Management feature was found to be adequately fit the sample data. Therefore, there was no need to improve the measurement model before it could be included in the full latent variable model. Hence, the Leadership and Top Management feature construct was adequately measured by the indicator variables and could be used in the analysis of the full latent variable model.

11.4.4.1.2 Measurement Model for Company Supplier Quality Management Features (CSQM) Construct.

A unidimensional model for Company Supplier Quality Management (CSQM) features is presented (Table 11.33). From the 536 cases analyzed for this construct, three (3) indicator variables (F2CSQM4, F2CSQM7, and F2CSQM8) made up of the same factor were realized and the name CSQM was maintained (Table 11.33). All the three (3) indicator variables obtained were used for the CFA (Byrne, 2006:94; Joreskog & Sorbom, 1988). In order for a variable to be included in a CFA, thus enabling the model to be described as well-fitting, the distribution of residuals covariance matrix should be symmetrical and centred around zero (Byrne, 2006:94; Joreskog & Sorbom, 1988). The three-indicator model provides good measures of residual matrix and evidence of convergent validity.

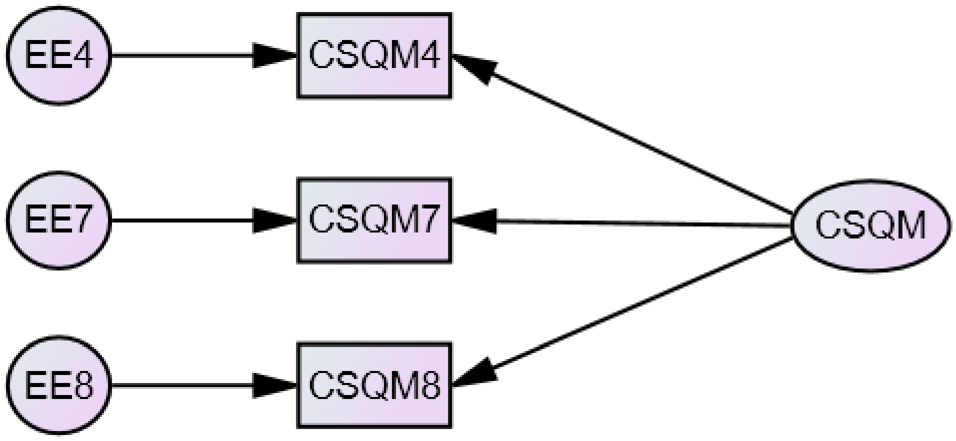

Figure 11.2: Measurement model of Company Supplier Quality Management

The CFA results further revealed that the Company Supplier Quality Management features had three (3) dependent variables, four (4) independent variables and six (6) free parameters. The number of fixed non-zero parameters was four (4). These are the three (3) dependent indicator variables for the Company Supplier Quality Management, namely Supplier performance evaluation, Supplier knowledge of TQM, and Suppliers' commitment to TQM. These indicator variables are presented in Table 11.41. The Company Supplier Quality Management features measurement model shown in Figure 11.2 was analyzed before it could be included in the full latent variable model.

In order to establish how well the model fit the sample data and the strength of the hypothesized relationship between the variables, results on residual covariance matrix (unstandardized and standardized), distribution of standardized residuals, fit statistics and statistical significance at a probability level of 5 per cent were examined. In addition, the Cronbach's alpha and the rho coefficient of internal consistency were examined to determine the score reliability. Results of these statistics are presented in the next section for the Company Supplier Quality Management features.

Table 11.41: Postulated Company Supplier Quality Management Features Model

Latent constructs	Indicator variables	Label
Company Supplier Quality Management (CSQM)	Supplier performance evaluation	CSQM4
	Supplier knowledge of TQM	CSQM7
	Suppliers' commitment to TQM	CSQM8

Source: Fieldwork (2018)

Diagnostic Fit Analysis: Analysis of Residual Covariance Estimate

The unstandardized and standardized absolute residual matrix values of the Company Supplier Quality Management features are presented in Table 11.42 and 11.43. The result reveals that all the absolute residual values and the average off-diagonal absolute residual values were close to zero. The unstandardized average off-diagonal residual was 0.000 while the standardized average off-diagonal residual was found to be 0.000. A residual value greater than 2.58 is described as large (Byrne, 2006:94). The results obtained for the Company Supplier Quality Management features measurement model suggested a fairly acceptable fit to the sample data because the absolute residuals were all less than 2.58. In order for a model to be described as well-fitting, the distribution of standardized residuals should be symmetrical and centred around zero (Byrne, 2006:94).

Table 11.42: Residual Covariance Matrix for Company Supplier Quality Management Model (Unstandardized)

Unstandardized Residual Covariance Matrix			
	CSQM8	CSQM4	CSQM7
CSQM8	0.000		
CSQM4	0.000	0.000	

CSQM7	0.000	0.000	0.000
Average absolute residual = **0.000**			
Average off-diagonal absolute residual = **0.000**			
% falling between -0.1 +0.1 = 99.99%			

Source: Fieldwork (2018)

Further review of the frequency distribution reveals most residual values (99.99%) fall between -0.1 and +0.1, which is in the acceptable range. Of the remaining residuals, 0.01% fell outside the -0.1 to 0.1 ranges.

Table 11.43: Residual Covariance Matrix for Company Supplier Quality Management Model (Standardized)

Standardized Residual Covariance Matrix			
	CSQM8	CSQM4	CSQM7
CSQM8	0.000		
CSQM4	0.000	0.000	
CSQM7	0.000	0.000	0.000
Average absolute residual = **0.000**			
Average off-diagonal absolute residual = **0.000**			
% falling between -0.1 +0.1 = 99.99%			

Source: Fieldwork (2018)

From this information, the results suggested a measurement model that was well fitting despite a minimal discrepancy in fit between the hypothesized model and the sample data. Therefore, since this diagnostic fit analysis indicated a good fit, further tests of goodness-of-fit were possible to make a conclusive decision on the fit and appropriateness of the measurement model.

Goodness-of-fit Statistics – Robust Maximum Likelihood (RML)

The analysis strategy of goodness-of-fit for the Company Supplier Quality followed a three-statistics strategy of fit indexes as recommended by Hu and Bentler (1999). The sample data on Company Supplier measurement model yielded the $S - B\chi 2$ of 0.000 with 0.000 degree of freedom (*df*) with a probability of $p = 0.000$. This chi-square value indicated that the departure of the sample data from the postulated measurement model was significant and hence indicative of good fit. The chi-square test is very sensitive to sample size and is used more as a descriptive index of fit rather than as a statistical test (Kline, 2005:136). The normed chi-square value is usually adopted by most researchers. The normed chi-square is the procedure of dividing the chi-square by the degrees of freedom. The normed values of up to 3.0 or even 5.0 are recommended (Kline, 2005:137).

Values for NFI range between 0 and 1 with Bentler and Bonnet (1980) recommended values greater than 0.90 indicating a good fit. Hu and Bentler (1999) have given a cut-off criterion of NFI $\geq$ 0.95. This index is sensitive to sample size, underestimating fit for samples less than 200 (Mulaik et al., 1989; Bentler, 1990), and is thus not recommended to be solely relied on (Kline, 2005). The non-normed fit index (NNFI, also known as the Tucker-Lewis index), is an index that prefers simpler models. The value of the NNFI can indicate poor fit despite other statistics pointing towards good fit if small samples are used (Bentler, 1990; Kline, 2005; Tabachnick & Fidell, 2007). Owing to their non-normed nature, NNFI values can go above 1.0 and can thus be difficult to interpret (Byrne, 1998). The chi-square and degrees of freedom were found to be 0.000. This ratio was lower than the limit of 3.00 or 5.0 advocated for by some authors (Kline, 2005:137).

The CFI value was found to be 1.000 which was greater than the cut-off limit of 0.95 so the model is described to have an acceptable fit. The NFI value was 1.000 which is slightly above the given cut-off value of NFI $\geq$ 0.95 is shown in Table 11.44. Therefore, the model is acceptable. The NNFI value obtained is 1.000 which is also above the cut-off value of 0.80. These fit indexes for the Company Supplier Quality Management model suggested that the postulated model adequately describes the sample data and could therefore be included in the full latent variable model analysis (Table 11.44).

Table 11.44: Robust Fit Indexes for Features Construct

Fit Index	**Cut-off value**	**Estimate**	**Comment**
S – Bχ²		0.000	
df	0≥	0.000	
Normed chi-square = x^2/df ratio	*≤2 or 3 good fit* *≤5 acceptable*	0.000	Good fit
CFI	0.90≥ acceptable 0.95≥ good fit	1.000	Good fit
RMSEA **95%**	Less than 0.05 with confidence interval (CI) 0.00-0.05 “good fit”	0.000	Good fit
NFI	Greater than 0.90 “good fit”	1.000	Good fit
NNFI	Greater than 0.80. “good fit”	1.000	Good fit
SRMR	Equal or less than 0.05 “good fit” Equal or less than 0.08 “acceptable fit”	0.000	Good fit

Source: Fieldwork (2018)

Statistical Significance of Parameter Estimates

Table 11.45 shows the correlation values, standard errors and the test of statistics. All the correlation values were less than 1.00 and all the *Z*-statistics were greater than 1.96 and show appropriate signs. The estimates were therefore deemed reasonable as well as statistically significant. The parameter with the highest standardized coefficient was the indicator with variable CSQM7 (Supplier knowledge of TQM) and its parameter coefficient was 0.893.

Table 11.45: Factor Loading and Z-statistics of Company Supplier Quality Management Measurement

Indicator Variable	Unstandardized Coefficient (λ)	Standardized Coefficient (λ)	*Z*-Statistics	R^2	Significant at 5% level?
CSQM4	0.895	0.773	4.547	0.598	Yes
CSQM7	1.000	0.893	2.467	0.798	Yes
CSQM8	0.959	0.834	3.100	0.696	Yes

(Robust Statistical Significance at 5% level)

Source: Fieldwork (2018)

Most of the parameter estimates had high correlation values close to 1.00. The high correlation values suggest a high degree of linear association between the indicator variables and the unobserved variable (Company Supplier Quality Management features). In addition, the R^2 values were also close to the desired value of 1.00, indicating that the factors explained more of the variance in the indicator variables. The results therefore suggest that the indicator variables significantly predict the unobserved construct because all the measured variables are significantly associated with the Company Supplier Quality Management features.

Internal Reliability and Validity of Scores

The internal consistency and reliability of scores for the Company Supplier Quality Management features construct was determined from the rho and the Cronbach's alpha coefficient. According to Kline (2005:59), the reliability coefficient should fall between zero and 1.00. Values close to 1.00 are desired. The rho coefficient of internal consistency was found to be 0.877. This value was above the minimum required value of 0.70. Likewise, the Cronbach's alpha was above the minimum acceptable value of 0.70. The Cronbach's alpha was found to be 0.871 (Table 11.46). Both of these values revealed a high level of internal consistency and therefore reliability, suggesting that the indicator variables represent the same latent construct (Company Supplier Quality Management).

Table 11.46: Reliability and Construct Validity of Company Supplier Quality Management Feature Model

Factor	Indicator Variable	Factor Loading	Cronbach's Alpha	Rho Coefficient
Company Supplier Quality Management	CSQM4	0.773	0.871	0.877
	CSQM7	0.893		
	CSQM8	0.834		

*Parameter estimates are based on standardized solutions

Source: Fieldwork (2018)

Further, construct validity was determined from the magnitude and reasonableness of the parameter coefficients (factor loading). The parameter coefficients represent the magnitude of correlation or covariance between an item and a construct. Higher parameter coefficients show that the indicator variables have a stronger relationship with a construct and thus converge at a common point. Parameter coefficients of greater than 0.5 indicate a close relationship between the construct and an indicator variable. A parameter coefficient of 0.5 is interpreted as 25 per cent of the total variance in the indicator variable being explained by the latent variable (factor). Hence, a parameter coefficient should be 0.5 or higher, and ideally 0.7 or greater to explain about 50 per cent of the variance in an indicator variable (Hair et al., 1998:111).

The standardized parameter coefficient presented in Table 11.46 revealed that all coefficients were significantly higher, with the lowest being 0.773 for Company Supplier Quality Management features. The magnitude of the parameter estimate was above the 50 per cent minimum. This indicates a strong relationship between the indicator variables and the factors of the Company Supplier Quality Management features construct. Therefore, the Company Supplier

Quality Management features satisfied both internal reliability and the construct criteria. The rho value was above the minimum value of 0.70, and the magnitude, signs and statistical significance of the parameter estimates were appropriate (Table 11.46).

Summary on Company Supplier Quality Management Feature Measurement Model

The CFA revealed that the residual covariance estimates fell within the acceptable range. Likewise, the robust fit indexes met the cut-off index criteria and all the parameter estimates were statistically significant and feasible. Considering these criteria, the measurement model for the Company Supplier Quality Management feature was found to adequately fit the sample data. Therefore, there was no need to improve the measurement model before it could be included in the full latent variable model. Hence, the Company Supplier Quality Management feature construct was adequately measured by the indicator variables and could be used in the analysis of the full latent variable model.

11.4.4.1.3 Measurement Model for Client Focus and Involvement Features (CFI) Construct.

A unidimensional model for Client Focus and Involvement (CFI) features is presented (Table 11.33). From the 536 cases analyzed for this construct, three (3) indicator variables (F3CFI1, F3CFI2, and F3CFI4) made up of the same factor were realized and the name CFI was maintained (Table 11.33). All the three (3) indicator variables obtained were used for the CFA (Byrne, 2006:94; Joreskog & Sorbom, 1988). In order for a variable to be included in a CFA, thus enabling the model to be described as well-fitting, the distribution of residuals covariance matrix should be symmetrical and centred around zero (Byrne, 2006:94; Joreskog & Sorbom, 1988). The five-indicator model provides good measures of residual matrix and evidence of convergent validity.

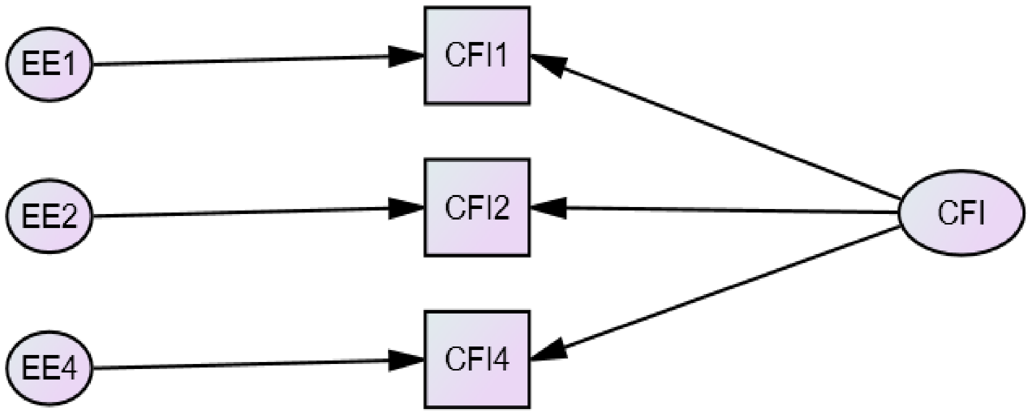

Figure 11.3: Measurement Model of Client Focus and Involvement

The CFA results further revealed that the Client Focus and Involvement features had three (3) dependent variables, four (4) independent variables and six (6) free parameters. The number of fixed non-zero parameters was four (4). These are the three (3) dependent indicator variables for the Client Focus and Involvement: Client brief/input, Client complaint information/feedback, and Client satisfaction survey. These indicator variables are presented in Table 11.47. The Client Focus and Involvement features measurement model shown in Figure 11.33 was analyzed before it could be included in the full latent variable model.

In order to establish how well the model fit the sample data and the strength of the hypothesized relationship between the variables, results on residual covariance matrix (unstandardized and standardized), distribution of standardized residuals, fit statistics and statistical significance at a probability level of 5 per cent were examined. In addition, the Cronbach's alpha and the rho coefficient of internal consistency were examined to determine the score reliability. Results of these statistics are presented in the next section for the Client Focus and Involvement features.

Table 11.47: Postulated Client Focus and Involvement Features Model

Latent constructs	Indicator variables	Label
Client Focus and Involvement (CFI)	Client brief/input	CFI1
	Client complaint information/feedback	CFI2
	Client satisfaction survey	CFI4

Source: Fieldwork (2018)

Diagnostic Fit Analysis: Analysis of Residual Covariance Estimate

The unstandardized and standardized absolute residual matrix values of the Client Focus and Involvement features are presented in Tables 11.48 and 11.49. The result reveals that all the absolute residual values and the average off-diagonal absolute residual values were close to zero. The unstandardized average off-diagonal residual was 0.000 while the standardized average off-diagonal residual was found to be 0.000. A residual value greater than 2.58 is described as large (Byrne, 2006:94). The results obtained for the Client Focus and Involvement features measurement model suggested a fairly acceptable fit to the sample data because the absolute residuals were all less than 2.58. In order for a model to be described as well-fitting, the distribution of standardized residuals should be symmetrical and centred around zero (Byrne, 2006:94).

Table 11.48: Residual Covariance Matrix for Client Focus and Involvement Model (Unstandardized)

Unstandardized Residual Covariance Matrix

	CFI4	CFI2	CFI1
CFI4	0.000		
CFI2	0.000	0.000	
CFI1	0.000	0.000	0.000

Average absolute residual = 0.000

Average off-diagonal absolute residual = 0.000
% falling between -0.1 +0.1 = 99.99%

Source: Fieldwork (2018)

Further review of the frequency distribution reveals most residual values (99.99%) fall between -0.1 and +0.1, which is in the acceptable range. Of the remaining residuals, 0.01% fell outside the -0.1 to 0.1 ranges.

Table 11.49: Residual Covariance Matrix for Client Focus and Involvement Model (Standardized)

Standardized Residual Covariance Matrix			
	CFI4	CFI2	CFI1
CFI4	0.000		
CFI2	0.000	0.000	
CFI1	0.000	0.000	0.000
Average absolute residual = 0.000			
Average off-diagonal absolute residual = 0.000			
% falling between -0.1 +0.1 = 99.99%			

Source: Fieldwork (2018)

From this information, the results suggested a measurement model that was well fitting despite a minimal discrepancy in fit between the hypothesized model and the sample data. Therefore, since this diagnostic fit analysis indicated a good fit, further tests of goodness-of-fit were possible to make a conclusive decision on the fit and appropriateness of the measurement model.

Goodness-of-fit Statistics – Robust Maximum Likelihood (RML)

The analysis strategy of goodness-of-fit for the Client Focus and Involvement followed a three-statistics strategy of fit indexes as recommended by Hu and Bentler (1999). The sample data on Client Focus and Involvement measurement model yielded the $S - B\chi2$ of 0.000 with 0.000

degree of freedom (*df*) with a probability of $p = 0.0000$. This chi-square value indicated that the departure of the sample data from the postulated measurement model was significant and hence indicative of good fit. The chi-square test is very sensitive to sample size and is used more as a descriptive index of fit rather than as a statistical test (Kline, 2005:136). The normed chi-square value is usually adopted by most researchers. The normed chi-square is the procedure of dividing the chi-square by the degrees of freedom. The normed values of up to 3.0 or even 5.0 are recommended (Kline, 2005:137).

Values for NFI range between 0 and 1 with Bentler and Bonnet (1980) recommended values greater than 0.90 indicating a good fit. Hu and Bentler (1999) have given a cut-off criterion of NFI ≥ 0.95. This index is sensitive to sample size, underestimating fit for samples less than 200 (Mulaik et al., 1989; Bentler, 1990) and is thus not recommended to be solely relied on (Kline, 2005). The non-normed fit index (NNFI, also known as the Tucker-Lewis index) is an index that prefers simpler models. The value of the NNFI can indicate poor fit despite other statistics pointing towards good fit if small samples are used (Bentler, 1990; Kline, 2005; Tabachnick & Fidell, 2007). Owing to their non-normed nature, NNFI values can go above 1.0 and can thus be difficult to interpret (Byrne, 1998). The chi-square and degrees of freedom were found to be 0.000. This ratio was lower than the limit of 3.00 or 5.0 advocated for by some authors (Kline, 2005:137).

The CFI value was found to be 1.000 which was greater than the cut-off limit of 0.95 so the model is described to have an acceptable fit. The NFI value was 1.000 which is within the given range, but the given cut-off value of NFI ≥ 0.95 is shown in Table 11.50. Therefore, the model is acceptable. The NNFI value obtained is 1.000 which is also above the cut-off value of 0.80. These fit indexes for the Client Focus and Involvement model suggested that the postulated model adequately describes the sample data and could therefore be included in the full latent variable model analysis (Table 11.50).

Table 11.50: Robust Fit Indexes for Client Focus and Involvement Features Construct

Fit Index	Cut-off value	Estimate	Comment
***S – B*χ^2**		0.000	
df	0≥	0.000	
Normed chi-square = x^2/df ratio	*≤2 or 3 good fit* *≤5 acceptable*		
CFI	0.90≥ acceptable 0.95≥ good fit	1.000	Good fit
RMSEA **95%**	Less than 0.05 with confidence interval (CI) 0.00-0.05 “good fit”	0.000	Good fit
NFI	Greater than 0.90 “good fit”	1.000	Good fit
NNFI	Greater than 0.80. “good fit”	1.000	Good fit
SRMR	Equal or less than 0.05 “good fit” Equal or less than 0.08 “acceptable	0.000	Good fit

Source: Fieldwork (2018)

Statistical Significance of Parameter Estimates

Table 11.51 shows the correlation values, standard errors and the test of statistics. All the correlation values were less than 1.00 and all the *Z*-statistics were greater than 1.96 and show appropriate signs except CFI4 the value of which (1.895) was slightly below 1.96. However, the estimates were deemed reasonable as well as statistically significant. The parameter with the highest standardized coefficient was the indicator with variable CFI1 (Client brief/input) and its parameter coefficient was 0.825.

Table 11.51: Factor Loading and Z-statistics of Client Focus and Involvement Measurement

Indicator Variable	Unstandardized Coefficient (λ)	Standardized Coefficient (λ)	*Z*-Statistics	R^2	Significant at 5% level?
CFI1	1.000	0.825	4.125	0.714	Yes
CFI2	0.979	0.823	3.532	0.655	Yes
CFI4	0.928	0.718	2.211	0.524	Yes

(Robust Statistical Significance at 5% level)

Source: Fieldwork (2018)

Most of the parameter estimates had high correlation values close to 1.00. The high correlation values suggest a high degree of linear association between the indicator variables and the unobserved variable (Client Focus and Involvement). In addition, the R^2 values were also close to the desired value of 1.00, indicating that the factors explained more of the variance in the indicator variables. The results therefore suggest that the indicator variables significantly predict the unobserved construct because all the measured variables are significantly associated with the Client Focus and Involvement features.

Internal Reliability and Validity of Scores

The internal consistency and reliability of scores for the Client Focus and Involvement features construct were determined from the rho and the Cronbach's alpha coefficient. According to Kline (2005:59), the reliability coefficient should fall between zero and 1.00. Values close to 1.00 are desired. The rho coefficient of internal consistency was found to be 0.724. This value was above the minimum required value of 0.70. Likewise, the Cronbach's alpha was above the minimum acceptable value of 0.70. The Cronbach's alpha was found to be 0.834 (Table 11.53). Both of these values revealed a high level of internal consistency and therefore reliability, suggesting that the indicator variables represent the same latent construct (Client Focus and Involvement).

Table 11.52: Reliability and Construct Validity of Client Focus and Involvement Feature Model

Factor	Indicator Variable	Factor Loading	Cronbach's Alpha	Rho Coefficient
Client Focus and Involvement	CFI1 CFI2 CFI4	0.825 0.823 0.718	0.834	0.724

*Parameter estimates are based on standardized solutions

Source: Fieldwork (2018)

Furthermore, construct validity was determined from the magnitude and reasonableness of the parameter coefficients (factor loading). The parameter coefficients represent the magnitude of correlation or covariance between an item and a construct. Higher parameter coefficients show that the indicator variables have a stronger relationship with a construct and thus converge at a common point. Parameter coefficients of greater than 0.5 indicate a close relationship between the construct and an indicator variable. A parameter coefficient of 0.5 is interpreted as 25 per cent of the total variance in the indicator variable being explained by the latent variable (factor). Hence, a parameter coefficient should be 0.5 or higher, and ideally 0.7 or greater to explain about 50 per cent of the variance in an indicator variable (Hair et al., 1998:111).

The standardized parameter coefficient presented in Table 11.51 revealed that all coefficients were significantly higher with the lowest being 0.718 for Client Focus and Involvement features. The magnitude of the parameter estimate was below the 50 per cent minimum. This indicates a weak relationship between the indicator variables and the factors of the Client Focus and Involvement features construct. Therefore the Client Focus and Involvement features satisfied both internal reliability and the construct criteria. The rho value was above the minimum value of 0.70, and the magnitude, signs and statistical significance of the parameter estimates were appropriate (Table 11.52).

Summary on Client Focus and Involvement Feature Measurement Model

The CFA revealed that the residual covariance estimates fell within the acceptable range. Likewise, the robust fit indexes met the cut-off index criteria and all the parameter estimates were statistically significant and feasible. Considering these criteria, the measurement model for the Client Focus and Involvement feature was found to adequately fit the sample data. Therefore, there was no need to improve the measurement model before it could be included in the full latent variable model. Hence, the Client Focus and Involvement feature construct was adequately measured by the indicator variables and could be used in the analysis of the full latent variable model.

11.4.4.1.4 Measurement Model for Company Quality System Evaluation features (CQSE) Construct

A unidimensional model for Company Quality System Evaluation **(CQSE)** features is presented (Table 11.33). From the 536 cases analysed for this construct, three (3) indicator variables (F4CQSE1, F4CQSE2, and F4CQSE3) made up of the same factor were realized and the name CQSE was maintained (Table 11.33). All the three (3) indicator variables obtained were used for the CFA (Byrne, 2006:94; Joreskog & Sorbom, 1988). In order for a variable to be included in a CFA, thus enabling the model to be described as well-fitting, the distribution of residuals covariance matrix should be symmetrical and centred around zero (Byrne, 2006:94; Joreskog & Sorbom, 1988). The three-indicator model provides good measures of residual matrix and evidence of convergent validity.

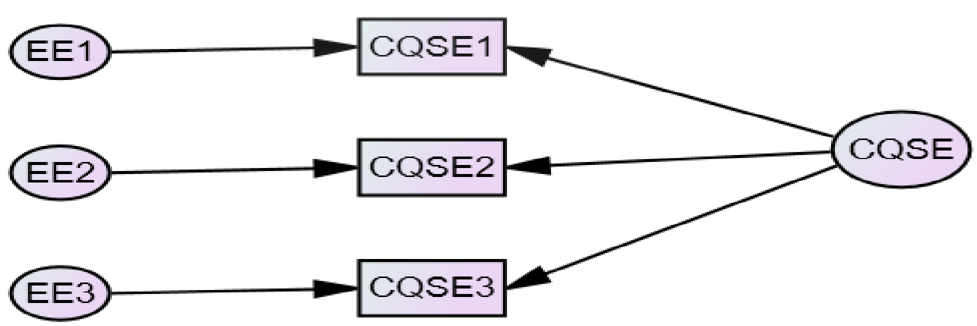

Figure 11.4: Measurement Model of Company Quality System Evaluation

The CFA results further revealed that the Company Quality System Evaluation features had three (3) dependent variables, four (4) independent variables and six (6) free parameters. The number of fixed non-zero parameters was four (4). These are the three (3) dependent indicator variables for the Company Quality System Evaluation: Evaluation of the quality strategy framework, Evaluation of overall company performance, and Evaluation of employee performance. These indicator variables are presented in Table 11.53. The Company Quality System Evaluation features measurement model shown in Figure 11.4 was analyzed before it could be included in the full latent variable model.

In order to establish how well the model fit the sample data and the strength of the hypothesised relationship between the variables, results on residual covariance matrix (unstandardized and standardized), distribution of standardized residuals, fit statistics and statistical significance at a probability level of 5 per cent were examined. In addition, the Cronbach's alpha and the rho coefficient of internal consistency were examined to determine the score reliability. Results of these statistics are presented in the next section for the Company Quality System Evaluation features.

Table 11.53: Postulated Company Quality System Evaluation Features Model

Latent constructs	**Indicator variables**	**Label**
Company Quality System Evaluation (CQSE)	Evaluation of the quality strategy framework	CQSE1
	Evaluation of overall company performance	CQSE2
	Evaluation of employee performance	CQSE3

Source: Fieldwork (2018)

Diagnostic Fit Analysis: Analysis of Residual Covariance Estimate

The unstandardized and standardized absolute residual matrix values of the Company Quality System Evaluation features are presented in Tables 11.54 and 11.55. The results reveal that all the absolute residual values and the average off-diagonal absolute residual values were close to zero. The unstandardized average off-diagonal residual was 0.000 while the standardized average off-diagonal residual was found to be 0.000. A residual value greater than 2.58 is described as large (Byrne, 2006:94). The results obtained for the Company Quality System Evaluation features measurement model suggested a fairly acceptable fit to the sample data because the absolute residuals were all less than 2.58. In order for a model to be described as well-fitting, the distribution of standardized residuals should be symmetrical and centred around zero (Byrne, 2006:94).

Table 11.54: Residual Covariance Matrix for Company Quality System Evaluation Model (Unstandardized)

Unstandardized Residual Covariance Matrix			
	CQSE3	CQSE1	CQSE2
CQSE3	0.000		
CQSE1	0.000	0.000	
CQSE2	0.000	0.000	0.000
Average absolute residual = **0.000**			
Average off-diagonal absolute residual = **0.000**			
% falling between -0.1 +0.1 = 99.99%			

Source: Fieldwork (2018)

Further review of the frequency distribution reveals most residual values (99.99%) fall between -0.1 and +0.1, which is in the acceptable range. Of the remaining residuals, 0.01% fell outside the -0.1 to 0.1 ranges.

Table 11.55: Residual Covariance Matrix for Company Quality System Evaluation Model (Standardized)

Standardized Residual Covariance Matrix			
	CQSE3	CQSE1	CQSE2
CQSE3	0.000		
CQSE1	0.000	0.000	
CQSE2	0.000	0.000	0.000
Average absolute residual = **0.000**			
Average off-diagonal absolute residual = **0.000**			
% falling between -0.1 +0.1 = 99.99%			

Source: Fieldwork (2018)

From this information, the results suggested a measurement model that was well fitting despite a minimal discrepancy in fit between the hypothesized model and the sample data. Therefore, since this diagnostic fit analysis indicated a good fit, further tests of goodness-of-fit were possible to make a conclusive decision on the fit and appropriateness of the measurement model.

Goodness-of-fit Statistics – Robust Maximum Likelihood (RML)

The analysis strategy of goodness-of-fit for the Company Quality System Evaluation followed a three-statistics strategy of fit indexes as recommended by Hu and Bentler (1999). The sample data on Company Quality System Evaluation measurement model yielded the $S - B\chi 2$ of 0.000 with a 0.000 degree of freedom (*df*) with a probability of $p = 0.0000$. This chi-square value indicated that the departure of the sample data from the postulated measurement model was significant and hence indicative of good fit. The chi-square test is very sensitive to sample size and is used more as a descriptive index of fit rather than as a statistical test (Kline, 2005:136). The normed chi-square value is usually adopted by most researchers. The normed chi-square is the procedure of dividing the chi-square by the degrees of freedom. The normed values of up to 3.0 or even 5.0 are recommended (Kline, 2005:137).

Values for NFI range between 0 and 1 with Bentler and Bonnet (1980) recommended values greater than 0.90 indicating a good fit. Hu and Bentler (1999) have given a cut-off criterion of NFI ≥ 0.95. This index is sensitive to sample size, underestimating fit for samples less than 200 (Mulaik et al., 1989; Bentler, 1990), and is thus not recommended to be solely relied on (Kline, 2005). The non-normed fit index (NNFI, also known as the Tucker-Lewis index) is an index that prefers simpler models. The value of the NNFI can indicate poor fit despite other statistics pointing towards good fit if small samples are used (Bentler, 1990; Kline, 2005; Tabachnick & Fidell, 2007). Owing to non-normed nature, NNFI values can go above 1.0 and can thus be difficult to interpret (Byrne, 1998). The chi-square and degrees of freedom were found to be 0.000. This ratio was lower than the limit of 3.00 or 5.0 advocated for by some authors (Kline, 2005:137). The CFI value was found to be 1.000 which was slightly greater than the cut-off limit of 0.95 so the model is described to have an acceptable fit. The NFI value was 1.000 which is slightly above the given cut-off value of NFI ≥ 0.95 which is shown in Table 11.56. Therefore, the model is acceptable. The NNFI value obtained is 1.000 which is also above the cut-off value of 0.80. These fit indexes for the Company Quality System Evaluation model suggested that the postulated model adequately describes the sample data and could therefore be included in the full latent variable model analysis (Table 11.56).

Table 11.56: Robust fit Indexes for Company Quality System Evaluation Features Construct

Fit Index	Cut-off value	Estimate	Comment
$S - B\chi^2$		0.000	
df	0≥	0.000	
Normed chi-square = x^2/df ratio	*≤2 or 3 good fit* *≤5 acceptable*		
CFI	0.90≥ acceptable 0.95≥ good fit	1.000	Good fit
RMSEA	Less than 0.05 with confidence	0.000	Good fit

95%	(CI) 0.00-0.05 "good fit"		
NFI	Greater than 0.90 "good fit"	1.000	Good fit
NNFI	Greater than 0.80. "good fit"	1.000	Good fit
SRMR	Equal or less than 0.05 "good fit" Equal or less than 0.08 "acceptable fit"	0.000	Good fit

Statistical significance of parameter estimates

Source: Fieldwork (2018)

Table 11.57 shows the correlation values, standard errors and the test of statistics. All the correlation values were less than 1.00 and all the *Z*-statistics were greater than 1.96 and show appropriate signs. The estimates were therefore deemed reasonable as well as statistically significant. The parameter with the highest standardized coefficient was the indicator with a variable CQSE2 (Evaluation of overall company performance) and its parameter coefficient was 0.832.

Table 11.57: Factor Loading and Z-statistics of Company Quality System Evaluation Measurement

Indicator Variable	Unstandardized Coefficient (λ)	Standardized Coefficient (λ)	*Z*-Statistics	R^2	Significant at 5% level?
CQSE1	1.000	0.813	4.542	0.660	Yes
CQSE2	0.984	0.832	4.139	0.692	Yes
CQSE3	0.987	0.741	2.301	0.549	Yes
					Yes

(Robust Statistical Significance at 5% level)

Source: Fieldwork (2018)

Most of the parameter estimates had high correlation values close to 1.00. The high correlation values suggest a high degree of linear association between the indicator variables and the unobserved variable (Company Quality System Evaluation). In addition, the R^2 values were also close to the desired value of 1.00, indicating that the factors explained more of the variance in the indicator variables. The results therefore suggest that the indicator variables significantly predict the unobserved construct because all the measured variables are significantly associated with the Company Quality System Evaluation features.

Internal Reliability and Validity of Scores

The internal consistency and reliability of scores for the Company Quality System Evaluation features construct were determined from the rho and the Cronbach's alpha coefficient. According to Kline (2005:59), the reliability coefficient should fall between zero and 1.00. Values close to 1.00 are desired. The rho coefficient of internal consistency was found to be 0.830. This value was above the minimum required value of 0.70. On the other hand, the Cronbach's alpha was above the minimum acceptable value of 0.70. The Cronbach's alpha was found to be 0.835 (Table 11.58). The Cronbach's alpha value revealed a high level of internal consistency and therefore reliability, suggesting that the indicator variables represent the same latent construct (Company Quality System Evaluation).

Table 11.58: Reliability and Construct Validity of Company Quality System Evaluation Feature Model

Factor	**Indicator Variable**	**Factor Loading**	**Cronbach's Alpha**	**Rho Coefficient**
Company Quality System Evaluation Features	CQSE1	0.813	0.835	0.830
	CQSE2	0.832		
	CQSE3	0.741		

*Parameter estimates are based on standardized solutions

Source: Fieldwork (2018)

Furthermore, construct validity was determined from the magnitude and reasonableness of the parameter coefficients (factor loading). The parameter coefficients represent the magnitude of correlation or covariance between an item and a construct. Higher parameter coefficients show that the indicator variables have a stronger relationship with a construct and thus converge at a common point. Parameter coefficients of greater than 0.5 indicate a close relationship between the construct and an indicator variable. A parameter coefficient of 0.5 is interpreted as 25 per cent of the total variance in the indicator variable being explained by the latent variable (factor). Hence, a parameter coefficient should be 0.5 or higher and ideally 0.7 or greater to explain about 50 per cent of the variance in an indicator variable (Hair et al., 1998:111).

The standardized parameter coefficient presented in Table 11.62 revealed that all coefficients were significantly higher with the lowest being 0.741 for Company Quality System Evaluation features. The magnitude of the parameter estimate was above the 50 per cent minimum. This indicates a strong relationship between the indicator variables and the factors of the Company Quality System Evaluation features construct. Therefore the Company Quality System Evaluation features satisfied both internal reliability and the construct criteria. The rho value was slightly below the minimum value of 0.70, and the magnitude, signs and statistical significance of the parameter estimates were appropriate (Table 11.58).

Summary on Company Quality System Evaluation Feature Measurement Model

The CFA revealed that the residual covariance estimates fell within the acceptable range. Likewise, the robust fit indexes met the cut-off index criteria and all the parameter estimates were statistically significant and feasible. Considering these criteria, the measurement model for the Company Quality System Evaluation feature was found to adequately fit the sample data. Therefore, there was no need to improve the measurement model before it could be included in the full latent variable model. Hence, the Company Quality System Evaluation feature construct was adequately measured by the indicator variables and could be used in the analysis of the full latent variable model.

11.4.4.1.5 Measurement Model for Company Vision and Plan Statement features (CVPS) Construct

A unidimensional model for Company Vision and Plan Statement (CVPS) features is presented (Table 11.33). From the 536 cases analyzed for this construct, three (3) indicator variables (F5CVPS5, F5CVPS6 and F5CVPS7) made up of the same factor were realized and the name CVPS was maintained (Table 11.33). All the three (3) indicator variables obtained were used for the CFA (Byrne, 2006:94; Joreskog & Sorbom, 1988). In order for a variable to be included in a CFA, thus enabling the model to be described as well-fitting, the distribution of residuals covariance matrix should be symmetrical and centred around zero (Byrne, 2006:94; Joreskog & Sorbom, 1988). The three-indicator model provides good measures of residual matrix and evidence of convergent validity.

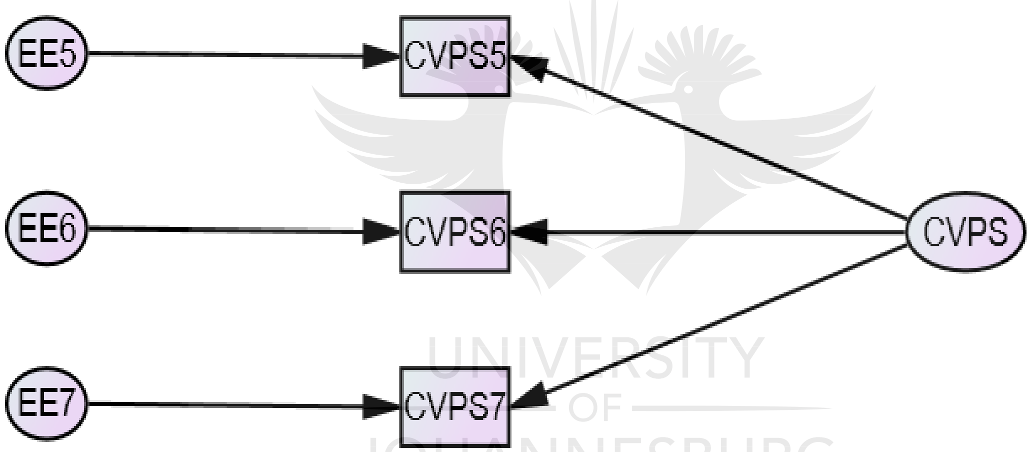

Figure 11.5: Measurement Model of Company Vision and Plan Statement

The CFA results further revealed that the Company Vision and Plan Statement features had three (3) dependent variables, four (4) independent variables and six (6) free parameters. The number of fixed non-zero parameters was four (4). These are the three (3) dependent indicator variables for the Company Vision and Plan Statement: Concreteness of the future plan, Employee contribution to the vision and Involvement of employees in the development of the vision statement. These indicator variables are presented in Table 11.59. The Company Vision and Plan Statement features measurement model shown in Figure 11.5 was analyzed before it could be included in the full latent variable model.

In order to establish how well the model fit the sample data and the strength of the hypothesized relationship between the variables, results on residual covariance matrix (unstandardized and standardized), distribution of standardized residuals, fit statistics and statistical significance at a probability level of 5 per cent were examined. In addition, the Cronbach's alpha and the rho coefficient of internal consistency were examined to determine the score reliability. Results of these statistics are presented in the next section for the Company Vision and Plan Statement features.

Table 11.59: Postulated Company Vision and Plan Statement Features Model

Latent constructs	Indicator variables	Label
Company Vision and Plan Statement (CVPS)	Concreteness of the future plan	CVPS5
	Employee contribution to the vision	CVPS6
	Involvement of employees in the development of the vision statement	CVPS7

Diagnostic Fit Analysis: Analysis of Residual Covariance Estimate

The unstandardized and standardized absolute residual matrix values of the Company Vision and Plan Statement features are presented in Tables 11.60 and 11.61. The results reveal that all the absolute residual values and the average off-diagonal absolute residual values were close to zero. The unstandardized average off-diagonal residual was 0.000 while the standardized average off-diagonal residual was found to be 0.000. A residual value greater than 2.58 is described as large (Byrne, 2006:94). The results obtained for the Company Vision and Plan Statement features measurement model suggested a fairly acceptable fit to the sample data because the absolute residual were all less than 2.58. In order for a model to be described as well-fitting, the distribution of standardized residuals should be symmetrical and centred around zero (Byrne, 2006:94).

