KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ARCHITECTURE AND PLANNING

FACULTY OF ARCHITECTURE AND BUILDING TECHNOLOGY

DEPARTMENT OF BUILDING TECHNOLOGY

CONTRACTOR SELECTION IN GHANA

AN MSC DISSERTATION PROPOSAL SUBMITTED TO THE DEPARTMENT OF BUILDING TECHNOLOGY, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

BY

SIDIK, MOHAMMED AWAL

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KUMASI

CONTRACTOR SELECTION IN GHANA

AN MSc DISSERTATION SUBMITTED TO THE DEPARTMENT OF BUILDING TECHNOLOGY, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY IN PARTIAL FULFILMENT OF THE REQUIRMENT FOR A DEGREE OF MASTER OF SCIENCE IN CONSTRUCTION MANAGEMENT

by
SIDIK MOHAMMED AWAL

Supervised by
PETER AMOAH

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ABSTRACT

The main aim of this study is to identify the significant factors for contractor selection in Ghana using factor analysis. The study was also to find the preferred criteria for evaluation and selection of contractors in Ghana.

The study identified 67 variables used in evaluation and subsequent selection of contractors. Using factor analysis, it was determined that the variables had common underlying factors. The significant factors determined after reduction were five, namely: Managerial factors, Quality and Standards factors, Resource Availability factors, Duration and Cost factors and Location factors.

It was also revealed that Ghanaian construction professionals prefer multi-criteria selection of contractors to single criteria and would also allocate higher marks to technical evaluation than to financial evaluation in selecting a contractor for a project. However, very few of them know about modern multi-criteria selection methods such as Analytical Hierarchy Process, Analytical Network Process, Evidential Reasoning, etc, developed by researchers for multi-criteria selection.

DEDICATION

To my father, the late Alhaji Sidik Zakariya, and mother, Baratu Alhaji Sidik

ACKNOWLEDGEMENTS

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

Clients undertake projects for specific targeted objectives. Underlying these objectives is the attainment of value for money. More importantly, regarding obtaining value for money is the public client who must be responsible and accountable for the tax payers' money. For construction projects, clients undergo a procurement process to select a contractor to carry out the construction using predetermined selection variables.

Contractor selection is one of the main activities and decisions made by the clients. Without a proper and accurate method for selecting the most appropriate contractor, the performance of the project will be affected (Cheng and Heng, 2004), thereby denying the client value for money. In order to ensure that the project can be completed successfully, the client must select the most appropriate contractor. This involves a procurement system that comprises five common process elements; project packaging, invitation, pre-qualification, short-listing and bid evaluation (Hatush, 1996; Hatush and Skitmore, 1997). Competitive tenders are to ensure that clients obtain the benefits of the lowest building cost (James, 1990).

Of utmost importance is the selection of the most suitable contractor to avert project implementation failure due to the contractor's inability to undertake or complete the work. Therefore, a uniform set of guideline in selecting a contractor is essential to ensure that pricing and background of the bidder is thoroughly assessed and the best selected for award to ensure the successful implementation of the project (Faridah, 2007).

In Ghana, the Public Procurement Act, 2003 (Act 663) was enacted with the overall objective of providing the best value for money by ensuring that public funds are spent in transparent, efficient and fair manner (clause 16). The act provides for public procurement, establish the Public Procurement Authority, make administrative and institutional arrangements for procurement, stipulate tendering procedures and provide for purposes connected with these. Procurement is complex and therefore requires that its complicated series of interactions be completed in a logical and pre-determined sequence.

"The object of the Public Procurement Board is to harmonize the process of public procurement in the public service to secure a judicious, economic and efficient use of state resources in public procurement and ensure that public procurement is carried out in a fair, transparent and non-discriminatory manner" (Act 663, Section 2).

"In order to have a successful project, it should be guaranteed by some means that all participants are experienced and trained to do the project: it matters what kind of network is conducting the work. To improve the present situation, authors suggest different kinds of improvement to the contracts incentive for good quality and awarding capabilities more than just the price" (Odeh and Battaineh, 2002).

1.2 DEFINITIONS

- A Procurement Entity is an organization or person that has legal or administrative mandate for procurement purposes.
- Procurement is the amalgam of activities undertaken by the client to obtain a building, (James, 1990).
- Procurement is defined as the act of obtaining by care or effort, acquiring or bringing out. In building and civil engineering works, it is generally understood to involve all the processes of acquiring, from the design through the construction, financing and sometimes operation until the client acquires what is required (Hibberd *et al*., 1991).
- Contractor evaluation is the process of investigating or measuring project-specific attributes (Faridah, 2007).
- Contractor selection refers to the process of aggregating the results of evaluation to identify optimum choice (Faridah, 2007).
- Bid evaluation is used to denote the procedure for strategic assessment to tender bids submitted by contractors (Hardy, 1978).
- Works means work associated with the construction, reconstruction, demolition, repair or renovation of a building or structure or surface and includes site preparation, excavation, erection, assembly, installation of plant, fixing of equipment and laying out of materials, decoration and finishing, and any incidental activity under a procurement contract [PPA Act 663 (2003): Manual(5.1)].

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1.3 STATEMENT OF THE PROBLEM

In the last two decades, there has been a steady increase in the range of methods used for the procurement of construction work. However, there has been no commensurate improvement in the 'success' rate of construction projects (Latham, 1994). Instead, there have been extensive delays in the planned schedule, cost overruns, serious problems in quality and an increased number of claims and litigation (Latham, 1994).

Quite often construction projects behind schedule, price changes and inappropriate quality are a direct outcome of the selection of an inadequate contractor(Nerija and Audrius, 2006).

Contractor selection process is based on the lowest evaluated price and this methods exhibit an inherent weakness (Faridah, 2007). Researchers and practitioners have realized that lowest-price is not the promising approach to attain the overall lowest project cost upon project completion (Wong *et al.*, 2001). Therefore, it is important to adopt an approach that will include all the criteria that are important in selecting a contractor.

1.4 AIM OF STUDY

The main aim of this study is to identify the significant factors for contractor selection in Ghana using factor analysis. The study is also to find the preferred criteria and method for evaluation and selection of contractors in Ghana.

1.5 OBJECTIVES

1. To identify from the literature and other sources the variables which have been determined to be used for contractor selection.

2. To determine the common underlying factors which affect contractor selection in Ghana based on the perceptions of clients and consultants using factor analysis.

3. To determine multi criteria selection methods that Ghanaian construction professionals prefer in order to enhance contractor selection in Ghana.