Table 11.60: Residual Covariance Matrix for Company Vision and Plan Statement Model (Unstandardized)

Unstandardized Residual Covariance Matrix			
	CVPS7	CVPS6	CVPS5
CVPS7	0.000		
CVPS6	0.000	0.000	
CVPS5	0.000	0.000	0.000
Average absolute residual = **0.000**			
Average off-diagonal absolute residual = **0.000**			
% falling between -0.1 +0.1 = 99.99%			

Source: Fieldwork (2018)

Further review of the frequency distribution reveals most residual values (99.99%) fall between -0.1 and +0.1, which is in the acceptable range. Of the remaining residuals, 0.01% fell outside the -0.1 to 0.1 ranges.

Table 11.61: Residual Covariance Matrix for Company Vision and Plan Statement Model (Standardized)

Standardized Residual Covariance Matrix			
	CVPS7	CVPS6	CVPS5
CVPS7	0.000		
CVPS6	0.000	0.000	
CVPS5	0.000	0.000	0.000
Average absolute residual = **0.000**			
Average off-diagonal absolute residual = **0.000**			
% falling between -0.1 +0.1 = 99.99%			

Source: Fieldwork (2018)

From this information, the results suggested a measurement model that was well fitting despite a minimal discrepancy in fit between the hypothesized model and the sample data. Therefore, since this diagnostic fit analysis indicated a good fit; further tests of goodness-of-fit were possible to make a conclusive decision on the fit and appropriateness of the measurement model.

Goodness-of-fit Statistics – Robust Maximum Likelihood (RML)

The analysis strategy of goodness-of-fit for the Company Vision and Plan Statement followed a three-statistics strategy of fit indexes as recommended by Hu and Bentler (1999). The sample data on the Company Vision and Plan Statement measurement model yielded the $S - B\chi 2$ of 0.000 with 0.000 degree of freedom (*df*) with a probability of $p = 0.0000$. This chi-square value indicated that the departure of the sample data from the postulated measurement model was significant and hence indicative of good fit. The chi-square test is very sensitive to sample size and is used more as a descriptive index of fit rather than as a statistical test (Kline, 2005:136). The normed chi-square value is usually adopted by most researchers. The normed chi-square is the procedure of dividing the chi-square by the degrees of freedom. The normed values of up to 3.0 or even 5.0 are recommended (Kline, 2005:137).

Values for NFI range between 0 and 1 with Bentler and Bonnet (1980) recommended values greater than 0.90 indicating a good fit. Hu and Bentler (1999) have given a cut-off criterion of NFI ≥ 0.95. This index is sensitive to sample size, underestimating fit for samples less than 200 (Mulaik et al., 1989; Bentler, 1990), and is thus not recommended to be solely relied on (Kline, 2005). The non-normed fit index (NNFI, also known as the Tucker-Lewis index), is an index that prefers simpler models. The value of the NNFI can indicate poor fit despite other statistics pointing towards good fit if small samples are used (Bentler, 1990; Kline, 2005; Tabachnick & Fidell, 2007). Owing to their non-normed nature, NNFI values can go above 1.0 and can thus be difficult to interpret (Byrne, 1998). The chi-square and degrees of freedom were found to be 0.000. This ratio was lower than the limit of 3.00 or 5.0 advocated for by some authors (Kline, 2005:137).

The CFI value was found to be 1.000 which was slightly greater than the cut-off limit of 0.95 so this is described to have an acceptable fit. The NFI value was 1.000 which is within the given range, but the given cut-off value of NFI ≥ 0.95 is shown in Table 11.62. Therefore, the model is acceptable. The NNFI value obtained is 1.000 which is above the cut-off value of 0.80. These fit indexes for the Company Vision and Plan Statement model suggested that the postulated model adequately describes the sample data and could therefore be included in the full latent variable model analysis (Table 11.62).

Table 11.62: Robust Fit Indexes for Company Vision and Plan Statement Features Construct

Fit Index	Cut-off value	Estimate	Comment
$S - B\chi^2$		0.000	
df	0≥	0.000	
Normed chi-square = x^2/df ratio	*≤2 or 3 good fit* *≤5 acceptable*	-	
CFI	0.90≥ acceptable 0.95≥ good fit	1.000	Good fit
RMSEA **95%**	Less than 0.05 with confidence interval (CI) 0.00-0.05 “good fit”	0.000	Good fit
NFI	Greater than 0.90 “good fit”	1.000	Good fit
NNFI	Greater than 0.80. “good fit”	1.000	Good fit
SRMR	Equal or less than 0.05 “good fit” Equal or less than 0.08 “acceptable fit”	0.000	Good fit

Source: Fieldwork (2018)

Statistical Significance of Parameter Estimates

Table 11.63 shows the correlation values, standard errors and the test of statistics. All the correlation values were less than 1.00 and all the *Z*-statistics were greater than 1.96 and show appropriate signs. The estimates were therefore deemed reasonable as well as statistically significant. The parameter with the highest standardized coefficient was the indicator with variable CVPS6 (Employee contribution to the vision) and its parameter coefficient was 0.850.

Table 11.63: Factor Loading and Z-statistics of Company Vision and Plan Statement Measurement

Indicator Variable	Unstandardized Coefficient (λ)	Standardized Coefficient (λ)	*Z*-Statistics	R^2	Significant at 5% level?
CVPS5	1.000	0.828	3.101	0.685	Yes
CVPS6	1.056	0.850	3.414	0.723	Yes
CVPS7	0.847	0.775	2.788	0.601	Yes

(Robust Statistical Significance at 5% level)

Source: Fieldwork (2018)

Most of the parameter estimates had high correlation values close to 1.00. The high correlation values suggest a high degree of linear association between the indicator variables and the unobserved variable (Company Vision and Plan Statement). In addition, the R^2 values were also close to the desired value of 1.00, indicating that the factors explained more of the variance in the indicator variables. The results therefore suggest that the indicator variables significantly predict the unobserved construct because all the measured variables are significantly associated with the Company Vision and Plan Statement features.

Internal Reliability and Validity of Scores

The internal consistency and reliability of scores for the Company Vision and Plan Statement features construct were determined from the rho and the Cronbach's alpha coefficient. According to Kline (2005:59), the reliability coefficient should fall between zero and 1.00. Values close to 1.00 are desired. The rho coefficient of internal consistency was found to be 0.816. This value was above the minimum required value of 0.70. Likewise, the Cronbach's alpha was above the minimum acceptable value of 0.70. The Cronbach's alpha was found to be 0.857 (Table 11.64). Both of these values revealed a high level of internal consistency and therefore reliability, suggesting that the indicator variables represent the same latent construct (Company Vision and Plan Statement).

Table 11.64: Reliability and Construct Validity of Company Vision and Plan Statement Feature Model

Factor	**Indicator Variable**	**Factor Loading**	**Cronbach's Alpha**	**Rho Coefficient**
Company Vision and Plan Statement (CVPS	CVPS5	0.828		
	CVPS6	0.850		
	CVPS7	0.775	0.857	0.816

*Parameter estimates are based on standardized solutions

Source: Fieldwork (2018)

Furthermore, construct validity was determined from the magnitude and reasonableness of the parameter coefficients (factor loading). The parameter coefficients represent the magnitude of correlation or covariance between an item and a construct. Higher parameter coefficients show that the indicator variables have a stronger relationship with a construct and thus converge at a common point. Parameter coefficients of greater than 0.5 indicate a close relationship between the construct and an indicator variable. A parameter coefficient of 0.5 is interpreted as 25 per cent of the total variance in the indicator variable being explained by the latent variable (factor). Hence, a parameter coefficient should be 0.5 or higher and ideally 0.7 or greater to explain about 50 per cent of the variance in an indicator variable (Hair et al., 1998:111).

The standardized parameter coefficient presented in Table 11.64 revealed that all coefficients were significantly higher with the lowest being 0.775 for Company Vision and Plan Statement features. The magnitude of the parameter estimate was above the 50 per cent minimum. This indicates a strong relationship between the indicator variables and the factors of the Company Vision and Plan Statement features construct. Therefore the Company Vision and Plan Statement features satisfied both internal reliability and the construct criteria. The rho value was above the minimum value of 0.70, and the magnitude, signs and statistical significance of the parameter estimates were appropriate (Table 11.64).

Summary of Company Vision and Plan Statement Feature Measurement Model

The CFA revealed that the residual covariance estimates fell within the acceptable range. Likewise, the robust fit indexes met the cut-off index criteria and all the parameter estimates were statistically significant and feasible. Considering these criteria, the measurement model for the Company Vision and Plan Statement feature was found to adequately fit the sample data. Therefore, there was no need to improve the measurement model before it could be included in the full latent variable model. Hence the Company Vision and Plan Statement feature construct was adequately measured by the indicator variables and could be used in the analysis of the full latent variable model.

11.4.4.1.6 Measurement Model for Product Design Management features (PDM) Construct

An unidimensional model for Product Design Management (PDM) features was presented (Table 11.33). From the 536 cases analyzed for this construct, three (3) indicator variables (F6APDM2, F6APDM3, and F6APDM6) made up of the same factor were realized and the name PDM was maintained (Table 11.33). All the three (3) indicator variables obtained were used for the CFA (Byrne, 2006:94; Joreskog & Sorbom, 1988). In order for a variable to be included in a CFA, thus enabling the model to be described as well-fitting, the distribution of residuals covariance matrix should be symmetrical and centred around zero (Byrne, 2006:94; Joreskog & Sorbom, 1988). The three-indicator model provides good measures of residual matrix and evidence of convergent validity.

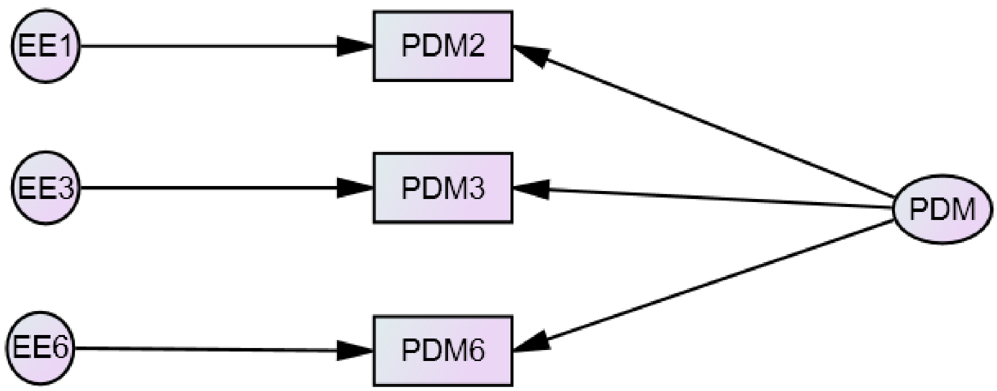

Figure 11.6: Measurement Model of Product Design Management

The CFA results further revealed that the Product Design Management features had three (3) dependent variables, four (4) independent variables and six (6) free parameters. There were four (4) fixed non-zero parameters. The three (3) dependent indicator variables for the Product Design Management are Strength required for the end product, Intended purpose of the material, and Design detailing. These indicator variables are presented in Table 11.65. The Product Design Management features measurement model shown in Figure 11.6 was analyzed before it could be included in the full latent variable model.

In order to establish how well the model fit the sample data and the strength of the hypothesized relationship between the variables, results on residual covariance matrix (unstandardized and standardized), distribution of standardized residuals, fit statistics and statistical significance at a probability level of 5 per cent were examined. In addition, the Cronbach's alpha and the rho coefficient of internal consistency were examined to determine the score reliability. Results of these statistics are presented in the next section for the Product Design Management features.

Table 11.65: Postulated Product Design Management Features Model

Latent	Indicator variables	Label
Product Design Management (PDM)	Strength required for the end product	PDM2
	Intended purpose of the material	PDM3
	Design detailing	PDM6

Source: Fieldwork (2018)

Diagnostic Fit Analysis: Analysis of Residual Covariance Estimate

The unstandardized and standardized absolute residual matrix values of the Product Design Management features are presented in Tables 11.66 and 11.67. The results reveal that all the absolute residual values and the average off-diagonal absolute residual values were close to zero. The unstandardized average off-diagonal residual was 0.000 while the standardized average off-diagonal residual was found to be 0.000. A residual value greater than 2.58 is described as large (Byrne, 2006:94). The results obtained for the Product Design Management Features measurement model suggested a fairly acceptable fit to the sample data because the absolute residual were all less than 2.58. In order for a model to be described as well-fitting, the distribution of standardized residuals should be symmetrical and centred around zero (Byrne, 2006:94).

Table 11.66: Residual Covariance Matrix for Product Design Management Model (Unstandardized)

Unstandardized Residual Covariance Matrix

	PDM16	PDM3	PDM2
PDM6	0.000		
PDM3	0.000	0.000	
PDM2	0.000	0.000	0.000

Average absolute residual = **0.000**

Average off-diagonal absolute residual = **0.000**

% falling between -0.1 +0.1 = 99.99%

Source: Fieldwork (2018)

Further review of the frequency distribution reveals most residual values (99.99%) fall between -0.1 and +0.1, which is in the acceptable range. Of the remaining residuals, 0.01% fell outside the -0.1 to 0.1 ranges.

Table 11.67: Residual Covariance Matrix for Product Design Management Model (Standardized)

Standardized Residual Covariance Matrix

	PDM6	PDM3	PDM2
PDM6	0.000		
PDM3	0.000	0.000	
PDM2	0.000	0.000	0.000

Average absolute residual = **0.000**
Average off-diagonal absolute residual = **0.000**

% falling between -0.1 +0.1 = 99.99%

Source: Fieldwork (2018)

From this information, the results suggested a measurement model that was well fitting despite a minimal discrepancy in fit between the hypothesized model and the sample data. Therefore, since this diagnostic fit analysis indicated a good fit; further tests of goodness-of-fit were possible to make a conclusive decision on the fit and appropriateness of the measurement model.

Goodness-of-fit Statistics – Robust Maximum likelihood (RML)

The analysis strategy of goodness-of-fit for Product Design Management followed a three-statistics strategy of fit indexes as recommended by Hu and Bentler (1999). The sample data on Product Design Management measurement model yielded the $S - B\chi 2$ of 0.000 with 0.000

degrees of freedom (*df*) with a probability of $p = 0.000$. This chi-square value indicated that the departure of the sample data from the postulated measurement model was significant and hence indicative of good fit. The chi-square test is very sensitive to sample size and is used more as a descriptive index of fit rather than as a statistical test (Kline, 2005:136). The normed chi-square value is usually adopted by most researchers. The normed chi-square is the procedure of dividing the chi-square by the degrees of freedom. The normed values of up to 3.0 or even 5.0 are recommended (Kline, 2005:137). Values for NFI range between 0 and 1 with Bentler and Bonnet (1980) recommended values greater than 0.90 indicating a good fit. Hu and Bentler (1999) have given a cut-off criterion of NFI ≥ 0.95. This index is sensitive to sample size, underestimating fit for samples less than 200 (Mulaik et al., 1989; Bentler, 1990) and is thus not recommended to be solely relied on (Kline, 2005). The non-normed fit index (NNFI, also known as the Tucker-Lewis index) is an index that prefers simpler models. The value of the NNFI can indicate poor fit despite other statistics pointing towards good fit if small samples are used (Bentler, 1990; Kline, 2005; Tabachnick & Fidell, 2007). Owing to their non-normed nature, NNFI values can go above 1.0 and can thus be difficult to interpret (Byrne, 1998). The chi-square and degrees of freedom were found to be 0.000. This ratio was lower than the limit of 3.00 or 5.0 advocated for by some authors (Kline, 2005:137). The CFI value was found to be 1.000 which was slightly greater than the cut-off limit of 0.95 so the model is described to have an acceptable fit. The NFI value was 1.000 which is slightly greater than the given cut-off value of NFI ≥ 0.95 is shown in Table 11.68. Therefore, the model is acceptable. The NNFI value obtained is 1.000 which is also above the cut-off value of 0.80. These fit indexes for the Product Design Management model suggested that the postulated model adequately describe the sample data and could therefore be included in the full latent variable model analysis (Table 11.68).

Table 11.68: Robust fit indexes for Product Design Management Features Construct

Fit Index	Cut-off value	Estimate	Comment
S – Bχ²		0.000	
df	0≥	0.000	
Normed chi-square = x^2/df ratio	*≤2 or 3 good fit* *≤5 acceptable*	-	
CFI	0.90≥ acceptable 0.95≥ good fit	1.000	Good fit
RMSEA	Less than 0.05 with confidence interval (CI) 0.00-0.05 "good fit"	0.000	Good fit
NFI	Greater than 0.90 "good fit"	1.000	Good fit
NNFI	Greater than 0.80. "good fit"	1.000	Good fit
SRMR	Equal or less than 0.05 "good fit" Equal or less than 0.08 "acceptable fit"	0.000	Good fit

Source: Fieldwork (2018)

Statistical Significance of Parameter Estimates

Table 11.69 shows the correlation values, standard errors and the test of statistics. All the correlation values were less than 1.00 and all the *Z*-statistics were greater than 1.96 and show appropriate signs. The estimates were therefore deemed reasonable as well as statistically significant. The parameter with the highest standardized coefficient was the indicator with variable PDM2 (Strength required for the end product) and its parameter coefficient was 0.786.

Table 11.69: Factor Loading and Z-statistics of Product Design Management Condition Measurement

Indicator Variable	**Unstandardized Coefficient (λ)**	**Standardized Coefficient (λ)**	***Z*-Statistics**	R^2	**Significant at 5% level?**
PDM2	1.000	0.786	3.169	0.600	Yes
PDM3	1.009	0.757	2.980	0.627	Yes
PDM6	0.886	0.718	2.370	0.515	Yes

(Robust Statistical Significance at 5% level)

Source: Fieldwork (2018)

Most of the parameter estimates had high correlation values close to 1.00. The high correlation values suggest a high degree of linear association between the indicator variables and the unobserved variable (Product Design Management features). In addition, the R^2 values were also close to the desired value of 1.00, indicating that the factors explained more of the variance in the indicator variables. The results therefore suggest that the indicator variables significantly predict the unobserved construct because all the measured variables are significantly associated with the Product Design Management features.

Internal Reliability and Validity of Scores

The internal consistency and reliability of scores for the Product Design Management features construct were determined from the rho and the Cronbach's alpha coefficient. According to Kline (2005:59), the reliability coefficient should fall between zero and 1.00. Values close to 1.00 are desired. The rho coefficient of internal consistency was found to be 0.762. This value was above the minimum required value of 0.70. Likewise, the Cronbach's alpha was above the minimum acceptable value of 0.70. The Cronbach's alpha was found to be 0.798 (Table 11.70).

Both of these values revealed a high level of internal consistency and therefore reliability, suggesting that the indicator variables represent the same latent construct (Product Design Management).

Table 11.70: Reliability and Construct Validity of Product Design Management Feature Model

Factor	Indicator Variable	Factor Loading	Cronbach's Alpha	Rho Coefficient
Product Design Management Features	PDM2	0.786	0.798	0.762
	PDM3	0.757		
	PDM6	0.718		

*Parameter estimates are based on standardized solutions

Source: Fieldwork (2018)

Further, construct validity was determined from the magnitude and reasonableness of the parameter coefficients (factor loading). The parameter coefficients represent the magnitude of correlation or covariance between an item and a construct. Higher parameter coefficients show that the indicator variables have a stronger relationship with a construct and thus converge at a common point. Parameter coefficients of greater than 0.5 indicate a close relationship between the construct and an indicator variable. A parameter coefficient of 0.5 is interpreted as 25 per cent of the total variance in the indicator variable being explained by the latent variable (factor). Hence, a parameter coefficient should be 0.5 or higher and ideally 0.7 or greater to explain about 50 per cent of the variance in an indicator variable (Hair et al., 1998:111). The standardized parameter coefficient presented in Table 11.70 revealed that all coefficients were significantly higher with the lowest being 0.718 for Product Design Management features. The magnitude of the parameter estimate was above the 50 per cent minimum. This indicates a strong relationship between the indicator variables and the factors of the Product Design Management features construct. Therefore, the Product Design Management features satisfied both internal reliability and the construct criteria. The rho value was above the minimum value of 0.70 and the magnitude, signs and statistical significance of the parameter estimates were appropriate (Table 11.70).

Summary on Product Design Management Feature Measurement Model

The CFA revealed that the residual covariance estimates fell within the acceptable range. Likewise, the robust fit indices met the cut-off index criteria and all the parameter estimates were statistically significant and feasible. Considering these criteria, the measurement model for the Product Design Management feature was found to adequately fit the sample data. Therefore, there was no need to improve the measurement model before it could be included in the full latent variable model. Hence, the Product Selection and Design Management feature construct was adequately measured by the indicator variables and could be used in the analysis of the full latent variable model.

11.4.4.1.7 Measurement Model for Product Selection Management Features (PSM) Construct

A unidimensional model for Product Selection Management (PSM) features was presented (Table 11.33). From the 536 cases analyzed for this construct, three (3) indicator variables (F6BPSM1, F6BPSM2, and F6BPSM4) made up of the same factor were realized and the name PSM was maintained (Table 11.33). All the three (3) indicator variables obtained were used for the CFA (Joreskog & Sorbom, 1988; Byrne, 2006:94). In order for a variable to be included in a CFA, thus enabling the model to be described as well-fitting, the distribution of residuals covariance matrix should be symmetrical and centred around zero (Joreskog & Sorbom, 1988; Byrne, 2006:94). The three-indicator model provides good measures of residual matrix and evidence of convergent validity.

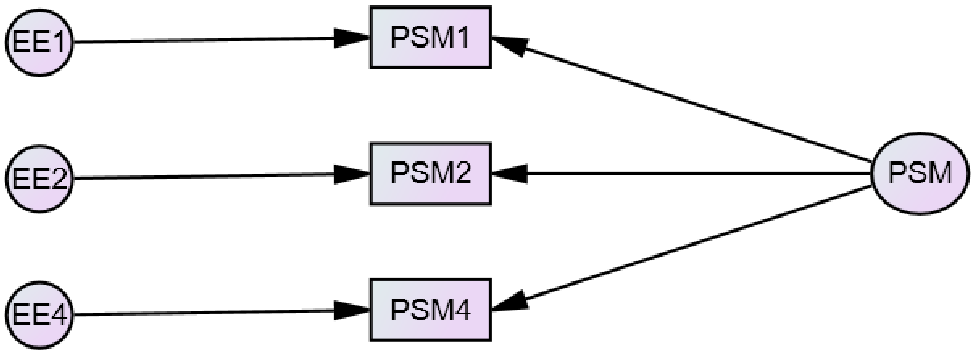

Figure 11.7: Measurement Model of Product Selection Management

The CFA results further revealed that the Product Selection Management features had three (3) dependent variables, four (4) independent variables and six (6) free parameters. There were four (4) fixed non-zero parameters. There are three (3) dependent indicator variables for the Product Selection Management, namely Client brief/input, Cost of selection and design of the product and Appearance/finishes required. These indicator variables are presented in Table 11.71. The Product Selection Management features measurement model shown in Figure 11.7 was analyzed before it could be included in the full latent variable model.

In order to establish how well the model fit the sample data and the strength of the hypothesized relationship between the variables, results on residual covariance matrix (unstandardized and standardized), distribution of standardised residuals, fit statistics and statistical significance at a probability level of 5 per cent were examined. In addition, the Cronbach's alpha and the rho coefficient of internal consistency were examined to determine the score reliability. Results of these statistics are presented in the next section for the Product Selection Management features.

Table 11.71: Postulated Product Selection Management Features Model

Latent constructs	Indicator variables	Label
Product Selection Management (PSM)	Client brief/input	PSM1
	Cost of selection and design of the product	PSM2
	Appearance/finishes required	PSM4

Source: Fieldwork (2018)

Diagnostic Fit analysis: Analysis of Residual Covariance EDstimate

The unstandardized and standardized absolute residual matrix values of the Product Selection and Design Management features are presented in Tables 11.72 and 11.73. The results reveal that all the absolute residual values and the average off-diagonal absolute residual values were close to zero. The unstandardized average off-diagonal residual was 0.000 while the standardized average off-diagonal residual was found to be 0.000. A residual value greater than 2.58 is described as large (Byrne, 2006:94). The results obtained for the Product Selection Management Features measurement model suggested a fairly acceptable fit to the sample data because the absolute residuals were all less than 2.58. In order for a model to be described as well-fitting, the distribution of standardized residuals should be symmetrical and centred around zero (Byrne, 2006:94).

Table 11.72: Residual Covariance Matrix for Product Selection Management Model (Unstandardized)

Unstandardized Residual Covariance Matrix			
	PSM4	PSM2	PSM1
PSM4	0.000		
PSM2	0.000	0.000	
PSM1	0.000	0.000	0.000
Average absolute residual = **0.000**			

Average off-diagonal absolute residual = **0.000**

% falling between -0.1 +0.1 = 99.99%

Source: Fieldwork (2018)

Further review of the frequency distribution reveals most residual values (99.99%) fall between -0.1 and +0.1, which is in the acceptable range. Of the remaining residuals, 0.01% fell outside the -0.1 to 0.1 ranges.

Table 11.73: Residual Covariance Matrix for Product Selection Management Model (Standardized)

Standardized Residual Covariance Matrix

	PSM4	PSM2	PSM1
PSM4	0.000		
PSM2	0.000	0.000	
PSM1	0.000	0.000	0.000

Average absolute residual = **0.000**
Average off-diagonal absolute residual = **0.000**

% falling between -0.1 +0.1 = 99.99%

Source: Fieldwork (2018)

From this information, the results suggested a measurement model that was well fitting despite a minimal discrepancy in fit between the hypothesized model and the sample data. Therefore, since this diagnostic fit analysis indicated a good fit; further tests of goodness-of-fit were possible to make a conclusive decision on the fit and appropriateness of the measurement model.

Goodness-of-fit Statistics – Robust Maximum Likelihood (RML)

The analysis strategy of goodness-of-fit for Product Selection Management followed a three-statistics strategy of fit indexes as recommended by Hu and Bentler (1999). The sample data on Product Selection Management measurement model yielded the $S - B\chi 2$ of 0.000 with 0.000

degrees of freedom (*df*) with a probability of p = 0.0000. This chi-square value indicated that the departure of the sample data from the postulated measurement model was significant and hence indicative of good fit. The chi-square test is very sensitive to sample size and is used more as a descriptive index of fit rather than as a statistical test (Kline, 2005:136). The normed chi-square value is usually adopted by most researchers. The normed chi-square is the procedure of dividing the chi-square by the degrees of freedom. The normed values of up to 3.0 or even 5.0 are recommended (Kline, 2005:137). Values for NFI range between 0 and 1 with Bentler and Bonnet (1980) recommended values greater than 0.90 indicating a good fit. Hu and Bentler (1999) have given a cut-off criterion of NFI ≥ 0.95. This index is sensitive to sample size, underestimating fit for samples less than 200 (Mulaik et al., 1989; Bentler, 1990), and is thus not recommended to be solely relied on (Kline, 2005). The non-normed fit index (NNFI, also known as the Tucker-Lewis index) is an index that prefers simpler models. The value of the NNFI can indicate poor fit despite other statistics pointing towards good fit if small samples are used (Bentler, 1990; Kline, 2005; Tabachnick & Fidell, 2007). Owing to their non-normed nature, NNFI values can go above 1.0 and can thus be difficult to interpret (Byrne, 1998). The chi-square and degrees of freedom were found to be 0.000. This ratio was lower than the limit of 3.00 or 5.0 advocated for by some authors (Kline, 2005:137). The CFI value was found to be 1.000 which was slightly greater than the cut-off limit of 0.95 so the model is described to have an acceptable fit. The NFI value was 1.000 which is slightly greater than the given cut-off value of NFI ≥ 0.95 which is shown in Table 11.74. Therefore, the model is acceptable. The NNFI value obtained is 1.000 which is above the cut-off value of 0.80. These fit indexes for the Product Selection Management model suggested that the postulated model adequately describes the sample data and could therefore be included in the full latent variable model analysis (Table 11.74).

Table 11.74: Robust Fit Indexes for Product Selection and Design Management Features Construct

Fit Index	Cut-off value	Estimate	Comment
$S - B\chi^2$		0.000	
df	0≥	0.00 0	
Normed chi-square = x^2/df ratio	*≤2 or 3 good fit* *≤5 acceptable*	-	
CFI	0.90≥ acceptable 0.95≥ good fit	1.000	Good fit
RMSEA	Less than 0.05 with confidence interval (CI) 0.00-0.05 "good fit"	0.000	Good fit
NFI	Greater than 0.90 "good fit"	1.000	Good fit
NNFI	Greater than 0.80. "good fit"	1.000	Good fit
SRMR	Equal or less than 0.05 "good fit" Equal or less than 0.08 "acceptable fit"	0.000	Good fit

Source: Fieldwork (2018)

Statistical Significance of Parameter Estimates

Table 11.75 shows the correlation values, standard errors and the test of statistics. All the correlation values were less than 1.00 and all the *Z*-statistics were greater than 1.96 and show appropriate signs. The estimates were therefore deemed reasonable as well as statistically significant. The parameter with the highest standardized coefficient was the indicator with variable PSM1 (Client brief/input) and its parameter coefficient was 0.893.

Table 11.75: Factor Loading and Z-statistics of Product Selection and Design Management Condition Measurement

Indicator Variable	Unstandardized Coefficient (λ)	Standardized Coefficient (λ)	*Z*-Statistics	R^2	Significant at 5% level?
PSM1	1.000	0.893	4.934	0.797	Yes
PSM2	0.851	0.843	4.014	0.710	Yes
PSM4	0.752	0.771	2.804	0.594	Yes

(Robust Statistical Significance at 5% level)

Source: Fieldwork (2018)

Most of the parameter estimates had high correlation values close to 1.00. The high correlation values suggest a high degree of linear association between the indicator variables and the unobserved variable (Product Selection Management features). In addition, the R^2 values were also close to the desired value of 1.00, indicating that the factors explained more of the variance in the indicator variables. The results therefore suggest that the indicator variables significantly predict the unobserved construct, because all the measured variables are significantly associated with the Product Selection Management features.

Internal Reliability and Validity of Scores

The internal consistency and reliability of scores for the Product Selection Management features construct were determined from the rho and the Cronbach's alpha coefficient. According to Kline (2005:59), the reliability coefficient should fall between zero and 1.00. Values close to 1.00 are desired. The rho coefficient of internal consistency was found to be 0.766. This value was above the minimum required value of 0.70. Likewise, the Cronbach's alpha was above the minimum acceptable value of 0.70. The Cronbach's alpha was found to be 0.872 (Table 11.76). Both of these values revealed a high level of internal consistency and therefore reliability, suggesting that the indicator variables represent the same latent construct (Product Selection Management).

Table 11.76: Reliability and Construct Validity of Product Selection Management Feature Model

Factor	Indicator Variable	Factor Loading	Cronbach's Alpha	Rho Coefficient
Product Selection and Design Management Features	PSM1	0.893	0.872	0.766
	PSM2	0.843		
	PSM4	0.771		

*Parameter estimates are based on standardized solutions

Source: Fieldwork (2018)

Further, construct validity was determined from the magnitude and reasonableness of the parameter coefficients (factor loading). The parameter coefficients represent the magnitude of correlation or covariance between an item and a construct. Higher parameter coefficients show that the indicator variables have a stronger relationship with a construct and thus converge at a common point. Parameter coefficients of greater than 0.5 indicate a close relationship between the construct and an indicator variable. A parameter coefficient of 0.5 is interpreted as 25 per cent of the total variance in the indicator variable being explained by the latent variable (factor). Hence, a parameter coefficient should be 0.5 or higher, and ideally 0.7 or greater to explain about 50 per cent of the variance in an indicator variable (Hair et al., 1998:111). The standardized parameter coefficient presented in Table 11.75 revealed that all coefficients were significantly higher with the lowest being 0.771 for Product Selection Management features. The magnitude of the parameter estimate was above the 50 per cent minimum. This indicates a strong relationship between the indicator variables and the factors of the Product Selection Management features construct. Therefore the Product Selection Management features satisfied both internal reliability and the construct criteria. The rho value was above the minimum value of 0.70 and the magnitude, signs and statistical significance of the parameter estimates were appropriate (Table 11.76).

Summary on Product Selection Management Feature Measurement Model

The CFA revealed that the residual covariance estimates fell within the acceptable range. Likewise, the robust fit indices met the cut-off index criteria and all the parameter estimates were statistically significant and feasible. Considering these criteria, the measurement model for the Product Selection Management feature was found to adequately fit the sample data. Therefore, there was no need to improve the measurement model before it could be included in the full latent variable model. Hence, the Product Selection Management feature construct was adequately measured by the indicator variables and could be used in the analysis of the full latent variable model.

11.4.4.1.8 Measurement Model for Construction Process Management and Improvement Features (CPMI) Construct

A unidimensional model for Construction Process Management and Improvement (CPMI) features was presented (Table 11.33). From the 536 cases analyzed for this construct, four (4) indicator variables (F7CPMI9, F7CPMI10, F7CPMI11, and F7CPMI12) made up of the same factor were realized and the name CPMI was maintained (Table 11.33). All four (4) indicator variables obtained were used for the CFA (Byrne, 2006:94; Joreskog & Sorbom, 1988). In order for a variable to be included in a CFA, thus enabling the model to be described as well-fitting, the distribution of residuals covariance matrix should be symmetrical and centred around zero (Byrne, 2006:94; Joreskog & Sorbom, 1988). The five-indicator model provides good measures of residual matrix and evidence of convergent validity.

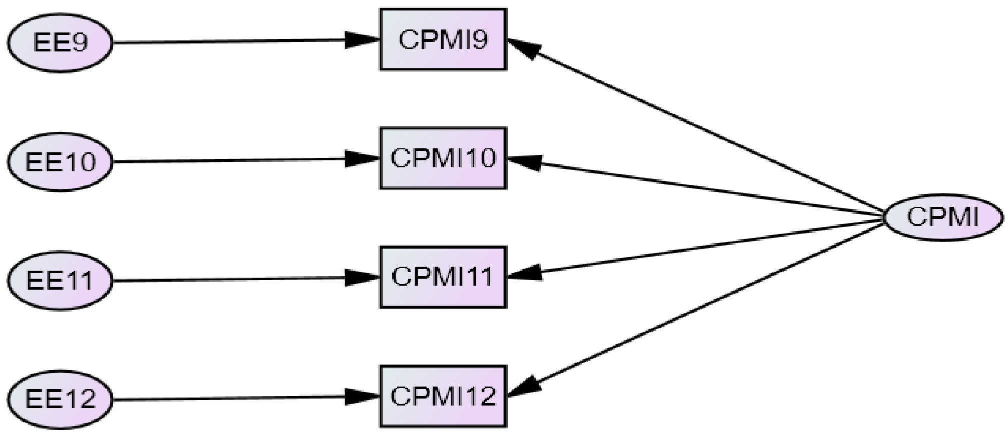

Figure 11.8: Measurement Model of Construction Process Management and Improvement

The CFA results further revealed that the Construction Process Management and Improvement features had four (4) dependent variables, five (5) independent variables and eight (8) free parameters. The number of fixed non-zero parameters was five (5). The four (4) dependent indicator variables for the Construction Process Management and Improvement are Quality control system, Institution of a continuous improvement process within the company, Appropriate use of system structure and standards, and Efficient management system. These indicator variables are presented in Table 11.77. The Construction Process Management and Improvement features measurement model is shown in Figure 11.8 as analyzed before it could be included in the full latent variable model.

In order to establish how well the model fit the sample data and the strength of the hypothesized relationship between the variables, results on residual covariance matrix (unstandardized and standardized), distribution of standardized residuals, fit statistics and statistical significance at a probability level of 5 per cent were examined. In addition, the Cronbach's alpha and the rho coefficient of internal consistency were examined to determine the score reliability. Results of these statistics are presented in the next section for the Construction Process Management and Improvement features.

Table 11.77: Postulated Construction Process Management and Improvement Features Model

Latent constructs	**Indicator variables**	**Label**
Construction Process Management and Improvement (CPMI)	Quality control system	CPMI9
	Institution of a continuous improvement process within the company	CPMI10
	Appropriate use of system structure and standards	CPMI11
	Efficient management system	CPMI12

Source: Fieldwork (2018)

Diagnostic Fit Analysis: Analysis of Residual Covariance Estimate

The unstandardized and standardized absolute residual matrix values of the Construction Process Management and Improvement features are presented in Tables 11.78 and 11.79. The results reveal that all the absolute residual values and the average off-diagonal absolute residual values were close to zero. The unstandardized average off-diagonal residual was 0.0000 while the standardized average off-diagonal residual was found to be 0.0003. A residual value greater than 2.58 is described as large (Byrne, 2006:94). The results obtained for the Construction Process Management and Improvement Features measurement model suggested a fairly acceptable fit to the sample data because the absolute residuals were all less than 2.58. In order for a model to be described as well-fitting, the distribution of standardized residuals should be symmetrical and centred around zero (Byrne, 2006:94).

Table 11.78: Residual Covariance Matrix for Construction Process Management and Improvement Model (Unstandardized)

Unstandardized Residual Covariance Matrix				
	CPMI11	CPMI10	CPMI9	CPMI12
CPMI11	0.000			
CPMI10	-0.005	0.000		

CPMI9	0.004	0.001	0.000	
CPMI12	-0.001	0.003	-0.004	0.000
Average absolute residual = **0.0000**				
Average off-diagonal absolute residual = **0.0000**				
% falling between -0.1 +0.1 = 99.99%				

Source: Fieldwork (2018)

Further review of the frequency distribution reveals most residual values (99.99%) fall between -0.1 and +0.1, which is in the acceptable range. Of the remaining residuals, 0.01% fell outside the -0.1 to 0.1 ranges.

Table 11.79: Residual Covariance Matrix for Construction Process Management and Improvement Model (Standardized)

Standardized Residual Covariance Matrix				
	CPMI11	CPMI10	CPMI9	CPMI12
CPMI11	0.000			
CPMI10	-0.141	0.000		
CPMI9	0.124	0.020	0.000	
CPMI12	-0.015	0.093	-0.109	0.000
Average absolute residual = **0.0002**				
Average off-diagonal absolute residual = **0.0003**				
% falling between -0.1 +0.1 = 99.99%				

Source: Fieldwork (2018)

From this information, the results suggested a measurement model that was well fitting despite a minimal discrepancy in fit between the hypothesized model and the sample data. Therefore, since this diagnostic fit analysis indicated a good fit, further tests of goodness-of-fit were possible to make a conclusive decision on the fit and appropriateness of the measurement model.

Goodness-of-fit Statistics – Robust Maximum Likelihood (RML)

The analysis strategy of goodness-of-fit for the Construction Process Management and Improvement followed a three-statistics strategy of fit indexes as recommended by Hu and Bentler (1999). The sample data on safe act of workers measurement model yielded the $S - B\chi 2$ of 0.630 with 2 degrees of freedom (*df*) with a probability of p = 0.0000. This chi-square value indicated that the departure of the sample data from the postulated measurement model was significant and hence indicative of good fit. The chi-square test is very sensitive to sample size and is used more as a descriptive index of fit rather than as a statistical test (Kline, 2005:136). The normed chi-square value is usually adopted by most researchers. The normed chi-square is the procedure of dividing the chi-square by the degrees of freedom. The normed values of up to 3.0 or even 5.0 are recommended (Kline, 2005:137). Values for NFI range between 0 and 1 with Bentler and Bonnet (1980) recommended values greater than 0.90 indicating a good fit. Hu and Bentler (1999) have given a cut-off criterion of NFI ≥ 0.95. This index is sensitive to sample size, underestimating fit for samples less than 200 (Mulaik et al., 1989; Bentler, 1990), and it does not recommended to be solely relied on (Kline, 2005). The non-normed fit index (NNFI, also known as the Tucker-Lewis index) is an index that prefers simpler models. The value of the NNFI can indicate poor fit despite other statistics pointing towards good fit if small samples are used (Bentler, 1990; Kline, 2005; Tabachnick & Fidell, 2007). Owing to their non-normed nature, NNFI values can go above 1.0 and can thus be difficult to interpret (Byrne, 1998). The chi-square and degrees of freedom were found to be 0.315. This ratio was lower than the limit of 3.00 or 5.0 advocated for by some authors (Kline, 2005:137). The CFI value was found to be 1.000 which was slightly greater than the cut-off limit of 0.95 so the model is described to have an acceptable fit. The NFI value was 0.999 which is slightly above the given cut-off value of NFI ≥ 0.95 is shown in Table 11.80. Therefore, the model is acceptable. The NNFI value obtained is 1.000 which is above the cut-off value of 0.80. These fit indexes for the Construction Process Management and Improvement model suggested that the postulated model adequately describes the sample data and could therefore be included in the full latent variable model analysis (Table 11.80).

Table 11.80: Robust fit Indexes for Construction Process Management and Improvement Features Construct

Fit Index	Cut-off value	Estimate	Comment
S – Bχ²		0.630	
df	0≥	2	Good fit
Normed chi-square = x^2/df ratio	*≤2 or 3 good fit* *≤5 acceptable*	0.31 5	
CFI	0.90≥ acceptable 0.95≥ good fit	1.000	Good fit
RMSEA	Less than 0.05 with confidence interval (CI) 0.00-0.05 "good fit"	0.000	Good fit
NFI	Greater than 0.90 "good fit"	0.999	Good fit
NNFI	Greater than 0.80. "good fit"	1.000	Good fit
SRMR	Equal or less than 0.05 "good fit" Equal or less than 0.08 "acceptable fit"	0.003	Good fit

Source: Fieldwork (2018)

Statistical Significance of Parameter Estimates

Table 11.81 shows the correlation values, standard errors and the test of statistics. All the correlation values were less than 1.00 and all the *Z*-statistics were greater than 1.96 and show appropriate signs. The estimates were therefore deemed reasonable as well as statistically significant. The parameter with the highest standardized coefficient was the indicator with variable CPMI12 (Efficient management system) and its parameter coefficient was 0.827.

Table 11.81: Factor Loading and Z-statistics of Construction Process Management and Improvement Measurement

Indicator Variable	Unstandardized Coefficient (λ)	Standardized Coefficient (λ)	*Z*-Statistics	R^2	Significant at 5% level?
CPMI9	1.366	0.798	3.046	0.622	Yes
CPMI10	1.369	0.795	3.034	0.627	Yes
CPMI11	1.310	0.793	3.346	0.632	Yes
CPMI12	1.411	0.827	4.034	0.701	Yes

(Robust Statistical Significance at 5% level)

Source: Fieldwork (2018)

Most of the parameter estimates had high correlation values close to 1.00. The high correlation values suggest a high degree of linear association between the indicator variables and the unobserved variable (Construction Process Management and Improvement features). In addition, the R^2 values were also close to the desired value of 1.00, indicating that the factors explained more of the variance in the indicator variables. The results therefore suggest that the indicator variables significantly predict the unobserved construct because all the measured variables are significantly associated with the Construction Process Management and Improvement features.

Internal Reliability and Validity of Scores

The internal consistency and reliability of scores for the Construction Process Management and Improvement features construct was determined from the rho and the Cronbach's alpha coefficient. According to Kline (2005:59), the reliability coefficient should fall between zero and 1.00. Values close to 1.00 are desired. The rho coefficient of internal consistency was found to be 0.824. This value was above the minimum required value of 0.70. Likewise, the Cronbach's alpha was above the minimum acceptable value of 0.70. The Cronbach's alpha was found to be 0.875 (Table 11.82). Both of these values revealed a high level of internal consistency and therefore reliability, suggesting that the indicator variables represent the same latent construct (Construction Process Management and Improvement).

Table 11.82: Reliability and Construct Validity of Construction Process Management and Improvement Feature Model

Factor	Indicator Variable	Factor Loading	Cronbach's Alpha	Rho Coefficient
Construction Process Management and Improvement Features	CPMI9	0.798	0.879	0.824
	CPMI10	0.795		
	CPMI11	0.793		
	CPMI12	0.827		

*Parameter estimates are based on standardized solutions

Source: Fieldwork (2018)

Further, construct validity was determined from the magnitude and reasonableness of the parameter coefficients (factor loading). The parameter coefficients represent the magnitude of correlation or covariance between an item and a construct. Higher parameter coefficients show that the indicator variables have a stronger relationship with a construct and thus converge at a common point. Parameter coefficients of greater than 0.5 indicate a close relationship between the construct and an indicator variable. A parameter coefficient of 0.5 is interpreted as 25 per cent of the total variance in the indicator variable being explained by the latent variable (factor). Hence, a parameter coefficient should be 0.5 or higher and ideally 0.7 or greater to explain about 50 per cent of the variance in an indicator variable (Hair et al., 1998:111). The standardized parameter coefficient presented in Table 11.81 revealed that all coefficients were significantly higher with the lowest being 0.793 for Construction Process Management and Improvement features. The magnitude of the parameter estimate was above the 50 per cent minimum. This indicates a strong relationship between the indicator variables and the factors of the Construction Process Management and Improvement features construct. Therefore the Construction Process Management and Improvement features satisfied both internal reliability and the construct criteria. The rho value was above the minimum value of 0.70 and the magnitude, signs and statistical significance of the parameter estimates were appropriate (Table 11.82).

Summary on Construction Process Management and Improvement feature Measurement Model

The CFA revealed that the residual covariance estimates fell within the acceptable range. Likewise, the robust fit indices met the cut-off index criteria and all the parameter estimates were statistically significant and feasible. Considering these criteria, the measurement model for the Construction Process Management and Improvement feature was found to adequately fit the sample data. Therefore, there was no need to improve the measurement model before it could be included in the full latent variable model. Hence, the Construction Process Management and Improvement feature construct was adequately measured by the indicator variables and could be used in the analysis of the full latent variable model.

11.4.4.1.9 Measurement Model for Construction Employees' Involvement and Motivation Features (CEIM) construct

A unidimensional model for Construction Employees Involvement and Motivation (CEIM) features was presented (Table 11.33). From the 536 cases analyzed for this construct, three (3) indicator variables (F8CEIM3, F8CEIM4, and F8CEIM5) made up of the same factor were realized and the name CEIM was maintained (Table 11.33). All the three (3) indicator variables obtained were used for the CFA (Byrne, 2006:94; Joreskog & Sorbom, 1988). In order for a variable to be included in a CFA, thus enabling the model to be described as well-fitting, the distribution of residuals covariance matrix should be symmetrical and centred around zero (Byrne, 2006:94; Joreskog & Sorbom, 1988). The three-indicator model provides good measures of residual matrix and evidence of convergent validity.

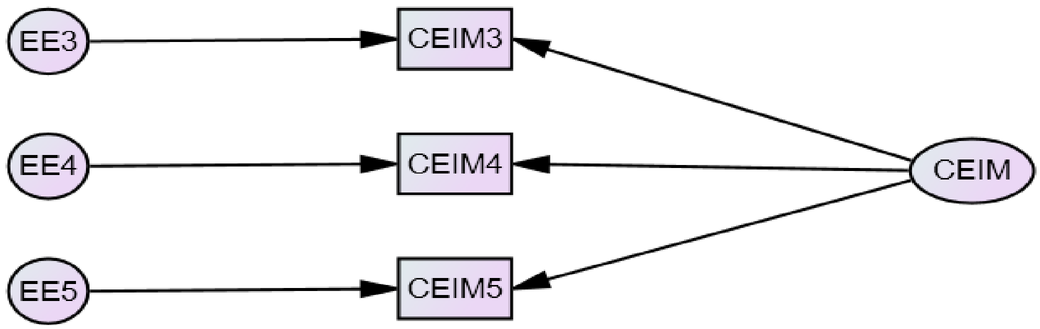

Figure 11.9: Measurement Model of Construction Employees Involvement and Motivation

The CFA results further revealed that the Construction Employees Involvement and Motivation features had three (3) dependent variables, four (4) independent variables and six (6) free parameters. There werefour (4) fixed non-zero parameters. The three (3) dependent indicator variables for the Construction Employees Involvement and Motivation are Salary/Position promotion, Employee rewards, and Bonus scheme. These indicator variables are presented in Table 11.84. The Construction Employees Involvement and Motivation features measurement model shown in Figure 11.9 was analyzed before it could be included in the full latent variable model.

In order to establish how well the model fit the sample data and the strength of the hypothesized relationship between the variables, results on residual covariance matrix (unstandardized and standardized), distribution of standardized residuals, fit statistics and statistical significance at a probability level of 5 per cent were examined. In addition, the Cronbach's alpha and the rho coefficient of internal consistency were examined to determine the score reliability. Results of these statistics are presented in the next section for the Construction Employees Involvement and Motivation features.

Table 11.83: Postulated Construction Employees Involvement and Motivation Features Model

Latent constructs	Indicator variables	Label
Construction Employees Involvement and Motivation (CEIM)	Salary/Position promotion	CEIM3
	Bonus scheme	CEIM4
	Employee rewards	CEIM5

Source: Fieldwork (2018)

Diagnostic Fit Analysis: Analysis of Residual Covariance Estimate

The unstandardized and standardized absolute residual matrix values of the Construction Employees Involvement and Motivation features are presented in Tables 11.84 and 11.85. The result reveals that all the absolute residual values and the average off-diagonal absolute residual values were close to zero. The unstandardized average off-diagonal residual was 0.000 while the standardized average off-diagonal residual was found to be 0.000. A residual value greater than 2.58 is described as large (Byrne, 2006:94). The results obtained for the Construction Employees Involvement and Motivation Features measurement model suggested a fairly acceptable fit to the sample data because the absolute residuals were all less than 2.58. In order for a model to be described as well-fitting, the distribution of standardized residuals should be symmetrical and centred around zero (Byrne, 2006:94).

Table 11.84: Residual Covariance Matrix for Construction Employees Involvement and Motivation Model (Unstandardized)

Unstandardized Residual Covariance Matrix			
	CEIM5	CEIM4	CEIM3
CEIM5	0.000		
CEIM4	0.000	0.000	

CEIM3	0.000	0.000	0.000

Average absolute residual = **0.000**
Average off-diagonal absolute residual = **0.000**

% falling between -0.1 +0.1 = 99.99%

Source: Fieldwork (2018)

Further review of the frequency distribution reveals most residual values (99.99%) fall between -0.1 and +0.1, which is in the acceptable range. Of the remaining residuals, 0.01% fell outside the -0.1 to 0.1 ranges.

Table 11.85: Residual Covariance Matrix for Construction Employees Involvement and Motivation Model (Standardized)

Standardized Residual Covariance Matrix

	CEIM5	CEIM4	CEIM3
CEIM5	0.000		
CEIM4	0.000	0.000	
CEIM3	0.000	0.000	0.000

Average absolute residual = **0.000**
Average off-diagonal absolute residual = **0.000**

% falling between -0.1 +0.1 = 99.99%

Source: Fieldwork (2018)

From this information, the results suggested a measurement model that was well fitting despite a minimal discrepancy in fit between the hypothesized model and the sample data. Therefore, since this diagnostic fit analysis indicated a good fit, further tests of goodness-of-fit were possible to make a conclusive decision on the fit and appropriateness of the measurement model.

Goodness-of-fit Statistics – Robust Maximum Likelihood (RML)

The analysis strategy of goodness-of-fit for the Construction Employees Involvement and Motivation measurement followed a three-statistics strategy of fit indexes as recommended by Hu and Bentler (1999). The sample data on Construction Employees' Involvement and Motivation measurement model yielded the $S - B\chi 2$ of 0.000 with 0.000 degrees of freedom (*df*) with a probability of $p = 0.000$. This chi-square value indicated that the departure of the sample data from the postulated measurement model was significant and hence indicative of good fit. The chi-square test is very sensitive to sample size and is used more as a descriptive index of fit rather than as a statistical test (Kline, 2005:136). The normed chi-square value is usually adopted by most researchers. The normed chi-square is the procedure of dividing the chi-square by the degrees of freedom. The normed values of up to 3.0 or even 5.0 are recommended (Kline, 2005:137). Values for NFI range between 0 and 1 with Bentler and Bonnet (1980) recommended values greater than 0.90 indicating a good fit. Hu and Bentler (1999) have given a cut-off criterion of NFI $\geq$ 0.95. This index is sensitive to sample size, underestimating fit for samples less than 200 (Mulaik et al., 1989; Bentler, 1990), and is thus not recommended to be solely relied on (Kline, 2005). The non-normed fit index (NNFI, also known as the Tucker-Lewis index) is an index that prefers simpler models. The value of the NNFI can indicate poor fit despite other statistics pointing towards good fit if small samples are used (Bentler, 1990; Kline, 2005; Tabachnick & Fidell, 2007). Owing to their non-normed nature, NNFI values can go above 1.0 and can thus be difficult to interpret (Byrne, 1998). The chi-square and degrees of freedom were found to be 0.000. This ratio was lower than the limit of 3.00 or 5.0 advocated for by some authors (Kline, 2005:137). The CFI value was found to be 1.000 which was slightly greater than the cut-off limit of 0.95 so the model is described to have an acceptable fit. The NFI value was 1.000 which is slightly above the given cut-off value of NFI $\geq$ 0.95 is shown in Table 11.86. Therefore, the model is acceptable. The NNFI value obtained is 1.000 which is also above the cut-off value of 0.80. These fit indexes for the Construction Employees Involvement and Motivation model suggested that the postulated model adequately describes the sample data and could therefore be included in the full latent variable model analysis (Table 11.86).

Table 11.86: Robust Fit Indexes for Construction Employees Involvement and Motivation Features Construct

Fit Index	Cut-off value	Estimate	Comment
S – Bχ²		0.000	
df	0≥	0.00 0	Good fit
Normed chi-square = *x²*/df ratio	*≤2 or 3 good fit* *≤5 acceptable*	-	
CFI	0.90≥ acceptable 0.95≥ good fit	1.000	Good fit
RMSEA	Less than 0.05 with confidence interval (CI) 0.00-0.05 "good fit"	0.000	Good fit
NFI	Greater than 0.90 "good fit"	1.000	Good fit
NNFI	Greater than 0.80. "good fit"	1.000	Good fit
RMSEA 95% CI		0.000: 0.076	Acceptabl e range
SRMR	Equal or less than 0.05 "good fit" Equal or less than 0.08 "acceptable fit"	0.000	Good fit

Source: Fieldwork (2018)

Statistical Significance of Parameter Estimates

Table 11.87 shows the correlation values, standard errors and the test of statistics. All the correlation values were less than 1.00 and all the *Z*-statistics were greater than 1.96 and show appropriate signs except CEIM5 the value of which (1.454) was slightly below 1.96. However, the estimates were deemed reasonable as well as statistically significant. The parameter with the highest standardized coefficient was the indicator with variable CEIM4 (Bonus scheme) and its parameter coefficient was 0.932.

Table 11.87: Factor Loading and Z-statistics of Construction Employees Involvement and Motivation Measurement

Indicator Variable	Unstandardized Coefficient (λ)	Standardized Coefficient (λ)	*Z*-Statistics	R^2	Significant at 5% level?
CEIM3	1.000	0.706	2.102	0.500	Yes
CEIM4	1.590	0.932	18.390	0.911	Yes
CEIM5	1.100	0.695	1.454	0.482	Yes

(Robust Statistical Significance at 5% level)

Source: Fieldwork (2018)

Most of the parameter estimates had high correlation values close to 1.00. The high correlation values suggest a high degree of linear association between the indicator variables and the unobserved variable (Construction Employees Involvement and Motivation features). In addition, the R^2 values were also close to the desired value of 1.00, indicating that the factors explained more of the variance in the indicator variables except CEIM5 the value of which (0.482) was slightly below 0.50. Although the CEIM5 value was slightly below 0.50, the results still suggest that the indicator variables significantly predict the unobserved construct because all the measured variables are significantly associated with the Construction Employees Involvement and Motivation features.

Internal Reliability and Validity of Scores

The internal consistency and reliability of scores for the Construction Employees Involvement and Motivation features construct was determined from the rho and the Cronbach's alpha coefficient. According to Kline (2005:59), the reliability coefficient should fall between zero and 1.00. Values close to 1.00 are desired. The rho coefficient of internal consistency was found to be 0.838. This value was above the minimum required value of 0.70. Likewise, the Cronbach's alpha was above the minimum acceptable value of 0.70. The Cronbach's alpha was found to be 0.837 (Table 11.88). Both of these values revealed a high level of internal consistency and therefore reliability, suggesting that the indicator variables represent the same latent construct (Construction Employees Involvement and Motivation).

Table 11.88: Reliability and Construct Validity of Construction Employees Involvement and Motivation Condition Feature Model

Factor	Indicator Variable	Factor Loading	Cronbach's Alpha	Rho Coefficient
Construction Employees. Involvement and Motivation Features	CEIM3	0.706	0.837	0.838
	CEIM4	0.932		
	CEIM5	0.695		

*Parameter estimates are based on standardized solutions

Source: Fieldwork (2018)

Further, construct validity was determined from the magnitude and reasonableness of the parameter coefficients (factor loading). The parameter coefficients represent the magnitude of correlation or covariance between an item and a construct. Higher parameter coefficients show that the indicator variables have a stronger relationship with a construct and thus converge at a common point. Parameter coefficients of greater than 0.5 indicate a close relationship between the construct and an indicator variable. A parameter coefficient of 0.5 is interpreted as 25 per cent of the total variance in the indicator variable being explained by the latent variable (factor).

Hence, a parameter coefficient should be 0.5 or higher and ideally 0.7 or greater to explain about 50 per cent of the variance in an indicator variable (Hair et al., 1998:111). The standardized parameter coefficient presented in Table 11.87 revealed that all coefficients were significantly higher with the lowest being 0.695 for Construction Employees Involvement and Motivation features. The magnitude of the parameter estimate was above the 50 per cent minimum. This indicates a strong relationship between the indicator variables and the factors of the Construction Employees Involvement and Motivation features construct. Therefore the Construction Employees Involvement and Motivation features satisfied both internal reliability and the construct criteria. The rho value was above the minimum value of 0.70 and the magnitude, signs and statistical significance of the parameter estimates were appropriate (Table 11.88).

Summary of Construction Employees Involvement and Motivation Feature Measurement Model

The CFA revealed that the residual covariance estimates fell within the acceptable range. Likewise, the robust fit indices met the cut-off index criteria and all the parameter estimates were statistically significant and feasible. Considering these criteria, the measurement model for the Construction Employees Involvement and Motivation feature was found to adequately fit the sample data. Therefore, there was no need to improve the measurement model before it could be included in the full latent variable model. Hence, the Construction Employees Involvement and Motivation feature construct was adequately measured by the indicator variables and could be used in the analysis of the full latent variable model.

11.4.4.1.10 Measurement Model for TQM features (TQM) Construct

A unidimensional model for TQM **(TQM)** features was presented (Table 11.33). From the 536 cases analyzed for this construct, four (4) indicator variables (F9TQMO1, F9TQMO4, F9TQMO5, and F9TQMO6) were realized (Table 11.33). All the four (4) indicator variables obtained were used for the CFA (Byrne, 2006:94; Joreskog & Sorbom, 1988). In order for a variable to be included in a CFA, thus enabling the model to be described as well-fitting, the distribution of residuals covariance matrix should be symmetrical and centred around zero

(Byrne, 2006:94; Joreskog & Sorbom, 1988). The four-indicator model provides good measures of residual matrix and evidence of convergent validity.

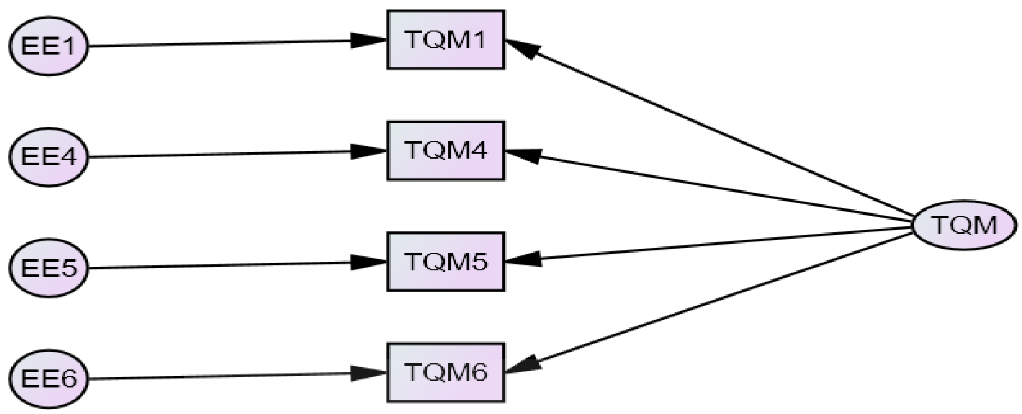

Figure 11.10: Measurement model of TQM

The CFA results further revealed that the TQM features had four (4) dependent variables, five (5) independent variables and 8 free parameters. The number of fixed non-zero parameters was five (5). The four (4) dependent indicator variables for the TQM are Greater reduction of construction costs, Elimination of reworks, Defect-free product at first attempt, and Higher safety standards. These indicator variables are presented in Table 11.89. The TQM features measurement model shown in Figure 11.10 was analyzed before it could be included in the full latent variable model.

In order to establish how well the model fit the sample data and the strength of the hypothesized relationship between the variables, results on residual covariance matrix (unstandardized and standardized), distribution of standardized residuals, fit statistics and statistical significance at a probability level of 5 per cent were examined. In addition, the Cronbach's alpha and the rho coefficient of internal consistency were examined to determine the score reliability. Results of these statistics are presented in the next section for the TQM features.

Table 11.89: Postulated TQM Features Model

Latent constructs	Indicator variables	Label
TQM Outcomes (TQMO)	Greater reduction of construction costs	TQMO1
	Elimination of reworks	TQMO4
	Defect-free product at first attempt	TQMO5
	Higher safety standards	TQMO6

Source: Fieldwork (2018)

Diagnostic Fit Analysis: Analysis of Residual Covariance Estimate

The unstandardized and standardized absolute residual matrix values of the TQM features are presented in Tables 11.90 and 11.91. The result reveals that all the absolute residual values and the average off-diagonal absolute residual values were close to zero. The unstandardized average off-diagonal residual was 0.0007 while the standardized average off-diagonal residual was found to be 0.0012. A residual value greater than 2.58 is described as large (Byrne, 2006:94). The results obtained for the TQM features measurement model suggested a fairly acceptable fit to the sample data because the absolute residuals were all less than 2.58. In order for a model to be described as well-fitting, the distribution of standardized residuals should be symmetrical and centred around zero (Byrne, 2006:94).

Table 11.90: Residual Covariance Matrix for TQM Model (Unstandardized)

Unstandardized Residual Covariance Matrix				
	TQMO6	TQMO5	TQMO4	TQMO1
TQMO6	0.000			
TQMO5	0.008	0.000		
TQMO4	0.000	-0.010	0.000	

TQMO1	-0.017	0.000	0.020	0.000
Average absolute residual = **0.0400**				
Average off-diagonal absolute residual = **0.0007**				
% falling between -0.1 +0.1 = 99.99%				

Source: Fieldwork (2018)

Further review of the frequency distribution reveals most residual values (99.99%) fall between -0.1 and +0.1, which is in the acceptable range. Of the remaining residuals, 0.01% fell outside the -0.1 to 0.1 ranges.

Table 11.91: Residual Covariance Matrix for TQM Model (Standardized)

Standardized Residual Covariance Matrix				
	TQMO6	TQMO5	TQMO4	TQMO1
TQMO6	0.000			
TQMO5	0.246	0.000		
TQMO4	0.010	-1.242	0.000	
TQMO1	-0.456	0.005	0.430	0.000
Average absolute residual = **0.0002**				
Average off-diagonal absolute residual = **0.0012**				
% falling between -0.1 +0.1 = 99.99%				

Source: Fieldwork (2018)

From this information, the results suggested a measurement model that was well fitting despite a minimal discrepancy in fit between the hypothesized model and the sample data. Therefore, since this diagnostic fit analysis indicated a good fit, further tests of goodness-of-fit were possible to make a conclusive decision on the fit and appropriateness of the measurement model.

Goodness-of-fit Statistics – Robust Maximum Likelihood (RML)

The analysis strategy of goodness-of-fit for the TQM followed a three-statistics strategy of fit indexes as recommended by Hu and Bentler (1999). The sample data on TQM measurement model yielded the $S - B\chi 2$ of 4.926 with a 2 degree of freedom (*df*) with a probability of p = 0.0000. This chi-square value indicated that the departure of the sample data from the postulated measurement model was significant and hence indicative of good fit. The chi-square test is very sensitive to sample size and is used more as a descriptive index of fit rather than as a statistical test (Kline, 2005:136). The normed chi-square value is usually adopted by most researchers. The normed chi-square is the procedure of dividing the chi-square by the degrees of freedom. The normed values of up to 3.0 or even 5.0 are recommended (Kline, 2005:137).

Values for NFI range between 0 and 1 with Bentler and Bonnet (1980) recommended values greater than 0.90 indicating a good fit. Hu and Bentler (1999) have given a cut-off criterion of NFI $\geq$ .95. This index is sensitive to sample size, underestimating fit for samples less than 200 (Mulaik et al., 1989; Bentler, 1990), and is thus not recommended to be solely relied on (Kline, 2005). The non-normed fit index (NNFI, also known as the Tucker-Lewis index) is an index that prefers simpler models. The value of the NNFI can indicate poor fit despite other statistics pointing towards good fit if small samples are used (Bentler, 1990; Kline, 2005; Tabachnick & Fidell, 2007). Owing to their non-normed nature, NNFI values can go above 1.0 and can thus be difficult to interpret (Byrne, 1998). The chi-square and degrees of freedom were found to be 2.463. This ratio was lower than the limit of 3.00 or 5.0 advocated for by some authors (Kline, 2005:137).

The CFI value was found to be 0.997 which was slightly greater than the cut-off limit of 0.95 so the model is described to have an acceptable fit. The NFI value was 0.995 which is slightly above the given cut-off value of NFI $\geq$ 0.95 and is shown in Table 11.92. Therefore, the model is acceptable. The NNFI value obtained is 0.992 which is above the cut-off value of 0.80. These fit indexes for the TQM model suggested that the postulated model adequately describes the sample data and could therefore be included in the full latent variable model analysis (Table 11.92).

Table 11.92: Robust Fit Indexes for TQM Features Construct

Fit Index	Cut-off value	Estimate	Comment
S – Bχ^2		4.926	
df	0≥	2	
Normed chi-square = x^2/df ratio	*≤2 or 3 good fit* *≤5 acceptable*	2.463	Good fit
CFI	0.90≥ acceptable 0.95≥ good fit	0.997	Good fit
RMSEA **95%**	Less than 0.05 with confidence interval (CI) 0.00-0.05 "good fit"	0.052	Good fit
NFI	Greater than 0.90 "good fit"	0.995	Good fit
NNFI	Greater than 0.80. "good fit"	0.992	Good fit
RMSEA 95% CI		0.000 – 0.113	Slightly out of range
SRMR	Equal or less than 0.05 "good fit" Equal or less than 0.08 "acceptable fit"	0.009	Good fit

Source: Fieldwork (2018)

Statistical Significance of Parameter estimates

Table 11.93 shows the correlation values, standard errors and the test of statistics. All the correlation values were less than 1.00 and all the *Z*-statistics were greater than 1.96 and show appropriate signs except TQMO1 the value of which (1.803) was slightly below 1.96. However, the estimates were deemed reasonable as well as statistically significant. The parameter with the highest standardized coefficient was the indicator with variable TQMO5 (Defect-free product at first attempt) and its parameter coefficient was 0.868.

Table 11.93: Factor Loading and Z-statistics of TQM Measurement

Indicator Variable	Unstandardized Coefficient (λ)	Standardized Coefficient (λ)	*Z*-Statistics	R^2	Significant at 5% level?
TQMO1	1.421	0.768	2.017	0.602	Yes
TQMO4	1.228	0.771	2.394	0.594	Yes
TQMO5	1.333	0.868	4.667	0.748	Yes
TQMO6	1.000	0.766	3.450	0.583	Yes

(Robust Statistical Significance at 5% level)

Source: Fieldwork (2018)

Most of the parameter estimates had high correlation values close to 1.00. The high correlation values suggest a high degree of linear association between the indicator variables and the unobserved variable (TQM). In addition, the R^2 values were also close to the desired value of 1.00, indicating that the factors explained more of the variance in the indicator variables. The results therefore suggest that the indicator variables significantly predict the unobserved construct because all the measured variables are significantly associated with the TQM features.

Internal Reliability and Validity of Scores

The internal consistency and reliability of scores for the TQM features construct were determined from the rho and the Cronbach's alpha coefficient. According to Kline (2005:59), the reliability coefficient should fall between zero and 1.00. Values close to 1.00 are desired. The rho coefficient of internal consistency was found to be 0.785. This value was above the minimum required value of 0.70. Likewise, the Cronbach's alpha was above the minimum acceptable value of 0.70. The Cronbach's alpha was found to be 0. 866 (Table 11.94). Both of these values revealed a high level of internal consistency and therefore reliability, suggesting that the indicator variables represent the same latent construct (TQM).

Table 11.94: Reliability and Construct Validity of TQM Feature Model

Factor	Indicator Variable	Factor Loading	Cronbach's Alpha	Rho Coefficient
TQM Outcomes Features	TQMO1	0.768	0.866	0.785
	TQMO4	0.771		
	TQMO5	0.868		
	TQMO6	0.766		

*Parameter estimates are based on standardized solutions

Source: Fieldwork (2018)

Furthermore, construct validity was determined from the magnitude and reasonableness of the parameter coefficients (factor loading). The parameter coefficients represent the magnitude of correlation or covariance between an item and a construct. Higher parameter coefficients show that the indicator variables have a stronger relationship with a construct and thus converge at a common point. Parameter coefficients of greater than 0.5 indicate a close relationship between the construct and an indicator variable. A parameter coefficient of 0.5 is interpreted as 25 per cent of the total variance in the indicator variable being explained by the latent variable (factor). Hence, a parameter coefficient should be 0.5 or higher and ideally 0.7 or greater to explain about 50 per cent of the variance in an indicator variable (Hair et al., 1998:111).

The standardized parameter coefficient presented in Table 11.94 revealed that all coefficients were significantly higher with the lowest being 0.766 for TQM features. The magnitude of the parameter estimate was above the 50 per cent minimum. This indicates a strong relationship between the indicator variables and the factors of the TQM features construct. Therefore the TQM features satisfied both internal reliability and the construct criteria. The rho value was above the minimum value of 0.70, and the magnitude, signs and statistical significance of the parameter estimates were appropriate (Table 11.94).

Summary of TQM Measurement Model

The CFA analysis revealed that the residual covariance estimates fell within the acceptable range. Likewise, the robust fit indexes met the cut-off index criteria and all the parameter estimates were statistically significant and feasible. Considering these criteria, the measurement model for the TQM feature was found to adequately fit the sample data. Therefore, there was no need to improve the measurement model before it could be included in the full latent variable model. Hence the TQM feature construct was adequately measured by the indicator variables and could be used in the analysis of the full latent variable model.

11.4.5 Structural Model – Testing of the Hypothesized SEM Model

Each of the nine latent factors to be included in the full latent model was working very well based on the test indexes and the statistically significances of the parameter estimates. Then the full structural model was tested, which included all nine factors (with tested indicator variables) and the TQM outcome (manifest) variables for the study.

Once again, the CFA measurement model for latent constructs was tested in order to confirm whether the indicators that have been used to measure one or more latent factors hold. Thus, loadings of the indicators on the specific factors were examined to see how well each factor has been specified in the context of the others.

Table 11.95: Reliability and Construct Validity of the Latent Variables

Latent (Exogenous	No. of Indicator Variables	Indicator Variable	Parameter Coefficient	Cronbach's Alpha	Rho Coefficient
Leadership and Top Management (LTM)	4	LTM1	0.847		
		LTM4	0.847		
		LTM8	0.826		
		LTM9	0.783		

Company Supplier Quality Management (CSQM)	3	CSQM4 CSQM7 CSQM8	0.773 0.893 0.834	0.963	0.751
Client Focus and Involvement (CFI)	3	CFI1 CFI2 CFI4	0.825 0.823 0.718		
Company Quality System Evaluation (CQSE)	3	CQSE1 CQSE2 CQSE3	0.813 0.832 0.741		
Company Vision and Plan Statement (CVPS)	3	CVPS5 CVPS6 CVPS7	0.828 0.850 0.775		
Product Design Management (PDM)	3	PDM2 PDM3 PDM6	0.786 0.757 0.718		
Product Selection Management (PSM)	3	PSM1 PSM2 PSM4	0.893 0.843 0.771		

Construction Process Management and Improvement (CPMI)	4	CPMI9	0.798		
		CPMI10	0.795		
		CPMI11	0.793		
		CPMI12	0.827		
Construction Employees' Involvement and Motivation	3	CEIM3	0.706		
		CEIM4	0.932		
		CEIM5	0.695		
TQM Outcomes (TQMO)	4	TQMO1	0.768	0.866	0.785
		TQMO4	0.771		
		TQMO5	0.868		
		TQMO6	0.766		

Source: Fieldwork (2018)

Covariances between the latent factors are added to the model for any relationship that will be examined when the structural model is tested. Also, covariances between the latent factors and outcome variables are also added to rule out the possibility that any of them may serve as an indicator of any of the proposed factors. As already indicated above (analysis of the measurement models), the measurement models indicated that the models (latent variables CFAs) worked well and it was therefore feasible to test the full latent variable model. The question of whether measurement models should be checked before analysing the full SEM is simply a strategy a researcher adopts (Hayduk & Glaser, 2000:122). Similarly, the question of how many factors a construct should have is also debatable (Bollen, 1989; Hayduk & Glaser, 2000:122). However, assessing the measurement models first has an advantage. The first merit of analyzing the latent variable measurement models separately before analyzing the full SEM model is that the research is assured of a proper working measurement model before analyzing the full SEM latent model. Hence, the researcher avoids the frustration of re-specifying the full model if a solution cannot be obtained. According to Herting and Costner (2000:100), "…if a CFA model cannot be satisfactorily fitted, moving to the structural model will provide no additional guidance or benefit". However, these observations as presented in the current study were a pure confirmatory analysis and therefore recommendations were based on whether the postulated priori model fit the sample data. Hence, not all the initially derived indicator variables from the literature which were on the questionnaires were tested in the CFA, as the preliminary residual covariance matrix (factor loadings) for some indicator variables of some latent constructs were more than the recommended value. A residual covariance matrix value greater than 2.58 is described as large (Byrne, 2006:94). In order for a model to be described as well fitting, the distribution of the residuals should be symmetrical and centred around zero (Byrne, 2006:94; Joreskog & Sorbom, 1988).

11.4.6 Hypothesized Relation for the Structural Model

The hypothesized model (Model 2.0) was tested in which leadership and top management, company supplier quality management, client focus and involvement, company quality system evaluation, company vision and plan statement, product design management, product selection management, construction process management and improvement and construction employees' involvement and motivation were expected to define TQM. The hypothesized model was fitted to the data for the entire sample and, as is the norm, covariances for all the exogenous factors and variables were specified. The nine-factor model was fitted to the data with the RML method of EQS and the model converged. As with all of the analyses presented in this study, the testing of this model was based on the robust ML estimation and robust statistics were used to ascertain the fit of the model. The robust solution adjusts for non-normality in the data. As is the norm in SEM analyses (Kline, 2005), one variable loading per latent factor was set equal to 1.0 in order to set the metric for that factor.

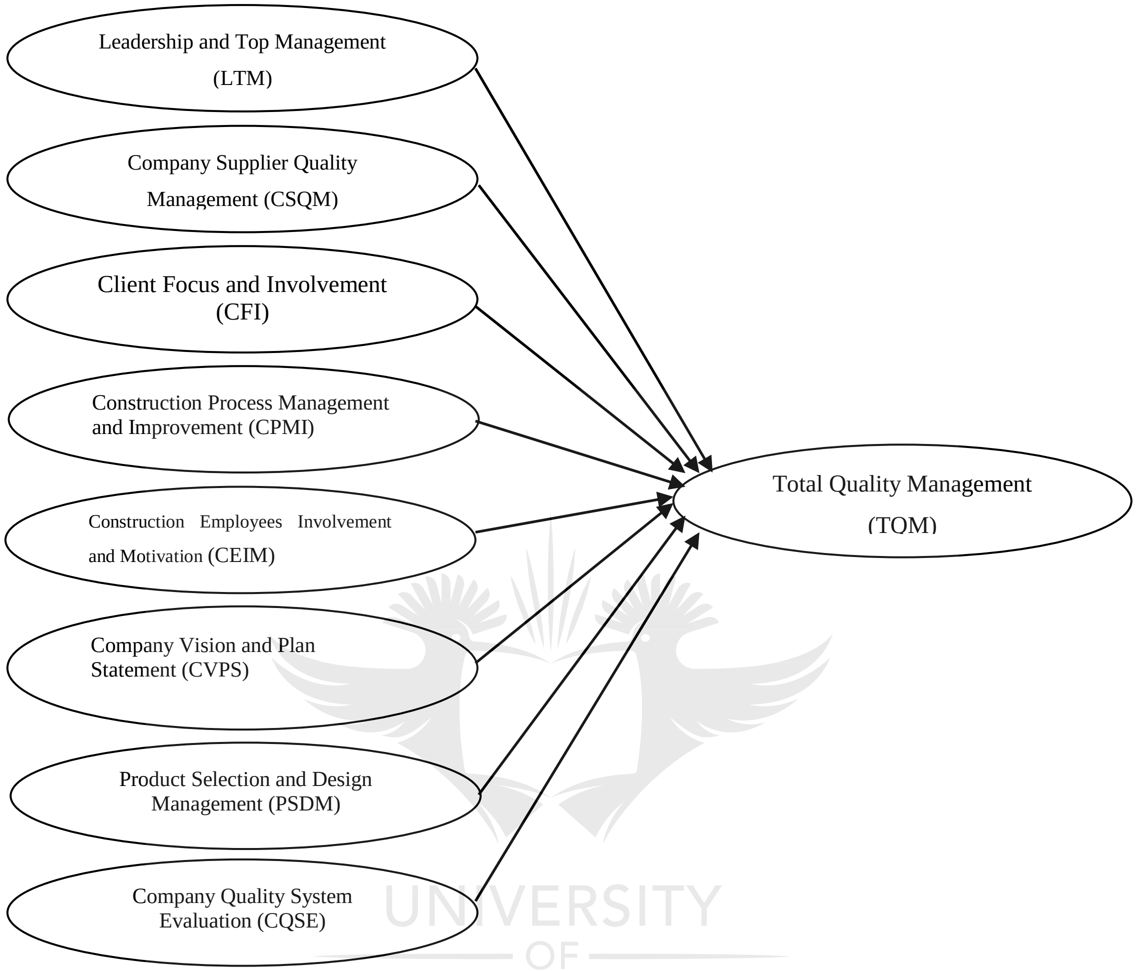

Figure 11.11: Hypothesized Model of TQM (Model 1.0)

11.4.7 Fit Statistics on the Structural Model

A CFA of the full latent model was conducted. The full structural model hypothesized that leadership and top management features, company supplier quality management features, client focus and involvement features, company quality system evaluation features, company vision and plan statement features, product design management features, product selection management features, construction process management and improvement features and construction employees' involvement and motivation features define TQM in the Ghanaian construction industry. The SEM model is presented in Figure 11.12 (Model 2.0). Model 2.0 is founded on the general hypothesis for the study, which is based on the fact that overall TQM is directly related to the influence of the exogenous variables in predicting or determining overall TQM practices. The theory and basis of the model were presented in Chapter 10 of the thesis. The number of cases that were analyzed for the full latent variable Model 2.0 was 536. Out of the total sample size, all the 536 cases had positive weights. The model had 33 dependent variables and 43 independent variables. It also had 66 free parameters and 43 numbers of fixed non-zero parameters. The covariance matrix of the model was analyzed using the RML estimation method. Raw data was used for the analysis.

The raw data was not transformed since data transformation can provide an incorrect specification (Shook, Ketchen, Hult & Kacmar, 2004: 399). One alternative to transformation is to use an estimation approach available in EQS (robust maximum likelihood) as already discussed, which adjusts the model fit chi-square test statistics and standard errors of individual parameter estimates.

11.4.7.1 Analysis of Residual Covariance Estimate

Investigation of the average absolute residual values of the structural model revealed that all the absolute residual values and the average off-diagonal absolute residual values were close to zero. The unstandardized average off-diagonal residual was 0.0814 while the standardized average off-diagonal residual was found to be 0.0865 (refer to Appendix G). These residual values were considered small as they were all less than 2.58 (Byrne, 2006:94). In addition, 99.99 per cent of the residuals fell within the acceptable range of -0.1 and +0.1. The significance of this distribution is that for a structural model to be described as well-fitting, the distribution of residuals should be symmetrical and centred around zero (Joreskog &Sorbom, 1988; Byrne, 2006:94), which the analyzed data has displayed. From the above information, the results suggest that the hypothesized structural model had a good-fit to the sample data. Overall, the model as a whole appears to be quite well fitting. Therefore, since this initial assessment of the structural model residuals indicated a good fit, further tests of goodness-of-fit were justified.

11.4.7.2 Structural Model Goodness-of-fit Statistics – Robust Maximum Likelihood

The test of the hypothesis that TQM in the Ghanaian construction industry is a nine-factor structure as depicted in Figure 11.12 (Model 2.0) via the sample data on the model yielded a robust likelihood ratio test ($S - B\chi 2$) of 3134.617 with 450 degrees of freedom. The associated p value was less than 0.001 ($p = 0.000$) with a sample of 536 cases. The chi-square index suggested that the difference between the hypothesized model and the sample data matrix was significant, but not entirely adequate. However, the chi-square test (likelihood ratio test) of fit is very sensitive and therefore could not be relied upon to determine model fit. The chi-square test tends to be affected by the sample size with a propensity to reject models if the samples are large (Joreskog & Sorbom, 1993). Yet, the analysis of covariance structure (SEM) is grounded in large sample size theory (Byrne, 2006:96). As such, large sample sizes are critical to obtaining precise parameter estimates, as well as to the tenability of asymptotic distribution approximations (MacCallum et al., 1996; Byrne, 2006:96). Therefore a normed chi-square value is usually adopted by most researchers (MacCallum et al., 1996; Bentler, 1999; Kline, 2005:137; Byrne, 2006;). Normed chi-square is the procedure of dividing the $S - B\chi 2$ by the degrees of freedom. The normed values of up to 3.0 or even 5.0 are recommended (Kline, 2005:137). From the above chi-square and degrees of freedom values, the ratio was found to be 6.97:1. This ratio was slightly above the limit of 5.0 but could be acceptable as advocated for by some authors (Kline, 2005:137; Byrne, 2006) and therefore indicative of a reasonable fit of the model.