4. To recommend the factors to be considered in the selection of contractors in Ghana.

1.6 KEY QUESTIONS

The questions that this research sought to answer based on the objectives are as follows:

- What are the factors (variables) considered elsewhere in contractor selection?

- To what extent do the factors determined in the question above apply in Ghana?

- What common factors are important for contractor selection in Ghana?

- Which contractor selection method(s) is/are suitable for Ghana?

To achieve value for money through the selection of the best evaluated contractor, the above questions need satisfactory answers in order to achieve the clients' objectives.

1.7 SCOPE OF STUDY

Given the constraints of time and resources, the actors involved, the spatial coverage of a research have to be clearly defined. For that matter, this research was done on clients and consultants from the various professional bodies involved in construction in Ghana that are based in Accra. Greater Accra was chosen because of reason explained in chapter 3. Registered consulting firms with the Ghana Institute of Architects, Ghana Institution of Engineers and Ghana Institution of Surveyors (Quantity Surveying Division) were surveyed because they are directly involved in contractor evaluation and selection for construction projects.

1.8 METHOD OF STUDY

Literature review was the initial means of information gathering.

Study was done mainly by surveys, through questionnaires and structured interviewing of construction consultants and clients using statistical approaches. Statistical approaches are shown in chapter 3.

The responses of the questionnaires were then analyzed using factor analysis, and evaluated to determine the common factors of contractor selection variables in Ghana.

1.9 LIMITATION OF STUDY

Study was done in Only one region of Ghana because of limited time available for study.

1.10 ORGANIZATION OF STUDY

Chapter One: Introduction into Contractor Selection and Evaluation in Ghana, introduce the existing problem in the industry, aims and objectives, justification and methodology.

Chapter Two: Literature Review on Contractor Selection and Evaluation.

Chapter Three: Discusses research methodology, type of data used and how it was collected.

Chapter Four: Presents analysis of survey results and deductions made from survey.

Chapter Five: Presents findings, conclusions and recommendations of study.

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CHAPTER TWO

CONTRACTOR EVALUATION AND SELECTION

2.1 INTRODUCTION

Procurement of building works involves the selection of contractors through effective evaluation and it is a very important aspect of contract administration which if not carefully undertaken could adversely affect contract execution. It is therefore important that contractor selection be carried out with careful thought and consideration. The procedure for contractor selection however is giving way to more modern methods which seek to correct the inherent deficiencies and maladies to more realistic evaluation and reporting.

"The methods of selection of contractors can be described as either by competition or by negotiation. In either case, the decision taken should reflect the client's development aims – i.e. the completion of his or her construction project economically, safely, quickly to the required quality and at a profit" Kwakye (1997) .

The utility of any procurement method is measured in terms of time/speed, cost, quality and other variables such as certainty, flexibility of the method to accommodate unforeseen but important design changes without a problem, ability to deal with complex projects, the level of risk associated and how risk is shared and finally the avoidance of disputes (Osei Tutu, 1999).

Public Institution and Government Agencies in Ghana are regulated in their procurement, since 2003, by the norms of economic transaction established by the state. The 663rd Act of the Republic of Ghana entitled "*The Public Procurement Act, 2003*" was enacted to provide the legal framework for the procurement of public works.

Anvvor and Kumaraswamy (2006) concluded in their work that, while the Ghana Procurement Act sets out the legal, institutional and regulatory framework to secure fiscal transparency and public accountability, the sole reliance on traditional contracting and price-based selection limits the scope for the value for money achievable. Expanding the reforms to cover procurement, project delivery methods and strategies, with a focus on 'best value', will increase the potential and likelihood of achieving value for money in public construction in Ghana.

Contractor selection is a major project success factor. Owners, assisted by streamlined guidelines, will be able to clearly identify their requirements and select the builder that is best qualified to complete the project. This is an issue of extreme importance to the construction industry because a qualified contractor can ensure delivery on time, within budget and meeting the owner's expectations. On the other hand, an inefficient procurement method can result in numerous problems during and subsequent to construction.

In addition, contractors' competencies factor is identified as a critical success one. The contractors' financial capabilities, effective implementation of project planning, design and construction within a build environment are crucial elements that should be considered by owners when procuring for a building project. Technical abilities and past experience are also elements of the contractor's competencies that should be part of the evaluation process. As noted, it is essential that the contractor engaged in a building project possesses the appropriate knowledge and ability to manage the project, as it highly impacts the project performance (Chan *et al*. 2001).

2.2 ASSESSMENT OF THE EXISTING CONTRACTOR SELECTION PRACTICES

A study conducted within the U.K. construction industry indicated that some of the current practices for contractor selection are characterized by major weaknesses. Usually, cost is the decisive factor based on which the contractor is selected. Contractors' capabilities to deliver a project on time, within budget and satisfactorily complying with requirements are not highly considered during the contractor selection process. Although the reasoning behind the competitive approach is to allow free market competition, which results in better value for the owner's money, this competitive approach sometimes leads to the acceptance of the lowest cost non-competent contractor (Marwa, 2003).

The practices and procedures for selecting contractors and awarding contracts in the construction industry are based on those used in the public sector [Holt *et al* (1994), Herbsman and Ellis (1992), Merna and Smith (1990), and Moore (1985)]. These involve systems of bid evaluation dominated by the principle of acceptance of the lowest evaluated price [Russel and Skibnieswski (1988), Nguyen (1985)]. Many now believe that the public sector system of bid evaluation, concentrating as it does solely on bid price, is one of the major causes of project delivery problems [Holt *et al* (1994), Ellis and Herbsman (1991), and Bower (1989)]. Contractors, when faced with shortage of work, are more likely to submit low bids simply to stay in business in the short term and with the hope of somehow raising additional income through 'claims' or cutting costs to compensate for their low bids (Hatush and Skitmore, 1998). From a client's point of view, such contractors are risky. This suggest also that the automatic selection of the lowest bidding contractor is also risky - a fact that is seldom appreciated by construction clients (Hatush and Skitmore, 1998). Changing this process, however, is not easy. Most clients, especially those in the public sector, necessarily have to be accountable for their decisions and this becomes more difficult when selecting bidders other than the bidder with the lowest evaluated price. This has led researchers to look for techniques for contractor selection which utilize information concerning client objectives and contractor capabilities as well as bid price as objectively and transparently as possible as a means of achieving the best value for money (Hatush and Skitmore, 1998).