Other fit indexes such as goodness-of-fit statistics indexes were also applied to determine goodness-of-fit or acceptable fit of the model to the latent variables. The robust CFI index was determined and found to be 0.897. The CFI index was equivalent to an upper limit of 0.90, but was considered because the value was within the range for model acceptance. In addition, the absolute fit index, NFI, was found to be 0.794 which indicated an adequate fit of the full structural model to the sample data, while the NNFI was found to be 0.817, indicating a good fit of the full structural model to the sample data. Another strategic approach is also considered satisfactory to accept or reject a model (Hu & Bentler, 1999:28). Hence, SRMR statistics were further used to decide on the acceptability of the model.

Table 11.96: Robust Fit Indexes for Structural Model 2.0

Fit Index	**Cut-off value**	**Estimate**	**Comment**
S – Bχ²		3134.617	
df	0≥	450	Good fit
Normed chi-square = x^2/df ratio	*≤2 or 3 good fit* *≤5 acceptable*	6.966	Acceptable range
CFI	0.90≥ acceptable 0.95≥ good fit	0.897	Acceptable
NFI	Greater than 0.90 “good fit”	0.794	Acceptable
NNFI	Greater than 0.80. “good fit”	0.817	Good fit
SRMR	Equal or less than 0.05 “good fit” Equal or less than 0.08 “acceptable fit”	0.039	Good fit

Source: Fieldwork (2018)

SRMR fit index in this study was found to be 0.039, a value which is lower than a goodness-of-fit index of 0.05. Hence, SRMR fit index indicated a good fit of the model to the latent variables. Schreiber et al. (2006) and Hu and Bentler (1999) posit that an SRMR equal to or less than 0.05 indicates “good fit” and also equal to or less than 0.08 indicates “acceptable fit”. Therefore, the goodness-of-fit statistics indexes (CFI, NFI, NNFI, SRMR and *S – Bχ2*) met the condition for model acceptance (Table 11.96) except the RMSEA index @ 95%., which was found to be just above the upper limit of 0.08 for the model to be described as acceptable. The robust RMSEA with a 95 per cent confidence interval (lower bound value = 0.102 and the upper bound value = 0.109) was found to be 0.106. MacCallum et al. (1996) informed that an RMSEA below 0.08 shows a good fit. The model was found to be somewhat unstable with the RMSEA index because of issues such as the high correlation between factors. However, the Lagrange multiplier (LM) test conducted on the full latent model sample data did not reveal any significant indicators of model mis-specification of the hypothesized parameters. In EQS, a model can be said to be mis-specified if there are any mis-fitting parameters using the LM test (Byrne, 2006:112). The criterion is to identify any significant drop in the $\chi 2$ values of parameters. Also, in univariate and multivariate analysis, the probability that a parameter estimate is equal to zero should be less than 0.05 in order to be rejected. This is also an indication of mis-specification according to Byrne (2006:112). Hence, inspection of the LM test output revealed that there were no significant mis-fitting variables that would have warranted mode re-specification.

11.4.7.3 Internal Reliability and Construct Validity of the SEM Model

The rho coefficient and the Cronbach's alpha coefficient were examined in order to establish score reliability for the SEM model. According to Kline (2005:59), the reliability coefficient should fall between zero and 1.00. Values close to 1.00 are desired. The rho coefficient of internal consistency was found to be 0.751. This value was above the minimum required value of 0.70. Similarly, the Cronbach's alpha was above the minimum acceptable value of 0.70 at 0.963. Both of these values indicated a high degree of internal consistency and homogeneity (Table 11.97). These findings informed that the degree to which responses are consistent across all indicator variables was statistically significant, indicating that the measures of the latent variables total scores are the best possible unit of analysis for the exogenous variables which predictor the endogenous variable (TQM). The construct validity for the SEM model was determined by examining the magnitude of the parameter coefficients. High parameter coefficients of greater than 0.5 indicate a close relation between the factor and an indicator variable. However, a parameter coefficient has to be between 0.5 - 0.7 or greater to explain about 50 per cent of the variance in an indicator variable (Hair et al., 1998:111). Inspection of the standardized parameter coefficients presented in Table 11.98 shows that they were significantly high with a maximum of 0.932. The parameter estimate of 0.932 meant that the TQM accounted for about 93.2 per cent of the variance CEIM 4 and was therefore indicative of a good fit between the indicator variable and the factor, likewise in the other factors.

11.4.7.4 Structural Model Hypothesis Testing

Besides assessing the goodness-of-fit of the structural model, the feasibility of a model can be judged by a further inspection of the obtained solution and this involves inspection of the statistical significance of the parameter estimates, standard errors and the test statistics (Raykov, 1991:501). Therefore, the rejection of the hypothesis depends on how reasonable parameter estimates were in terms of their magnitude, signs and statistical significance. In addition, if the output showed estimates that had correlation values greater than 1.00, had negative variances and the correlation or covariances were not definitely positive, then they were said to be displaying unreasonable estimates (Byrne, 2006:103). Likewise, the test statistics had to be greater than 1.96 based on the probability level of 5 per cent before the hypothesis can be rejected (Byrne, 2006:103). The test statistics reported was the parameter estimate divided by its standard error and therefore it functions as a *Z*-statistics to test that the estimate is statistically different from zero. Hence, the test was used to evaluate the hypothesis.

Testing the Influence of the Exogenous Variables on overall TQM

It was general hypothesized that TQM is related to the influence of the exogenous variables in predicting the overall TQM in the construction industry using Ghana as a case study. Results from the SEM analysis yielded support for the hypothesis. The hypothesized relationships between all exogenous factors and the endogenous factor were found to be significant and they all had definite positive directions. Inspection of the correlation values, standard errors and the test statistic in Table 11.98 revealed that all standardized coefficient correlation values were not greater than 1.00. All test statistics (Z-values) were greater than 1.96 ($p<0.05$) and the signs were appropriate. They all have positive values (refer to Tables 11.98 and 11.99), suggesting that all latent variables measured the overall TQM. The estimates were therefore reasonable as well as statistically significant. Therefore, the general hypothesis that TQM is directly related to the influence of the exogenous variables in predicting overall TQM in the Ghanaian construction industry could not be rejected. The relationship between TQM and TQM indicators was found to be the most significant. In order to determine whether each exogenous variable considerably predicted the endogenous construct, an inspection of the interfactor correlation (R^2) values were examined, thus establishing the exogenous variables' direct influence on the dependent variable (presented in the subsequent sections). However, the overall results therefore suggest that the exogenous variables considerably predict the endogenous variable (TQM). Further assessment of the outcome variables of overall TQM revealed that all standardized factor loadings' values were generally large and statistically significant (values ranged from 0.695 to 0.932). However, the interfactor correlation (R^2) values were all statistically significant (values ranged from 0.482 to 0.911) as shown in Table 11.99. The variance accounted for in each measure by the endogenous variable revealed that the scores were significant at 5 per cent level. The score results suggested that the interfactor relationship between the manifest variables is strong and has significant levels of correlations.

Testing the Direct Influence of Leadership and Top Management Features on Overall TQM

Results from the CFA of the full structural model presented in Tables 11.97 and 11.98 yield support for the general hypothesis. The relationship between the factors and the endogenous variable (dependent variable) was found to be statistically significant at 5 per cent probability level. On the other hand, all standardized parameter estimates showed high correlations values close to 1.00, suggesting a high degree of linear association between the indicator variables and the endogenous construct. Inspection of the R^2 values for the Leadership and Top Management variables revealed that the values were above 0.50. LTM1 (R^2 = 0.717), LTM4 (R^2 = 0.718), LTM8 (R^2 = 0.682) and LTM9 (R^2 = 0.613) and close to the desired value of 1.00. Hence, the direct influence of Leadership and Top Management factor on overall TQM is statistically significant as shown in Table 11.99.

Table 11.97: Model 2.0 Factor Loadings and Z-statistics

Indicator Variable	Unstandardized Coefficient (λ)	Standardized Coefficient (λ)	(Z-values)	Significant at 5% level?
LTM1	1.000	0.847	4.132	Yes
LTM4	1.111	0.847	3.361	Yes
LTM8	0.988	0.826	3.500	Yes
LTM9	0.995	0.783	2.417	Yes
CSQM4	0.895	0.773	4.547	Yes
CSQM7	1.000	0.893	2.467	Yes
CSQM8	0.959	0.834	3.100	Yes
CFI1	1.000	0.825	4.125	Yes
CFI2	0.979	0.823	3.532	Yes
CFI4	0.928	0.718	2.211	Yes
CQSE1	1.000	0.813	4.542	Yes
CQSE2	0.984	0.832	4.139	Yes
CQSE3	0.987	0.741	2.301	Yes
CVPS5	1.000	0.828	3.101	Yes
CVPS6	1.056	0.850	3.414	Yes
CVPS7	0.847	0.775	2.788	Yes
PDM 2	1.000	0.786	3.169	Yes
PDM 3	1.009	0.757	2.980	Yes
PDM 6	0.886	0.718	2.370	Yes

PSM 1	1.000	0.893	4.934	Yes
PSM 2	0.851	0.843	4.014	Yes
PSM 4	0.752	0.771	2.804	Yes
CPMI9	1.366	0.798	3.046	Yes
CPMI10	1.369	0.795	3.034	Yes
CPMI11	1.310	0.793	3.346	Yes
CPMI12	1.411	0.827	4.034	Yes
CEIM3	1.000	0.706	2.102	Yes
CEIM4	1.590	0.932	18.390	Yes
CEIM5	1.100	0.695	1.982	Yes
TQMO1	1.421	0.768	2.017	Yes
TQMO4	1.228	0.771	2.394	Yes
TQMO5	1.333	0.868	4.667	Yes
TQMO6	1.000	0.766	3.450	Yes

(Robust Statistical Significance at 5% level)

Source: Fieldwork (2018)

*** SEM Analysis Norm (Kline, 2005) - One variable loading per latent factor is set equal to 1.0 in order to set the metric for that factor*

Testing the Direct Influence of Company Supplier Quality Management Features on Overall TQM

Inspection of the R^2 values for the Company Supplier Quality Management indicators revealed that all the three indicator variables that were used to measure the latent factor had values close to the desired value of 1.00. All the three variables, namely CSQM4 (R^2 = 0.598), CSQM7 (R^2 = 0.798) and CSQM8 (R^2 = 0.696) were strong in predicting the endogenous variable (Table

11.99). This suggests that the interfactor relationship of these variables and other indicators in determining the overall TQM is major. Furthermore, assessment of the variance accounted for in each measure by the endogenous variable revealed that all scores were significant at 5 per cent level. The reported parameter coefficient explained more than 25 per cent of the variance in the latent variable, which was indicative of an adequate fit between the latent variables and the endogenous construct. Thus, the score results suggested that the influence of this latent factor on the endogenous variable was direct and significant.

Testing the Direct Influence of Client Focus and Involvement Features on Overall TQM

Inspection of the score values for this factor revealed that all standardized factor loadings were generally large and statistically significant (values ranged from 0.718 to 0.825). The interfactor correlation (R^2) values were also moderately large and statistically significant (values ranged from 0. 516 to 0.680) as shown in Table 11.98. Also, the variances accounted for in each measure by the endogenous variable revealed that the scores were significant at 5 per cent level. The values were above the minimum required value of 25 per cent. Hence, the score results suggested that the influence of the Client Focus and Involvement on the endogenous variable was direct and statistically significant.

Testing the Direct Influence of Company Quality System Evaluation Features on Overall TQM

Assessment of the standardized factor loadings revealed that all values were generally large and statistically significant (values ranged from 0.741 to 0.832). Also, the interfactor correlation (R^2) values were also moderate and statistically significant (values ranged from 0.549 to 0.692) as shown in Table 11.98. The total variances accounted for in each indicator variable by the endogenous variable revealed that the scores were significant at 5 per cent level. The score results suggested that the influence of Company Quality System Evaluation in determining overall TQM was direct and statistically significant.

Table 11.98: Model 2.0 Factor Loadings, Z-statistics, Variance Accounted for & Reliability and Construct Validity

Indicator Variable	**Standardized Coefficient (λ)**	**(*Z*-values)**	**R^2**	**Cronbach's Alpha**	**Rho Coefficient**
LTM1	0.847	4.132	0.717		
LTM4	0.847	3.361	0.718		
LTM8	0.826	3.500	0.682		
LTM9	0.783	2.417	0.613		
CSQM4	0.773	4.547	0.598		
CSQM7	0.893	2.467	0.798		
CSQM8	0.834	3.100	0.696		
CFI1	0.825	4.125	0.714		
CFI2	0.823	3.532	0.655	0.963	0.751
CFI4	0.718	2.211	0.524		
CQSE1	0.813	4.542	0.660		
CQSE2	0.832	4.139	0.692		
CQSE3	0.741	2.301	0.549		
CVPS5	0.828	3.101	0.685		
CVPS6	0.850	3.414	0.723		
CVPS7	0.775	2.788	0.601		
PDM 2	0.786	3.169	0.600		
PDM 3	0.757	2.980	0.627		
PDM 6	0.718	2.370	0.515		

PSM 1	0.893	4.934	0.797		
PSM 2	0.843	4.014	0.710		
PSM 4	0.771	2.804	0.594		
CPMI9	0.798	3.046	0.622		
CPMI10	0.795	3.034	0.627		
CPMI11	0.793	3.346	0.632		
CPMI12	0.827	4.034	0.701		
CEIM3	0.706	2.102	0.500		
CEIM4	0.932	18.390	0.911		
CEIM5	0.695	1.982	0.482		
TQMO1	0.768	2.017	0.602		
TQMO4	0.771	2.394	0.594	0.866	0.785
TQMO5	0.868	4.667	0.748		
TQMO6	0.766	3.450	0.583		

(Robust Statistical Significance at 5% level)

Source: Fieldwork (2018)

Testing the Direct Influence of Company Vision and Plan Statement Features on Overall TQM

The inspection of the standardized factor loadings revealed that all values were generally very large and statistically significant significant (values ranged from 0.775 to 0.850) as shown in Table 11.99). The R^2 values were large and statistically significant (values ranged from 0.601 to 0.723). This suggests that the inter-factor relationship between the variables is significant. The variance accounted for in each measure by the endogenous variable revealed that the scores were significant at 5 per cent level. The score results suggested that the direct influence of Company Vision and Plan Statement in determining overall TQM is statistically significant.

Testing the Direct Influence of Product Design Management Features on Overall TQM

Assessment of the standardized factor loadings revealed that all values were generally large and statistically significant (values ranged from 0.718 to 0.786). Also, the interfactor correlation (R^2) values were also moderate and statistically significant (values ranged from 0.515 to 0.618) as shown in Table 11.99. The total variances accounted for in each indicator variables by the endogenous variable revealed that the scores were significant at 5 per cent level. The score results suggested that the influence of Product Design Management in determining overall TQM is statistically significant.

Testing the Direct Influence of Product Selection Management Features on Overall TQM

The inspection of the standardized factor loadings revealed that all values were generally very large and statistically significant (values ranged from 0.771 to 0.893) as shown in Table 11.99. The R^2 values were large and statistically significant (values ranged from 0.594 to 0.797). This suggests that the inter-factor relationship between the variables is significant. The variance accounted for in each measure by the endogenous variable revealed that the scores were significant at 5 per cent level. The score results suggested that the direct influence of Product Selection Management in determining overall TQM is statistically significant.

Testing the Direct Influence of Construction Process Management and Improvement Features on Overall TQM

The inspection of the standardized factor loadings revealed that all values were generally large and statistically significant (values ranged from 0.793 to 0.827) as shown in Table 11.99. The R^2 values were large and statistically significant (values ranged from 0.629 to 0.684). This suggests that the inter-factor relationship between the variables is significant. The variance accounted for in each measure by the endogenous variable revealed that the scores were significant at 5 per cent level. The score results suggested that the direct influence of Construction Process Management and Improvement in determining overall TQM is statistically significant.

Testing the Direct Influence of Construction Employees Involvement and Motivation Features on Overall TQM

Assessment of the standardized factor loadings revealed that all values were generally large and statistically significant (values ranged from 0.695 to 0.932). On the other hand, the R^2 values CEIM3 (R^2 = 0.500) and CEIM4 (R^2 = 0.911), were found to be moderate and very largely statistically significant respectively. The exception is the indicator variable CEIM5 (R^2 = 0.482) which is the weakest among the variables. The result of R^2 for CEIM5 suggests that this indicator variable did not considerably predict the endogenous factor construct. Despite the non-coherent level of the inter-factor correlation within the indicator variables, the direct influence of Construction Employees' Involvement and Motivation factor on overall TQM is statistically significant because the scores were significant at 5 per cent level as shown in Table 11.98.

11.4.8 Model Explanation

The CFA structures in figure 11.12 comprise nine (9) unobserved latent factors for an integrated TQM model (Leadership and Top Management (LTM), Company Supplier Quality Management (CSQM), Client Focus and Involvement (CFI), Company Quality System Evaluation (CQSE), Company Vision and Plan Statement (CVPS), Product Design Management (PDM), Product Selection Management (PSD), Construction Process Management and Improvement (CPMI), and Construction Employees' Involvement and Motivation (CEIM)). These factors are termed first order factors and consist of 29 observed variables. Four of them are considered to measure LTM (LTM1, LTM4, LTM8 and LTM9), and CPMI (CPMI9, CPMI10, CPMI11 and CPMI12) respectively, while three are considered to measure CSQM (CSQM4, CSQM7 and CSQM8), CFI (CFI1, CFI2 and CFI4), CQSE (CQSE1, CQSE2 and CQSE3), CPVS (CPVS5, CPVS6 and CPVS7), PDM (PDM2, PDM3 and PDM6), PSM (PSM1, PSM2 and PSM4), and CEIM (CEIM3, CEIM4 and CEIM5) respectively. These 29 observed variables function as indicators of their respective underlying latent factors. Associated with each observed variable is an error termed (EEI – EE29) with factors being predicted (LTM, CSQM, CFI, CQSE, CPVS, PDM, PSM, CPMI and CEIM). The error associated with observed variables represents measurement error which reflects on their adequacy in measuring the related underlying factors (LTM, CSQM, CFI, CQSE, CPVS, PDM, PSM, CPMI and CEIM).

In order to determine whether each exogenous variable considerably predicted the endogenous construct (dependent variable), an inspection of the interfactor correlation (R^2) values, standard errors and the test statistic was done. The results revealed that all standardized coefficient correlation values were not greater than1.00, the test statistics (Z-values) were greater than 1.96 ($p<0.05$), and the signs were appropriate. They all have positive values, suggesting that all latent variables measured the overall TQM outcomes as shown in Figure 11.13. The relationships between all exogenous factors and the endogenous factors in Figure 11.13 were found to be significant and they all had definite positive directions. The overall results therefore suggested that the exogenous variables considerably predict the endogenous variable (TQM). Hence, the finalized model (Figure 11.13) revealed that the exogenous variables (LTM, CSQM, CFI, CQSE, CVPS, PDM, PSD, CPMI, and CEIM) had a statistically significant influence in determining TQM (TQM) for the Ghanaian construction industry although the exogenous variables such as CEIM had a weak (indirect) influence on determining TQM for the Ghanaian construction industry. However, the assessment of the variance accounted for in each measure by the endogenous variable revealed that the scores were significant as the values were above the minimum required value. Therefore the weak variable has a good indirect association with the other latent variables in the prediction of overall TQM in the construction industry.

Further, construct validity was determined from the magnitude and reasonableness of the parameter coefficients (factor loading) which represent the magnitude of correlation or covariance between an item and a construct. Higher parameter coefficients were achieved which also shows that the indicator variables have a stronger relationship with a construct and thus converge at a common point and indicate a close relationship between the construct and an indicator variable. The lines of covariances (Figure 11.13) indicate that the integrated holistic influence of the latent variables determines overall TQM because they were all statistically significant. It can therefore be concluded that the nine-factor model schematically portrayed in Figures 11.12 and 11.13 (Model 2.0) represents an adequate description of TQM for the Ghanaian construction industry.

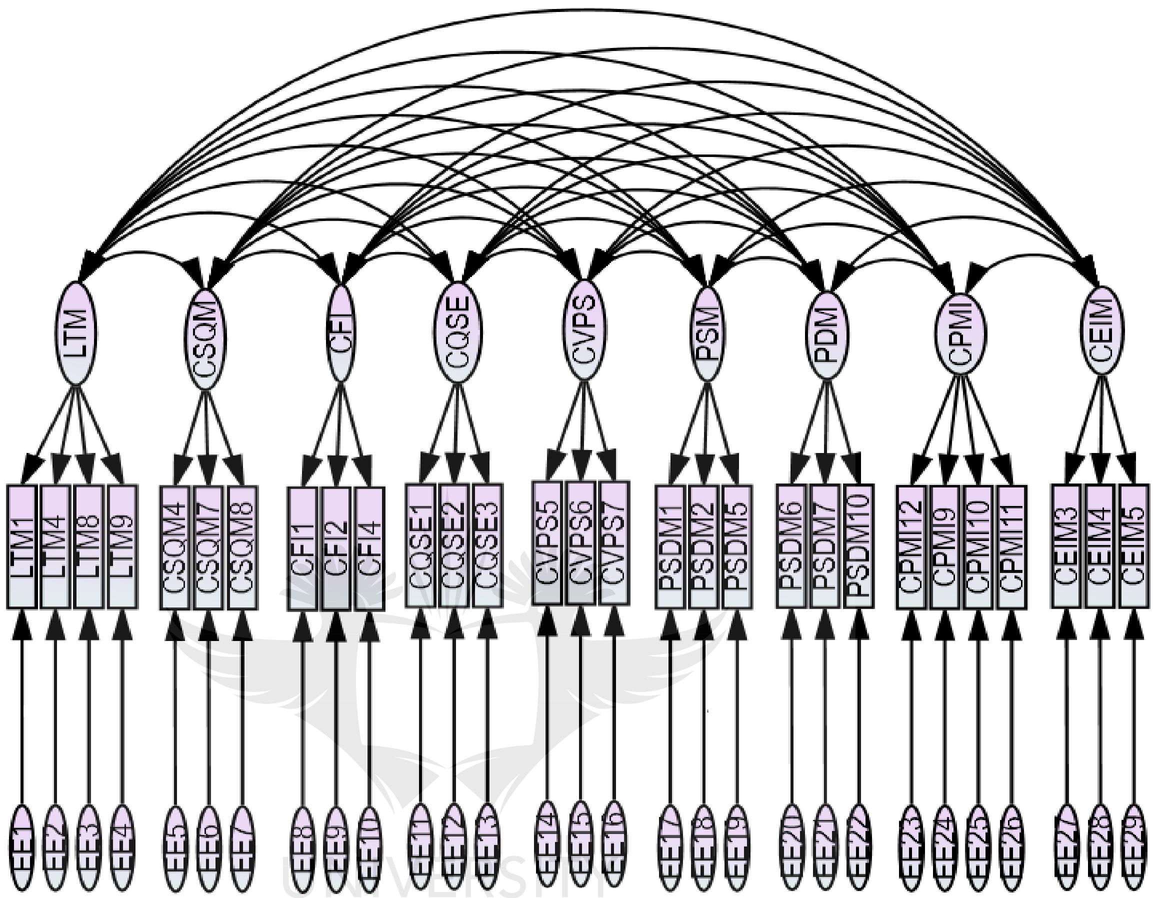

Figure 12.12: Model 2.0 – An Integrated TQM Model

Model parameters (from left to right): LTM (4 indicator variables), CSQM (3 indicator variables), CFI (3 indicator variables), CQSE (3 indicator variables), CVPS (3 indicator variables), PSM (3 indicator variables), PDM (3 indicator variables), CPMI (4 indicator variables), and CEIM (3 indicator variables)

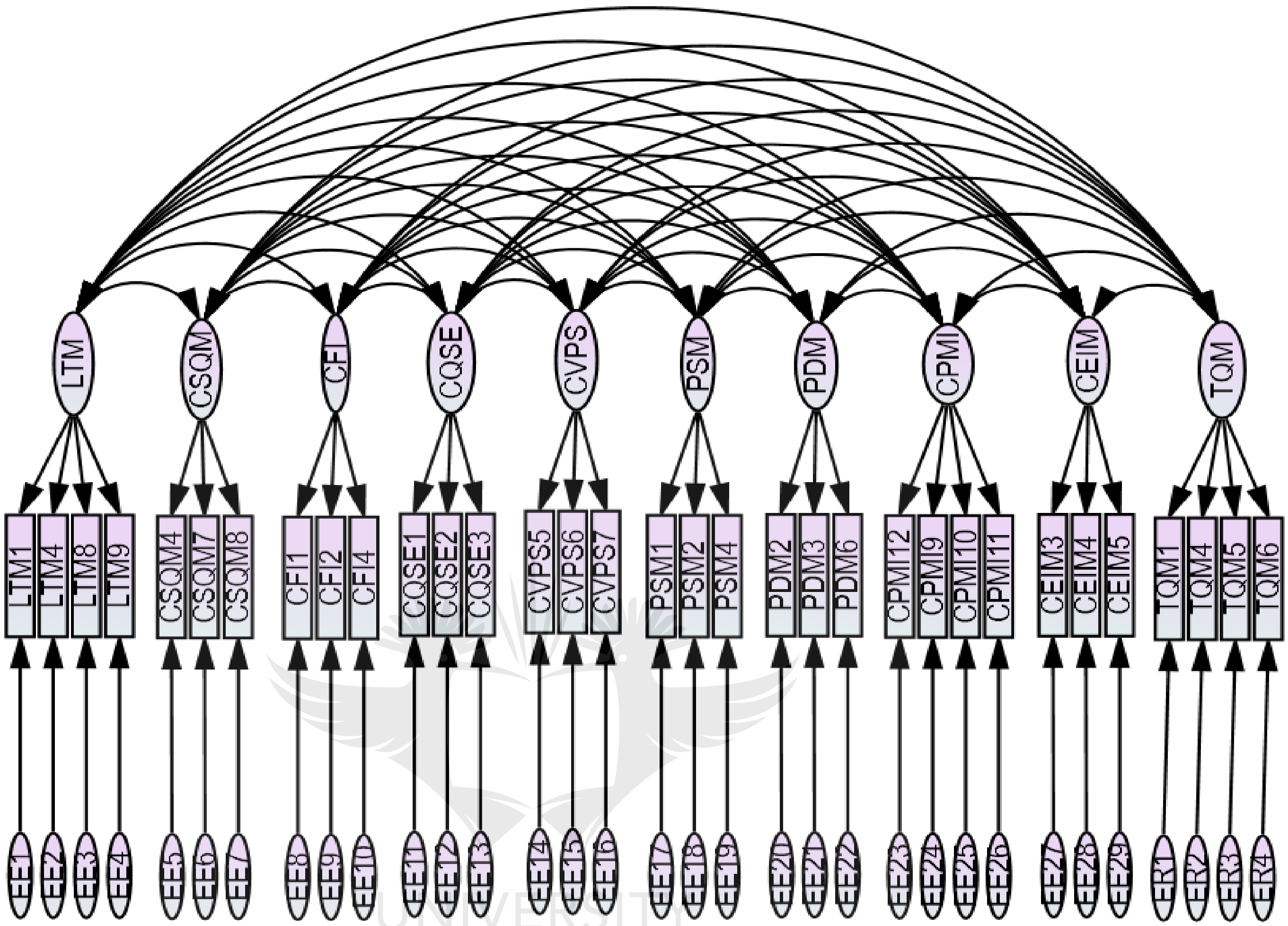

Figure 11.13: Model 2.0 – An Integrated TQM Model Covariances Association

Covariance relationship (from left to right): LTM (4 indicator variables), CSQM (3 indicator variables), CFI (3 indicator variables), CQSE (3 indicator variables), CVPS (3 indicator variables), PSM (3 indicator variables), PDM (3 indicator variables), CPMI (4 indicator variables), CEIM (3 indicator variables) and TQM (4 indicator variables)

11.4.9 Summary of SEM Model

Results from the EQS output revealed that the robust fit indexes, CFI, NFI, NNFI, and the SRMR values were acceptable and met the cut-off index criteria except RMSEA the value of which was slightly above the cut-off index criterion. On the other hand, the parameter estimates were found to be statistically significant and reasonable. The postulated model, which hypothesized that overall TQM, is directly related to the influence of the exogenous variables in predicting or determining overall TQM fit the sample data adequately. In view of the fact that the analysis was both exploratory and confirmatory of a prior model, there was no need to further improve the structural model. Investigation of alternative models, such as the reduction of latent variables, could be a matter for further studies as the current study was both an exploratory and confirmatory analysis of a prior model. However, the Lagrange multiplier test did not unveil significant indication of model mis-specification to demand a re-specification. Byrne (2006:112) informs that for most models, model enhancement is purely a process that attempts to fine-tune small features of the sample and does not essentially add value to an already fitted model, such as the current model. Likewise, MacCallum et al. (1992:501) cautioned that "…when an initial model fits well, it is probably unwise to modify it to achieve even better fit because modifications may simply be fitting idiosyncratic characteristics of the sample". Hence, the presented model (Model 2.0) was therefore accepted with its level of fit. The lines of covariances (Figure 11.13) indicate that the integrated holistic influence of the latent variables determines overall TQM because they were all statistically significant.

11.5 CONCLUSION

The postulation for the overall model was that the overall TQM practice is directly related to the influence of the exogenous (latent) variables in predicting or determining overall TQM. The SEM results of the measurement model were presented in this chapter. These results were obtained from an analysis of SEM to determine whether the indicator variables (questionnaire items) actually measured the constructs that they were supposed to measure. In addition, results were presented in order to establish whether the statistically significant number of factors for the latent models was feasible. Likewise, the measurement model reliability and construct validity were also reported. The analysis of the structural model (full latent model-SEM) was conducted, which validates the hypothesized integrated holistically TQM model. The influence of the latent variables on the endogenous variable was also reported. It was concluded that there is therefore no need to further improve the fit of the structural model. Further findings from the SEM results revealed that the exogenous variables influence or determine TQM in the Ghanaian construction industry. Further, it was found that all the nine exogenous variables have a significant direct influence on the endogenous variables. It can therefore be concluded that the nine-factor model schematically portrayed in Figure 11.12 (Model 2.0) represents an adequate description of TQM in the Ghanaian construction industry.

CHAPTER TWELVE

12 DISCUSSION OF RESULTS

12.1 INTRODUCTION

The quantitative research findings with reference to the descriptive and inferential statistics are discussed in detail and presented in this chapter. Also, the research hypotheses are tested based on the SEM result analysis, validating the assumption that TQM is a nine-factor model schematically portrayed in Figure 11.12 (Model 2.0). The findings from the SEM analysis which model TQM as a nine-factor model showed that the factors of Leadership and Top Management, Company Supplier Quality Management, Client Focus and Involvement, Company Quality System Evaluation, Company Vision and Plan Statement, Product Selection Management, Product Design Management, Construction Process Management and Improvement, and Construction Employees' Involvement and Motivation were found to have a significant influence in predicting the TQM in the construction industry. However, the Construction Employees' Involvement and Motivation feature had a weak (indirect) influence in predicting TQM in the construction industry. Notwithstanding, the covariation with the other exogenous construct to determine TQM in the construction industry was found to be statistically significant.

12.2 QUESTIONNAIRE SURVEY RESULTS

To successfully implement TQM in construction industry, it is important to identify the factors required for the implementation process. The questionnaire survey of the current study was designed purposely to determine the factors or attributes that influence or predict TQM in the construction industry and to develop a holistic integrated TQM model for the Ghanaian construction industry. The structural model results of the thesis hypothesis testing revealed that the general hypothesis, which states that leadership and top management, company supplier quality management, client focus and involvement, company quality system evaluation, company vision and plan statement, product design management, product selection management, construction process management and improvement, and construction employees' involvement and motivation jointly predict TQM in the Ghanaian construction industry could not be rejected. In view of the hypothesis, the discussion section was structured in order to respond to the research's sub-questions.

Harris and McCaffer (2002) inform that TQM consists of all activities that managers carry out to improve their quality and strategy such as quality control, quality planning, quality improvement and quality assurance. It includes continuous improvement, training and re-training of staff, customers' satisfaction, top management support, defect-free products at first attempt, elimination of reworks, and cost effectiveness, amongst others. Tang, Ahmed, Aoieoung and Poon (2005), on the other hand, indicated that the five core principles of TQM are continuous improvement, customer focus, employee participation, teamwork and process focus. These five principles are related to the five drivers of change suggested by the Egan (1998) report, namely committed leadership, integrated processes and teams, focus on the customer, commitment to people and a quality-driven agenda. Hence, the need for top management commitment and leadership is recognised by most prominent writers in the area of quality such as Deming (1986), Garvin (1988), Aalbregtse et al. (1991), Berry (1991), Juran and Gryna (1993), Oakland (1993), Bounds et al. (1994), Dale (1994), Dahlgaard et al. (1998), and Yusof (2000) . Many of these writers have also found that top management support for quality was a key factor in quality improvement. Therefore, the first observation that must be made is that the respondents in this study are among the top management who most probably have worked in their respective firms for a number of years as revealed by findings related to the position held in the firm by the respondents (Table 11.5) and work experience in the construction industry (Table 11.4). Findings from these aspect revealed that a combined percentage of 87.5% of the respondents formed part of the top management (Project Managers = 16.2%, Site Engineers = 40.9% and Quality Control Officers 2.4%) while a combined percentage of 12.5% were foremen and others. It was also found that a combined percentage of 70% of the respondents have worked in their respective firms for more than six years while 30% have worked in the construction industry for less than six years. Therefore, their opinions could thus be used to make an inference.

Furthermore, Ahire and Ravichandran (2001) informed that the commitment of top management is generally a preliminary point for implementing and practising TQM in order to enhance the performance of an organization. Management at the top level of an organization is responsible for the implementation of TQM. If top management refuses to get involved and support the new philosophy, it will most likely fail. Top management must support this philosophy both monetarily and morally or TQM will probably not survive (Walton, 1986). Hence, the most critical factor contributes to a successful TQM programme is top management commitment (Ramirez & Looney, 1993; Lewis & Smith, 1994).

12.2.1 Leadership and Top Management Features' Influence on TQM

The research's sub-question RO1 was put forward to determine the extent to which Leadership and Top Management features influenced TQM in the construction industry. First, a descriptive assessment of the Leadership and Top Management features revealed that 100.0 per cent of the respondents indicated that top management participation in TQM activities, top management support of TQM, the leadership style of managing employees, leadership initiatives, and top management empowerment of employees towards TQM will contribute to TQM in the construction industry. Another 99.8 per cent of the respondents indicated that the top management interaction with workers will contribute to TQM in the construction industry. Also, 98.9 per cent of the respondents indicated that top management commitment to TQM and top management knowledge and proper understanding of TQM will contribute to TQM in the construction industry. A further assessment of the Leadership and Top Management features revealed that 98.7 per cent of the respondents indicated leadership ability in solving quality-related problems as a contributor to TQM in the construction industry (Table 11.11). Furthermore, results from the structural model revealed that the relationship between the Leadership and Top Management features and the endogenous variable (TQM) was found to be statistically significant at a 5 per cent probability level.

On the other hand, all standardized parameter estimates showed high correlations values, suggesting a high degree of linear association between the indicator variables and the endogenous construct. Also the interfactor values for this variable were considerable, suggesting that more than 50.0 per cent of the latent variable considerably predicted the endogenous factor construct. The summarized result for this variable revealed that the latent factor has a direct influence in determining overall TQM. The results suggest that most variables included in the model have a significant effect on TQM. Further findings suggest that Leadership and Top Management features are a significant determinant of TQM in the construction industry. In addition to this statement, Perles (2002) asserted that top management's role and managerial leadership is one of the factors that determine the variation in the success rate of TQM implementation. The Deming Prize, the European Quality Award (EQA), and the Malcolm Baldrige National Quality Award (MBNQA) also recognize the crucial role of top management leadership in creating the goals, values, and systems that guide the pursuit of continuous performance improvement (Das et al., 2011). Although many of the activities occur in the lower levels of the organization, only the leadership of top management is in a position to create the necessary organizational culture that is capable of leading and supporting TQM actions among employees from the lower levels of the organization (Serafimovska & Ristova, 2011). The same notion is asserted by Flynn et al. (1995), namely that it is impracticable to adopt TQM and improve performance without strong top management support. Therefore, as seen from the above opinions, TQM literature widely supports the necessity of management commitment and leadership for successful TQM implementation (Gonza´lez & Guille´n, 2002).

The implication of these findings is that overall TQM is a product of the direct influence of Leadership and Top Management features. Therefore, the TQM in the Ghanaian construction industry can be improved through Leadership and Top Management features established in this study, namely the leadership style of managing employees, top management knowledge and proper understanding of TQM, top management empowerment of employees to solve quality problems and top management support of TQM. The present work concurs with the work of Ahire and Ravichandran (2001) who argued that the commitment of top management is generally a preliminary point for implementing and practising TQM in order to enhance the performance of an organization. Hence, the most critical factor contributing to a successful TQM programme is top management commitment (Ramirez & Looney, 1993; Lewis & Smith, 1994).

The findings emanating from the Leadership and Top Management features assessment were therefore significant, and when attention is given to the Leadership and Top Management features identified in this study, the much desired TQM in the construction industry will be achieved. The study also recognized that management at the top levels of an organization is responsible for the implementation of TQM. If top management refuses to get involved and support the new philosophy, it will most likely fail. Hence, top management must support this philosophy both monetarily and morally or TQM will probably not survive (Walton, 1986).

12.2.2 Company Supplier Quality Management Features' Influence on TQM

The findings suggested that Supplier Quality Management features have a direct influence on the prediction of TQM in the construction industry. These findings support the views of Hackman and Wageman (1995) who stated that building relationships with suppliers is one of the main TQM implementation practices. Findings from the interfactor relationship revealed that Supplier Quality Management features had a significant association with the latent variables in predicting the endogenous variable. From the assessment of the variance accounted for in each measure by the endogenous variable it was revealed that all scores were statistically significant at 5 per cent level (Table 11.47). The reported parameter coefficient explained more than the baseline level of the variance in the latent variable, which was indicative of an adequate prediction of the endogenous construct. Hence, these results suggested that the influence of this latent factor on the endogenous variable was direct and statistically significant.

A descriptive assessment of the Supplier Quality Management features also revealed that the nine indicator variables used in measuring the Supplier Quality Management construct were highly effective as shown in Table 11.12. Supplier selection criteria and partnership with suppliers was the most effective item with 100.0 per cent followed by supplier quality audit, supplier knowledge of TQM, supplier communication, participation of suppliers in TQM activities, and suppliers' orientation on TQM with 99.8 per cent. The lowest effective items were supplier performance evaluation and suppliers' commitment to TQM with 99.4 per cent. The findings suggest that the respondents were in agreement with the Supplier Quality Management features. These findings support the views of Deming (1986) who strongly suggested that working with the supplier as a partner in a long-term relationship of loyalty and trust enhances the quality of incoming materials and decreases costs. Mann (1992) and Zhan (2000a) also added that companies should take part directly in suppliers' activities related to quality. Deming (1986) and Ishikawa (1985) therefore suggested that companies work directly with suppliers to ensure that their materials are of the highest possible quality.

The implication of these findings is that overall TQM is a product of the direct influence of Supplier Quality Management features and that TQM in the construction industry is paramount. The findings originating from the Supplier Quality Management features' assessment were therefore significant. Anderson et al. (1994a) pointed out that external collaboration between a company and its suppliers has benefits in the just-in-time buying systems and in the case of a poor quality situation such information can be used by the supplier and the company to come up with corrective action.

12.2.3 Client Focus and Involvement Features Influence on TQM

The finding was that Client Focus and Involvement features have a direct positive influence on TQM in the construction industry. The SEM analysis of the study established three indicator variables for Client Focus and Involvement. These indicator variables are Client brief/input, Client complaint information/feedback, and Client satisfaction survey. The SEM analysis for these variable indicators revealed that all the three indicators were closely associated with the dependent variable. This is apparent from the standardized factor loadings and interfactor correlations with other indicator variables, which were statistically significant (Table 11.52). Also, the variances accounted for in each measure by the endogenous variable revealed that the scores were statistically significant and the values were above the minimum required value of 25 per cent to be ascribed as an influence on TQM. The findings suggested that Client Focus and Involvement features have a direct positive influence on the overall TQM. Similarly, a descriptive assessment of the Client Focus and Involvement features also revealed that the indicator variables used in measuring the Client Focus and Involvement construct were highly effective as shown in Table 11.13. The finding was consistent with that of Ishikawa (1985) who stated that to achieve quality, it is essential to know what customers need and to provide products that meet their requirements. Hackman and Wageman (1995) also added that obtaining data about customers is one of the most commonly used TQM implementation practices.

The implication of these findings is that overall TQM is a product of the direct influence of Client Focus and Involvement features. The finding was significant in that it will provide the firms with a full understanding of what the customer needs and wishes now and in the future so that products and services can be designed to satisfy those needs and wishes. The overall results suggested that the influence of Client Focus and Involvement in determining TQM is direct and statistically more significant than any other factor. Similarly, the findings are significant because the key to quality management is keeping a close connection with the customer in order to fully establish the customer's needs, as well as to receive feedback on the degree to which those needs are being met. Client Focus and Involvement will help to define the extent to which a company continuously satisfies client or customer desires and expectations. A successful company recognizes the need to put the customer first in every decision taken (Philips Quality, 1995). Therefore the customer should be closely involved in the product design and development process with input at every point so that there is less probability of quality problems once full production begins (Flynn et al., 1994). The insights gained from this finding can clearly help the firm to improve quality.