Except where clients have an identified single criterion, such as a fixed price or fixed completion date, several criteria relating to contractors' likely performance (such as technical experience, structure of the organization, financial stability, past performance and safety records) need to be considered in selecting contractors (Hatush and Skitmore, 1998).

Tender evaluation is a very important and critical means through which the best evaluated tenderer is selected to undertake a project for a client, to achieve best value for money. Evaluation of tenders is a task that involves not only consideration of the prices offered, but the financial and technical expertise of the tenderers as well. By adding the average technical score of each tenderer to his financial score, the evaluator can easily rate each tenderer's ability to carry out the work rather than depending only on price, which might not always mean a good choice (Faridah, 2007).

The "lowest price wins" philosophy has been a consistent theme for contractor selection over the years. It is important to comprehensively elucidate the lowest price win selection preference and compare it with the use of a multi-criteria selection approach in the tender evaluation process (Chee *et al*, 2001).

In the last two decades, there has been a steady increase in the range of methods used for the procurement of construction work. Despite this, however, there has been no commensurate improvement in the 'success' rate of construction projects (Latham, 1994). Instead, there have been extensive delays in the planned schedule, cost overruns, serious problems in quality and an increased number of claims and litigation (Latham, 1994).
By far, the most frequently used method of selecting construction contractors is by competitive bidding, in which the lowest evaluated bidder is awarded the contract (Hatush and Skitmore, 1997).

2.3 PUBLIC PROCUREMENT

Effective and efficient public procurement systems are essential to the achievement of the Millennium Development Goals (MDGs) and the promotion of sustainable development (OECD, 2005). Public procurement systems are at the centre of the way public money is spent since budgets get translated into services largely through the government’s purchase of goods, works, and services. Unfortunately, procurement systems in many developing countries are particularly weak and serve to squander scarce domestic and foreign resources. Strengthening procurement capacity in developing countries must be a vital component of efforts to improve social and economic well-being and a necessary feature of programs designed to meet the international commitment to reducing poverty (OECD, 2005).

Governments the world over have tried to streamline their tender evaluation processes through laid down procedures in order to remove unfair competition in the selection of contractors. The government of Ghana, for that matter enacted the Public Procurement Act (Act 663, 2003), to guide its procurement processes; including procurement of works.

2.4 RESPONSIBILITY OF PUBLIC PROCUREMENT ENTITY

In Ghana, a procurement entity is responsible for procurement, subject to the Public Procurement Act [Act 663(2003)] and to such other conditions as may be laid down in the procurement regulations and administrative instructions of the Minister (finance), issued in consultation with the Public Procurement Authority (clause 15. 1).

The head of an entity and any officer to whom responsibility is delegated are responsible and accountable for action taken and for any instructions with regard to the implementation of the Public Procurement Act that may be issued by the Minister acting in consultation with the Public Procurement Authority (clause 15.2).

The head of an entity is responsible to ensure that provisions of the Public Procurement Act are complied with; and concurrent approval by any Tender Review Board shall not absolve the head of entity from accountability for a contract that may be determined to have been procured in a manner that is inconsistent with the provisions of the Act (clause 15.4).

2.5 CONTRACTOR SELECTION PROCESS

A contractor is selected either from all the bidders or the contractor selection process can be divided into two phases: prequalification and final selection (Hatush and Skitsmore, 1997).

2.5.1 PRE-QUALIFICATION

Pre-qualification is the process that compares the key contractor-organizational criteria among a group of contractors desirous to tender. Such criteria can be past performance, past experience, and financial stability. Contractor prequalification is a commonly used process for identifying a qualified, sound and reliable construction contractor. A general prequalification exercise is performed to identify an appropriate (the best) contractor from the applicants and to evaluate and score them according to their economic and technical aspects, quality standards, past performance and other characteristics (Nerija and Audrius, 2006). The contractor pre-qualification process involves the establishment of a standard for measuring and assessing the capabilities of potential contractors (Ng *et al*, 1999).

Contractor prequalification involves a screening procedure based on a set of criteria set forth by each individual owner (Russel *et al*, 1992). As pointed out by Palaneeaswaran (2001), contractor prequalification is generally preferred by clients to minimize risks and failures and to enhance the performance levels of selected contractors by means of established minimal capacities below which contractors will not be considered. Ang *et al* (2005) states that traditional forms of procurement and tendering supported by prescriptive, solution-based specifications and the lowest price only are suitable for routine projects but will hamper innovation in other types of projects. An extensive literature review by researchers revealed that the most acceptable contractor's pre-qualification attributes are financial stability, management and technical ability, contractor's experience, contractor's performance, resources, quality management and health and safety concerns. Therefore, the contractor's attributes corresponding to those stated above should be evaluated (Hatush and Skitmore, 1997). According to Hatush and Skitmore (1997) and Holt (1996), the information used for the assessment of parameters for pre-qualification falls into the following groups:

- General information that is used mainly for administrative purposes;
- Financial information;
- Technical information;
- Managerial information;
- Experience attributes;
- Performance attributes;
- Safety information;
- Environmental concerns.

2.5.2 FINAL SELECTION

Selecting a construction contractor is a major decision which may influence the progress and success of any construction project. When selecting a contractor, a client evaluates its qualification (checks whether it meets specified legal, financial, economic and technical requirements) and compares qualification of different contractors (Nerija and Audrius, 2006).

Contractor selection refers to the process of aggregating the results of evaluation to identify optimum choice.

Research has significantly improved the contractor selection process in the construction industry. However, some of the proposed methods and approaches could be complex and difficult to apply in practice. The construction industry needs simple but effective methods in contractor selection process due to the limited time intervals of the bidding periods. For these and many other reasons, selection of a construction contractor requires a contractor selection model that should be able to meet the critical characteristics of the qualification:

• A multi-attribute problem;

• Risks inherited from different decision-maker's opinion;

• Uncertain date given by different contractors;

• Subjective judgment made by decision-makers;

•Non-linear relationships between contractor's attributes and their corresponding prequalification decisions;

• To deal with qualitative as well as quantitative data.

It should be noted that the stakeholders must adjust the attributes depending on the demand of each project. The critical point is that the selected attributes should have a direct effect on performance. In addition, the selected evaluation attributes should also be based on the measurement culture of the stakeholder.

In most studies of contractor selection, selection criteria are assumed to be independent of each other. Apparently, these criteria are likely to affect each other. For example, Fong and Choi (2000) used a sample of 13 respondents to identify and prioritize eight ‘un-correlated’ criteria (tender price, financial capability, past performance, past experience, resources, current workload, past relationship and safety performance) for contractor selection. In fact, the eight criteria are interrelated to a certain extent. For example, good past experience may lead to good safety performance if the past experience includes good safety records. Good past performance and experience is good evidence of successful projects, which in turn results in strong financial capability. Resources and financial capability may be positively correlated. Tender price may be negatively related to other criteria.