12.2.4 Company Quality System Evaluation Features' Influence on TQM

The concept of Company Quality System Evaluation can be defined as a systematic examination of the extent to which an entity is capable of fulfilling specified requirements (ISO 8402, 1994). Juran and Gryna (1993) affirmed that a formal evaluation of quality provides a starting point by offering an understanding of the size of the quality issue and the areas demanding attention. It is important to make it known that the Company Quality System Evaluation offers an important base for the company to enhance its quality management practices. Descriptive assessment of the Company Quality System Evaluation features as presented in Table 11.14 revealed the following: Evaluation of overall company performance (100%), Evaluation of the quality strategy framework (100%), Evaluation of quality system procedures (100%), Evaluation of the quality information system (100%), Evaluation of end results (100%), and Evaluation of quality costs (100%). Further findings from the descriptive statistics show the presence of the following Company Quality System Evaluation: Evaluation of employee performance (99.8%), Evaluation of the quality manual (99.6%) and Evaluation of the quality control system (98.9%). In addition, the SEM analysis of the study established three indicator variables for Company Quality System Evaluation. These indicator variables are Evaluation of the quality strategy framework, Evaluation of overall company performance and Evaluation of employee performance. The SEM analysis for these variable indicators revealed that all the three indicators were closely associated with the dependent variable. This is apparent from the standardized factor loadings and interfactor correlations with other indicator variables, which were statistically significant (Table 11.58). Also, the variances accounted for in each measure by the endogenous variable revealed that the scores were statistically significant and the values were above the minimum required value of 25 per cent to be ascribed as an influence on TQM. The findings suggested that Company Quality System Evaluation features have a direct positive influence on the overall TQM. Hence, such Company Quality System Evaluation information should be communicated to workers in order to encourage workers to make things better. The study findings concurred with the work of Juran and Gryna (1993) and Mann (1992) who opined that in order to have an effective evaluation, a quality information system is essential as it is an organized method of collecting, storing, analyzing, and reporting information on quality to assist decision-makers at all levels.

The implication of these findings is that overall TQM is a product of the direct influence of Company Quality System Evaluation features. The finding was significant in that based on Company Quality System Evaluation activities the company can amend its business strategy in order to keep it dynamic as stated by Mann (1992). It should be noted that evaluating the situation in a company's quality management practices offers an important base for the company to enhance its quality management practices. Furthermore, Company Quality System Evaluation can help to recognize the difference between actual performance and the goal of the company.

12.2.5 Company Vision and Plan Statement Features' Influence on TQM

The importance of including this variable in the model is to determine the Company Vision and Plan Statement features' influence on TQM in the construction industry. Descriptive assessment of the Company Vision and Plan Statement features as presented in Table 11.15 revealed that 100.0 per cent of the respondents indicated that all the seven variable indicators are influential in determining TQM in the construction industry. It is notable that all the Company Vision and Plan Statement features have a MS $> 4.00 \leq 5.00$, which indicates that the respondents perceive the Company Vision and Plan Statement features to be between ‘very influential’ and ‘extremely influential’. Furthermore, SEM analysis was conducted to further determine statistical fitness of the Company Vision and Plan Statement features. The following three Company Vision and Plan Statement features were found to be statistically fit for the overall structural modeling of the study, namely concreteness of the future plan, employee contribution to the vision, and involvement of employees in the development of the vision statement. The SEM results for this exogenous variable revealed that the standardized factor values and interfactor correlations for the Company Vision and Plan Statement latent factors were large and statistically significant (Table 11.64). Inspection of the total variances accounted for in each measure by the endogenous variable revealed that the scores were also significant. This result agreed with the findings of Kanji and Asher (1993) who stated that all employees should involve themselves in the development of the vision statement to be able to understand how they can contribute to the vision.

The relatively high agreement achieved by the respondents with regard to Company Vision and Plan Statement variables suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana. The implication of these findings is that overall TQM is a product of the direct influence of Company Vision and Plan Statement features. The finding was also significant in that a vision statement explains how a company wants to be seen in its chosen business. In this regard, it explains standards, principles, and values. In addition, a vision statement is the advertisement of the intention to change. As such, it drives the company ahead and acts against complacency. Meredith and Shafer (1999) explained that the purpose of a vision and plan statement is to communicate the firm’s values, principles, aspirations and purpose so that workers can make decisions that are consistent with and supportive of these objectives.

12.2.6 Product Design Management Features' Influence on TQM

This research's sub-question was put forward to determine the extent to which Product Design Management features influenced TQM in the construction industry. First, a descriptive assessment of the Product Design Management features revealed that all the MSs are above the midpoint score of 3.00, which indicates that the respondents agreed with the Product Design Management features of TQM implementation. It is notable that all the product design management features have a MS > 3.50 ≤ 5.00, which indicates that the respondents perceive the Product Design Management features to be 'very influential'. The relatively high MS = 3.83-4.23 achieved suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana (see Table 11.16). Furthermore, results from the structural model revealed that the relationship between the Product Design Management features and the endogenous variable (TQM) was found to be statistically significant at 5 per cent probability level.

On the other hand, all standardized parameter estimates showed high correlations values, suggesting a high degree of linear association between the indicator variables and the endogenous construct. Also the interfactor values for this variable were considerable, suggesting that more than 50.0 per cent of the latent variable considerably predicted the endogenous factor construct. The summarized result for this variable revealed that the latent factor has a direct influence in determining overall TQM. The results suggest that most variables included in the model have a significant effect on TQM. Further findings suggest that Product Design Management features are a significant determinant of TQM in the construction industry. The study established the following three variables (strength required for the end product, intended purpose of the material and design detailing) as the most significant determinants of Product Design Management which in effect influenced the overall TQM model. These findings concur with the work of Juran and Gryna (1993) who asserted that sound product design can add to the improvement of product quality. The findings emanating from the Product Design Management features' assessment were significant, and when attention is given to the Product Design Management features identified in this study, the much desired TQM in the construction industry will be achieved.

The implication of these findings is that overall TQM is a product of the direct influence of Product Design Management features. Therefore, the TQM in the Ghanaian construction industry can be improved through Product Design Management features established in this study, namely strength required for the end product, intended purpose of the material and design detailing.

12.2.7 Product Selection Management Features' Influence on TQM

The importance of including this variable in the model is to determine the Product Selection Management features influence on TQM in the construction industry. A descriptive assessment of the Product selection Management features as presented in Table 11.16 revealed that that all the MSs were above the midpoint score of 3.00, which indicates that the respondents agreed with the Product Selection Management features of TQM implementation. It is notable that all the Product Selection Management features have a MS $> 3.50 \leq 5.00$, which indicates that the respondents perceive the Product Selection Management features to be 'very influential'. The relatively high MS = 3.83- 4.23 achieved suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana (see Table 11.16). On the other hand, SEM analysis was conducted to further determine statistical fitness of the Product Selection Management features. The following three Product Selection Management features were found to be statistically fit for the overall structural modelling of the study: client brief/input, cost of selection and design of the product, and appearance/finishes required. The SEM results for this exogenous variable revealed that the latent factors were large and statistically significant (Table 11.76). Inspection of the total variances accounted for in each measure by the endogenous variable revealed that the scores were also significant. These findings concur with the work of Juran and Gryna (1993) who asserted that good product selection can add to the improvement of product quality. The findings emanating from the Product Selection Management features assessment were significant, and when attention is given to the Product Selection Management features identified in this study, the much desired TQM in the construction industry will be achieved.

The relatively high agreement achieved by the respondents with regard to Product Selection Management variables suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana. The implication of these findings is that overall TQM is a product of the direct influence of Product Selection Management features. Therefore, the TQM in the Ghanaian construction industry can be improved through Product Selection Management features established in this study, namely client brief/input, cost of selection and design of the product, and appearance/finishes required.

12.2.8 Construction Process Management and Improvement features influence on TQM

This research's sub-question was put forward to determine the extent to which Construction Process Management and Improvement features influenced TQM in the construction industry. First, a descriptive assessment of the Construction Process Management and Improvement features revealed that all the MSs were above the midpoint score of 3.00, which indicates that the respondents agreed with the Construction Process Management and Improvement features of TQM. It is notable that all the Construction Process Management and Improvement features have a MS $> 4.00 \leq 5.00$, which indicates that the respondents perceive the Construction Process Management and Improvement features to be between 'very influential' and 'extremely influential'. The relatively high MS = 4.02 - 4.33 achieved suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana (Table 11.11). Furthermore, results from the structural model revealed that the relationship between the Construction Process Management and Improvement features and the endogenous variable (TQM) was found to be statistically significant at 5 per cent probability level.

On the other hand, all standardized parameter estimates showed high correlations values, suggesting a high degree of linear association between the indicator variables and the endogenous construct. Also the interfactor values for this variable were considerable, suggesting that more than 50.0 per cent of the latent variable considerably predicted the endogenous factor construct. The summarized result for this variable revealed that the latent factor has a direct influence in determining overall TQM. The results suggest that most variables included in the model have a significant effect on TQM. Further findings suggest that Construction Process

Management and Improvement features are a significant determinant of TQM in the construction industry. The study established the following four variables, namely quality control system, institution of a continuous improvement process within the company, appropriate use of system structure and standards and efficient management system, as the most significant determinants of Construction Process Management and Improvement which in effect influenced overall TQM model. These findings concur with the work of Mann (1992) who posited that institution of a continuous improvement process within the company and the appropriate use of a system structure improved TQM. The findings emanating from the Construction Process Management and Improvement features assessment were significant, and when attention is given to the Construction Process Management and Improvement features identified in this study, the much desired TQM in the construction industry will be achieved.

The implication of these findings is that overall TQM is a product of the direct influence of Construction Process Management and Improvement features. Therefore, the TQM in the Ghanaian construction industry can be improved through Construction Process Management and Improvement features established in this study, namely quality control system, institution of a continuous improvement process within the company, appropriate use of system structure and standards and efficient management system.

12.2.9 Construction Employees' Involvement and Motivation Features' Influence on TQM

The SEM analysis for this construct Construction Employees' Involvement and Motivation revealed that only two indicator variables were closely associated with the dependent variable. The other variable was weak in predicting the endogenous variable. The statistical assessment suggests that the direct influence of these factors on the endogenous variable was weak (indirect). However, a further assessment of the internal consistency and reliability of scores for the Construction Employees' Involvement and Motivation features construct was determined from the rho and the Cronbach's alpha coefficient. The assessment of the variance accounted for in each measure by the endogenous variable revealed that the scores were significant as the values were above the minimum required value. Therefore the weak variable has a good indirect association with the other latent variables in the prediction of overall TQM in the construction industry. Further, construct validity was determined from the magnitude and reasonableness of the parameter coefficients (factor loading) (Table 11.88). The parameter coefficients represent the magnitude of correlation or covariance between an item and a construct. Higher parameter coefficients were achieved which also show that the indicator variables have a stronger relationship with a construct and thus converge at a common point. Parameter coefficients were found to be greater than 0.5 indicate a close relationship between the construct and an indicator variable.

Similarly, descriptive assessment of the Construction Employees' Involvement and Motivation features revealed that all the MSs were above the midpoint score of 3.00, which indicates that the respondents agreed with the Construction Employees Involvement and Motivation features of TQM implementation. It is notable that all the Construction Employees' Involvement and Motivation features have a MS $> 4.00 \leq 5.00$, which also indicates that the respondents perceive the Construction Employees Involvement and Motivation features to be between 'very influential' and 'extremely influential'. The relatively high MS = 4.04- 4.29 achieved suggests that these variables are very significant in driving TQM implementation among construction firms in Ghana. These findings agree with the work of Armstrong (2006) who posits that close attention should be given to individuals and they should best be motivated through means such as incentives, rewards, and promotions among others and the organizational context within which they carry out the work. The findings also supported work of Laufer and Moore (1983) who advocated the use of financial incentive programmes to improve construction labour productivity, reinforcing Maloney's (1982) thesis of driving forces that lead to productivity improvements. On the other hand, the findings disagreed with the work of McClelland (1961) who suggested that achievement, affiliation, competence and power are four types of motivational drives that are found in individuals who are self-motivated and this may be the case for many construction workers.

The implication of these findings is that overall TQM is a product of the direct influence of Construction Employees' Involvement and Motivation features. The finding is significant in that lack of motivation in turn affects TQM. The finding is also significant in that Construction Employees' Involvement and Motivation features will define the set of processes that determine the choices people make about their behaviour towards TQM implementation in construction industry. According to McClelland (1961), individuals tend to develop certain motivational drives in the cultural environment in which they live and these drives affect the way people view their jobs and TQM. Hence, the variables established under this construct will serve as standards for managers of construction firms who are ready to implement TQM for their projects.

12.2.10 Other Questionnaire survey results

Level of TQM implementation in the Ghanaian construction industry

This research's sub-question was put forward to determine the level of TQM implementation in the Ghanaian construction industry in terms of percentage responses. Descriptive assessment of this sub-question revealed that the majority of the respondents (38.1%) indicated that their firms have implemented TQM to a moderate extent, followed by (30.4%) indicating that their firms have implemented TQM in a large extent and the statement 'To no extent"'constituted the least level TQM implementation by the firms, namely 2.4 per cent of the sample. This suggests that not all the firms under study have implemented TQM. This finding is in line with the work of McIntyre and Kirschenman (2000) that surveyed the acceptance of TQM in upper Midwestern in the United States. Their study revealed that 27.5% of the respondents did not employed TQM practices.The finding also partially supports the work of Ansah, Aigbavboa and Thwala (2015) who stated that the construction industry which includes Ghanaian construction industry is slow in implementing the TQM concept despite its identified potential benefits. Agha (2011) opines that the reason for the late arrival of the construction industry to the TQM approach is that construction professionals are not familiar with its principles and techniques. However, Boaden and Dale (1992) note that the relative immaturity of the construction industry in adopting TQM may be an advantage if companies learn from their mistakes and the best practices of other organizations.

Project Outcomes that Motivate Construction Companies to Implement TQM

This research's sub-question was put forward to determine the project outcomes that motivate construction companies to implement TQM. A descriptive assessment of this sub-question revealed that all the MSs were above the midpoint score of 3.00, which indicates that the respondents agreed with the project outcomes that motivate firms to implement TQM in the Ghanaian construction industry. It is notable that all the ten ranked motivating factors influencing the implementation of TQM in the construction industry have a MS > 4.00 ≤ 5.00, which indicates that the respondents perceive the motivating factors influencing the implementation of TQM in the construction industry to be between 'high motivating factor' and 'very high motivating factor'. All the rankings of motivating factors that motivate the implementation of TQM in the construction industry indicate MS> 4.08 - 4.35. The relatively high MS achieved suggests that all the motivating factors that motivate the implementation of TQM in the construction industry are very significant in driving TQM implementation among construction firms in Ghana. Among the ten factors identified, higher productivity was ranked first, good methods of working was ranked second, higher product quality and higher reduction of construction waste were ranked third, higher safety standards and higher profitability were ranked fourth, followed by defect-free product at first, elimination of reworks, greater reduction of construction costs and improvement schedule performance which was ranked last as shown in Table 11.19.

The literature indicates that the motivating factors that influence the implementation of TQM are also the benefits that TQM brings at the end of project execution. The benefits include higher customer satisfaction, reduction in construction costs, improved employee job satisfaction, improved schedule performance, improved relationships with subcontractors, reduced rework, improved safety, higher productivity, lower employee turnover, speeding up construction work, improved methods of working, better control over the construction process, gaining competitive advantage, increase profitability, decreasing waste and rework, better coordination of activities and being more customer focused (Hassin et al., 2006; Love et al., 2000; McIntyre & Kirschenman, 2000; Al-Momani, 2007; Khadour & Darkwa, 2008; Chini & Valdez, 2003; Love et al., 2004). In considering the application of TQM to construction project schedule, Kiwus and

Williams (2001) also conclude that TQM techniques may reduce the frequency and severity of schedule overruns.

Reasons for Non-Implementation (Non-Adoption) of TQM in Ghanaian Construction Industry

This research's sub-question was put forward to determine the reasons for the non-implementation (non-adoption) of TQM in the Ghanaian construction industry. A descriptive assessment of this sub-question revealed that all the MSs were above the midpoint score of 3.00, which indicates that the respondents agreed with the factors identified as the reasons for non-implementation of TQM in the Ghanaian construction industry. It is notable that all the sixteen ranked factors affecting the implementation of TQM in the construction industry have a MS > 3.50 ≤ 5.00, which indicates that the respondents perceive the factors affecting the implementation of TQM in the construction industry to be between 'agree' and 'strongly agree'. All the rankings of factors affecting firms' TQM implementation indicate MS> 3.79 - 4.33. The relatively high MS achieved suggests that these variables are the major factors preventing construction firms from implementing or adopting TQM. Among the sixteen factors identified, lack of or limited knowledge of TQM was ranked first, followed by lack of enforcement from the legislative bodies overseeing the implementation of TQM, lack of an efficient TQM management system, lack of interest in the application of TQM, the absence of a TQM policy, lack of commitment from management, reluctance to change old management techniques, lack of coordination of the implementation of TQM policy within the organization, lack of training and inability to train and educate employees on TQM, the complex nature of the TQM technique, lack of TQM experts, lack of finance in the management of TQM experts, lack of understanding among construction professionals in applying TQM, the perception that TQM may not yield any better results, TQM technique is costly, and TQM technique is time consuming which was ranked last as shown in Table 11.20.

On the other hand, EFA was conducted to assess the reliability of the identified factors that serve as the reasons for non-implementation of TQM in the Ghanaian construction industry. The reliability of the study's instrument was measured using Cronbach's alpha. The Cronbach's alpha was found to be greater than 0.700 at 0.944. The lowest Cronbach's alpha value was 0.938 while the highest value was 0.944, indicating acceptable internal reliability. The corrected item-total correlation was also conducted and the finding revealed that the corrected item-total correlation was greater than the suggested cut-off value of 0.30, suggesting that the items were good reasons for non-implementation of TQM in Ghanaian construction industry. These findings concur with the work of Whalen and Rahim (1994) who mentioned that some of the reasons for non-implementation of TQM in construction industry are the lack of management commitment, lack of appropriate training, the inability to change the organizational philosophy (culture), and insufficiency of resources. Mosadeghrad (2014) supported this assertion by adding that ineffective or inappropriate TQM models and ineffective or inappropriate methods for the implementation of the TQM are the reasons for the non-implementation of TQM in the construction industry.

12.3 MAJOR FINDINGS FROM DELPHI SURVEY AND QUESTIONNAIRE RESULTS

Findings from the Delphi study were the factors considered to be the principal determinants of TQM in the Ghanaian construction industry. These include Leadership and Top Management, Company Supplier Quality Management, Client Focus and Involvement, Company Quality System Evaluation, Company Vision and Plan Statement, Product Selection and Design Management, Construction Process Management and Improvement, and Construction Employees' Involvement and Motivation. The first objective of the Delphi study was to identify the main and sub-attributes that determine TQM in the Ghanaian construction industry. In determination of whether an attribute reached consensus or not by the experts, consensus was reached for four (4) attributes (Leadership and Top Management, Company Quality System Evaluation, Product Selection and Design Management, Construction Process Management and Improvement) under the main attributes that determine TQM in the Ghanaian construction industry, with an IQD score of 1.00. Six (6) of the attributes had strong consensus, with the exception of Client Focus and Involvement, and Product Selection and Design Management, which had good consensus. Seven (7) attributes from the eight (8) identified main attributes that determine TQM in the construction industry were considered by the experts to have a very high influence (VHI: 9-10), with the exception of one (1) attribute (Product Selection and Design

Management) which had a high influence (HI: 7-8.99). These indicate that all the attributes have a high level of influence on TQM implementation in the Ghanaian construction industry.

Also, from the ninety-eight (98) sub-attributes identified under the (8) major determinants, only thirty-six (36) were found to be the strong determinants of TQM in the construction industry in Ghana. Among these sub-attributes which were determined by the experts to have reached strong consensus are leadership style, leadership ability in solving quality problem, leadership initiatives, leadership and top management knowledge in TQM, top management commitment in TQM, top management interaction with workers, top management participation, top management encouragement, supplier performance evaluation, supplier quality audit, supplier communication, supplier knowledge of TQM, cooperation from suppliers, client complaint information/feedback, client satisfaction survey, evaluation of overall company performance, evaluation of departments' performance evaluation of quality control system, evaluation of quality system procedures, evaluation of end results, quality audit, quality benchmarking, and quality information system. Other sub-attributes which were considered by the experts to have strong determinants on total quality in the construction industry are quality improvement plan, client brief/input, appearance/finishes required, strength required, intended purpose of the material, design detailing, quality function deployment, value engineering, project monitoring and control improvement, use of quality materials, understanding of work instructions/quality manual, continuity of quality control circle activities, and education and training. The assessment of the sub-attributes findings replicated the results of the majority of studies on TQM in the construction industry in relation to adequate training and education, supplier quality management and in general leadership and top management commitment (Saraph et al., 1989; Flynn et al., 1994; Ahire et al., 1996; Imbeah & Dansoh framework, 2011; Adusa-Poku framework, 2014) upon which the current study's sub-attributes were also based.

The second objective of the Delphi study was to determine the factors that enable construction companies to implement TQM in the construction industry. The assessment of the twenty-two (22) factors of major determinants of TQM in the construction industry showed that sixteen (16) factors were considered by the experts to have achieved strong consensus with an IQD score between 0.00 and one (1). Eight (8) of the enabling factors (top management support, good quality driven agenda, training and re-training of staff, institution of continuous improvement process within the company, efficient management system, proper understanding of TQM among construction professionals, good organizational and quality culture, and clarity of goals and objectives) had a very high impact (VHI: 9-10) on TQM in the construction industry. The remaining fourteen (14) of the enable factors had a high impact (HI: 7-8.99) on TQM in the construction industry. These indicate that all the enabling factors have high levels of influence on TQM implementation in the Ghanaian construction industry.

The third objective of the Delphi study was to identify the factors that affect construction companies in Ghana that do not implement TQM. The assessment of the twenty (20) factors of major determinants of TQM in the construction industry showed that nine (9) factors were considered by the experts to have achieved strong consensus with an IQD less than or equal to one (1). Eleven (11) of the factors (lack of efficient TQM management system, unavailable TQM policy, lack or limited knowledge of TQM, lack of training and inability to train and educate employees on TQM, lack of understanding among construction professionals in applying TQM, lack of coordination of the implementation of TQM policy within the organisation, lack of TQM expert, reluctance to change old management technique, lack of commitment from management, lack of enforcement from the legislative bodies overseeing the implementation of TQM, and lack of interest in the application of TQM) had a very high impact (VHI: 9-10) on TQM in the construction industry. The remaining nine (9) factors had a high impact (HI: 7-8.99) on TQM in the construction industry. These indicate that most of the factors have very high levels of influence which affect construction companies in Ghana which do not implement TQM.

The fourth objective of the Delphi study was to evaluate the organizational factors that affect the implementation of TQM in the construction industry. The assessment of the twenty (20) organizational factors as considered by the experts to be the major determinants of TQM in the construction industry showed that twelve (12) (leadership and top management commitment, top management support, project manager competence, quality policy, supplier management, limited cash flow to manage TQM, employee involvement, client involvement, feedback by project participants, design quality management, strategic quality management, and quality data and reporting) were considered by the experts to have achieved consensus with IQD less than or equal to one (1). Six (6) of the organizational factors (leadership and top management commitment, top management support, project manager competence, quality policy, education and training, employee involvement) as considered by the experts had very high levels of influence (VHI: 9-10) on TQM in the construction industry. The remaining fourteen (14) of the organizational factors as considered by the experts had high levels of influence (HI: 7-8.99) on TQM in the construction industry. These indicate how significant organizational factors and issues are towards TQM implementation in the construction industry.

The fifth objective of the Delphi study was to identify the effects of implementation of TQM in the construction industry. The assessment of the seventeen (17) major effects of the implementation of TQM in the construction industry showed that fourteen (14) of the effects were considered by the experts to have achieved consensus with an IQD less than or equal to one (1). Eleven (11) of the effects (elimination/reduction of reworks, reduction in construction costs, higher client satisfaction, improved employee job satisfaction, improved schedule performance, defect-free product at first attempt, higher productivity, better control over the construction process, increased profitability, gaining competitive advantage over other companies, decreasing waste) had very high levels of influence (VHI: 9-10) on TQM in the construction industry, while the remaining six (6) of the effects had high levels of influence (HI: 7-8.99). These indicate how important the influence is that these effects have on TQM implementation in the construction industry.

However, the Delphi study was validated by a field questionnaire survey. The results suggested that the identified factors from the Delphi study have both a direct and indirect influence in determining TQM. In the questionnaire survey the hypothesis that the exogenous factors had a direct and positive influence on TQM could not be rejected. The exogenous variables of Leadership/Top Management, Company Supplier Quality Management, Client Focus and Involvement, Company Quality System Evaluation, Company Vision and Plan Statement, Product Selection Management, Product Design Management, Construction Process

Management and Improvement, and Construction Employees' Involvement and Motivation were found to have a statistically significant influence in predicting TQM in the Ghanaian construction industry. The findings from both the Delphi and the questionnaire survey therefore suggested that the exogenous variables influenced the determination of the endogenous variable (TQM). The merit of using SEM to validate the Delphi findings was that it was possible to specifically ascertain which of the exogenous factors had a significant influence on TQM. Therefore, instead of making a general statement that the exogenous variables had an influence on determining the TQM, it was possible to state specifically that the factors Leadership/Top Management features, Company Supplier Quality Management features, Client Focus and Involvement features, Company Quality System Evaluation features, Company Vision and Plan Statement features, Product Design Management features, Product Selection Management features, and Construction Process Management and Improvement features had a direct or stronger statistically significant influence on TQM in construction industry. Construction Employees' Involvement and Motivation features had an indirect (weak) influence in determining TQM in the construction industry. However, the covariation with the other exogenous construct to determine TQM in the construction industry was found to be statistically significant. Therefore the weak variables have a good indirect association with the other latent variables in the prediction of overall TQM in the construction industry.

12.4 CONCLUSION

In conclusion, the findings from the questionnaire survey generally supported the predictions that were made by the experts from the Delphi study. The validated predictions were those of leadership and top management, company supplier quality management, client focus and involvement, company quality system evaluation, company vision and plan statement, product selection management, product design management, construction process management and improvement, and construction employees' involvement and motivation. In addition, the existing literature lends support to the findings of the current study. The supported findings were that leadership and top management, company supplier quality management, client focus and involvement, company quality system evaluation, company vision and plan statement, product selection management, product design management, construction process management and improvement, and construction employees' involvement and motivation are fundamental to TQM in the Ghanaian construction industry.

CHAPTER THIRTEEN

13 CONCLUSION

13.1 INTRODUCTION

The general overall objective of the current study was to develop an integrated TQM model for the Ghanaian construction industry. Ghana was used as a case study to identify the determinant attributes which collectively predict TQM in the construction industry. The study adopted a mixed-method approach to achieve the general objectives of the study. An extensive literature review, a Delphi survey and a field questionnaire survey were carried out. The field questionnaire survey was conducted in order to validate findings from the Delphi study with regard to the factors which predict TQM. The final results were analyzed using SEM. Conclusions regarding the study are presented relative to the objectives of the study in the next sections.

13.1.1 Research Objective RO1

The first objective of the study was to establish the factors that determine TQM in the construction industry, based on a literature review. In order to achieve this objective, a review of literature was conducted. Findings are that TQM in the construction industry is a product of a multi-faceted construct. Findings further reveal that TQM in the construction industry is about incorporating fundamental management techniques, existing improvement efforts, and the technical tools (US Department of Defense, 1988) under a disciplined approach focused on continuous improvement. Kanji and Asher (1996) posited that TQM has a set of four principles (delight the client, management by fact, people-based management, and continuous improvement) that determine TQM in the construction industry.

Black and Porter (1996) recognized ten significant factors of TQM, namely client, people and management, supplier partnership, teamwork structure for improvement, communication of improvement information, client satisfaction orientation, external interface management, strategic quality management, operational quality planning, quality improvement measurement systems, and corporate quality culture. On the other hand, Ho and Fung (1994) recognized ten TQM elements as commitment, leadership total customer satisfaction, continuous improvement, total involvement, training and education, ownership, reward and recognition, error prevention, and cooperation and teamwork. Research conducted by Powell (1995) also identified the following components as a TQM framework, namely executive dedication, adopting the philosophy, nearer to customers, nearer to suppliers, benchmarking, open organization, training, employee empowerment, zero-defects mentality, flexible manufacturing, process improvement, and measurement. On the other hand, Waldman (1994) recognized eight key TQM components as top management commitment to place quality as a top priority, a broad definition of quality as meeting customers' expectations, TQM values and vision, the development of a quality culture, involvement and empowerment of all organizational members in cooperative efforts to achieve quality improvements, an orientation toward managing-by-fact, the dedication to continuously improving employees' capabilities and work processes through training and benchmarking, and attempts to get external suppliers and customers involved in TQM efforts.

In fact, researchers have different views on the factors that determine TQM in the construction industry. Nevertheless, most agree with the works of Saraph et al. (1989), Flynn et al. (1989), Ahire et al. (1996) and Adusa-Poku (2014). The framework of Saraph et al. (1989) identified factors that affect TQM in the construction industry as the role of divisional top management and quality policy; role of quality department; training; product/service design; supplier quality management; process management/operating; quality data and reporting; and employee relations. The framework of Flynn et al. (1989) also identified factors that affect TQM in the construction industry as quality leadership, quality improvement rewards, process control, feedback, cleanliness and organization new product quality, interfunctional design process; selection for teamwork potential, teamwork, supplier relationship, and customer involvement. The framework of Ahire et al. (1996) on the other hand, identified factors that affect TQM in the construction industry as top management commitment, customer focus, supplier quality management, design quality management, benchmarking, SPC usage, internal quality information usage, employee empowerment, employee involvement, employee training, product quality, and supplier performance. Finally, the framework of Adusa-Poku (2014) identified factors that affect TQM in the construction industry as process management, leadership commitment, customer focus, continuous improvement, training and development, and supplier management. Findings from the literature were that more research and effort are required to establish or develop an integrated TQM that includes the most critical factors that determine TQM for the construction industry.

13.1.2 Research Objective RO2

The second objective of the research was to establish the theories and literature that have been advanced on TQM in the construction industry and to identify the gaps that needed consideration. A review of literature was carried out to achieve this objective. The extensive review of TQM literature proposes that TQM includes an enormous variety of topics and perspectives. Different writers have varying opinions on the concept of TQM. Nevertheless, the study identified the theories of Deming, Crosby, Joseph Juran, and Ishikawa as theories that have been advanced on TQM. The theoretical significance of the Deming strategy to TQM concerns the creation of an organizational system that encourages learning and cooperation for facilitating the execution of process management practices which, in turn, results in continuous enhancement of procedures, products, and services as well as employee fulfilment, both of which are necessary to client care and eventually to company success. Deming's theory motivated a thorough strategy to problem solving and promoted the commonly known Plan, Do, Check, Act (PDCA) cycle. The PDCA cycle is also known as the Deming cycle**.** The cycle is about studying and continuous enhancement, studying what works and what does not in a systematic way; and the cycle repeats; after one cycle has been completed, another is started. Deming's theory also placed significance and liability on management, at the individual and company level, knowing management to be liable for 94% of quality problems. Deming therefore insisted that management's responsibility is to build excellent systems that promote high quality management. On the other hand, Crosby is well-known for the theory of "Quality is Free" and "Zero Defects". He emphasized avoidance rather than after-the-event examination, doing things right the first time, and zero problems. Crosby's concept relies on four absolutes of quality management as follows: Quality is defined as to sticking requirements, prevention is the best way to guarantee quality, zero defects (mistakes) is the performance standard for quality, and quality is measured by the cost of non-conformity. Juran's theory also is responsible for what has become well-known as the "Quality Trilogy". The quality trilogy is made up of quality planning, quality control and quality improvement. Ishikawa's theory is focused on how companies should handle their quality improvement tasks. This is the final theory which takes a look at quality from a human viewpoint. One of the most well-known of these is the Ishikawa (or fishbone or cause and effect) diagram. Like other tools, it assists groups in quality improvement. It lists the major and minor causes leading to one effect (or problem), describes the issue, and recognizes possible and potential causes by figuring out the possible ones. The diagram consistently symbolizes and analyses the real causes behind a problem or effect.

This study adopted Deming's theory of profound knowledge which is a management philosophy grounded in systems theory in order to help to understand and develop a framework for TQM. System theory is based on the principle that each organization is composed of a system of interrelated processes and people which make up the system's components. The three quality award models identified also provide a framework for identifying a range of intangible and tangible processes that influence the firm's TQM implementation and the end results.

The findings revealed three constructs as gaps which have not been evaluated as all-inclusive TQM constructs in the development of the previous models and theories. The identified gaps from the extensive literature review were company vision and plan statement, product selection and design management, and company quality system evaluation. The identified gaps formed the new constructs in the current study's conceptual framework (Model 1.0). The current study offers a synthesized classification of the constructs which should be collectively considered in order to predict TQM in the Ghanaian construction industry.

13.1.3 Research Objective RO3

The third research objective (RO3) of the study was to determine the main and sub-attributes of TQM in the Ghanaian construction industry. A Delphi study was conducted in order to achieve this objective. The findings indicated that a number of factors that were considered to be important in determining TQM were identified and amplified by the Delphi study. The factors considered as being paramount and main determinants of TQM were Leadership and Top Management, Company Supplier Quality Management, Client Focus and Involvement, Company

Quality System Evaluation, Company Vision and Plan Statement, Product Selection and Design Management, Construction Process Management and Improvement, and Construction Employees' Involvement and Motivation. In addition to the main attributes, thirty-six (36) sub-attributes were found to be strong determinants of TQM in the construction industry in Ghana. Among these sub-attributes which were determined by the experts to have reached strong consensus are leadership style, leadership ability in solving quality problem, leadership initiatives, leadership and top management knowledge in TQM, top management commitment in TQM, top management interaction with workers, top management participation, top management encouragement, supplier performance evaluation, supplier quality audit, supplier communication, supplier knowledge of TQM, cooperation from suppliers, client complaint information/feedback, client satisfaction survey, evaluation of overall company performance, evaluation of departments' performance, evaluation of quality control system, evaluation of quality system procedures, evaluation of end results, quality audit, quality benchmarking, and quality information system.

Others sub-attributes which were considered by the experts to have strong determinants on total quality in the construction industry are quality improvement plan, client brief/input, appearance/finishes required, strength required, intended purpose of the material, design detailing, quality function deployment, value engineering, project monitoring and control improvement, use of quality materials, understanding of work instructions/quality manual, continuity of quality control circle activities, and education and training.

The findings suggested that the attributes that bring about TQM in the Ghanaian construction industry are similar to the determinants in other cultural contexts. Further, TQM is assured if there is a consideration of these factors in the development of construction firms in Ghana. These factors were collectively considered for the development of the all-inclusive (integrated holistic) TQM model for construction industry.

13.1.4 Research Objective RO4

The fourth research objective (RO4) was to evaluate the critical factors that affect construction firms for not implementing TQM in Ghana. A Delphi study was conducted in order to achieve this objective. Findings were that a number of factors that were considered to be important in evaluating the critical factors and issues that affect the construction firms for not implementing TQM were identified and amplified by the Delphi study. Findings further reveal that the critical factors which affect TQM implementation in Ghana, and which are equally applicable to other developing countries is the lack or limited knowledge of TQM. Also, it is revealed that there is a lack of enforcement from the legislative bodies overseeing the implementation of TQM. Moreover, it was found that there is a lack of an efficient TQM management system. The findings also reveal a lack of interest in the application of TQM. Other critical factors identified in the study are the absence of a TQM policy, a lack of commitment from management, reluctance to change old management techniques, a lack of coordination of the implementation of a TQM policy within the organization, a lack of training and an inability to train and educate employees on TQM, the complex nature of the TQM technique, a lack of a TQM expert, a lack of finance in the management of TQM experts, a lack of understanding among construction professionals in applying TQM, the perception that TQM may not yield any better results, TQM technique is costly, and that the TQM technique is time consuming. It is notable that all the sixteen identified factors which influencing firms regarding the non-implementation of TQM in the Ghanaian construction industry were ranked high. The relatively high MS achieved suggests that these variables are the reason why construction companies in Ghana do not implement or adopt TQM.

13.1.5 Research Objective RO5

The fifth research objective of the study was to develop an integrated TQM model for the Ghanaian construction industry based on a literature review, a Delphi study and the questionnaire survey. A synthesis of the reviewed literature together with the findings from the Delphi study was used to achieve this objective. The conceptual model theorized that TQM in the Ghanaian construction industry is an eight-factor construct. These factors were Leadership and Top Management, Company Supplier Quality Management, Client Focus and Involvement, Company Quality System Evaluation, Company Vision and Plan Statement, Product Selection and Design Management, Construction Process Management and Improvement, and Construction Employees' Involvement and Motivation. This hypothesis factor model was validated by conducting a questionnaire survey and analyzing it using SEM software, EQS Version 6.2. The theorised eight-factor model was taken through EFA. A nine-factor model was realized during the EFA. The latent construct with the name 'Product Selection and Design Management (PSDM)' had two factor loadings during EFA, hence, was separated into two with the assigned names 'Product Selection Management (PSM)', and 'Product Design Management (PDM)'. The final nine-factors for the model are Leadership and Top Management, Company Supplier Quality Management, Client Focus and Involvement, Company Quality System Evaluation, Company Vision and Plan Statement, Product Design Management, Product Selection Management, Construction Process Management and Improvement, and Construction Employees' Involvement and Motivation, which jointly predict TQM in the Ghanaian construction industry.

13.1.6 Research Objective RO6

The sixth and final research objective of the study was to test and validate the conceptually integrated TQM model for the Ghanaian construction industry. A questionnaire survey and analysis of the results using SEM software, EQS Version 6.2 were conducted in order to achieve this objective. Findings from the SEM analysis, which models TQM for the Ghanaian construction industry as a nine-factor model showed that the factors of Leadership and Top Management, Company Supplier Quality Management, Client Focus and Involvement, Company Quality System Evaluation, Company Vision and Plan Statement, Product Design Management, Product Selection Management, Construction Process Management and Improvement, and Construction Employees' Involvement and Motivation were found to have a significant influence in determining the TQM for the Ghanaian construction industry. However, the Construction Employees' Involvement and Motivation feature had a weak (indirect) influence in predicting TQM. Nevertheless, its covariances with the other exogenous construct to determine TQM for the Ghanaian construction industry was found to be statistically significant. These findings validated the conceptually integrated holistic model developed from literature and the Delphi study. The nine-factor model therefore was deemed fit for the current study.

13.2 CONTRIBUTION AND VALUE OF THE RESEARCH

The value and contribution of the current research are described at three levels, namely the theoretical, methodological and practical levels of the research findings. However, it is pertinent to note that the outstanding contribution of the study is the revelation of the influence of top management in the construction industry in predicting TQM in the Ghanaian construction industry.

13.2.1 Theoretical Contribution

The results of the SEM analysis indicated that an integrated TQM model is a nine-factor model. This was achieved through the following processes:

i. The compilation of historical documentation on TQM practices, policy and standards in developed and developing countries;

ii. The use of a mixed-method approach made up of a Delphi study and a questionnaire survey. The Delphi survey was used to arrive at a theoretical model. Furthermore, a questionnaire survey was employed to ascertain the variables in the theoretical model. The SEM software EQS version 6.2 was used to obtain the required variables on the TQM model;

iii. Finally, an integrated TQM model for construction firms was developed.

Findings from the literature review did not reveal evidence of research conducted on the current study and this therefore shows that the study on TQM will assist in improving the quality of work undertaken by construction firms. Moreover, there was no evidence that suggested that a mixed method using Delphi and SEM had been used by researchers in this field in Ghana. Therefore, this study may offer a base for other researchers to use for other follow-up studies. Likewise, the current study modelled TQM as a nine-factor construct. Apart from the study contributing to theoretical knowledge, it also contributes to methodological advance in terms of the approach used in conducting the research as indicated in the next section.

13.2.2 Methodological Contribution

Most studies have used univariate statistical methods such as ANOVA, MANOVA or regression modelling to model TQM. However, the current study used SEM, which is more robust and superior to the methods mentioned in determining causality of factors in a model and their direction of influence (Kline, 2005; Musonda, 2012:252, Aigbavboa, 2013:248). SEM is most commonly thought of as a hybrid between some form of analysis of variance (ANOVA) or regression and some form of factor analysis. In general, it can be noted that SEM allows one to perform some type of multilevel regression/ANOVA on factors. With SEM analysis, it was possible to identify the factors of TQM which have a significant effect and hence influence construction firms in the construction industry as opposed to a general blanket statement that there are numerous constructs which influence TQM. The questionnaire survey instrument had high internal reliability values and therefore could be used in similar studies to validate the current study or for similar purposes. Findings from the Delphi study and the conceptual model developed from both the literature review and the Delphi study were validated by conducting a questionnaire survey. Data from the questionnaire survey was analysed using SEM software, EQS Version 6.2. As a result of this mixed method, a parsimonious model was developed. Aside from this contribution and value to the body of knowledge in terms of the methodological approach, a contribution to practice and the housing industry was also achieved.

13.2.3 Practical Contribution and Value

SEM results indicated that leadership or top management in construction firms had an influence on TQM in the construction industry. Moreover, the knowledge of the influence of the nine-factor construct could help the leadership or top management to plan, organize, coordinate and control all aspects relating to the TQM issues. The practical significance of the study is further elaborated on as follows:

Significance to Construction Firms

The output of the study will help construction firms in making decisions about the criteria to be given priority in TQM issues. The findings will also help the leadership or top management to plan programmes for their firms, as well as planning effective TQM policies. This will ultimately enable the construction firms to know how to commit resources for an effective TQM implementation. It should be noted that the first building block of the successful TQM model is to understand and adopt its principles. Hence, the Association of Building and Civil Engineering Contractors of Ghana (ABCECG) should monitor TQM practices in the Ghanaian construction industry in order to ensure compliance with the laid down principles of TQM. The integrated holistic TQM model should be used as a guide to ensure that all construction firms abide by it. The study offers an opportunity for further research to improve the model developed in this study and probably refine indicator variables to suit specific environments. Therefore the recommendations and policy implications for the practice of all these areas in which the current study may add value and contribute are presented below.

13.3 RECOMMENDATIONS

Recommendations are made from the methodological, theoretical and practical points of view.

13.3.1 Methodological

It is recommended that a similar study should be conducted by soliciting views from both top management and junior staff (all employees) in construction industry. The inclusion of both top management and junior staff (all employees) will enable researcher/researchers to have general and solid views from them with regard to TQM practices in Ghana. Also, further research should be conducted on the indicator variables to establish any improvement in model fit, as the current study was purely a factor analysis. There is the possibility that TQM could be defined by more indicator variables. Recognition should be given, however, to the fact that there is no such a thing as a perfect model. Moreover, there should be a move to try to improve on the current model rather than invent a new model. The recommended method could commence with a Delphi study followed by a questionnaire survey or vice versa in order to improve its generalisability. Most of the studies in Social Science and most especially TQM studies used standard statistical procedures such as ANOVA or MANOVA and multiple regressions which do not offer an appropriate and a straightforward way to test a hypothesis at a higher level of abstraction. Therefore, for similar studies as the current one, SEM with EQS is recommended to be used as the analysis technique for better results and abstraction.

13.3.2 Theoretical

It was observed from the literature that there were still different definitions and varying understanding of how TQM is formed in construction industry. This has led in the past to a limited view and narrow conceptualization of TQM in the Ghanaian construction industry. Besides, there has not been consensus on how TQM in the Ghanaian construction industry should be measured. However, in the current study, literature was reviewed and synthesized on the determinants of TQM. In conjunction with the experts' knowledge obtained through the Delphi study, an eight-factor TQM model was arrived at for construction firms in Ghana. These factors were identified as Leadership and Top Management, Company Supplier Quality Management, Client Focus and Involvement, Company Quality System Evaluation, Company Vision and Plan Statement, Product Selection and Design Management, Construction Process Management and Improvement, and Construction Employees' Involvement and Motivation. The latent construct with the name 'Product Selection and Design Management (PSDM)' had two factor loadings during EFA, and was separated into two with the following assigned names: 'Product Selection Management (PSM)', and 'Product Design Management (PDM)'. 'Product Selection and Design Management (PSDM)' was substituted with the two new latent constructs ('Product Selection Management' and 'Product Design Management'), and the number of the latent constructs of the original conceptual TQM model in Figure 10.1 (Model 1.0) increased from eight to nine, hence a nine-factor model was realized. The nine-factor model was therefore deemed fit for the current study. The final nine factors for the model are Leadership and Top Management, Company Supplier Quality Management, Client Focus and Involvement, Company Quality System Evaluation, Company Vision and Plan Statement, Product Design Management, Product Selection Management, Construction Process Management and Improvement, and Construction Employees' Involvement and Motivation. It is therefore recommended that the developed model and theory of TQM with particular emphasis on operationalization should form the basis for further refinement of the concept and thereby make it useful to the construction firms' TQM in Ghana and other developing countries.

13.3.3 Practical and Policy Implication

As a result of the identified contributions that the current study makes as revealed by the findings, the following policy implications and practical recommendations have been identified:

i. The policy implication suggests that TQM can be improved through the construction firms' adherence to the core principles of the TQM.

ii. Stakeholders responsible for project quality in Ghana and other developing countries should adopt effective management strategies to encourage all construction firms to implement TQM.

iii. Future TQM in the Ghanaian construction industry should contain the nine factors.

iv. Planning, organising, monitoring, measuring and controlling of TQM would be feasible if the stakeholders are aware of indicator variables that define TQM.

13.4 LIMITATIONS

Interesting and valuable findings have emerged from this study. However, the following limitations regarding the current study should be considered. Firstly, the research was only conducted among top management in the Ghanaian construction industry. Given enough resources, it would be preferable to conduct a similar research study among both top management and junior staff (all employees) in the Ghanaian construction industry. Also, the consideration of other developing countries could be included. Secondly, the use of additional items or constructs might improve the inherent reliability and validity of the measures used. Thirdly, several nested models, especially the measurement models, could have been evaluated to check the suitability of other alterative models. The current study was purely exploratory and confirmatory in nature. Fourthly, although the internal reliability tests indicated high internal consistency and therefore a well-constructed research tool, some constructs revealed high correlational values. This may be due to the fact that only one questionnaire was used to collect information among the firms under study. A review of the research tool would have benefited findings in this study. A final limitation is related to the sample: in addition to the aforementioned limitations, the study has shown that some of the SEM measures may have been influenced by the sample size of the study. All empirical studies are limited by the nature of the sample studied. The exploration of the dependent variable (TQM) has shown that it has a very complex organization (multi-faceted) and claims for further interpretations.

13.5 RECOMMENDATIONS FOR FURTHER RESEARCH

The following suggestions for further studies have been identified:

i. Further studies should be conducted to examine factors related to the limitations of the current study. More rigorous and detailed testing of measurement scales among both top management and junior staff (all employees) in the Ghanaian construction industry and other developing countries would increase the knowledge of TQM in the construction industry.

ii. Some features of TQM variables may be improved, while some might remain in common. Equally important are those groups of individual characteristics which were not considered in the conceptualization of the current model. Therefore, a validation of the Ansah Integrated Holistic TQM Model for the Ghanaian construction industry presented in Figure 11.13 (Model 2.0) is recommended.

iii. The SEM software with EQS version 6.2 methodology used in data analysis should be encouraged.

13.6 CONCLUSION

An integrated TQM model for the Ghanaian construction industry was developed based on the existing quality management issues, practices and grounded theories. It was postulated that overall TQM is directly related to the influence of the exogenous (latent) variables in predicting or determining overall TQM for the Ghanaian construction industry. The postulated model was analysed with the use of SEM software EQS Version 6.2. The fit statistics for the measurement and structural models had an adequate fit to the sample data. The finalized empirical model revealed that the exogenous variables (leadership and top management, company supplier quality management, client focus and involvement, company quality system evaluation, company vision and plan statement, product design management, product selection management, construction process management and improvement, and construction employees' involvement and motivation) had a statistically significant influence in determining TQM for the Ghanaian construction industry. Specifically, the exogenous variables such as construction employees' involvement and motivation had a weak (indirect) influence on determining TQM for the Ghanaian construction industry. From the findings, it is therefore concluded that the nine-factor model schematically portrayed in Figures 11.12 and 11.13 (Model 2.0) represents an adequate description of TQM for the Ghanaian construction industry.

The results of this study have theoretical, methodological and policy (practical) value because respondents for the Delphi study were drawn from academics and construction professionals. The respondents for the questionnaire survey were among the top management of construction firms. Furthermore, the respondents had a good working knowledge of the studied environment. In addition, the questionnaire survey results which modelled using SEM was a validating study of a conceptual model developed from synthesized theories established from literature and more importantly from the Delphi study. Hence, it is considered that the presented model for TQM interpretation maintains its validity. The result of the study provided information that can inform governmental, the Association of Building and Civil Engineering Contractors of Ghana and individual firms as they plan for and implement TQM. Secondly, the study provides indicators that will be a baseline for implementing TQM. Also, the conceptual model of TQM for the Ghanaian construction industry which has been formulated in this study will provide a reference to researchers who will study TQM in the near future. The current study lends support to other studies that have utilised alternative methods to establish the factors which influence TQM for the Ghanaian construction industry. These studies have concluded that TQM for the Ghanaian construction industry is multifaceted as is also claimed in the current study.

The current study utilizes the more robust modelling method of SEM. By adopting this methodology, the current study was able to model the influence of the selected multi-faceted variables and the constructs which were statistically significant. The practical implication is that the TQM for the Ghanaian construction industry model can be enhanced by improving on the factors of leadership and top management, company supplier quality management, client focus and involvement, company quality system evaluation, company vision and plan statement, product design management, product selection management, construction process management and improvement, and construction employees' involvement and motivation to enable their application by the construction firms. Moreover, the Association of Building and Civil Engineering Contractors of Ghana and other stakeholders responsible for construction projects in Ghana can adopt effective management strategies to improve on the TQM in the Ghanaian construction industry. In future, all firms managing construction projects should adopt the nine-factor model to enhance the quality of the implementation of TQM in the construction industry.

REFERENCES

Aaker, A., Kumar, V. and George, S. (2009). *Marketing research*. (10th edn.). New York: John Wiley and Sons.

Abdul-Rahman, H. (1995). The cost of non-conformance during a highway project: A case study. *Construction Management and Economics*, 13:23-32.

Abiodun, I.O. and Afangadem, A.U. (2007). An assessment of the effectiveness of regulatory measures for ensuring quality and standards in the construction industry of some selected cities in Nigeria. *Journal of the Nigerian Institute of Building*, pp. 63 – 70.

Addison, T. (2003). E-commerce project development risks: Evidence from a Delphi survey. *International Journal of Information Management*, 23(1):25-40.

Adeogun, B.K. and Okafor, C.C. (2013). Occupational Health, Safety and Environment (HSE) Trends in Nigeria. *International Journal of Environmental Sciences, Management and Engineering Research,* 2(1): 24-29, Jan-Feb. Available from http:// www.ijesmer.com [Accessed 23 October 2015].

Adetunji, I. O. (2005). *Sustainable construction: A web-based performance assessment tool.* Ph.D. Dissertation. Department of Civil and Building Engineering, Loughborough University, UK.

Adler, M. and Ziglio, E. (1996). *Gazing into the oracle: The Delphi method and its application to social policy and public health*. London: Kingsley Publishers.

Adusa-Poku, N. Y. (2014). *Assessing total quality management (TQM) in the Ghanaian construction industry: An exploratory study in Kumasi*. Master of Science Dissertation. Department of Building Technology, Faculty of Architecture and Building Technology, Kwame Nkrumah University of Science and Technology, Ghana.

African Development Fund. (ADF) (2008). Ghana country gender profile. Human Development Department (OSHD). Available from: http:// www.afdb.org [Accessed 30 August 2016].

African National Congress (1994). *Reconstruction and Development Programme White Paper.* Available from http://www.anc.org.za/ancdocs/policy/white.html. [Accessed 18 November 2015].

Agha, A. S. (2011) TQM in construction industry. Available from http://faculty.kfupm.edu.sa/CEM/bushait/cem515/term-papers/TQMinconstructionindustry.pdf. [Accessed 12 March 2015].

Ahire, S.L., Golhar, D.Y. and Waller, M.A. (1996). Development and validation of TQM implementation constructs. *Decision Sciences*, 27(1):23-56.

Ahmed, S. (1993). *An integrated total quality management (TQM) model for the construction process.* Ph.D. Dissertation, School of Civil & Environmental Engineering, Georgia Institute of Technology Atlanta, GA, USA.

Ahmed, SM., Azhar, S. and Castillo, M. (2002). *Measurement of construction processes for continuous improvement*. Final Report submitted to the Building Construction Industry Advisory Council, Department of Education (DOE), State of Florida

Aigbavboa, C. O. (2013). *An integrated beneficiary-centred housing satisfactory model for publicly funded housing schemes in South Africa.* Unpublished DPhil in Engineering Management, University of Johannesburg. South Africa. Available from http:www.ujdigispace.uj.ac.za [Accessed 15 June 2016].

Allens, A.R. (1994). Quality management in the construction phase of the traditional procurement system in South Africa: The case of the Western Cape. University of Cape Town in Cape Town, Western Cape, South Africa.

Al-Momani, A. (2007). TQM in construction: A case study of Jordan. In: Hughes, W. (Ed). *Proceedingss of the Inaugural Construction Management and Economics "Past, Present and Future" Conference*, 16th -18th July 2007, University of Reading, UK, pp. 741-752

Al-Musleh, A. M. (2010). Development of A Framework for Total Quality Management Principles in the Construction Companies with Special Reference to the Construction Companies in the State of Qatar. PhD Thesis. School of Engineering and Material Sciences at the Queen Mary, University of London, London, United Kingdom.

Amara, R. (1975). *Some methods of futures research*. Menlo Park: Institute for the Future.

Amaratunga, D., Baldry, D., Sarshar, M. and Newton, R. (2002). Quantitative qualitative research in the environment. *Work Study*, 51(1):17-31.

Ambrose, G.A.L. and Claasen, S.J. (2004). A total quality management approach to civil engineering consulting. *SA Journal of Industrial Engineering*, 15(1):67-81.

American Quality Foundation and Ernst & Young. (1991), *International quality study: The definitive study of the best international quality management practices*. Cleveland, OH.: Ernst & Young.

Anderson, J.C., Rungtusanatham, M. and Schroeder, R.G. (1994). A theory of quality management underlying the Deming management method. *Academy of Management Review*, 19(3):472-509.

Ankrah, N. I. (2007). *An investigation into the impact of culture on construction project performance*. PhD Thesis. SEBE, University of Wolverhampton, Wolverhampton.

Ansah, S.K. (2011). Partnering: An alternative contractual arrangement for construction project delivery in Ghana. *Journal of Polytechnics in Ghana* (JOPOG), 5(1):32 – 48.

Ansah, S.K., Aigbavboa, C. and Thwala, W.D. (2015). Total quality management implementation in the Ghanaian construction industry: A tool for improving construction productivity. In: Mojekwu, J.N., Nani G., Atepor, L., Thwala, W. D., Ogunsumi, L., Awere E., Ocran, S.P. and Bamfo-Agyei, E. (Eds). *Proceedings of the 4th Applied Research Conference in Africa. (ARCA) Conference*, 27-29 August 2015, Ibadan, Nigeria, pp. 336-347.

Anvuur, A., Kumaraswamy, M. M. and Male, S. (2006). Taking forward public procurement reforms in Ghana. CIB W107 Construction in Developing Countries. In: *Proceedings of the International Symposium, Construction in Developing Economies: New Issues and Challenges*, 18th - 20th January 2006, Santiago: Chile.

Arditi, D. and Gunaydin, H. M. (1997). TQM in the construction process. *International Journal of Project Management*, 15(14):235-243.

Aubrey, C. (2005). *Quality management in financial services*. Glencoe: McGraw Hill.

Babbie, E. R. (1990). *Survey research methods*. Belmont, California: Wadsworth.

Bagozzi, R.P. and Yi, Y. (2012). Specification, evaluation, and interpretation of structural equation models. *Journal of the Academy of Marketing Science*, 40(1):8-34.

Bamisile, A. (2004). Production management. Lagos, Nigeria: Foresight Press.

Barrett, P. (2007). Structural equation modeling: Adjudging model fit. *Personality and Individual Differences*, 42(5):815-824.

Beales, R. (2005). Delphi creates fresh CDS challenge: A new cash-settlement method for simplifying credit derivatives faces a stern test with the latest bankruptcy. *The fFnancial Times*, 43.

Bell, S. (1996). *Learning with information systems: Learning cycles in information systems development.* New York: Routledge.

Black, S.A. and Porter, L.J. (1996), Identification of the critical factors of TQM. *Decision Sciences*, 27(1):1-21.

Boaden, R. and Dale, B. (1992). TQM in the construction industry: A preliminary analysis. *International Journal of Technology Management*, 7(4/5): 244-253.

Boote, D.D. and Beile, P. (2005). Scholars before researchers: On the centrality of the dissertation literature review in research preparation. *Educational Researcher*, 34(5):3-15.

Boshoff, S. (2010). The Cape Town 2030 initiative: A contested vision for the future. In: *Counter-currents: Experiments in sustainability in the Cape Town region*. Cape Town: Jacana Media and African Centre for Cities, pp.70–79.

Bowen, P., Pearl, R. and Akintoye, A. (2007). Professional ethics in the South African construction industry. *Building Research & Information*, 35(2):189-205.

Brace, I. (2008). *Questionnaire design: How to plan, structure and write survey material for effective market research.* Philadelphia, United States: Kogan Page Publishers.

Brieschke, P.A. (1992). Reparative praxis: Rethinking the catastrophe that is social science. *Theory into Practice*, *31*(2): 173-180.

Brill, J., Bishop, M. & Walker, A. (2006). The competencies and characteristics required of an effective project manager: A web-based Delphi study. *Educational Technology Research and Development,* 54(2):115-40.

British Standards Institution (BSI). (1992). *BS 7850 Total quality management.* London: British Standards Publishing.

British Standards Institution (BSI). (2009). *History of BSI group*. Available from http://www.bsigroup.com/en/About-BSI/About-BSI-Group/BSI-History/ [Accessed 17 September 2016].

Bryman, A. (2001). *Social research methods*. Oxford, UK.: Oxford University Press.

Bryman, A. (2007). Barriers to integrating quantitative and qualitative research. *Journal of Mixed Methods Research*, 1(1):8-22.

Buckley, C. (1995). Delphi: A methodology for preferences more than predictions. *Library Management*, 16(7):16-19.

Buckley, C.C. (1994). Delphi technique supplies the classic result? *Australian Library Journal,* 43(3):158-64.

Buertey, J. I. T., Kaku, M. A. and Adjei-Kumi, T. (2013). Delays to large construction projects in Ghana: A risk overview. In: Laryea, S. and Agyepong, S. (Eds.). *Procedings of 5th West Africa Built Environment Research (WABER) Conference*, 12–14th August 2013, Accra, Ghana, pp.367 – 380.

Buertey, J., Amoa, P. and Adjei-Kumi, T. (2011). Construction cash flow prediction model in Ghana: A case study of the District Assembly Common Funded Projects. *Pentvars Business Journal*, 5(2).

Burati, J. L. and Kalidindi, S.N. (1991). Quality management in the construction industry. *ASCE Journal of Construction, Engineering and Management*, 117(2):341-359.

Burke, R. (2007). *Project management techniques*. Auckland, New Zealand: Burke Publishing.

Burns, A.C. and Bush, R.F. (2002). *Marketing research: Online research applications.* New Jersey: Prentice Hall.

Burrell, G. and Morgan, G. (1994). *Sociological paradigms and organizational analysis: Elements of the sociology of corporate life* (6th edn.). London: Heinemann, pp.1-37.

Byrne, B.M. (2010). *Structural equation modelling with AMOS. Basic concepts, applications and programming.* New York/London: Routledge.

Cain, C.T. (2004). *Performance measurement for construction profitability*. Oxford: Blackwell.

Cavalli-Sforza, V. and Ortolano, L. (1984). Delphi forecasts of land use – transportation interactions. *Journal of Transportation Engineering*, 110(3):324-39.

Cherrington, D.J. (1995). *The management of human resources* (4th edn.). Englewood Cliff, NJ.: Prentice- Hall.

Chini, A.R. and Valdez, H.E. (2003). ISO 9000 and the U.S construction industry. *Journal of Management in Engineering*, 16(2): 69-76.

Choi, T.Y. and Eboch, K. (1998). The TQM paradox: Relations among TQM practices, plant performance, and customer satisfaction. *Journal of Operations Management*, 17(1): 59-75.

Chou, C.P. and Bentler, P.M. (1995). *Estimates and tests in structural equation modelling.* In: Hoyle, R.H. (Ed.). *Structural equation modeling: Concepts, issues, and applications.*, Thousand Oaks, CA.: Sage Publications.

Choudhry, R.M., Fang, D. and Mohamed, S. (2007). The nature of safety culture: A survey of the state-of-the-art. *Safety Science,* 45(10):993-1012.

Churchill, G.A. (2001). *Basic marketing research*. Fort Worth: The Dryden Press.

Coates, J.F. (1975). *Review of Sackman Report - Technological forecasting and social change,* 7(2). New York: American Elsevier Publishing.

Comrey, A.L. and Lee, H.B. (1992). *A first course in factor analysis.* New Jersey: Lawrence Erlbaum Associates.

Conca, F.J., Llopis, J. and Tari, J. J. (2003). Development of a measure to assess quality management in certified firms. *Journal of Operational Reasearch*, 156(2004): 683-697.

Construction Industry Development Board (CIDB) (2004). *SA Construction Industry Status Report - Synthesis review on the South African construction industry and its development*. Pretoria: CIDB.

Construction Industry Development Board (CIDB) (2010) *The CIDB construction industry indicators summary results: 2009*. Pretoria, South Africa: CIDB.

Construction Industry Development Board (CIDB) (2012). *Construction industry indicators*, March 2012. Pretoria, South Africa: CIDB.

Construction Industry Development Board (CIDB). (2007). *The National Infrastructure Maintenance Strategy in support of ASGISA and Government growth objectives*. Pretoria, South Africa: CIDB.

Cooper, D. and Schindler, P. (2006). *Marketing research*. New York: McGraw-Hill.

Cooper, D.R. and Emory, W. (1995). *Business research methods.* Chicago: US: Irwin.

Cordon, C. P. (2013). System theories: An overview of various system theories and its application in healthcare. *American Journal of Systems Science*, 2(1):13-22 DOI: 10.5923/j.ajss.20130201.03.

Creative Research Systems (2003). *The survey system*. Available from http://www.surveysystem.com/sscalc.htm [Accessed 21October 2015].

Creswell, J.W. (1994). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks: Sage.

Creswell, J.W. (2003). *Research design: Qualitative, quantitative, and mixed method approaches*. Thousand Oaks, California: Sage Publications.

Creswell, J.W. and Clark, V.L. (2007). Designing and conducting mixed methods research. Thousand Oaks: CA: Sage Publications.

Creswell, J.W., Clark, V.L., Gutmann, M.L. and Hanson, W.E. (2003). Advanced mixed methods research designs. In: Tashakkori, A. and Teddlie, C. (Eds.). *Handbook of mixed methods in social and behavioral research*, Thousand Oaks, CA.: Sage Publications. pp. 209-240.

Crisp, J., Pelletier, D., Duffield, C., Adams, A. and Nagy, S. (1997). The Delphi method? *Nursing Research*, 46:116-8.

Critcher, C. and Gladstone, B. (1998). Utilizing the Delphi technique in policy discussion: A case study of a privatized utility in Britain. *Public Administration*, 76(3):431-49.

Crosby, P.B. (1979), *Quality is free*. New York: McGraw-Hill.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process.* London: Sage Publications.

Cuhls, K. (2003). *Delphi method*. Available from: http://www.unido.org/fileadmin/import/16959_DelphiMethod.pdf. [Accessed 26 October 2016].

Culp, G., Smith, A. and Abbott, J. (1993). Implementation TQM in consulting engineering firm. *Journal of Management in Engineering*, 9(4):340-366.

Czaja, R. and Blair, J. (1996). *Designing surveys: A guide to decisions and procedures*. Thousand Oaks, CA., London: Pine Forge Press.

Czinkota, M.R. and Ronkainen, I.A. (1992). Global marketing 2000: A marketing survival guide. *Marketing Management*, January/February, pp.37-44.

Dale, B.G. and Plunkett, J.J. (1990). *Managing quality*. New York: Philip Allan.

Dalkey, N.C. & Helmer, O. (1963). An experimental application of the Delphi method to the use of experts. *Journal of the Institute of Management Sciences*, 9:458-467.

Dean, J.W. Jr. and Bowen, D.E. (1994). Management theory and total quality: Improving research and practice through theory development. *Academy of Management Review*, 19(3):392-418.

Delbecq, A.L., Van de Ven, A.H. and Gustafson, D.H. (1975). *Group techniques for program planning: A guide to nominal group and Delphi processes*. Glenview, IL: Scott, Foresman & Company.

Deming, W. E. (1986). *Out of the crisis: Quality, productivity and competitive position.* Cambridge: Cambridge University Press.

Denzin, N. K. (1970). *The research act in sociology*. London: Butterworth.

Denzin, N. K., and Lincoln, Y. S. (2003). *Strategies of qualitative inquiry*. Thousand Oaks, CA: Sage Publications.

Dikmen, I. and Birgonul, M. T. (2003). Strategic perspective of Turkish construction companies. *Journal of Management in Engineering*, 19(1):33-40.

Dingsdag, D.P., Biggs, H.C., Sheahan, V.L. and Cipolla, C.J. (2006). *A construction safety competency framework: Improving OH&S performance by creating and maintaining a safety culture.* Brisbane: Cooperative Research Centre for Construction Innovation.Disaster Management Institute (DMI) nd. Accident Causation Theories

Dion, P.A. (2008). Interpreting structural equation modelling results: A reply to Martin and Cullen. *Journal of Business Ethics*, 83:365-368.

Dow, D., Samson, D. and Ford, S. (1999). Exploding the myth: Do all quality management practices contribute to superior quality performance. *Production and Operations Management*,8:1–27.

Du Plessis, C., Irurah, D.K. and Scholes, R.J. (2003). The built environment and climate change in South Africa. *Building Research and Information*, 31(3-4):240-256.

Dublin, R. (1978). *Theory of building. A practical guide to the construction and testing of theoretical models* (Rev. edn.) New York: The Free Press.

DuBrin, A.J. (1995). *Leadership: Research findings, practice, and skills*. Boston, MA: Houghton Mifflin Company.

Duncan, J.M., Thorpe, B. and Sunmer, P. (1990). *Quality assurance in construction.* Aldershot, Great Britain: Gower Publishing Company.

Dunn, W.N. (1994). *Public policy analysis: An introduction.* Englewood Cliffs, NJ: Prentice Hall.

Easton, G. (1993). The 1993 state of U.S. TQM: A Baldrige examiner's perspective. *California Management Review*, 35(3):32-54.

Easton, G.S. and Jarrell, S.L. (1998). The effects of TQM on corporate Economist. Construction and the Internet. *The Economist*. 15 January 2000.

Egan, S. J. (1998). Rethinking construction. *Report of the Construction Task Force, HMSO*. London: Department of the Environment.

Ellram, L. (1996). The use of the case study method in logistics research. *Journal of Business Logistics*, 17(8):93-138.

Els, D.A. and Delarey, R.P. (2006). Developing a holistic wellness model. *South African Journal of Human Resource Management*, 4(2):46-56.

Eto, H. (2003). The suitability of technology forecasting/foresight methods for decision systems and strategy. A Japanese view. *Technological Forecasting and Social Change,* 70:231-249.

Feigenbaum, A.V. (1991). *Total quality control* (3rd edn.). New York: McGraw-Hill. Fellows, R. and Liu, A. (1997). *Research methods for construction*. Oxford: Blackwell Science.

Fernandez-Muniz, B., Montes-Peon M.J. and Vazquez-Ordas, J.C. (2007). Safety culture: Analysis of the causal relationships between its key dimensions. *Journal of Safety Research,* 38(6):627-641.

Field, A. (2005). *Discovering statistics using SPSS (and sex, drugs and rock 'n 'roll)*, (2nd edn.). London: Sage Publications.

Fitzgerald, M.K. (2005). Safety performance improvement through culture change. *Process Safety Environmental Protection*, 83(4): 324-330.

Flick, U. (2009). *An introduction to qualitative research*. Thousand Oaks, CA: Sage Publications.

Flynn, B.B., Schroeder, R.G. and Sakakibara, S. (1994). A framework for quality management research and an associated measurement instrument. *Journal of Operations Management*, 11:339-366.

Fock, H.K.Y. and Woo, K.S. (1998). The China market: Strategic implications of Guanxi. *Business Strategy Review*, 9(3):33-43.

Fornell, C. (1983). Issues in the application of covariance structure analysis: A comment. *Journal of Consumer Research*, 9(4): 443-448.

Forzano, G. (2008). *Research methods for the behavioural sciences.* United States: Cengage Learning EMEA.

Foster, V. and Pushak, N. (2011). Ghana's infrastructure: A continental perspective. *World Bank Policy Research Working Paper No. 5600.* Available at SSRN: https://ssrn.com/abstract=1792258.

Garland, R. (1991). The mid-point on rating scale: Is it desirable? *Marketing Bulletin,* 2(May):66-70.

Garrod, B. (2008). *The Delphi technique.* Institute of Rural Sciences, University of Wales: Aberystwyth, UK.

Garvin, D.A. (1984). What does 'product quality' really mean? *Slogan Management Review*, 26(1):25-43.

Ghana Statistical Service. (GSS). (2012). *2010 Population & Housing Census: National Analytical Report.* Accra, Ghana: GSS.

Ghobadian, A. and Woo, H.S. (1996), Characteristics, benefits and shortcomings of four major quality awards. *International Journal of Quality & Reliability Management*, 13(2):10-44.

Goldratt, E. M (1995). *The haystack syndrome*. Croton-on-Hudson, NY: North River Press.

Goodman, C.M. (1987). The Delphi technique: A critique. *Journal of Advanced Nursing,* 12:729-734.

Green, B., Jones, M., Hughes, D. and Williams, A. (1999). Applying the Delphi technique in a study of GP's information requirements. *Health and Social Care in the Community*, 17(3):198-205.

Grisham, T. (2008). *Cross cultural leadership*. Doctor of Project Management, School of Property, Construction and Project Management, RMIT, Melbourne.

Grobbelaar, S. 2001. *Die kwaliteitsvereistes van die ISO 9000: 2000 dokumentasie en die invloed daarvan op die konstruksiebedryf*. Unpublished BSc (QS) dissertation, University of Pretoria, RSA.

Gunning, J.G. and McCallion, E.M. (2007). TQM in large Northern Ireland contracting organisations. In: Boyd, D. (Ed.). *Proceedings of the 23rd Annual ARCOM Conference*, 3-5 September 2007, Belfast, UK, Association of Researchers in Construction Management, pp. 577-586

Guy, R.F., Edgley, C.E, Arafat, I. and Allen, D.E. (1987). *Social research. Puzzles and solutions.* Boston: Allyn and Bacon.

Hackman, J.R. and Wageman, R. (1995). TQM: Empirical, conceptual, and practical issues. *Administrative Science Quarterly*, 40(June):309-342.

Häder, M. and Häder, S. (1995). Delphi und kognitionspsychologie: Einzugangzurtheoretischenfundierung der Delphi-Methode. *ZUMA-nachrichten,* 37(19):12.

Hair, J. F., Anderson, R.E., Tatham, R.L., Black, W.C. (1998). *Multivariate data analysis*. Upper Saddle River, NJ: Prentice Hall.

Hair, J.F., Black, W.C., Babin, J.B., Anderson, R.E. and Tatham, R.L. (2006). Multivariate data analysis (6th edn.). Upper Saddle River, NJ.: Pearson/Prentice Hall.

Hallowell, M. and Gambatese, J. (2010). Qualitative research: Application of the Delphi method to CEM research. *Journal of Construction Engineering and Management,* 136(*Special Issue: Research Methodologies in Construction Engineering and Management*):99-107.

Hamilton, J. (1997). The macro-macro interface in the construction of individual fashion forums and meanings. *Clothing and Textiles Research Journal*, 15(3):164-171.

Handfield, R.B. (1993). A resource dependence view of just-in-time purchasing. *Journal of Operations Management*, 11:289-311.

Hardy, J.D., O'Brien, A.P. and Gaskin, C.J. (2004). Practical application of the Delphi technique in a bicultural mental health nursing study in New Zealand. *Journal of Advanced Nursing*, 46(1):95-109.

Harrington, J.H. and Voehl, F. (2012). Applying TQM to the construction industry. *The Total Quality Management Journal*, 24(4):352-362.

Harris, F. and McCaffer, R (2005). *Modern construction management*. New Jersey: Blackwell Science Publishers.

Harris, F. and McCaffer, R. (1995). *Modern construction management* (4th edn.). Cambridge: Cambridge University Press.

Harris, F. and McCaffer, R. (2002). *Modern construction management*. E.P.P Books Series, Accra, Ghana.

Harris, F., McCaffer, R. and Edum-Fotwe, F. (2006). *Modern construction management.* New Jersey: Blackwell Publishing.

Harris, M.M. and Schaubroeck, J. (1990). Confirmatory modeling in OB/HRM: Technical issues and applications. *Journal of Management Information Systems*, 16:337-360.

Hassin, E., Tookey, J.E. and Vidalakis, C. (2007) Sustainable development and TQM implementation in Libya: A study of the electrical generation industry. In*:* Egbu, C.O. and Tong, M.K.L. (Eds). *Proceedings of the 3rd Scottish Conference for Postgraduate Researchers of the Built and Natural Environment (PRoBE)*, 20-22 November 2007, Glasgow Caledonian University, pp.203-215.

Hasson, F., Keeney, S. and McKenna, H. (2000). Research guidelines for the Delphi survey technique. *Journal of Advanced Nursing,* 32(4):1008-15.

Hatzichristos, T. and Giaoutzi, M. (2005). Landfill siting using GIS, fuzzy logic and the Delphi method (author abstract). *International Journal of Environmental Technology Advancement,* 6(1/2):218.

Haupt, T.C. and Whiteman, D.E. (2003). Deploying TQM on construction sites: inhibiting factors. *The International Journal of Construction Management*, 3(2): 51-68.

Hayes, B.E. (1998). *Measuring customer satisfaction: Survey design, use and statistical analysis methods*. Milwaukee: ASQ Quality Press.

Helmer, O. (1977). Problems in futures research: Delphi and causal cross-impact analysis. *Future*, 9(1):25-52.

Henderson, J.R.and Ruiker, K. (2010). Technology implementation strategies for construction organisations. *Engineering, Construction and Architectural Management*, 17(3): 309 - 327.

Hendricks, K.B. and Singhal, V.R. (1996). Quality awards and the market value of the firm: An empirical investigation. *Management Science*, 42(3): 415-436.

Hendricks, K.B. and Singhal, V.R. (1997). Delays in new product introductions and the market value of the firm: The consequences of being late to the market. *Management Science*, 43(4):422-436.

Henry, A.L. (1994). The factors associated with insolvency among contractors in the South African construction industry: A case study of the Western Cape Region. University of Cape Town in Cape Town, Western Cape, South Africa.

Heppner, P.P. and Heppner, M.J. (2004). *Writing and publishing your thesis, dissertation and research - A guide for students in the helping professions.* Belmont: Brooks & Cole Thomson Learning.

Hill, S. (1995). The social organization of boards of directors. *The British Journal of Sociology*, 46(2):245–279.

Hillebrandt, P.M. (2000). *Economic theory and the construction industry* (2nd edn.). Basingstoke: Macmillan.

Hinze, J. (2001). *Construction contracts* (2nd edn.). McGraw- Hill Companies.

Hishamuddin, I. (2007). *Empirical analysis on factors influencing customer loyalty in Malaysian telecommunication industry.* Multimedia University, Malaysia.

Hitchcock, G. and Hughes, D. (1989). *Research and the teacher*. London: Routledge.

Ho, S.K.M. and Fung, C.K.H. (1994). Developing a TQM excellence model. *Total Quality Managment Magazine*, 6(6):24-30.

Hoinville, G. and Jowell, R. (1978). *Survey research practice*. Aldershot, Great Britain: Gower Publishing Company.

Holey, E.A., Feeley, J.L., Dixon, J. and Whittaker, V.J. (2007). An exploration of the use of simple statistics to measure consensus and stability in Delphi studies. *BMC Medical Research Methodology,* 7(52):1-10.

Hooper, D., Coughlan, J. and Mullen, M. (2008). Structural equation modelling: Guidelines for determining model fit. *Electronic Journal of Business Research Methods,* 6(1):53-60.

Hopkins, A. (2006). Studying organisational cultures and their effects on safety. *Safety Science*, 44: 875-889.

Hossain, M. M., Prybutok, V.R., Abdullah, A.B.M., and Talukder, M (2010). The development and research tradition of statistical quality control. *International Journal of Productivity and Quality Management* 5(1): 21-37.

Hoyle, R. (1995). *SEM concepts, issues and applications*. London: Sage Publications.

Hsu, C.C. and Sandford, B.A. (2007). The Delphi technique: Making sense of consensus. *Practical Assessment, Research and Evaluation,* 12(10):1-8.

Hsu, I-Y., Su, T-S., Kao, C-S, Shu, Y-L, Lin, P-R. and Tseng, J-M. (2012). Analysis of business safety performance by structural equation models. *Safety Sciences*, 50(1):1-11.

Hu, L. and Bentler, P.M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation M odeling,* 6(1):1-55.

Hudson, C. R., Sears, G.A. and Keoki. S.S. (2000). *Construction project management* (4th edn.). Canada: John Wiley & Sons.

Imbeah, K. A. (2012). *Framework for the implementation of total quality management (TQM) in real estate firms in Ghana.* MSc Thesis, Facullty of Architecture and Building Technology, KNUST, Ghana.

Institute of Management Accountants (IMA). (1999). *Theory of constraints (TOC) Management System Fundamentals.* Institute of Management Accountants and Arthur Andersen LLP, USA: , IMA Publication Number 99342

Institution of Occupational Safety and Health (IOSH) (2004). *Promoting a positive culture - a guide to health and safety culture*. 4.2. Leicestershire: IOSH.

International Labour Organization (2001). *The construction industry in the twenty first century: Its image, employment prospects and skill requirements.* Geneva: International Labour Office.

International Organization for Standardization (ISO) 8402 (1994). *Quality management and quality assurance – vocabulary*. , Geneve, Switzerland: ISO.

Iqbal, S. and Pipon-Young, L. (2009). The Delphi method. *The Psychologist,* 22(7):598-600.

Ishikawa, K. (1985). *What is total quality control? The Japanese Way*. Englewood Cliffs, NJ.: Prentice-Hall.

Jack, E.P. and Raturi, A.S. (2006). Lessons learned from methodological triangulation in management research. *Management Research News,* 29(6):345-357.

Jean, K. (1992). *Livelihood strategies among farm youth in Rwanda.* Michigan: Michigan State University.

Jha, K. and Iyer, K.C. (2006). Critical factors affecting quality performance in construction projects. *TQM & Business Excellence,* 17(9): 1155-1170.

Johnson, R. B., Onwuegbuzie, A. J. and Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research*, 1(2):112–133.

Joubert, W., Cruywagen, J. H. and Basson, G. A. J. (2005). Will the implementation of a TQM system benefit South African construction companies? *South Africa Journal of Industrial Engineering,* 16 (1):29-40.

Juran, J. M. (1988). *Quality control handbook.* New York: McGraw-Hill.

Juran, J.M. and Gryna, F.M. (1993). *Quality planning and analysis* (3rd edn.). New York: McGraw-Hill.

Kanji, G.K. and Asher, M. (1993). Total quality management process: A systematic approach. *Advances in TQM Series*. Abingdon: Carfax.

Kanji, G.K. and Asher, M. (1996), *100 methods for total quality management*. London: Sage Publications.

Keeney, S., Hasson, F. and McKenna, H.P. (2001). A critical review of the Delphi technique as a research methodology for nursing. *International Journal of Nursing Studies,* 38(2):195200.

Kelloway, E. (1998). *Using LISEL for SEM: Researchers guide*. London: Sage Publications.

Kenya Institute of Management (2009). *Total quality management: Theory, concepts and practice*. Macmillan Publishers.

Kerlinger, F. and Lee, H. (2000). *Foundations of behavioural research*. Fort Worth, TX: Harcourt.

Kerzner, H. (2003). *Project management: A System approach to planning, schedualing, and controlling*. New Jersey: John Wiley & Sons.

Khadour, L. and Darkwa, J. (2008). TQEM in the UK construction industry: Some key findings from a survey. In: Dainty, A. (Ed.). *Proceedings of the 24th Annual Association of Researchers in Construction Management (ARCOM) Conference*, 1-3 September 2008, Cardiff, UK, pp.239-246.

Kinloch, G.C. (1977). *Sociology theory: Its development and major paradigms*. New York: Mc Graw-Hill.

Kiwus, C.H. and Williams, T.P. (2001). Application of TQM to environmental construction. *Journal of Management in Engineering*, 17(3):176-184.

Kline, R.B. (2005). *Principles and practice of structural equation modeling.* (2nd edn.). New York: Guilford Press.

Kline, R.B. (2010). *Principles and practice of structural equation modeling.* (3rd edn.). New York: Guilford Press.

Koh, T.Y. and Low, S.P. (2010). Empiricist framework for TQM implementation in construction companies. *Journal of Management in Engineering,* 26(3):133-143.

Kubal, M.T. (1994). Engineered quality in construction. In: Assessing contractor quality performance. *Construction Management and Economics*, 20: 211.

Kumaraswamy, M. M. and Dissanayaka, S. M. (2000). ISO 9000 and beyond: From a Hong Kong construction perspective. *Journal of Construction Management and Economics*, 18(7): 783-796.

Kwakye, A. A. (1998). *Construction project administration in practice*. Ascot, Berkshire: The Chartered Institute of Buildings.

Kwaw, P.K., Yalley, P.P., Cobbinah, J.F. and Opintan-Baah, E. (2011). Ghana's public procurement reform and continuous use of traditional procurement system: The case of the construction industry. *Takoradi Polytechnic Journal of Technology*, 1(1): 51-64.

Lad, J. and Beck, B. (2009). Construction quality: The key to successful capital projects delivery. *Pharmceutical Engineering*, 29(6).

Landeta, J. (2006). Current validity of the Delphi method in social sciences. *Technological Forecasting and Social Change*, 73(5):467-482.

Lang, T. (1995). An overview of four futures methodologies (Delphi, environmental scanning, issues management and emerging issue analysis). *The Manoa Journal of Fried and Halffried Ideas (about the future)*, 7 (Occasional Paper Number Seven) - Hawaii Research Center for Futures Studies, Honolulu.

Larsson, S., Pousette, A. and Törner, M. (2008). Psychological climate and safety in the construction industry-mediated influence on safety behavior. *Safety Science*, 46(3):405-412.

Lee, A. S. (1991). Integrating positive and interpretative approach to organisational research. *Organisational Science*, 2(4):342 – 365.

Leedy, D.P. and Ormrod, E.J. (2010). *Practical research: Planning and designing* (9th edn.). Upper Saddle River, NJ.: Pearson Education.

Leedy, P.D. and Ormrod, J.E. (2005). *Practical research: Planning and design.* (8th edn.). Upper Saddle River, NJ.: Prentice Hall.