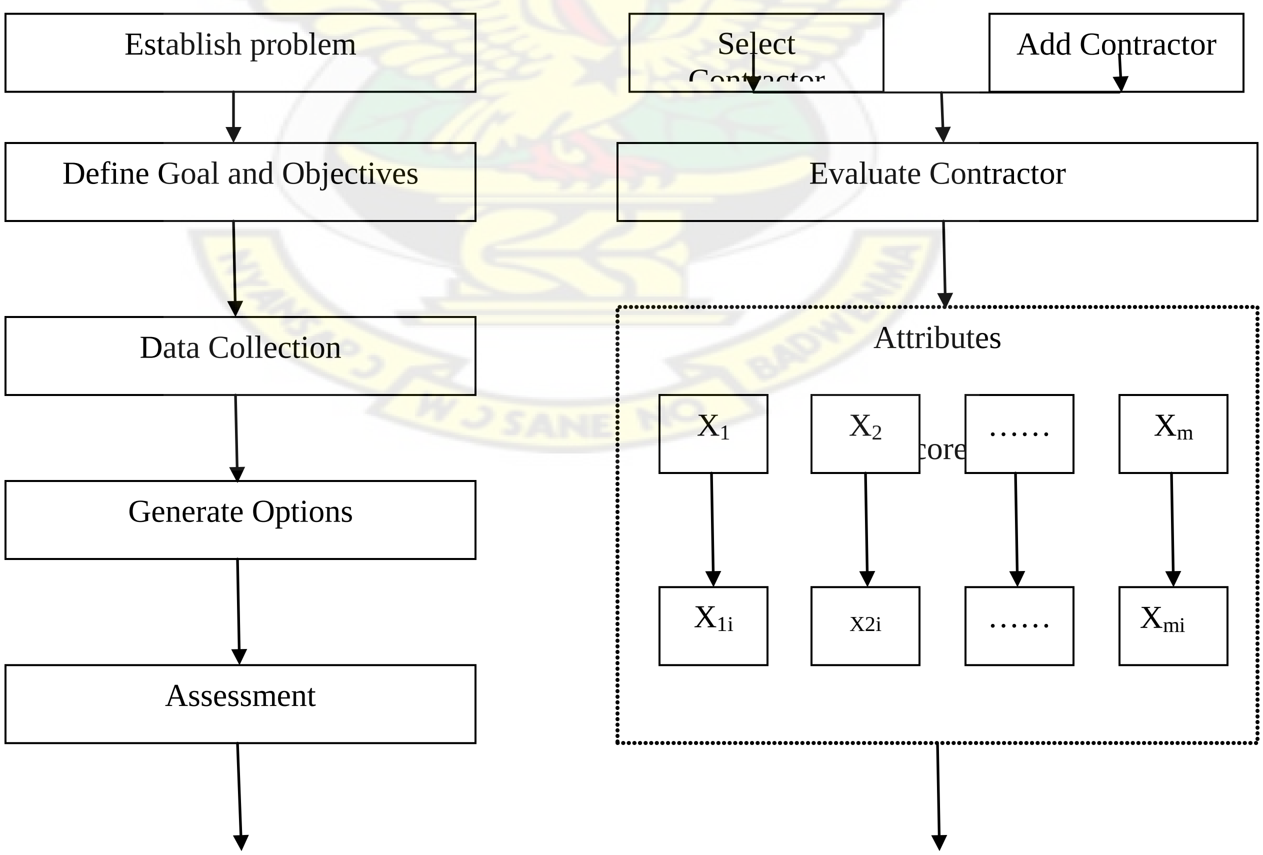
2.6 CONTRACTOR EVALUATION

Contractor evaluation is the process of investigating or measuring project-specific attributes. Many countries have introduced modifications, involving clearly defined procedures for bid evaluation, to this "lowest bidder" criterion [Herbsman and Ellis (1992), Merna and Smith (1990), Hardy (1978), and Martinelli (1986)]. Reliance on bid prices alone as the discriminating factor between bidders is, however, somewhat risky and short-sighted (Hatush and Skitmore, 1997).

Tender evaluation considers specific criteria that can measure the suitability of a contractor for the proposed project (Holt, 1998). According to the Standard Award Criteria for Housing Service Contracts by South Bedfordshire UK, the purpose of the

Tender Evaluation Assessment is to evaluate and award points on tender submissions from each contractor based upon price and quality. The points awarded will determine the number of contractors who may be selected for a post tender interview with the Evaluation Panel.

Figure 2.1 is a stage by stage Model of contractor evaluation and selection process presented by Zenonas (2008).