Lennon, S.L. and Burns, L.D. (2000). The diversity of research in textiles, clothing, and human behavior: The relationship between what we know and how we know. *Clothing Textiles Research Journal*, 18(4):213-226.

Lewis, T.M. (2007). Impact of globalization on the construction sector in developing countries. *Construction Management and Economics*, 25(1): 7–23.

Lincola, Y.S. and Guba, E.G. (1985). *Naturalistic inquiry*. London: Sage Publications.

Lingard, H., Wakefield, R. and Cashin, P. (2011). The development and testing of a hierarchical measure of project OHS performance. *Engineering Construction and Architectural Management*, 18(1):30-49.

Linstone, A. and Turoff, M. (1975). *The Delphi method: Techniques and applications.* Reading, MA: Addison-Wesley.

Linstone, H.A. (1978). The Delphi technique. In: Fowlers, J. *Handbook of Futures research*, (Ed.). J. Fowlers, Westport, CT: Greenwood Press, pp. 273-300.

Linstone, H.A. and Turoff, M. (2002). *The Delphi method: Techniques and applications*. Available from: http://www.is.njit.edu/pubs.php [Accessed 23 November 2016].

Lobelo, L. (1996). *An investigation into factors associated with insolvencies amongst civil engineering contracting firms in South Africa*. University of Cape Town in Cape Town, Western Cape, South Africa.

Loo, R. (2002). The Delphi method: A powerful tool for strategic management, policing. *An International Journal of Police Strategies and Management,* 25(4):762-769.

Love, P. E. D., Li, H., Irani, Z., and Holt, G.D. (2000). Re-thinking TQM: Toward a framework for facilitating learning and change in construction organisations. *The Total Quality Management Magazine*, 12(2):107-117.

Love, P.E.D. and Li, H. (2000). Quantifying the causes and costs of rework in construction, *Construction Management and Economics*, 18:479-490.

Love, P.E.D., Edwards, D.J. and Sohal, A. (2004). TQM in Australian contracting organisations: Pre-conditions for successful implementation. *Engineering, Construction and Architectural Management,* 11(3):189-198.

Low, S.P. and Jasmine, A.T. (2004). Implementing total quality management in construction firms. *Management in Engineering,* 20(1):8-15.

Lucko, G. and Rojas, E.M. (2010). Research validation: Challenges and opportunities in the construction domain. *Journal of Construction Engineering and Management,* 136(1):127135.

Luus, C. (2003). The ABSA residential property market database for South Africa: Key data trends and implication. In: *Proceedings of the IMF/BIS Conference on Real Estate Indicators and Financial Stability*, Washington DC, 27–28 October.

Maart, L. and Soa, S. (1996). *From political to development practice: Facing the challenges of field.* Durban: Olive Subscription Service.

Maguire, M. (1987). *Doing participatory research: A feminist approach*. Amherst, MA: The Center of International Education, University of Massachussetts.

Mahmood, W., Yusoff, W. and Mohammed, A. H. (2008). A conceptual framework for the development of quality culture in the construction industry. In: Dainty, A. (Ed.). *Proceedings of the 24th Annual Association of Researchers in Construction Management (ARCOM) Conference*, 1-3 September 2008, Cardiff, UK, pp.247-256.

Malhotra, N.K. (1999). *Marketing research: An applied orientation* (3rd edn.). New Jersey: Prentice Hall.

Mangan, J., Lalwani, C. and Gardner, B. (2004). Combining quantitative and qualitative methodologies in logistics research. *International Journal of Physical Distribution & Logistics Management,* 34(7):565-578.

Mann, R. and Kehoe, D. (1994). An evaluation of the effects of quality improvement activities on business performance. *International Journal of Quality & Reliability Management*, 11(4):29-44.

Mann, R.S. (1992). *The development of a framework to assist in the implementation of Total Quality Management*. PhD thesis, Department of Industrial Studies, University of Liverpool, UK.

Manu, P., Ankrah, N., Proverbs, D. and Suresh, S. (2010). Exploring the causal influence of construction project features in accident causation. In: Barrett, P., Amaratunga, D., Haigh, R., Keraminiyage, K. and Pathirage, C., eds. *Proceedings of the CIB 2010 World Congress*, Salford, UK, 10th – 13th May, 2010., pp. 241-252.

Marcoulides, G. and Hershberger, S. (1999). Multivariate statistical methods: A first course. *Structural Equation Modeling*, 6(1):127-133.

Martinez-Lorente, A. R., Dewhurst, F. and Dale, B.G (1998). Total quality management: Origin and evolution of the term. *The Total Quality Management Magazine,* 10(5):378-386.

Martins, E.C. and Terblanche, F. (2003). Building organisational culture that stimulates creativity and innovation. *European Journal of Innovation Management,* 6(1): 64-74.

Maruyama, G. (1998). *Basics of structural equation modelling*. London: Sage Publications.

Masini, E. (1993). *Why futures Studies?* London: Grey Seal.

Masser, I. and Foley, P. (1987). Delphi revisited: Expert opinion in urban analysis. *Urban Studies,* 24(3):217-224.

May, T. (2001). *Social research - Issues, methods and process* (3rd ed.). Buckingham & Philadelphia: Open University Press.

Mazzochi, F. (2008). Complexity in biology. Exceeding the limits of reductionism and determinism using complexity theory. *European Molecular Biology Organization Reports*, 9(1):10-14.

Mbande, C. (2010). Overcoming construction constraints through infrastructure deliver. In: *Proceedings of the Association of Schools of Construction of Southern Africa (ASOCSA), Fifth Built Environment Conference*, Durban, South Africa, 18–20 July.

McClave, J.T., Benson, P.G. and Sincich, T. (2008). *Statistics for business and economics.* (10th edn.). United States: Pearson Prentice Hall.

McCutcheon, R.T. and Taylor, F.L.M. (2003). *Employment and high-standard infrastructure.* Johannesburg: Work Research Center for Employment Creation in Construction.

McFarlin, D.B., Coster, E.A. and Mogale-Pretorius, C. (1999). South African management development in the 21st century. *Journal of Management Development*, 18(1):63-78.

McIntyre, C. and Kirschenman, M. (2000). Survey of TQM in construction industry in upper Midwest. *Journal of Management in Engineering*, 16(5):67-70.

McIntyre, L.J. (1999). *The practical skeptic: Core concepts in sociology*. Mountain View, CA: Mayfield Publishing.

McKenna, H. (1994). The Delphi technique: A worthwhile research approach for nursing? *Journal of Advanced Nursing*, 19(6):1221-1225.

Meadows, D. H. (2009). *Thinking in systems. A primer*. London, UK: Earthscan.

Mensah, S. (2012). Effects of project management practices on project performance: The case of three organisations. *Published monograph*. Lambert Academic Publishing.

Meredith, J.R. and Shafer, S.M. (1999). *Operations management for MBAs*. New York: John Wiley & Sons.

Metri, B.A. (2005). TQM critical success factors for construction firms. *Management Economics*, 10(2):61-72.

Milford, R. (2010). Public capacity payment and procurement issues should be a challenge to the operations of contractors in South Africa. *Paper presented at the Fifth Built Environment*

Conference of the Association of Schools of Construction of Southern Africa, Durban, South Africa, 18–20 July.

Miller, M.M. (1993). Enhancing regional analysis with the Delphi method. *Review of Regional Studies,* 23(2):191-212.

Ministry of Water Resources, Works and Housing (MWRWH) (2012). A Draft Building Code for Ghana. Accra: Ministry of Water Resources, Works and Housing.

Mitchell, J.C. (1983). Case and situation analysis. *Sociological Review,* 31(2):187-211.

Mitchell, M. and Jolley, J. (1992). Research design explained (2nd ed.). Forth Worth, TX: Harcourt Brace Jovanovich College Publishers.

Mohammed, S.M. and Rotimi, J.O. (2002). A review of quality control and assurance in building construction. *A paper presented at the Millennium Conference, held at A.B.U Zaria.*

Mohammed, U. S. (2011). Green buildings: A sustainable construction approach to sustainable built environment. *A paper presented at the workshop* held at Multi-Purpose Hall, Gombe State University, 3-7 July 2011, pp. 5.

Molenaar, R.K., Park, J-II. and Washington, S. (2009). Framework for measuring corporate safety culture and its impact on construction safety performance. *Journal of Construction Engineering and Management,* 135(6):488-496.

Morgan, D. L. (2006). Connected contributions as a motivation for combining qualitative and quantitative methods. Washington, DC: American Public Health Association.

Mosadeghrad, AM. 2014. Why TQM programmes fail? A pathology approach. *The Total Quality Management Journal,* 26(2):160-187.

Mulaik, S.A., James, L.R., Van Alstine, J., Bennet, N., Lind, S. and Stilwell, C.D. (1989). Evaluation of goodness-of-fit indices for structural equation models. *Psychological Bulletin*, 105(3):430-45.

Munn, P. and Drever, E. (1990). Using questionnaires in small-scale research: A teachers' guide. Edinburgh: SCRE.

Musonda, I. (2012). *Construction health and safety (H&S) performance improvement. A client-centred model.* Unpublished DPhil in Engineering Management, University of

Johannesburg. South Africa. Available from http://www.ujdigispace.uj.ac.za [Accessed 02 June 2016].

Muthén, L.K. and Muthén, B.O. (2007). *Mplus, user's guide*. (5th edn.). Los Angeles, CA: Muthén & Muthén.

Nazhad M. B., Mosavi J. S. and Kordabadi S. S. (2012). Organizational culture and quality management (ISO/9001) case study: Tehran Universities employees. *Journal of Basic and Applied Scientific Research*, 2(12):12590-12599.

Nee, P.A. (1996). *ISO 9000 in construction*. New York, USA.: Wiley.

Nesan, L. J. and Holt, G.D. (1999). *Empowerment in construction organisations: The way forward for performance improvement*. England: Research Studies Press.

Neuman, W.L. (2006). *Social research methods. Qualitative and quantitative approaches*. (6^{th} edn.). Boston: Pearson.

Newcombe, R., Fellows R., Langford, D. and Urry, S. (2001). *Construction management in Practice.* (Vol. 1). London: Blackwell Science.

Ngowi, A. B. (2000). Impact of culture on the application of TQM in the construction industry in Botswana. *International Journal of Quality & Reliability Management,* 17(4/5):442-452.

Ngowi, AB. 2001. Impact of culture on the application of TQM in the construction industry in Botswana. *International Journal of Quality and Reliability Management*, 17(4/5): 442-452.

Nicco–Annan, J. (2006). Partnering in construction. *The Quantity Surveyor,* 1:14-19.

Norberg, J. and Cumming, G. (2008). *Complexity theory for a sustainable future*. New York, NY: Columbia University Press.

Nuamah, F. A., Manu, P., and Manu, E. (2013). A preliminary inquiry into the applicability of client-contractor partnering in the Ghanaian Construction industry. In: Laryea, S. and Agyepong, S. (Eds). *Proceedings of 5^{th} West Africa Built Environment Research (WABER) Conference,* 12 – 14^{th} August 2013, Accra, Ghana, pp.77 – 85.

Nukulchai, W. K. (2003). *Towards total quality management in higher education: The experience of Asian Institute of Technology*. Asian Institute of Technology.

Oakland, J. (2000). TQM – Text with cases (2nd edn.). Butterworth Heinemann.

Oakland, J. and Marosszeky, M (2006). *Total quality in the construction supply chain.* Oxford, UK: Elsevier.

Ofori, G. (2012). *Developing the construction industry in Ghana: The case for a central agency*. Available from http://www.buildingcontractorsgh.com [Accessed 24 November 2015].

Okoli, C. and Pawlowski, S. (2004). The Delphi method as a research tool: An example, design considerations and applications. *Information Management*, 42:15-29.

Oliver, G.B.M. (1992). *Quality management in construction - Implementation in design services organisations.* London: CIRIA.

Ozaki, R. (2003). Customer–focused approaches to innovation in house building. *Construction Management and Economics*, 21(6): 557-564.

Pallant, J. (2007). SPSS, Survival manual: A step-by step guide to data analysis using SPPS Version 1.5. (3rd edn.). McGraw Hill.

Parente, R.J., Hiob, T.N., Silver, R.A., Jenkins, C., Poe, M.P. and Mullins, R.J. (2005). The Delphi method, impeachment and terrorism: Accuracies of short-range forecasts for volatile world events. *Technological Forecasting and Social Change*, 72(4):401-11.

Pheng, L.S. and Teo, J.A. (2004). Implementing TQM in construction firms. *Journal of Management in Engineering*, 20(1): 8-15.

Philips Quality (1995). *Philips quality - Let's make things better*. Eindhoven, The Netherlands: Corporate Quality Bureau, Philips Electronics N.V.

Phillips, R. (2000). *New applications for the Delphi technique.* San Diego: Pfeiffer and Company.

Phua, F. T. T. (2006). Predicting construction firm performance: An empirical assessment of the differential impact between industry- and firm-specific factors. *Construction Management and Economics*, 24(3):309-320.

Pinsonneault, A. and Kraemer, K.L. (1993). Survey research methodology in management information systems: An assessment. *Journal of Management Information Systems*, 10(2):75-105.

Powell, T.C. (1995). TQM as competitive advantage: A review and empirical study. *Strategic Management Journal*, 16: 15-37.

Project Management Institute. (2000). *A guide to the project management body of knowledge (PMBOK Guide).* Newtown Square: PSI.

Pyzdek, T. (2003). *Quality engineering handbook*. CRC Press.

Quattrone, P. (2000). Constructivism and accounting research: Towards a trans-disciplinary perspective. *Accounting, Auditing & Accountability Journal*, 13(2):130- 155.

Ramachandran, V. (2010). TQM in construction. Available at http://www.brighthub.com/office/project-management/articles/86518 [Accessed 24 June 2015].

Raskin, M.S. (1994). The Delphi study in field instruction revisited: Expert consensus on issues and research priorities. *Journal of Social work education*, 30:75-89.

Rategan, C. (1992). TQM. *Journal of Property Management*, 57: 32-34.

Rayens, M.K. and Hahn, E.J. (2000). Building consensus using the policy Delphi method. *Policy, Politics and Nursing Practices*, 1(2):308-31.

Raykov, T. and Marcoulides, G. (2000). A first course in structural equation modeling. New Jersey: Lawrence Erlbaum Associates.

Reid, N.G. (1988). The Delphi technique, its contributions to the evaluation of professional practice. In: Ellis. R. (Ed.). *Professional competence and quality assurance in the caring professions*. Chapman & Hall, pp. 230-62.

Republic of Ghana. (2011). *Ghana at a glance. Know more about Ghana*. Available from http://www.ghana.gov.gh/index.php?option=com_content&view=category&layout=blog&id=92&Itemid=238. [Accessed 10 December 2016].

Republic of South Africa. Department of Public Works. (1999). Creating an Enabling Environment for Reconstruction, Growth and Development in the Construction Industry. *The White Paper*, Pretoria, South Africa: Government Printing Works.

Robson, C. (2002). *Real word research: A research for social scientists and practitionerresearch*. Oxford: Blackwell Publishing.

Rogers, M.R. and Lopez, E.C. (2002). Identifying critical cross-cultural school psychology competencies. *Journal of School Psychology*, 40(2):115-141.

Ross, J.E. (1993). *Total quality management*. Delray Beach, FL.: St. Lucie Press.

Rowe, G., Wright, G. and Bolger, F. (1991). Delphi - A re-evaluation of research and theory. *Technological Forecasting and Social Change*, 39:238-251.

Ruyter, J.C. and Scholl, N.B. (1998). Positioning qualitative market research: Reflections from theory and practices. *Qualitative Market Research Journal*, 1(1):7-14.

Saad, M. U. and Dahiru, D. (2015) Project quality management practices in multinational and indigenous construction firms of Nigeria. In: Laryea, S. and Leiringer R. (Eds.). *Proceedings of the 6th West Africa Built Environment Research (WABER) Conference*, 10-12 August 2015, Accra, Ghana, pp.951-960.

Sackman, H. (1974). *Delphi assessment: Expert opinion, forecasting, and group process.* Santa Monica, CA: Rand Corporation.

Saizarbitoria, I.H. (2006). How quality management models influence company results – conclusions of an empirical study based on the Delphi method (ISO 9000 and EFQM quality management standards of Europe). *Total Quality Management and Business Excellence*, 17(6):775-94.

Sanni, A.A. and Windapo, A.O. (2008). Evaluation of contractor‘s quality control practices on construction sites in Nigeria. In: Dainty, A. (Ed.). *Proceedings of the 24th Annual Association of Researchers in Construction Management (ARCOM) Conference*, 1-3 September 2008, Cardiff, UK, pp.257-265.

Sarantakos, S. (2005). *Social research* (3rd edn.). Basingstoke: Palgrave Macmillan.

Saraph, J.V., Benson, G.P. and Schroeder, R.G. (1989). An instrument for measuring the critical factors of quality management. *Decision Sciences*, 20:810-829.

Scheele, D.S. (2002). Reality construction as a product of Delphi interaction. *The Delphi method: Techniques and applications, 37.*

Schoemaker, P.J.H. (1993). Multiple scenario development: Its conceptual and behavioral foundation. *Strategic Management Journal*, 14(3):193-213.

Schreiber, B.J., Stage, K.F., King, J., Nora, A. and Barlow, A.E. (2006). Reporting structural equation modelling and confirmatory factor analysis results: A review. *The Journal of Educational Research*, 99(6):323-338.

Schumacker, R. and Lomax, R. (2004). *A beginner's guide to structural equation modelling*. New York: Lawrence Erlbaum.

Seaver, M. (Ed.). 2003. *Gower handbook of quality management*. Aldershot, Great Britain: Gower Publishing Company.

Sekaran, U. (2000). *Research method for business: A skill building approach*. New York: John Wiley and Sons.

Seo, D.C., Torabi, M.R., Blair, E.H. and Ellis, N.T. (2004). A cross validation of safety climate scale using confirmatory factor analytic approach. *Journal of Safety Research*, 35(4):427-445.

Sharma, P.C. (2006). *A textbook of production engineering*. New Delhi: Rajendra Ravindra (PVT).

Shenkar, O. and Von Glinow, M.A. (1994). Paradoxes of organizational theory and research: Using the case of China to illustrate national contingency. *Management Science*, 40(1):56-71.

Shook, C.L., Ketchen, D.J., Hult, T. and Kacmar, J.M. (2004). An evaluation of structural equation modeling in strategic management research. *Strategic Management Journal,* 25:397-404.

Sila, I. and Ebrahimpour, M. (2002). An investigation of the total quality management survey-based research published between 1989 and 2000. *International Journal of Quality and Reliability Management*, 19(7):902-970.

Silva, M.C. (1977). Philosophy, science, theory. Interrelationships and implications for nursing research. *Image*, 9(3), 59-63.

Simmonds, C. (1977). *The nature of futures problems in futures research: New directions*. London: Addison-Wesley Publishing Company.

Singh, P. J. and Alan Jr., S. (2004). Relationship between TQM and innovation: An empirical study. *Journal of Manufacturing Technology Management,* 15(5):394 - 401.

Skulmoski, G.J., Hartman, F.T. and Krahn, J. (2007). The Delphi method for graduate research. *Journal of Information Technology Education,* 6:1-21.

Slack, N., Chambers, S., Harland, C., Harrison, A. and Johnston, R. (1995), *Operations management*. London: Pitman Publishing.

Smallwood, J.J. (2000). *A study of the relationship between occupational health and safety, labour productivity and quality in the South African construction industry*. Unpublished PhD, University of Port Elizabeth in Port Elizabeth, Eastern Cape, South Africa.

Smith, M.A. (1997). Perceptions of quality in journalism and communications education: A Delphi study. *Journal of the Association for Communication Administration*, 1:32-50.

Smith, M.H. (2004). A sample/population size activity: Is it the sample size of the sample as a fraction of the population that matters? *Journal of Statistics Education*, 12(2):1-12.

Society of Actuaries (SOA). (1999). *Final report of the 1999 Delphi study*. Schaumburg, IL: South Africa at a glance (2011). *Provinces & Metropolitan Municipalities*. Available from http://www.southafricaataglance.com/south-africa-provinces.html. [Accessed 17 September 2016].

Sommerville, J. and Sulaiman, N.F. (1997). An analysis of cultural elements influencing the implementation of TQM in the UK construction industry. *Norwegian Building Research Institute*, pp.77-85.

South African Government Information. Available from http://www.info.gov.za/aboutsa/economy.htm [Accessed 26 November 2009].

South African Reserve Bank. (2009). Monetary policy review - May 2009. Pretoria: Reserve Bank.

Spinelli, T. (1983). The Delphi decision-making process. *Journal of Psychology*, 113:73-80.

Statistics South Africa (2009). *Labour Force Survey*. Available from http://www.statssa.gov.za/publications/P0210/P0210September2000,2001,2002,2003,2004,2005 2006,2007.pdf.[Accessed 02 January 2010].

Statistics South Africa (Stats SA). (2010). *Statistical Release P0441 Gross Domestic Product Fourth Quarter: 2009*. Pretoria, South Africa: Stats SA. Available from www.statssa.gov.za [Accessed 12 December 2015].

Steiger, J. (2007). Understanding the limitations of global fit assessment in structural equation modelling. *Personality and Individual Differences*, 42(5): 893-898.

Steingard, D.S. and Fitzgibbons, D.E. (1993), A postmodern deconstruction of TQM, *Journal of Organization Change Management*, 6(5)27- 42.

Stenbacka, C. (2001). Qualitative research requires quality concepts of its own. *Management Decision*, 39(7):551-555.

Steyn, H., Basson, G., Carruthers, M., du Plesis, Y., Prozesky-Kuschke, B., Kruger, D., van Eck, S. and Visser, K. (2004). *Project management: A multi-disciplinary approach.* Pretoria: FPM Publishing.

Stitt-Gohdes, W.L. and Crews, T.B. (2004). The Delphi technique: A research strategy for career and technical education. *Journal of Career and Technical Education*, 20(2):55-67.

Subhash, K., and Narag, A.S. (2007). Recommending a TQM model for Indian organisations. *The TQM Magazine*, 19(4):328-353.

Sweeny, L. (2009). *A study of current practice of corporate social responsibility (CSR) and an examination of the relationship between CSR and financial performance using structural equation modeling (SEM*). Unpublished Doctoral thesis, Dublin Institute of Technology, Ireland.

Tabachnick, B. G. and Fidell, L. S. (2007). *Using multivariate statistics*. (5th edn). New York: Allyn and Bacon.

Tabachnick, B.G. and Fidell, L.S. (2001). *Using multivariate statistics.* (4th edn.). Boston: Allyn & Bacon.

Tackaberry, P. (1998). Intellectual property risks in China: Their effect on foreign investment and technology transfer. *Journal of Asian Business*, 14(4):1-38.

Takim, R., Akintoye, A. and Kelly, J. (2004). Analysis of performance measurement in the Malaysian construction industry. In: Ogunlana, S. O., Chareonngam, C., Herabet, P. and Hadikusumo, B. H. W. (Eds.). *Globalization and Construction*, AIT Conference Centre, Bangkok, Thailand, pp.533–546.

Talha, M. (2004). Total quality management (TQM): An overview. *Journal of the Bottom Line: Managing Library Finances,* 17(1):15-19.

Tam, L. W. H. (2000). Quality Management Theory and Practice: Some Observations of Practices in Australian Academic Libraries. *Library Management*, 21(7): 349-356.

Tamblyn, A. & Shelton, D. (1996). *Market research manual for providers of vocational education and training.* Melbourne: Victoria Office of Training and Further Education.

Tang, S.L., Ahmed, S.M., Aoieoung, R.T. and Poon, S.W. (2005). *Contruction quality management.* Hong Kong: Hong Kong University Press.

Tashakkori, A. and Teddlie, C. (1998). *Mixed methodology: Combining qualitative and quantitative approaches: Applied social research methods, 46.* Thousand Oaks, CA: Sage Publications.

Tashakkori, A. and Teddlie, C. (2003). *Handbook of mixed methods in social & behavioral research*. Thousand Oaks: Sage Publications.

Teddlie, C. and Tashakkori, A. (2009). *Foundations of mixed methods research.* Thousand Oaks, CA: Sage Publications.

Terkper, S. E. (2013). Budget statement and economic policy. Accra, Ghana: Ministry of Finance.

Thach, E.C. and Murphy, K.L. (1995). Training via distance learning. *Training and Development,* 49(12):44.

Thangaratinam, S. and Redman, C.W.E. (2005). The Delphi technique. *The Obstetrician & Gynaecologist,* 7(2):120-125.

Tingey, M. (1997). *Comparing ISO 9000, Malcolm Baldrige, and the SEICMM for Software: A reference and selection guide.* Englewood Cliffs, NJ.: Prentice-Hall.

Tomlinson, M.R. (2010). Ensuring mortgage repayment in South Africa. *Housing Finance International*. Available from http://www.housingfinance.org.pdf [Accessed 12 December 2015].

Tong, D.Y. (2007). *An empirical study of e-recruitment technology adoption in Malaysia: Assessment of modified technology acceptance model.* Multimedia University, Malaysia.

Touliatos, J. and Compton, N.H. (1988). *Research methods in human ecology/home economics*. Ames, IA: Iowa State University Press.

Trochim, W. and Donnelly, J. (2007). *The research methods knowledge base* (3rd edn.). Cincinnati, OH: Atomic Dog Publishing.

Turoff, M. (1970). The design of a policy Delphi. *Technological Forecasting and Social Change*, 2(2):140-71.

Tutesigensi, A. and Pleim, V. (2008) Why small and medium construction enterprises do not employ six sigma. In*:* Dainty, A. (Ed). *Proceedings of the 24th Annual Association of Researchers in Construction Management (ARCOM) Conference,* 1-3 September 2008, Cardiff, UK, pp. 267-276.

United States Department of Defense (1988), *The role of concurrent engineering in weapons system acquisition*, IDA Report R-338. Alexandra: United States: Institute of Defense Analysis.

Uysal, M. and Crompton, J. (1985). An overview of approaches used to forecast tourism demand. *Journal of Travel Research*, 23(4):7-15.

Van Wyk, L. (2003). *A review of the South African construction industry Part 1: Economic, regulatory and public sector capacity influences on the construction industry*. Pretoria, South Africa: CSIR Boutek. Available from http://www.csir.co.za/akani [Accessed 15 November 2015].

Van Wyk, L. (2004). *A review of the South African construction industry Part 2: Sustainable construction activities*. Pretoria, South Africa: CSIR Boutek. Available from http://www.csir.co.za/akani [Accessed on 18 December 2015].

Verster, J. J. P. (1998). Strategies for successfully meeting the demands of quality and service excellence. *Acta Structillia. Journal for the Physical & Development Sciences*, University of the Free State, Bloemfontein, RSA.

Vibe Ghana (2014). Towards establishing the "Construction Industry Development Authority" in Ghana. Available from http://vibeghana.com/2014/0 [Accessed 10 November 2015].

Von Bertalanffy, L. (1968). *General system theory*. New York, NY: George Braziller.

Vrijhoef, R. and Koskela, L. (2000). The four roles of supply chain in construction*. European Journal of Purchasing & Supply Management,* 6:169-178.

Vuppalapati, K., Ahire, S.L. and Gupta, T. (1995). JIT and TQM: A case for joint implementation. *International Journal of Operations & Production Management*, 15(5);84-94.

Wadsworth, H.M., Stephens, K.S. and Godfrey, A.B. (1986). *Modern methods for quality control and improvement.* John Wiley & Sons.

Waldman, D.A. (1994). The contribution of TQM to a theory of work performance. *Academy of Management Review*, 19(3):510-536.

Wessel, G. and Burcher, P. (2004). Six sigma for small and medium-sized enterprises. *The TQM Magazine,* 16(4):264 - 272.

Whalen, M.J. and Rahim, M.A. 1994. Common barriers to implementation and development of TQM Program. *Industrial Management,* 36(2):19.

Wheatley, M. J. (2006). *Leadership and the new science: Discovering order in a chaotic world.* San Francisco, CA: Berrett-Koehler Publishers.

Whitman, N.I. (1990). The committee meeting alternative: Using the Delphi technique. *The Journal of Nursing Administration,* 51(1):57-68.

Wiegmann, D. A., Zhang, H., von Thaden, T.L., Sharma, G.and Mitchell, A.A. (2002). *A synthesis of safety culture and safety climate research*. University of Illinois Aviation Research Lab Technical Report ARL-02-03/FAA-02-2.

Wilber, K. (2000). *Sex, ecology, spirituality*. Boston, MA: Shambhala Publications.

Womack, J.P., Jones, D.T. and Roos, D. (1990). *The machine that changed the world*. New York: Massachusetts Institute of Technology, Rawson Associates.

Wong, T.C. (1999). *Marketing research*. Oxford, UK: Butterworth-Heinemann.

World Bank (1984). *Housing and financial institutions in developing countries.* Washington DC: World Bank.

World Bank (2004). *The World Bank Report 2004* (Vol. 1). Retrieved from http://www.world bank.org/html/extpb/2004/pdf/volume_1.pdf. [Accessed 09 November 2015].

Woudenberg, F. (1991). An evaluation of Delphi. *Technological Forecasting and Social Change,* 40:131-150.

Yin, R.K. (1994). *Case study research: Design methods*. San Francisco: Sage Publications.

Yousuf, M.I. (2007). The Delphi technique. *Essays in Education,* 20:80-9.

Yu, C.S., Cochran, D.S. and Spencer, B. (1998), Quality management practices in China. *Quality Management Journal*, 5(2): 91-106

Yuan, K. (2005). Fit indices versus test statistics. *Multivariate Research*, 40(1):115-148.

Yuen, Y.Y. (2007). *An ergonomic study of mobile phone usage in Malaysia.* Multimedia University, Malaysia.

Zairi, M. (1991). *Total quality management for engineers*. Woodhead Publishing.

Zairi, M. (2006). Total quality management: Deming Juran Gift to the World (2nd edn.). Clitheroe: Spire City Publishing.

Zhang, Z. (2000a). Developing a model of quality management methods and evaluation their effects on business performance. *TQM*, 11(1):129-137.

Zhang, Z. (2000b). *Implementation of total quality management: An empirical study of Chinese manufacturing firms*. PhD Thesis, Faculty of Management and Organization, University of Groningen, The Netherlands.

Zikmund, W.G. (2000). *Exploring marketing research.* (7th edn.). Fort Worth: Dryden Press.

APPENDICES

APPENDIX A

January 20, 2017

Dear Sir

<u>INVITATION TO PARTICPATE IN A DELPHI SURVEY</u>

I am Samuel Kwame Ansah, a registered Ph.D. candidate in the Faculty of Engineering and the Built Environment at the University of Johannesburg. My Ph.D. study is under the supervision of Prof. Wellington Didibhuku Thwala (Master's Programme Co-ordinator, Faculty of Engineering and the Built Environment, University of Johannesburg, South Africa, and Vice-President of the South African Council for Project and Construction Management Professions - SACPCMP).

The area of my research is developing an Integrated Total Quality Management Model for the Ghanaian construction industry. I will be using a Delphi approach and need to compile a panel of experts in the field to participate in this process.

I understand that your time is important. Each round of the Delphi process will take approximately 10 - 15 minutes to complete. A more complete description of the Delphi process is attached for your information.

It would be appreciated if you would consent to participating in the study in this capacity.

Kind regards

Samuel Kwame Ansah, Ph.D. Candidate
University of Johannesburg

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APPENDIX B

Delphi Invitation Follow-Up Letter

10th February, 2017

Dear Sir

I would like to thank you for accepting the invitation to participate as an expert in our project to develop an integrated Total Quality Management model for the Ghanaian construction industry.

The process of collecting input from the expert panel will probably involve no less than three rounds.

We understand that your time is important. Each round of the Delphi process will take approximately 20 minutes to complete. A more complete description of the Delphi process is attached for your information.

To start with, I would like to request your curriculum vitae for our records and to confirm your area of expertise. We would appreciate your response by the **24th of February 2017.**

Kind regards

Samuel Kwame Ansah, Ph.D. Candidate
University of Johannesburg

Faculty of Engineering and the Built Environment

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APPENDIX C

Delphi Method and Application to this study

BACKGROUND INFORMATION

The Delphi Method

The Delphi method is a process to collect data and information to solve non-analytical problems. Used as a research tool, the process gathers knowledge from individuals (experts), analyses and combines the information to obtain a group consensus.

The Process

The information is gathered in a series of questionnaires or surveys called rounds. The first round is exploratory in nature and presents the participant with a standard questionnaire. The second round will present the participant with the group response aling with his or her response from the first round. Each expert (participants) member has the opportunity to alter his or her answer or to voice his or her opinion about new issues collected in the previous survey. The third round, if necessary, will finalise the statistical response of the group to form a consensus.

The Advantages of Delphi

Delphi has three features over other data collection methods: (1) anonymity, (2) controlled feedback of results, and (3) statistical group response or consensus.

Anonymity – The members of the process are unknown to other members. This feature will help minimise the "bandwagon effect." In public group meetings, one participant, possibly less knowledgeable, may be more vocal during discussion, potentially persuading more knowledgeable panellists. Also by keeping the participants unknown, one participant may change his or her answer to one question without publicly admitting that he or she has done so.

Controlled Feedback – The benefit to the participant of Delphi is gained by feedback of results collected in earlier rounds. The participant will be sent the group response of colleagues and other experts in the industry.

Statistical Group Response – The goal of Delphi is to move towards a group consensus. However, the end result will undoubtedly display a range of opinions. The statistical group response is created to assure that the opinions of all participants in the surveys are represented.

The Application of Delphi

The study aims to determine the factors that influence TQM (TQM) implementation in the construction industry and develop a holistic integrated TQM model for the Ghanaian construction industry. The title of the study is "An Integrated TQM Model for the Ghanaian construction industry". Your participation in the Delphi process for a doctoral study is very important.

Time Commitment

The time commitment is minimal. Each round or questionnaire should take approximately 10 - 15 minutes to complete and submit.

APPENDIX D

DELPHI INSTRUCTIONS FOR ROUND ONE QUESTIONNAIRE

DELPHI SURVEY – ROUND 1

Thank you for accepting to serve on the Delphi panel for this research. Your acceptance is highly appreciated. This first round survey is intended to be completed in approximately 15-20 minutes. Subsequent surveys will require significantly less time to complete. You will be given the opportunity to change your response later on after all Delphi participants have completed the first round survey and results have been analysed. The results will be communicated to you. The results will be in simple statistics e.g. median, average, range and percentage.
When you have finished answering all of the questions, please email your response to skansah@hotmail.co.uk by **Friday, March 24, 2017.**

INSTRUCTIONS

1. Please answer all of the questions to the best of your ability.
2. Please indicate your response by placing an **'X'** in the appropriate boxes. The survey requests that you rate the prospect of the elements influencing TQM in the construction industry in Ghana. You are also requested to rate the impact of other factors in predicting TQM in the Ghanaian construction industry.
3. The influence (probability) scale is presented, and only a number should be used for a probability range. For instance, if you consider the influence (probability) range to be between 71 & 80% of the feature's influence then you should mark **'X'** under the box '**8**'.

If the impact is considered to be high, then **'X'** should be marked under the '**7**' or **'8'** box depending on whether your opinion is inclined more towards high or very high impact.(See the attached questions).
Please use your experience, expertise and judgement to rate what you perceive the average negative or positive influence of the various features are for TQM and Quality Management in Ghanaian construction industry at large.

PROBABILITY SCALE (likelihood in percentage)

1-10%	11-20%	21-30%	31-40	41-50	51-60	61-70	71-80	81-90	91-100
							X		

IMPACT SCALE

No impact		Low impact		Medium impact		High impact		Very high impact	
1	2	3	4	5	6	7	8	9	10

Q. 1.1 TQM MAIN ATTRIBUTES: To identify the main attributes that contribute to TQM (TQM) in the Ghanaian construction industry.

TQM (TQM) attributes	What is the **influence** of the listed attributes on TQM (TQM) in the Ghanaian construction industry? (1=low probability, 10=high probability)											
		1	2	3	4	5	6	7	8	9	10	Rank
Leadership and Top Management (TML)												
Company Supplier Quality Management (CSQM)												
Client Focus and Involvement (CFI)												
Company Quality System Evaluation (CQSE)												
Company Vision and Plan Statement (CVPS)												
Product Selection and Design Management (PSDM)												
Construction Process Management and Improvement (CPMI)												
Construction Employees’												

Involvement and Motivation (CEIM)											

Any other main attributes: Please specify: ………………………………………………………
…………………………………………………………………………………………………

Q. 1.2. TQM SUB-ATTRIBUTES: To identify the sub-attributes that contributes to Total Quality Management (TQM) in the Ghanaian construction industry.

Q. 1.2.1 LEADERSHIP AND TOP MANAGEMENT FEATURES:

Leadership and Top Management	What is the **impact** of the listed leadership and top management features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Leadership style											
Leadership ability in solving quality problem											
Leadership skills											
Leadership initiatives											
Leadership and top management knowledge in TQM											
Top management commitment in TQM											
Top management interaction with workers											
Top management participation											
Top management learning											

Top management empowerment											
Top management encouragement											
Top management's role model											

Any other leadership and top management features? Please specify: …………………………..
……………………………………………………………………………………………………….

Q. 1.2.2 COMPANY SUPPLIER QUALITY MANAGEMENT FEATURES:

Company Supplier Quality Management	What is the **impact** of the listed company supplier quality management features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Partnership with Suppliers											
Supplier Selection Criteria											
Participation in Suppliers											
Supplier Performance Evaluation											
Supplier Quality Audit											
Supplier Communication											
Supplier Knowledge in/of? TQM											
Location of Supplier											
Suppliers' Past Records											

Suppliers' Commitment											
Cooperation from Suppliers											
Suppliers' Orientation											

Any other company supplier quality management features? Please specify: ……………………
…………………………………………………………………………………………………..

Q. 1.2.3 CLIENT FOCUS AND INVOLVEMENT FEATURES:

Client Focus and Involvement	What is the **impact** of the listed client focus and involvement features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Client brief/ input											
Client complaint information/feedback											
Market investigation											
Client satisfaction survey											
Quality warranty											
Client information system											
Client services											
Client cooperation											
Client orientation											

Any other client focus and involvement features? Please specify: ………………………………
…………………………………………………………………………………………………..

Q. 1.2.4 COMPANY QUALITY SYSTEM EVALUATION FEATURES:

Company Quality System Evaluation	What is the **impact** of the listed company quality system evaluation features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Evaluation of strategy											
Evaluation of overall company performance											
Evaluation of departments' performance											

Evaluation of employee performance											
Evaluation of quality costs											
Evaluation of quality manual											
Evaluation of quality control system											
Evaluation of quality system procedures											
Evaluation of end results											
Quality audit											
Quality benchmarking											
Quality information system											

Any other company quality system evaluation features? Please specify: ……………………….

Q. 1.2.5 COMPANY VISION AND PLAN STATEMENT FEATURES:

Company Vision and Plan Statement	What is the **impact** of the listed company vision and plan statement features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Vision statement											
Quality policy											

Overall business performance plan											
Product quality goal											
Quality improvement plan											
Formulation of vision and plan											
Concreteness of future plan											
Employees' contribution to the vision											
Involvement of employees in the development of vision statement											

Any other company vision and plan statement features? Please specify: ……………………
……………………………………………………………………………………………..

Q. 1.2.6 PRODUCT SELECTION AND DESIGN MANAGEMENT FEATURES:

Product Selection and Design Management	What is the **impact** of the listed product selection and design management features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Client brief/input											
Cost implication											
Environmental issues											
Socio-cultural issues											
Appearance/finishes required											
Strength required											
Intended purpose of the material											
Where the material to be used											
Design methods/techniques											
Design detailing											
Concurrent Engineering											
Design											

experiments/testing										
Quality function deployment										
Value engineering										
Computer-aided design										

Any other product selection and design management features please specify: ………………..
…………………………………………………………………………………………………..

Q. 1.2.7 CONSTRUCTION PROCESS MANAGEMENT AND IMPROVEMENT FEATURES:

Construction Process Management and Improvement	What is the **impact** of the listed construction process management and improvement features on TQM? (1=low probability, 10=high probability)									
	No impact		Low impact		Medium impact		High impact		Very high impact	
	1	2	3	4	5	6	7	8	9	10	Rank
Project monitoring and control improvement										
Equipment maintenance and innovation										
Inventory management										
Use of quality materials										
Use of quality tools										
Use of quality manual										
Understanding of work instructions/quality manual										

Quality system procedures improvement											
Obtaining ISO 9000 certification for operation											
Understanding of quality control system											
Continuity of quality control circle activities											
Appropriate use of system structure and standards											
Targets and priority measures											
Safe working environment											
Utilization of analysis results											

Any other construction process management and improvement features? Please specify: ……..
…………………………………………………………………………………………………..

Q. 1.2.8 CONSTRUCTION EMPLOYEES' INVOLVEMENT AND MOTIVATION FEATURES:

Construction Employees Involvement and Motivation	What is the **impact** of the listed construction employees' involvement and motivation features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Education and											

Training											
Salary Promotion											
Position Promotion											
Employee Rewards											
Bonus Scheme											
Conducive Working Environment											
Involvement of Employees withinFunctional Team											
Employee Participation											
Employee Suggestion											
Improving Employee Commitment											
Job rotation											
Involvement in Quality Control Circle											
Employee Involvement in Cross-functional Team											
Employee Recognition											

Any other construction employees involvement and motivation features? Please specify: …….
………………………………………………………………………………………………..