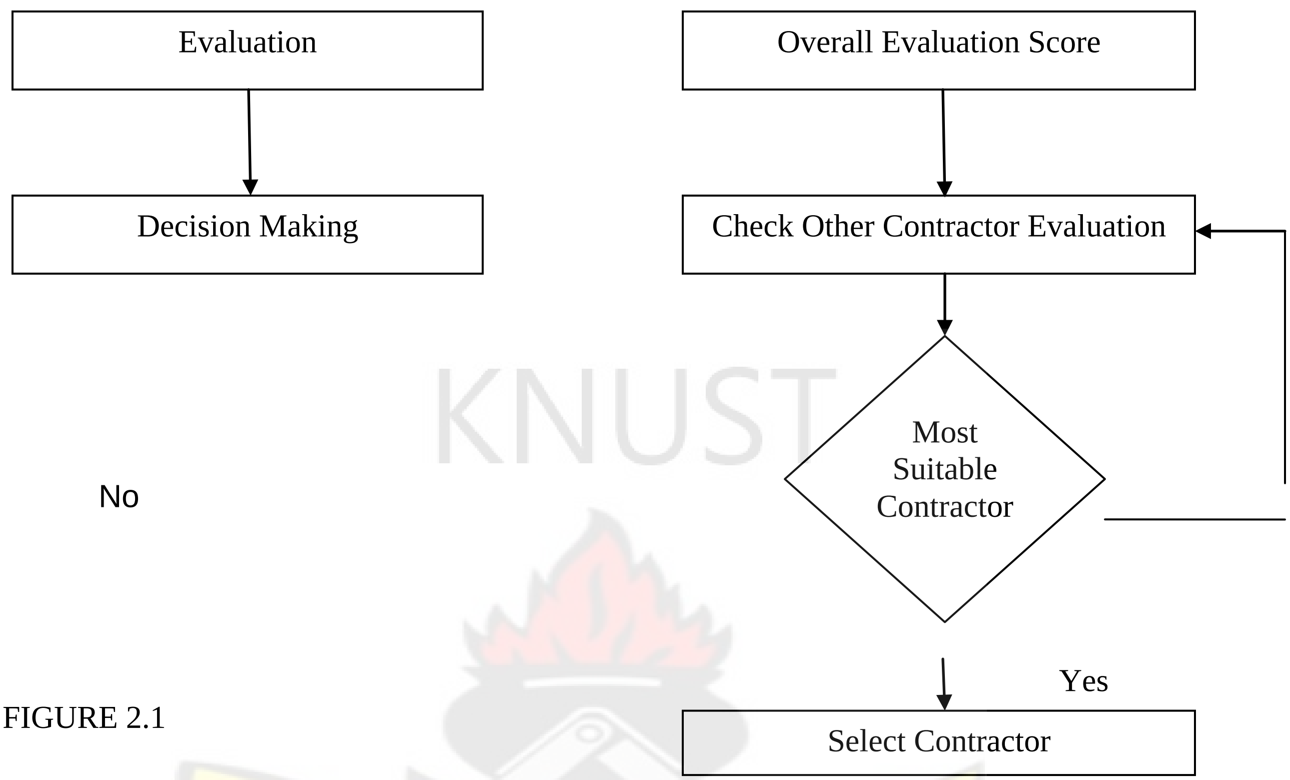


FIGURE 2.1

STAGE BY STAGE CONTRACTOR'S EVALUATING AND SELECTION PROCESS

2.6.1 FINANCIAL EVALUATION

Where cost/price is the consideration for evaluation, the tender is evaluated for:

- Arithmetical accuracy
- An analysis of the costs included
- Acceptability of the profit margin
- The sufficiency of the contingency sum and
- The credibility of the income forecast (Philip Sayers, 2004).

Figure 2.2 below illustrates a financial evaluation model presented by South Bedfordshire UK.

FIGURE 2.2 FINANCIAL EVALUATION MODEL

Tender for:		Term		Officer		Closing Date	
Financial Evaluation Model	Maximum Points	Contractor A	Contractor B	Contractor C	Contractor D	Contractor E	Contractor F
Total Contract Tender Sum		£40,000.00	£30,000.00	£35,000.00	£45,000.00	£50,000.00	£20,000.00
If Tender to be excluded/ rejected, input - **R**							**R**
Area In Blue Self Calculating - Do Not Input Information in this area							
Tenders Accepted on Quality Grounds to go to next stage		£40,000.00	£30,000.00	£35,000.00	£45,000.00	£50,000.00	No Accepted Tender
Lowest Accepted Tender = Max Total Points	100						
Lowest Tender Value	£30,000.00						
Percentage to reduce to lowest Tender		25.00%	0.00%	14.29%	33.33%	40.00%	
Contractor with lowest price is awarded Maximum Points (100). Thereafter for every percentage point above the Lowest price there is a deduction in points to the same value	Points to be deducted	25.00	0.00	14.29	33.33	40.00	
Points awarded to Remaining Contractors		75.00	100.00	85.71	66.67	60.00	
Contract Weighting and Total Points awarded	**40%**	**30.00**	**40.00**	**34.29**	**26.67**	**24.00**	
	Notes						

Any tender / quotation that scores an "R" (Essential criteria not met, therefore rejection of Tender) is automatically rejected and therefore not used
The acceptable Tender / Quotation with the best price scores 100 points, that figure is automatically multiplied by the percentage in which you have split the contract between Financial and Quality to give the final points score
The acceptable tenders whose prices are above the best tender, have points deducted on a percentage basis according to by how much they need to reduce their price to match the best price.
For example the best price is £90,000 the supplier scores 100 points and if the weighting is 60% quality and 40% finance then they are awarded the full 40 points towards their final score.
If the second best Price is £100,000 the supplier would have to reduce their price by 10% (£10,000) to match the best price and therefore loses 10 points.
Therefore the second best supplier achieves only 90% of the finance score of 40% so their total financial score is 36 points

2.6.2 TECHNICAL EVALUATION

Each tenderer is examined in the following categories:

- Staffing: numbers, calibre and experience.
- Management structure
- Operational procedures
- Marketing plans
- Understanding of the work
- Innovation and flair (Philip Sayers, 2004).

Score each tender in each category. A simple way will be to give marks out of 10 to each category. Thus one tenderer may score 6 out of 10 for staff while another may score 8 out of 10. A method of scoring encourages a greater objectivity in the evaluation (Philip Sayers, 2004).

Below are model figures for technical evaluation, technical evaluation summary and final evaluation summary by South Bedfordshire UK.

FIGURE 2.3 TECHNICAL EVALUATION MODEL

Tender for:						Term		Officer	Closing Date	
		R = Essential criteria not met, therefore rejection of Tender								
Quality and Service Delivery Evaluation Weighting	Points Awarded		Guidance for scoring	Scoring Ranges Please input percentage (self calculating)						Contractor
				V.Good (75 to 100% of score)	Good (50 to 75% of score)	Average (50% of score)	Poor (25 to 50% of score)	V.Poor (0 to 25% of score)	Comments	A
Quality of Organisation and Management / Capability to undertake works / Quality of work done / Quality Management control systems / Support and Back up arrangements	30	R	See method statement							0
Respect for Customers / Customer Care	30		See method statement							0
Respect for workforce / Health and Safety / On Site Welfare	10	R	See method statement							0
Communications / Data Quality	10		See method statement							0
Tenderer's Partnering Proposals resulting in efficiency gains	10		See method statement							0
Environmental Proposals	10		See method statement							0
			See method statement							0
Total	100									0
Adjust points awarded to 100	100									0.00
			Evaluation team	TeamLeade	Tenants	Finance	Legal	[illegible]		
Contract Weighting and Total Points awarded	60%		Signed off							0.00
			Ratification by Portfolio Holder							
			Ratification by CSM							

Notes

The criteria and points allocated should be preset and sent set to the supplier along with the ratio between Finance and quality at the tender quotation stage

Each officer on the evaluation team then completes this Score sheet, according to how they judge the Tender / Quotation.

The officer inputs a percentage in the correct column as to how they judge the tender / Quotation, which is automatically transferred into points allocated in the far right column.

Any Supplier who is adjudged to have not met minimum criteria against an essential criterial item will after discussion and majority agreement have their tender / quotation rejected

The scores are the compared any anomalies / extremes discussed and an average of the totals input into the quality evaluation document.

FIGURE 2.4 TECHNICAL EVALUATION SUMMARY

Tender for:			Term		Officer		Closing Date	
Quality and Service Delivery Evaluation Weighting	Points Awarded		Contractor A	Contractor B	Contractor C	Contractor D	Contractor E	Contractor F
Quality of Organisation and Management / Capability to undertake works / Quality of work done / Quality Management control systems / Support and Back up arrangements	30	R	28	28	26	20	16	0
Respect for Customers / Customer Care	30		27	28	26	21	18	11
Respect for workforce / Health and Safety / On Site Welfare	10	R	9	8	8	7	5	3
Communications / Data Quality	10		9	9	7	6	4	0
Tenderer's Partnering Proposals resulting in efficiency gains	10		8	6	3	3	2	0
Environmental Proposals	10		8	6	7	8	2	0
Total	**100**		**89**	**85**	**77**	**65**	**47**	**14**
Adjust points awarded to 100	100		89.00	85.00	77.00	65.00	47.00	14.00
Contract Weighting and Total Points awarded	**60%**		**53.40**	**51.00**	**46.20**	**39.00**	**28.20**	**8.40**

Notes

For each criteria you can award as many points as you want, to fit the profile of the tender. The form will automatically adjust it as a ratio to equal

That figure is then multiplied by the percentage in which you have split the contract between quality and finance to give the final quality points

For example your criteria comes to 230 points and the supplier scores 50% = 115 points, the points are adjusted down to 50 (half the available quality score)

The split is 60% quality 40% financial, so the 50 points are multiplied by 60% (Quality) to achieve 30 points that are brought forward into their final score.

FIGURE 2.5 EVALUATION SUMMARIES

Tender for:			Term		Officer		Closing Date	
Contract Evaluation	Contract Weighting		Contractor A	Contractor B	Contractor C	Contractor D	Contractor E	Contractor F
Quality and Service Delivery Evaluation	60%		53.40	51.00	46.20	39.00	28.20	8.40
Financial Evaluation	40%		30.00	40.00	34.29	26.67	24.00	
Total Points Awarded	**100%**		**83.40**	**91.00**	**80.49**	**65.67**	**52.20**	**#VALUE!**

2.7 EVALUATION PROCESS

The Evaluation Panel will appoint the successful contractor after a two week “Cooling Off” period in order to allow unsuccessful contractors, the opportunity to challenge a potential award of contract (Standard Award Criteria for Housing Service Contracts by South Bedfordshire UK).

The Employer having regard to the nature of the services and the complexity of the Contract predetermine the relative importance of quality and price.

The evaluation is carried out using the following procedure:

1. Give a maximum Quality Sub Total Score of 60 points.

2. Give a maximum score of 40 points for financial submissions.

3. Calculate the total quality score with the price score for each tender to produce total scores (Standard Award Criteria for Housing Service Contracts, Appendix A, South Bedfordshire UK).

The procurement manager must next:

- Decide on bid opening procedure and open bids
- Receive and log the bids as they arrive
- Assess previous experience and check reference contracts or sites
- Check financial stability of bidders
- Check list of past clients
- Set up bidders meetings
- Interview site or installation manager or foreman (if applicable)
- Discuss quantity discounts
- Negotiate early or other payment discounts

- Obtain parent company guarantees when the contract is with a subsidiary company
- Agree the maintenance (guarantee) period
- Discuss and agree bid, performance, maintenance and advance payment bonds
- Produce bid summary (bid tabulation)
- Carry out technical evaluation
- Carry out commercial evaluation.

The following are the main items which have to be compared when assessing competing bids:

- Basic cost
- Extras
- Delivery and shipping cost
- Insurance
- Cost of testing and inspection
- Cost of documentation
- Cost of recommended spares Discounts Delivery period
- Terms of payment
- Retentions guarantees
- Compliance with purchase conditions.

Tenders will be evaluated on price and quality. The clarification on which the financial and quality aspects of tenders are evaluated is given.

2.7.1 Quality Evaluation Areas

The specific areas of interest to the Employer in relation to the Contract should be fully listed in the Instructions to Tenderers as below:

1. General
2. Organization and Management
3. Respect for People
4. Health and Safety Policy/Risk Assessment
5. Equal Opportunities and Customer Care
6. Quality
7. Management Control Systems
8. Communications
9. Support/Back Up Arrangements
10. Environmental Proposals
11. Tender's Partnering Proposals and Efficiency Gains
12. Employment details (Standard Award Criteria for Housing Service Contracts, Appendix A, South Bedfordshire UK).

The Procurement Toolkit – Good Practice Guide suggest the evaluation process illustrated below:

Tender evaluation should be undertaken by a team, preferably consisting of representatives from the user department and someone with procurement expertise. The following guidelines provide a framework that will be suitable for many tender evaluation processes.

1. Eliminate any tenderers who do not meet your essential minimum criteria, including the minimum financial criteria.
2. Eliminate any late submissions not received by the published deadline.
3. Eliminate any submission that has significant omissions, which will hinder your ability to conduct a full evaluation. Having to ‘chase’ additional information, which should have been submitted by the deadline, can be a time consuming exercise.
4. Do not try to “read into” what may be meant. If part of a tender is not clear, it is appropriate to seek clarification.
5. Prepare a simple matrix to evaluate your selected qualitative criteria using your pre-determined weightings for each element. Use this matrix to score each tender submission. If you prepare your matrix in excel, the data is easier to evaluate. The evaluation criteria must be as advertised in the tender, in descending order of priority.
6. The quality score for each tender submission should then be divided by the maximum possible score and multiplied by the percentage allocated for quality. For example, the following applies to a tender where the quality / price balance is 60/40.

   In the following table, the score range is 1 to 4. Some prefer to use average of 1 to 5 (1= poor, 5= excellent). It is not recommended to use a range greater than this (say 10 or 1000).