Q. 2. FACTORS THAT ENABLES CONSRUCTION COMPANY TO IMPLEMENT TQM

	What is the **influence** of the listed enable factors on construction company to implement TQM? (1=low probability, 10=high probability)											
		1	2	3	4	5	6	7	8	9	10	Rank
Top management support												
Good quality driven agenda												
Commitment to people												
Training and re-training of staff												
Institution of continuous improvement process within the company												
Systematic TQM												

framework											
Efficient management system											
Proper understanding of TQM among construction professionals											
Availability of resources											
Good communication in organisation											
Good quality policy											
Changes in company structure											
Good organizational and quality culture											
Teamwork											
Availability of quality information											
Employee involvement											
Good climatic condition											
Good socio-economic environment											
Proper project conceptualization											
Project manager competence											
Clarity of goals and objectives											
Adequate TQM experts											

Any other enable factors? Please specify: ....

Q.3 FACTORS THAT AFFECT CONSTRUCTION COMPANY FOR NOT IMPLEMENTING TQM

	What is the **impact** of the listed factors on construction company for not implementing TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Lack of efficient TQM management system											
Lack or limited company resources											

Unavailable TQM policy											
Lack or limited knowledge of TQM											
Inability to employ TQM personnel											
Absent of systematic TQM framework											
Lack and Inability to train and educate employees on TQM											
Lack of understanding among construction professionals in applying TQM											
Lack of coordination of the implementation of TQM policy within the organisation											
Limited access to body responsible for the implementation of TQM policy											
Lack of TQM expert											
Reluctance to change old management technique											
Complex nature of TQM technique											
Lack of commitment from management											
Perception that TQM may not yield any better results											
TQM technique is time consuming											
TQM technique is costly											
Lack of finance in the management of TQM experts											
Lack of enforcement from the legislative bodies overseeing the											

implementation of TQM											
Lack of interest in the application of TQM											

Any other factors? Please specify: ……………………………………………………………..

Q. 4 ORGANIZATIONAL FACTORS AND ISSUES THAT AFFECT CONSTRUCTION COMPANIES IN THE IMPLEMENTATION OF TQM

	What is the **impact** of the listed success factors and issues that affect the **construction companies in the implementation of TQM**? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Leadership and top management commitment											
Top management support											
Project manager competence											
Quality policy											
Supplier management											
Limited cash flow to manage TQM											
Change in management behavior/attitude											
Change in status quo											
Personnel to manage and monitor TQM application											
Education and training											
Employee relations											
Employee involvement											
Lack of interest in the application of TQM											
Client involvement											
Teamwork											
Feedback by project											

participants											
Design quality management											
Strategic quality management											
Quality data and reporting											
Analysis of quality information											

Any other factors? Please specify: ………………………………………………………………
……………………………………………………………………………………………….

Q 5 EFFECTS OF IMPLEMENTING TQM IN THE CONSTRUCTION INDUSTRY

	What is the **effect** of the listed factors on construction industry for the implementation of TQM? (1=low probability, 10=high probability)											
		1	2	3	4	5	6	7	8	9	10	Rank
Reduction in construction costs												
Higher client satisfaction												
Improve employee job satisfaction												
Improve schedule performance												
Elimination/Reduction of reworks												
Defect-free product at first attempt												
Improve safety												
Higher productivity												
Lower employee turnover												
Speed up construction work												
Improve relationships with subcontractors												
Improve methods of working												
Better control over the construction process												
Increase profitability												

Gaining competitive advantage over other companies												
Decreasing waste												
Better coordination of activities												

Any other effects? Please specify: ……………………………………………………………..

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

Q. 6. PERSONAL INFORMATION OF EXPERT PANEL MEMBERS

Title (Mr, Mrs, Ms, Rev, Dr, Prof)	
Email:	
Highest qualification	
Field of specialisation	
Professional registration (ICIOB, MCIOB, FCIOB, MGIOC, FGIOC, MGhIS, FGhIS, etc.)	
Years of experience (TQM)	
Current employer	
Position	
Region	

Thank you for taking your time to fill out this first round survey. The second round of the Delphi process will be a follow-up email.
Please do not hesitate to contact me, my promoter, Prof. Wellington Didibhuku Thwala, or my co-promoter, Prof. C.O. Aigbavboa,if you have any questions about this survey or the research project in general. Kindly see contact details below.

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APPENDIX E

DELPHI INSTRUCTIONS FOR ROUND TWO QUESTIONNAIRE

DELPHI SURVEY – ROUND 2

Thank you for completing Round 1 of the Delphi survey. We recognise that the survey required a significant time investment to complete thoughtfully. We appreciate your time and effort. The purpose of Round 2 is to provide you with the opportunity to change your response, if desired, given the group median response for each question.

When you have finished answering all of the questions, please kindly email your response to skansah@hotmail.co.uk by **Friday, April 21, 2017.**

INSTRUCTIONS

For each element you will see two (2) values: your response from the Round 1 survey (indicated with a yellow highlighted box), and the group median from the Round 1 survey indicated in the column to the far right hand of each table. Please take one of the following three actions for each category:

1. Accept the group median response by leaving the field completely unchanged.
2. Maintain your original response by placing an 'X' in the highlighted field*.
3. Indicate a new response by placing an 'X' in the appropriate field*.

* *If your response is more than ten per cent (one unit) above or below the group median, please provide a reason for your outlying response in the field provided.

Q. 1.1 TQM MAIN ATTRIBUTES: To identify the main attributes that contributes to TQM (TQM) in the Ghanaian construction industry.

TQM (TQM) attributes	What is the **influence** of the listed attributes on TQM (TQM) in the Ghanaian construction industry? (1=low probability, 10=high probability)											
		1	2	3	4	5	6	7	8	9	10	Rank
Leadership and Top Management (TML)										X		10

Company Supplier Quality Management (CSQM)										X		9
Client Focus and Involvement (CFI)										X		8
Company Quality System Evaluation (CQSE)										X		9
Company Vision and Plan Statement (CVPS)											X	9
Product Selection and Design Management (PSDM)										X		8
Construction Process Management and Improvement (CPMI)										X		9
Construction Employees Involvement and Motivation (CEIM)										X		10

Any Comment:

Q. 1.2. TQM SUB-ATTRIBUTES: To identify the sub-attributes that contributes to TQM (TQM) in the Ghanaian construction industry.

Q. 1.2.1 LEADERSHIP AND TOP MANAGEMENT FEATURES:

Leadership and Top Management	What is the **impact** of the listed leadership and top management features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Leadership style									X		9
Leadership ability in solving quality problem									X		9
Leadership skills									X		9
Leadership initiatives									X		9
Leadership and top management knowledge in TQM									X		10
Top management commitment in TQM									X		9
Top management interaction with workers									X		9
Top management participation									X		9
Top management learning									X		8
Top management empowerment									X		8
Top management encouragement									X		9
Top management's role model									X		8

Any Comment:

Q. 1.2.2 COMPANY SUPPLIER QUALITY MANAGEMENT FEATURES:

Company Supplier Quality Management	What is the <u>**impact**</u> of the listed company supplier quality management features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Partnership with Suppliers									X		8
Supplier Selection Criteria								X			8
Participation in Suppliers								X			8
Supplier Performance Evaluation								X			9
Supplier Quality Audit								X			9
Supplier Communication									X		9
Supplier Knowledge in TQM									X		9
Location of Supplier									X		6
Suppliers' Past Records									X		9
Suppliers' Commitment									X		8
Cooperation from Suppliers									X		9
Suppliers' Orientation								X			7

Any Comment:

Q. 1.2.3 CLIENT FOCUS AND INVOLVEMENT FEATURES:

Client Focus and Involvement	What is the **<u>impact</u>** of the listed client focus and involvement features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Client brief/ input								X			9
Client complaint information/feedback							X				9
Market investigation							X				8
Client satisfaction survey							X				9
Quality warranty							X				8
Client information system							X				7
Client services							X				7
Client cooperation							X				8
Client orientation								X			7

Any Comment:

Q. 1.2.4 COMPANY QUALITY SYSTEM EVALUATION FEATURES:

Company Quality System Evaluation	What is the **<u>impact</u>** of the listed company quality system evaluation features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Evaluation of strategy										X	8
Evaluation of overall company performance									X		9
Evaluation of departments' performance									X		9
Evaluation of employee performance								X			8
Evaluation of quality costs								X			8
Evaluation of quality								X			8

	1	2	3	4	5	6	7	8	9	10	Rank
manual											
Evaluation of quality control system								X			9
Evaluation of quality system procedures									X		9
Evaluation of end results									X		9
Quality audit								X			9
Quality benchmarking								X			9
Quality information system								X			9

Any Comment:

Q. 1.2.5 COMPANY VISION AND PLAN STATEMENT FEATURES:

Company Vision and Plan Statement	What is the **impact** of the listed company vision and plan statement features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Vision statement							X				8
Quality policy								X			9
Overall business performance plan								x			8
Product quality goal									X		8
Quality improvement plan									X		9
Formulation of vision and plan									X		8
Concreteness of future plan									X		8

Employees' contribution to the vision									X		8
Involvement of employees in the development of vision statement									X		8

Any Comment:x

Q. 1.2.6 PRODUCT SELECTION AND DESIGN MANAGEMENT FEATURES:

Product Selection and Design Management	What is the **impact** of the listed product selection and design management features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Client brief/input									X		9
Cost implication									x		8
Environmental issues								X			7
Socio cultural issues								X			8
Appearance/finishes required								X			9
Strength required								X			9
Intended purpose of the material									x		9
Where the material to be used								X			7
Design methods/techniques								X			8
Design detailing								X			9
Concurrent Engineering								X			8
Design experiments/testing								X			8
Quality function deployment								X			9
Value engineering								X			9
Computer-aided design								X			7

Any Comment:

Q. 1.2.7 CONSTRUCTION PROCESS MANAGEMENT AND IMPROVEMENT FEATURES:

Construction Process Management and Improvement	What is the **impact** of the listed construction process management and improvement features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Project monitoring and control improvement								X			9
Equipment maintenance and innovation								X			8
Inventory Management								X			7
Use of quality materials								X			9
Use of quality tools								X			8
Use of quality manual								X			8
Understanding of work instructions/quality manual								x			9
Quality system Procedures improvement								X			8
Obtaining ISO 9000 certification for operation								X			8
Understanding of quality control system								X			8

Continuity of quality control circle activities								X			9
Appropriate use of system structure and standards								X			8
Targets and priority measures								X			8
Safe working environment								X			9
Utilization of analysis results								X			8

Any Comment:

Q. 1.2.8 CONSTRUCTION EMPLOYEES INVOLVEMENT AND MOTIVATION FEATURES:

Construction Employees Involvement and Motivation	What is the **impact** of the listed construction employees' involvement and motivation features on TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Education and Training								X			
Salary Promotion								X			
Position Promotion								X			
Employee Rewards								X			
Bonus Scheme								X			
Conducive Working Environment								X			
Involvement of Employees withinFunctional								X			

Team											
Employee Participation								X			
Employee Suggestion								X			
Improving Employee Commitment								X			
Job Rotation								X			
Involvement in Quality Control Circle								X			
Employee Involvement in Cross-functional Team								X			
Employee Recognition								X			

Any Comment:

Q. 2. FACTORS THAT ENABLES CONSRUCTION COMPANY TO IMPLEMENT TQM

	What is the **influence** of the listed enable factors on construction company to implement TQM? (1=low probability, 10=high probability)											
		1	2	3	4	5	6	7	8	9	10	Rank
Top management support									X			
Good quality driven agenda									X			
Commitment to people									X			
Training and re-training of staff									X			
Institution of continuous improvement process within the company										X		
Systematic TQM framework										X		
Efficient management system										X		
Proper understanding of TQM among construction professionals										X		
Availability of resources										X		
Good communication in organisation										x		
Good quality policy											x	
Changes in company										X		

structure												
Good organizational and quality culture										x		
Teamwork											X	
Availability of quality information											X	
Employee involvement											X	
Good climatic condition											X	
Good socio-economic environment											X	
Proper project conceptualization											X	
Project manager competence										X		
Clarity of goals and objectives										X		
Adequate TQM experts										X		

Any Comment:

Q.3 FACTORS THAT AFFECT CONSTRUCTION COMPANY FOR NOT IMPLEMENTING TQM

	What is the **impact** of the listed factors on construction company for not implementing TQM? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Lack of efficient TQM management system									X		
Lack or limited company resources									X		
Unavailable TQM policy									X		
Lack or limited knowledge of TQM									X		
Inability to employ TQM personnel									X		
Absent of systematic TQM framework									X		
Lack and inability to train and educate									x		

employees on TQM											
Lack of understanding among construction professionals in applying TQM									X		
Lack of coordination of the implementation of TQM policy within the organisation									X		
Limited access to body responsible for the implementation of TQM policy									X		
Lack of TQM expert									X		
Reluctance to change old management technique									X		
Complex nature of TQM technique									X		
Lack of commitment from management									X		
Perception that TQM may not yield any better results									X		
TQM technique is time consuming									X		
TQM technique is costly									X		
Lack of finance in the management of TQM experts									X		
Lack of enforcement from the legislative bodies overseeing the implementation of TQM									X		
Lack of interest in the application of TQM									X		

Any Comment:

Q. 4 ORGANIZATIONAL FACTORS AND ISSUES THAT AFFECT CONSTRUCTION COMPANIES IN THE IMPLEMENTATION OF TQM

	What is the **impact** of the listed success factors and issues that affect the **construction companies in the implementation of TQM**? (1=low probability, 10=high probability)										
	No impact		Low impact		Medium impact		High impact		Very high impact		
	1	2	3	4	5	6	7	8	9	10	Rank
Leadership and top management commitment									X		
Top management support									X		
Project manager competence									X		
Quality policy									X		
Supplier management									X		
Limited cash flow to manage TQM									X		
Change in management behavior/attitude									X		
Change in status quo									X		
Personnel to manage and monitor TQM application									X		
Education and training									X		
Employee relations									X		
Employee involvement									X		
Lack of interest in the application of TQM									X		
Client involvement									X		
Teamwork									X		
Feedback by project participants									X		
Design quality management									X		
Strategic quality management									X		
Quality data and reporting									X		

Analysis of quality information									X		

Any Comment:

Q 5 EFFECTS OF IMPLEMENTING TQM IN THE CONSTRUCTION INDUSTRY

	What is the **effect** of the listed factors on construction industry for the implementation of TQM? (1=low probability, 10=high probability)										
		1	2	3	4	5	6	7	8	9	10	Rank
Reduction in construction costs										X		
Higher client satisfaction										X		
Improve employee job satisfaction										X		
Improve schedule performance										X		
Elimination/Reduction of reworks										X		
Defect-free product at first attempt										X		
Improve safety										X		
Higher productivity										X		
Lower employee turnover										X		
Speed up construction work										X		
Improve relationships with subcontractors										X		
Improve methods of working										X		
Better control over the construction process										X		
Increase profitability										X		
Gaining competitive advantage over other companies										X		
Decreasing waste										X		
Better coordination of activities										X		

Any Comment:

Q. 6. PERSONAL INFORMATION OF EXPERT PANEL MEMBERS

Title (Mr, Mrs, Ms, Rev, Dr, Prof)	
Email:	
Highest qualification	Master's
Field of specialisation	Construction Management
Professional registration (ICIOB, MCIOB, FCIOB, MGIOC, FGIOC, MGhIS, FGhIS, etc.)	MGIOC,MIET
Years of experience (TQM)	7
Current employer	MAKDOSS GH
Position	PROJECTS MANAGER
Region	WESTERN

Please do not hesitate to contact me or my promoter and co-promoter Prof. C.O. Aigbavboa and Prof. Wellington Didibhuku Thwala if you have any questions about this survey or the research project in general. Kindly see contact details below.

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APPENDIX F

Research Introduction Letter and Questionnaire

UNIVERSITY OF JOHANNESBURG

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

Dear Respondent

The Postgraduate School of Engineering at the University of Johannesburg is undertaking a research project to develop an integrated TQM (TQM) model for the Ghanaian construction indudstry. To this end, we kindly request that you complete the following short questionnaire. It should take no longer than 20 minutes of your time. Your response is of the utmost importance to us.

To protect your anonymity, please do not enter your name or contact details on the questionnaire. Summary results of this research will be available in the Department of Construction Management and Quantity Surveying in November 2018.

Should you have any queries or comments regarding this survey, you are welcome to contact us telephonically at +233246769673, +27837420742, or email us at skansah@hotmail.co.uk

Yours sincerely

Ansah, S.K

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QUESTIONNAIRE TO EVALUATE TQM IMPLEMENTATION IN THE GHANAIAN CONSTRUCTION INDUSTRY

Please answer the following questions by crossing (x) in the relevant box or writing in the space provided.

SECTION A: PROFILE OF THE RESPONDENT AND THE FIRM

1. What is your gender?		1		2
	Male	☐	Female	☐

2. Which age category do you fall into?

15 - 20 years	21 - 25 years	26 -30 years	31 - 35 years	36 - 40 years	41- 45 years	46 years and above
☐	☐	☐	☐	☐	☐	☐
1	2	3	4	5	6	7

3. What is your highest qualification?

Qualification	**Tick One**	
National Diploma/National Certificate	☐	1
Bachelor's Degree (First Degree)	☐	2
Postgraduate – Master's Degree (MSc., MPhil.,etc)	☐	3
Postgraduate - Doctoral Degree (PhD)	☐	4

4. For how many years have you worked in the construction industry?

1-5 years	6 – 10	11 –15	16 - 20	21 – 25	26 - 30	31years and above
☐	☐	☐	☐	☐	☐	☐
1	2	3	4	5	6	7

5. What is your position in the firm?

Project Manager	Site Engineer	Quality Control Officer	Supervisor	Foreman	Other (Please specify) ……………………………… ………
☐	☐	☐	☐	☐	☐
1	2	3	4	5	6

6. How long have you held your current position?

1–5 years	6 – 10 year	11 –15 years	16 – 20 years	21 – 25 years	26 – 30 years	31 or more years
☐	☐	☐	☐	☐	☐	☐
1	2	3	4	5	6	7

7. How long has your firm been in existence?

1– 5 years	6 – 10 year	11 –15 years	16 – 20 years	21 – 25 years	26 – 30 years	31 or more years
☐	☐	☐	☐	☐	☐	☐
1	2	3	4	5	6	7

8. What type of construction project is your firm currently working on?

Building Construction	Civil Engineering	Other (Please specify) ....
☐	☐	☐
1	2	3

9. Please, indicate your firm's classification.

D1/K1	D2/K2	D3/K3	D4/K4
☐	☐	☐	☐
1	2	3	4

SECTION B: LEVEL OF TQM IMPLEMENTATION IN THE GHANAIAN CONSTRUCTION INDUSTRY

10. To what extent has your company implemented TQM? Please mark your choice of response with an **[X]**

A. To no extent [ ]

B. To a small extent [ ]

C. To a moderate extent [ ]

D. To a large extent [ ]

E. Completely [ ]

SECTION C: ATTRIBUTES THAT COULD LEAD TO THE IMPLEMENTATION OF TQM IN THE GHANAIAN CONSTRUCTION INDUSTRY.

Below is a list of attributes that could lead to the implementation of TQM in the Ghanaian Construction Industry. Based on your experience and using the scale provided, please indicate the degree of influence each attribute has on TQM being implemented in the Ghanaian Construction Industry.

1 = Not at all influential; 2 = Slightly influential; 3 = Moderately influential; 4 = Very influential; 5 = Extremely influential

11. LEADERSHIP AND TOP MANAGEMENT FEATURES (LTM)

Code	To what extent do the following attributes influence the implementation of TQM	1 Not at all influential	2 Slightly influential	3 Moderately influential	4 Very influential	5 Extremely influential

LTM 1	Leadership style of managing employees					
LTM 2	Leadership ability in solving quality-related problems					
LTM 3	Leadership initiatives towards TQM					
LTM 4	Top management knowledge and proper understanding of TQM					
LTM 5	Top management commitment to TQM					
LTM 6	Top management interaction with workers					
LTM 7	Top management participation in TQM activities					
LTM 8	Top management empowerment of employees to solve quality problems					
LTM 9	Top management support of TQM					

12. COMPANY SUPPLIER QUALITY MANAGEMENT FEATURES (CSQM)

Code	To what extent do the following attributes influence the implementation of TQM	1 Not at all influential	2 Slightly influential	3 Moderately influential	4 Very influential	5 Extremely influential
CSQM1	Partnership with suppliers					
CSQM 2	Supplier selection criteria					
CSQM 3	Participation of suppliers in TQM activities					
CSQM 4	Supplier performance evaluation					
CSQM 5	Supplier quality audit					
CSQM 6	Supplier communication					
CSQM 7	Supplier knowledge of TQM					
CSQM 8	Suppliers' commitment to TQM					
CSQM 9	Suppliers' orientation on TQM					

13. CLIENT FOCUS AND INVOLVEMENT FEATURES (CFI)

Code	To what extent do the following attributes influence the implementation of TQM	1 Not at all influential	2 Slightly influential	3 Moderately influential	4 Very influential	5 Extremely influential
CFI 1	Client brief/ input					
CFI 2	Client complaint information/feedback					
CFI 3	Market investigation					
CFI 4	Client satisfaction survey					
CFI 5	Quality warranty to clients					
CFI 6	Client information system					
CFI 7	Client services					
CFI 8	Client cooperation					

14. COMPANY QUALITY SYSTEM EVALUATION FEATURES (CQSE)

Code	To what extent do the following attributes influence the implementation of TQM	1 Not at all influential	2 Slightly influential	3 Moderately influential	4 Very influential	5 Extremely influential
CQSE 1	Evaluation of the quality					

	strategy framework					
CQSE 2	Evaluation of overall company performance					
CQSE 3	Evaluation of employee performance					
CQSE 4	Evaluation of quality costs					
CQSE 5	Evaluation of the quality manual					
CQSE 6	Evaluation of the quality control system					
CQSE 7	Evaluation of quality system procedures					
CQSE 8	Evaluation of end results					
CQSE 9	Evaluation of the quality information system					

15. COMPANY VISION AND PLAN STATEMENT FEATURES (CVPS)

Code	To what extent do the following attributes influence the implementation of TQM	1 Not at all influential	2 Slightly influential	3 Moderately influential	4 Very influential	5 Extremely influential

CVPS 1	Clarity of vision and plan statement					
CVPS 2	Good quality policy and driven agenda					
CVPS 3	Quality improvement plan					
CVPS 4	Formulation of vision and plan					
CVPS 5	Concreteness of the future plan					
CVPS 6	Employee contribution to the vision					
CVPS 7	Involvement of employees in the development of the vision statement					

16. PRODUCT SELECTION AND DESIGN MANAGEMENT (PSDM)

Code	To what extent do the following attributes influence the implementation of TQM	1 Not at all influential	2 Slightly influential	3 Moderately influential	4 Very influential	5 Extremely influential
PSDM 1	Client brief/input					
PSDM 2	Cost of selection and design of the product					

PSDM 3	Environmental issues					
PSDM 4	Socio-cultural issues					
PSDM 5	Appearance/finishes required					
PSDM 6	Strength required for the end product					
PSDM 7	Intended purpose of the material					
PSDM 8	Where the material to be used					
PSDM 9	Design methods/techniques					
PSDM 10	Design detailing					

17. CONSTRUCTION PROCESS MANAGEMENT AND IMPROVEMENT FEATURES (CPMI)

Code	To what extent do the following attributes influence the implementation of TQM	1	2	3	4	5
		Not at all influential	Slightly influential	Moderately influential	Very influential	Extremely influential
CPMI 1	Project monitoring and control improvement					
CPMI 2	Equipment maintenance and innovation					

CPMI 3	Inventory management					
CPMI 4	Use of quality materials					
CPMI 5	Use of quality tools					
CPMI 6	Use of a quality manual					
CPMI 7	Understanding of work instructions/quality manual					
CPMI 8	Obtaining ISO 9000 certification for operation					
CPMI 9	Quality control system					
CPMI 10	Institution of a continuous improvement process within the company					
CPMI11	Appropriate use of system structure and standards					
CPMI12	Efficient management system					

18. CONSTRUCTION EMPLOYEES INVOLVEMENT AND MOTIVATION FEATURES (CEIM)

Code	To what extent do the following attributes influence the implementation of TQM	1 Not at all influential	2 Slightly influential	3 Moderately influential	4 Very influential	5 Extremely influential
CEIM 1	Education and training/re-training of staff					
CEIM 2	Teamwork					
CEIM 3	Salary/position promotion					
CEIM 4	Employee rewards					
CEIM 5	Bonus scheme					
CEIM 6	Conducive working environment					
CEIM 7	Employee involvement in TQM activities					
CEIM 8	Availability of a suggestion forum for employees					
CEIM 9	Employee commitment					
CEIM10	Recognition of employees					

SECTION D: PROJECT OUTCOMES THAT COULD MOTIVATE A COMPANY TO IMPLEMENT TQM

19. Below is a list of positive project outcomes which could motivate a Construction company to implement TQM. Please use the scale provided to rate the degree to which each factor motivated your company to implement TQM.

1=Not a motivating factor; 2=Low motivating factor; 3=Moderate motivating factor; 4=High motivating factor; 5= Very high motivating factor

Code	To what extent each of the following project outcomes motivated your company to implement TQM					
		1	2	3	4	5
		Not a motivatin	Low motivatin	Moderate motivatin	High motivatin	Very high motivatin
19.1	Greater reduction of construction costs					
19.2	Higher product quality					
19.3	Improved schedule performance					
19.4	Elimination of reworks					
19.5	Defect-free product at first attempt					
19.6	Higher safety standards					
19.7	Higher productivity					
19.8	Good methods of working					
19.9	Higher profitability					
19.10	Higher reduction of construction waste					

SECTION E: REASONS FOR NON-IMPLEMENTATION (ADOPTION) OF TQM IN GHANAIAN CONSTRUCTION INDUSTRY

20. Below is a list of factors that could lead to the non-implementation of TQM in the Ghanaian Construction Industry. Using the scale provided, please indicate your level of agreement for each factor if they lead to Non-implementation of TQM in the Ghanaian Construction Industry.
1 = Strongly disagree (SD); 2 = Disagree (D); 3 = Neutral (N); 4 = Agree (A); 5 = Strongly Agree (SA)

	To what extent do you agree that the following factors are the reason why construction companies in Ghana do not adopt TQM	1	2	3	4	5
		SD	D	N	A	SA
20.1	Lack of efficient TQM management system					
20.2	Absent of TQM policy					
20.3	Lack of or limited knowledge of TQM					
20.4	Lack of and inability to train and educate employees on TQM					
20.5	Lack of understanding among construction professionals in applying TQM					
20.6	Lack of coordination of the implementation of TQM policy within the organization					
19.7	Lack of TQM expert					

20,8	Reluctance to change old management technique					
20,9	Complex nature of TQM technique					
20,10	Lack of commitment from management					
20.11	Perception that TQM may not yield any better results					
20.12	TQM technique is time consuming					
20.13	TQM technique is costly					
20.14	Lack of finance in the management of TQM experts					
20.15	Lack of enforcement from the legislative bodies overseeing the implementation of TQM					
20.16	Lack of interest in the application of TQM					

SECTION F: PERFORMANCE OF CONSTRUCTION COMPANIES IN GHANA

21. Below is a list of performance indicators for a construction company. Please use the scale provided to rate your company's performance of each indicator over the past year.

1 = Very poor; 2 = Poor; 3 = Average; 4 = Good; 5 = Excellent

	Rate how well your company	

Code	performed for each of the following performance indicators	1 Very poor	2 Poor	3 Average	4 Good	5 Excellent
21.1	Construction costs					
21.2	Product quality					
21.3	Schedule performance					
21.4	Reworks elimination					
21.5	Defect-free product at first attempt					
21.6	Safety standards					
21.7	Productivity levels					
21.8	Methods of working					
21.9	Degree of control over the construction process					
21.10	Amount of waste produced					

Thank you for your contribution. We value your contribution and time spent in completing this questionnaire. If you have any queries, please do not hesitate to contact the undersigned.

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APPENDIX G

Model 2.0 covariance matrix (Unstandardized)

	PSDM10	PSDM7	PSDM6	CEIM5	CEIM4	CEIM3	CPMI11
PSDM10	0						
PSDM7	-0.011	0					
PSDM6	0.01	0.003	0				
CEIM5	0.036	0.001	-0.008	0			
CEIM4	0.028	0.004	-0.06	0.007	0		
CEIM3	0.122	0.029	0.002	-0.056	0.004	0	
CPMI11	0.006	0.018	-0.027	-0.023	0.042	0.09	0
CPMI10	-0.022	0.012	0.004	-0.062	-0.043	-0.039	0.021
CPMI9	0.037	0.104	0.001	0.016	-0.033	-0.013	0.003
CPMI12	-0.029	0.002	-0.09	0.028	0.021	0.032	0.01
D19.6	0.064	0.026	-0.01	0.067	0.016	0.083	0.01
D19.5	0.047	0.024	0.036	-0.004	-0.034	0.002	-0.058
D19.4	-0.017	0.001	-0.004	0.031	0.036	0.037	0.04
D19.1	-0.006	-0.065	-0.066	0.011	-0.054	-0.008	-0.03
PSDM5	0.05	0.096	0.082	-0.029	-0.021	0.005	-0.049
PSDM2	0.027	-0.021	-0.004	-0.01	0.001	0.077	-0.005
PSDM1	0.054	-0.081	-0.036	-0.013	-0.005	0.066	0.006
CVPS7	0.085	-0.032	-0.046	0.056	0.023	0.062	0.086
CVPS6	0.066	-0.042	-0.063	0.034	-0.017	0.068	-0.014
CVPS5	0.095	0.019	-0.026	0.048	-0.058	0.071	-0.059
CFI4	-0.017	0.037	-0.047	-0.035	0.064	0.114	0.01
CFI2	0.017	-0.052	-0.003	-0.079	0.01	0.024	0.045
CFI1	-0.014	0.04	0.018	-0.099	-0.032	0.007	-0.04
CQSE3	0.022	-0.007	-0.024	0.148	0.013	-0.001	-0.019
CQSE2	0.006	-0.034	0.029	0.058	-0.077	-0.03	0.021
CQSE1	0.018	-0.012	0.024	0.087	0.015	0.045	0.024
CSQM8	-0.04	0.052	-0.027	-0.012	0.002	0.006	0.044
CSQM7	-0.037	0.047	-0.03	0.04	-0.028	-0.027	0.058
CSQM4	-0.056	0.034	-0.018	0.042	0.03	0.066	0.009
LTM9	-0.031	0.007	0.046	0.109	0.037	-0.016	0.022
LTM8	-0.004	0.037	0.027	0.042	0.016	0.03	0.031
LTM4	0.006	0.062	0.036	-0.038	-0.03	-0.017	0.026
LTM1	0.011	-0.001	0.041	-0.032	-0.022	-0.032	0.017

CPMI10	CPMI9	CPMI12	D19.6	D19.5	D19.4	D19.1	PSDM5	PSDM2
0								
-0.009	0							
0.011	0.012	0						
-0.004	-0.011	0.005	0					
-0.014	-0.018	-0.036	0.021	0				
0.067	0.055	-0.031	-0.03	-0.006	0			
0.008	0.011	0.022	-0.022	0.042	-0.001	0		
0.024	0.043	0.013	0.036	-0.001	-0.018	0.027	0	
-0.047	0.067	0.01	0.006	-0.045	-0.019	0.063	-0.021	0
-0.079	0.028	0.01	0.011	-0.039	-0.011	0.043	-0.007	0.022
-0.01	0.011	-0.024	0.034	-0.001	0.02	-0.037	0.07	0.002
0.031	0.039	0.02	0.04	0.024	0.041	-0.064	-0.005	-0.039
0.013	0.023	0.045	-0.003	-0.018	-0.031	-0.046	0.106	-0.063
0.044	-0.025	0.051	0.041	-0.054	-0.004	0.02	0.057	-0.008
0.058	-0.032	-0.049	0.012	-0.009	0.031	0.011	-0.008	-0.027
0.011	0.038	-0.076	0.013	-0.051	0.028	-0.035	0.051	-0.006
0.048	0.033	0.055	-0.041	-0.017	0.01	-0.005	0.078	-0.008
0.001	-0.037	-0.008	0.005	0.008	-0.067	0.052	0.003	0.017
0.011	-0.013	-0.003	0.018	0.034	-0.029	0.048	0.046	0.025
-0.046	0.035	0.011	-0.048	0.022	-0.031	-0.044	0.05	-0.02
-0.009	0.043	0.017	0.04	-0.032	-0.02	0.019	0.047	0.001
-0.013	0.03	0.063	0.05	0.011	-0.002	0.064	0.082	0.001
0.008	0.026	0.014	-0.072	-0.017	0.03	-0.002	-0.013	0.051
-0.018	0.042	0.031	0.014	0.011	0.017	0.041	0.062	0.08
-0.013	0.016	-0.081	0.034	-0.016	0.02	0.054	-0.023	-0.003
-0.027	0.008	-0.051	0.002	-0.035	-0.05	0.01	-0.003	0.002

PSDM1	CVPS7	CVPS6	CVPS5	CFI4	CFI2	CFI1	CQSE3	CQSE2
0								
0.073	0							
-0.023	0.009	0						
-0.062	-0.008	0	0					
0.051	0.025	0.012	0.044	0				
-0.044	-0.038	0.027	-0.045	-0.01	0			
-0.014	-0.002	0.006	-0.001	0.002	0.004	0		
-0.021	0.055	0.005	0.109	0.088	-0.005	-0.023	0	
-0.079	-0.085	-0.047	-0.019	-0.031	0.044	-0.047	-0.002	0
-0.027	0.01	-0.035	0.026	-0.025	0.016	0.004	-0.019	0.017
-0.035	0.011	0.014	0.006	0.019	0.002	-0.014	0.02	-0.028
-0.052	-0.011	-0.002	0.014	0.025	-0.014	-0.022	0.063	0.023
-0.021	0.016	-0.09	0.035	0.025	0.018	0.011	-0.006	-0.025
-0.064	0.013	0.024	0.02	-0.013	0.01	-0.055	0.094	0.019
0.081	0.031	0.077	0.042	-0.012	0.02	0.001	-0.009	0.029
-0.086	0.047	-0.01	-0.067	-0.078	0.084	-0.006	-0.109	-0.04
-0.037	0.024	-0.049	-0.058	-0.085	0.049	0.003	-0.013	-0.034

CQSE1	CSQM8	CSQM7	CSQM4	LTM9	LTM8	LTM4	LTM1
0							
-0.046	0						
-0.021	0.014	0					
0.004	-0.01	-0.011	0				
0.058	0.028	0.006	0.059	0			
0.007	-0.006	-0.033	0.015	-0.01	0		
-0.036	-0.117	-0.068	0.044	-0.006	0.017	0	
0.031	-0.005	0.025	0.11	0.003	-0.025	0.025	0

Average absolute residual = **0.0025**
Average off-diagonal absolute residual = **0.0814**

% falling between -0.1 +0.1 = 99.99%

APPENDIX H:

Model 2.0 covariance matrix (Standardized)

	PSDM10	PSDM7	PSDM6	CEIM5	CEIM4	CEIM3	CPMI11
PSDM10	0						
PSDM7	-0.339	0					
PSDM6	0.343	0.079	0				
CEIM5	1.116	0.02	-0.24	0			
CEIM4	0.854	0.097	-1.746	0.143	0		
CEIM3	4.177	0.915	0.077	-1.402	0.088	0	
CPMI11	0.216	-0.567	-0.898	-0.648	1.122	2.788	0
CPMI10	-0.746	0.374	0.131	-1.651	-1.093	-1.156	-0.597
CPMI9	1.264	3.157	0.043	0.424	-0.855	-0.399	-0.085
CPMI12	-0.968	0.074	-2.917	0.746	0.544	0.979	0.284
D19.6	2.482	0.897	-0.39	-2.075	0.493	2.892	0.36
D19.5	1.558	-0.697	1.146	-0.115	-0.857	0.057	-1.698
D19.4	-0.546	-0.015	-0.131	0.794	0.887	1.053	1.136
D19.1	-0.177	-1.624	-1.744	0.237	-1.141	-0.208	0.741
PSDM5	1.717	2.994	2.694	0.819	-0.576	0.16	-1.585
PSDM2	0.902	-0.615	-0.117	-0.264	0.023	2.322	-0.14
PSDM1	-1.609	-2.181	-1.027	-0.321	-0.126	1.79	0.165
CVPS7	2.894	-0.99	-1.503	1.557	0.632	1.936	-2.714
CVPS6	1.961	-1.125	-1.806	0.834	-0.404	1.865	-0.381
CVPS5	2.905	0.52	-0.763	1.2	-1.422	1.977	-1.66
CFI4	-0.529	1.066	-1.436	-0.908	1.663	3.362	0.3
CFI2	0.578	-1.582	-0.094	-2.247	0.269	0.747	1.381
CFI1	-0.465	1.185	0.588	-2.746	-0.856	0.212	-1.188
CQSE3	0.745	-0.206	-0.752	4.084	0.345	-0.026	-0.593
CQSE2	0.207	-1.122	1.007	1.761	-2.294	-1.027	-0.705
CQSE1	0.661	-0.385	0.825	2.631	0.458	1.512	-0.804
CSQM8	-1.17	1.353	-0.763	-0.302	0.059	0.153	-1.19
CSQM7	-1.091	1.243	-0.855	1.002	-0.683	-0.755	-1.599
CSQM4	-1.646	0.889	-0.5	1.025	0.711	1.812	0.234
LTM9	-0.937	-0.188	1.358	2.736	0.902	0.452	0.627
LTM8	-0.126	-1.075	0.827	1.109	0.42	0.892	0.917
LTM4	0.18	-1.648	1.01	-0.93	-0.701	-0.466	0.696
LTM1	0.371	-0.033	1.292	-0.868	-0.562	-0.949	-0.489

CPMI10	CPMI9	CPMI12	D19.6	D19.5	D19.4	D19.1	PSDM5	PSDM2	PSDM1
0									
-0.245	0								
0.303	0.349	0							
-0.149	-0.37	0.181	0						
-0.392	-0.524	-1.018	0.666	0					
1.825	1.501	-0.859	-0.911	-0.151	0				
0.185	0.263	0.531	-0.583	0.938	-0.013	0			
0.728	1.325	0.399	1.277	-0.026	-0.525	0.67	0		
-1.376	1.996	0.311	0.21	-1.28	-0.537	1.529	-0.56	0	
-2.097	0.76	0.269	0.339	-0.996	-0.264	0.923	-0.166	0.51	0
-0.313	0.336	-0.741	1.197	-0.016	0.566	-0.91	2.182	0.05	1.964
0.82	1.038	0.531	1.192	0.613	1.01	-1.375	-0.129	-1.005	-0.534
0.351	0.636	1.213	-0.105	-0.466	-0.773	-1.015	2.96	-1.681	-1.494
1.204	-0.698	1.429	1.318	-1.471	-0.1	0.463	1.638	-0.212	1.273
1.701	-0.936	-1.452	0.402	-0.262	0.872	0.272	-0.239	-0.805	-1.164
0.301	1.102	-2.179	0.437	-1.444	0.771	-0.821	1.538	-0.171	-0.363
1.432	1.004	1.667	1.423	-0.489	0.283	-0.129	2.437	-0.251	-0.582
0.027	-1.23	-0.266	0.191	0.266	-2.121	1.428	0.09	0.569	-2.374
0.357	-0.419	-0.11	0.678	1.094	-0.908	1.305	1.568	0.817	-0.806
-1.212	0.921	0.283	-1.483	0.562	-0.773	-0.972	1.371	-0.515	-0.826
-0.239	1.142	0.445	1.246	-0.851	-0.514	0.433	1.311	0.021	-1.254
-0.346	0.797	1.673	1.535	0.284	-0.051	1.4	2.247	0.031	-0.501
0.227	0.712	0.39	-2.264	-0.456	0.772	-0.049	-0.357	1.368	-1.539
-0.499	1.199	0.87	0.448	0.296	0.449	0.964	1.826	2.255	2.042
-0.342	0.422	-2.107	1.02	-0.397	0.485	1.166	-0.627	-0.086	-2.004
-0.755	0.225	-1.473	0.058	-0.995	-1.35	0.235	-0.095	0.047	-0.943

CVPS7	CVPS6	CVPS5	CFI4	CFI2	CFI1	CQSE3	CQSE2	CQSE1	CSQM8
0									
0.21	0								
-0.204	0.001	0							
0.708	0.287	1.129	0						
-1.168	0.714	-1.226	-0.263	0					
-0.05	0.165	-0.026	0.043	0.124	0				
1.689	0.129	2.953	2.554	-0.14	-0.683	0			
-2.873	-1.388	-0.569	-1.003	1.511	-1.574	-0.06	0		
0.34	-1.02	0.776	-0.796	0.533	0.132	-0.583	0.575	0	
0.29	0.326	0.141	0.47	0.053	-0.353	0.518	-0.818	-1.307	0
-0.302	-0.059	0.332	0.619	-0.371	-0.571	1.657	0.685	-0.61	0.31
0.428	-2.115	0.84	0.621	0.486	0.287	-0.167	-0.711	0.101	-0.208
0.376	0.588	0.507	-0.324	0.275	-1.46	2.564	0.568	1.725	0.667
0.933	2.007	1.134	-0.334	0.586	0.029	-0.257	0.902	0.223	-0.157
-1.276	-0.247	-1.628	-1.929	2.2	-0.154	-2.848	-1.158	-1.015	-2.673
0.726	-1.298	-1.555	-2.323	1.421	0.093	-0.374	-1.07	0.984	-0.131

CSQM7	CSQM4	LTM9	LTM8	LTM4	LTM1
0					
-0.243	0				
0.138	1.406	0			
-0.83	0.382	-0.233	0		
-1.568	1.004	-0.127	0.399	0	
0.628	2.77	0.08	-0.633	0.594	0

Average absolute residual = **0.0027**
Average off-diagonal absolute residual = **0.0865**

% falling between -0.1 +0.1 = 99.99%