TABLE 2.1 SAMPLE WEIGHTING CALCULATIONS

		Weighting	Score	Total
1	Quality of goods	4	3	12
2	Financial information	PASS/FAIL		
3	Health and Safety	2	3	6
4	Quality Assurance Procedures	4	4	16
5	Insurance	2	4	8
6	Previous Experience	4	2	8
	Total Score			50

Calculation: Maximum score = 16 ×4 =64

Therefore score for quality = 50÷64×60 = **47**

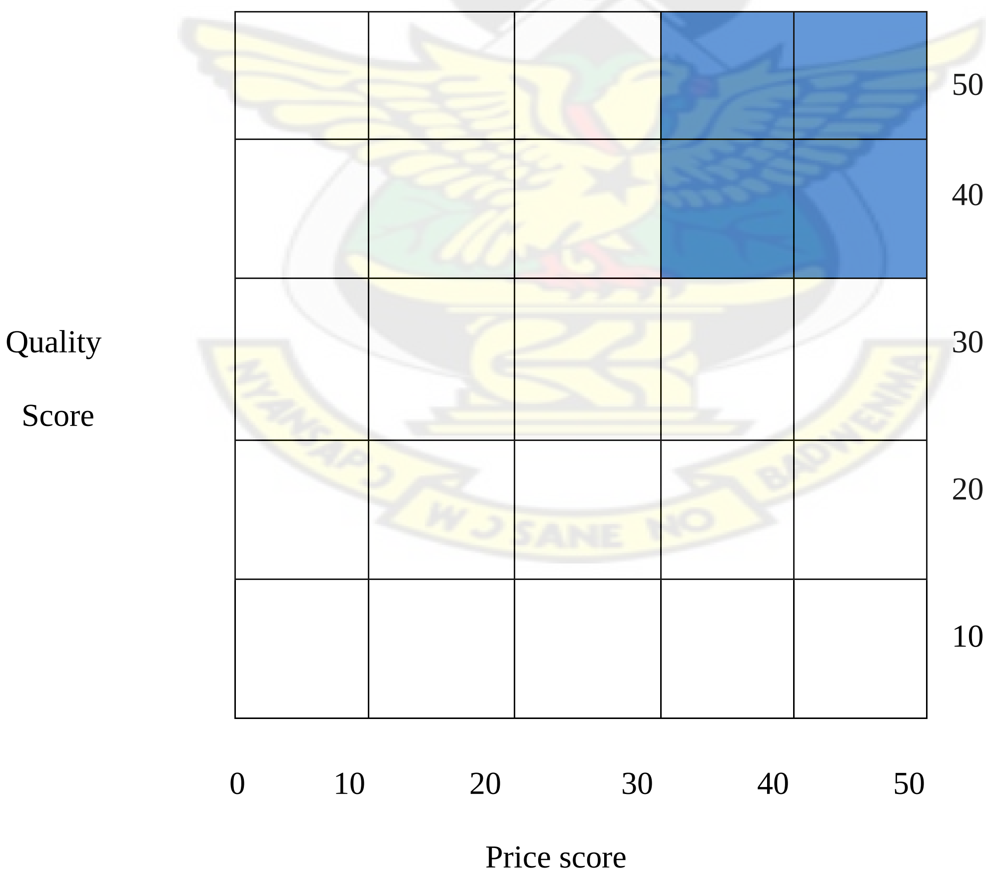
7. Allocate 40 points for the lowest price submitted (remember; calculate the whole life cost not just initial purchase price). Then allocate points to the remaining tender prices as a percentage of the lowest price, and then convert to a point score to reflect that this carries 40% of the total score. For example:

TABLE 2.2 PRICE EVALUATIONS

Tender	Price (£)	Calculation	Convert To 40%	Points
1	500	425÷500×100=85	40×85÷100	34
2	622	425÷622×100=68	40×68÷100	27
3	425			40
4	440	425÷440×100=97	40×97÷100	39
5	625	425÷625×100=68	40×68÷100	27

8. Plot the price and quality scores on a simple scatter chart. If you have prepared your spreadsheet in excel, you can automatically produce a chart. For example:

FIGURE 2.6 PREFERED REGION OF CONTRACTOR TO BE SELECTED



The preferred tenderer is the one that best fits (or is nearest) to the quarter of the graph for the highest on both price and quality (shaded in Figure 2.6).

You may decide to incorporate site visits to the supplier or a customer of the supplier as part of the evaluation process. Presentations or demonstrations can also be useful ways of exploring the quality of a tender, and evaluated as part of the process.

All decisions made must be fully documented and all paperwork produced from the evaluation process must be kept in the tender file.

All tenderers are within their right to request feedback from the tender process so it is essential that accurate and objective records are kept to ensure that constructive feedback can be given.

2.8 OVERVIEW OF CONTRACTOR SELECTION METHODS

2.8.1 SINGLE CRITERIA (Bid Price)

This is largely through competitive bidding where the bid price is evaluated, after preliminary inspection found tenderers to meet minimum tender requirements, and the lowest price bidder is awarded the contract.

Ang *et al* (1984) state that traditional forms of procurement and tendering supported by prescriptive, solution-based specifications and the lowest price only, are suitable for routine projects but will hamper innovation in other types of projects. Selection of the lowest price bidding contractor is one of the major causes of the poor performance of a construction project (Nerija and Audrius, 2006).

The "lowest price wins" philosophy has been a consistent theme of contractor selection over the years. It is important to comprehensively elucidate the lowest price win selection preference and compare it with the use of a multi-criteria selection approach in the tender evaluation process (Cheeh *et al*, 2001).

2.8.2 MULTI-CRITERIA

For this approach, selection and evaluation of contractors is based upon multiple criteria, sometimes by more than one interested party to the project. Decision analysis is concerned with situations in which decision-makers have to choose among several alternatives A_1, A_2... A_n through the consideration of a common, but differently scored, set of attributes (criteria) for each alternative. Traditionally, the criteria scores are manipulated in such a way as to provide a consequence describable in terms of single criterion making it an easy task for the decision-maker (DM) to choose the most desirable alternative (Hatush and Skitmore, 1998).

Many researchers (Zavadskas and Kaklauskas, 1996, 2007; Zavadskas and Vilutiene 2006; Vilutiene and Zavadskas, 2003) have pointed out that in construction it is essential to be able to take into account the impacts of cultural, social, moral, legislative, demographic, economic, environmental, governmental and technological change, as well as changes in the business world on international, national, regional and local real estate (construction) markets.

Evaluation of contractors based on multi-attributes is becoming more popular and is, in essence, largely dependent on the uncertainty inherent in the nature of construction projects and subjective judgment of decision-makers.

Multi-attribute decision-making is defined by processes that involve designing the best alternative or selecting the best one from a set of alternatives, that has the most attractive overall attributes, and that involves the selection of the optimal alternative, handled via preference models (Sage 1977; Bui 1987; Chankong and Haimes, 1983; French *et al*., 1998; Hwang and Lin, 1987; and Hwang and Yoon, 1981).

A multi-criteria decision making can generally be represented in a matrix format as;

$$W = [\, W_1, \quad W_2, \ldots\ldots\ldots\ldots W_n \,]$$

$$R = \begin{matrix} A_1 \\ A_2 \\ \vdots \\ \vdots \\ A_m \end{matrix} \begin{bmatrix} R_{11} & R_{12} & \cdots & \cdots & R_{1n} \\ R_{21} & R_{22} & \cdots & \cdots & R_{2n} \\ \vdots & \vdots & \cdots & \cdots & \vdots \\ \vdots & \vdots & \cdots & \cdots & \vdots \\ R_{m1} & R_{m2} & \cdots & \cdots & R_{mn} \end{bmatrix}$$

$$C_{1,} \quad C_2, \ldots\ldots\ldots\ldots\ldots C_n$$

Where Ai denotes bidder i, Cj denotes criterion j with which performances of bidders are measured; Rij denotes rating or score of bidder i with respect to criterion, and Wj denotes weight of criterion j. The product of W and R is used to select the appropriate bidder.

2.8.3 CLASSIFICATION OF MULTI-ATTRIBUTE DECISION MAKING

Multi-attribute decision-making can be classified as follows:

a) Multi-attribute decision-making (MADM) for the sorting or the ranking of alternatives according to several attributes, and

b) Multi-objective decision-making (MODM), for driving a vector optimization-based design process to a solution (Colson and Bruyn, 1989).

Train (2002) certifies that in the eighties of the 20th century main models of qualitative selection analysis methods, defined statistic and economic properties of such methods were delivered. The methods were successfully applied in many fields; including transport, energy, civil engineering and market (enumerated a few only). Multi-attribute decision-making methods have different characteristics (Triantaphyllou, 2000). There are different ways to classify them. Multi-attribute methods can be classified by the type of initial information (deterministic, stochastic, fuzzy set theory methods) or by the number of decision-makers (one or a group). Scientists classify deterministic MADM methods differently. Lin and Wu (2007) presented classification of the methodology which can be used for qualitative and quantitative methods aimed at technology management. The classification of MADM methods according to the type of information proposed by Larichev (2000) is given below:

1) Methods based on quantitative measurements. The methods based on multi-attribute utility theory may be referred to this group (TOPSIS – Technique for Order Preference by Similarity to Ideal Solution (Hwang and Yoon 1981; Arditi and Günaydın 1998), SAW – Simple Additive Weighting (MacCrimon, 1968; Zavadskas *et al*., 2007b),

LINMAP – Linear Programming Techniques for Multidimensional Analysis of Preference (Srinivasan and Shocker, 1973; COPRAS – COmplex PRoportional

ASsessment (Zavadskas and Kaklauskas, 1996; Zavadskas *et al*., 2007a) and other new methods.

2) Methods based on qualitative initial measurements. These include two widely known groups of methods, i.e. analytic hierarchy methods (AHP) (Saaty, 1994) and fuzzy set theory methods (Zimmermann, 2000).

3) Comparative preference methods based on pairwise comparison of alternatives. This group comprises the modifications of the Elimination and Choice Translating Reality (ELECTRE) (Roy 1996), Preference Ranking Organization Methods (PROMETHEE) I and II (Brans *et al*., 1984), and other methods.

4) Methods based on qualitative measurements not converted to quantitative variables. This group includes methods of verbal decision-making analysis (Flanders *et al.*, 1998) and uses qualitative data for decision environments involving high levels of uncertainty.

All these procedures are aimed at selecting a qualified contractor on a competitive basis, but in reality a decision is usually based on a single criterion (Hatush and Skitmore, 1998).

There are many MCDM methods proposed each having different ways of eliciting a DM's assessments in order to evaluate alternatives based on multiple criteria. Below are some multi-criteria selection techniques applied in the selection of contractors by researchers.

2.8.4 ANALYTICAL HIERARCHY PROCESS

The Analytical Hierarchy Process (AHP) is a multi-objective decision-making approach that includes hierarchically arranging different objectives and sub-objectives, assessing their relative significance, making pair-wise comparisons, undertaking a structured analysis of available alternatives and thereby enabling more systematic decision making (Saaty, 1994b). This method helps to establish decision models through a process that contains both qualitative and quantitative components.

Qualitatively, it helps to decompose a decision problem from the top overall goal to a set of manageable clusters, sub-clusters, and so on down to the final level that usually contains scenarios or alternatives. The clusters or sub-clusters can be forces, attributes, criteria, activities, objectives, etc.

Quantitatively, it uses pair-wise comparison to assign weights to the elements at the cluster and sub-cluster levels and finally calculates 'global' weights for assessment taking place at the final level. Each pair-wise comparison measures the relative importance or strength of the elements within a cluster by using a ratio scale.

One of the main functions of AHP is to calculate the consistency ratio to ascertain that the matrices are appropriate for analysis (Saaty, 1980).

Conceptually, AHP is only applicable to a hierarchy that assumes a unidirectional relation between decision levels. The top level of the hierarchy (apex) is the overall goal for the decision model, which decomposes to a more specific level of elements until a level of manageable decision criteria is met (Meade and Sarkis, 1999).

Decision Makers (DMs) are to compare alternatives in a pair-wise fashion based on each decision criterion (Saaty & Wind, 1980). Here, DMs are required to make exact or precise statements like `I think alternative A is three times more important than alternative B as far as a particular criterion is concerned'.

The relative importance values are determined with Saaty’s 1-9 scale (Table 2.3), where a score of 1 represents equal importance between the two elements and a score of 9 indicates the extreme importance of one element (row component in the matrix) compared to the other one (column component in the matrix) (Meade and Sarkis, 1999).

Table 2.3: Saaty’s 1-9 Scale for AHP Preference

Intensity of importance	Definition	Explanation
1 objective	Equal importance	two activities contribute equally to the
3	Moderate importance	experience and judgment slightly favour one over another
5 one	Strong importance	experience and judgment strongly favour over another
7 dominance	Very strong importance	activity is strongly favoured and its is demonstrated in practice

9 the	Absolute importance	importance of one over another affirmed on highest possible order
2,4,6,8	Intermediate values	Used to represent compromise between the priorities listed above
Reciprocal of compared above non-zero Numbers	if activity *i* has one of the above non-zero numbers assigned to it when with activity *j*, then *j* has the reciprocal value when compared with *i*	

FIGURE 2.7: Analytical Hierarchy Diagram for Contractor Selection

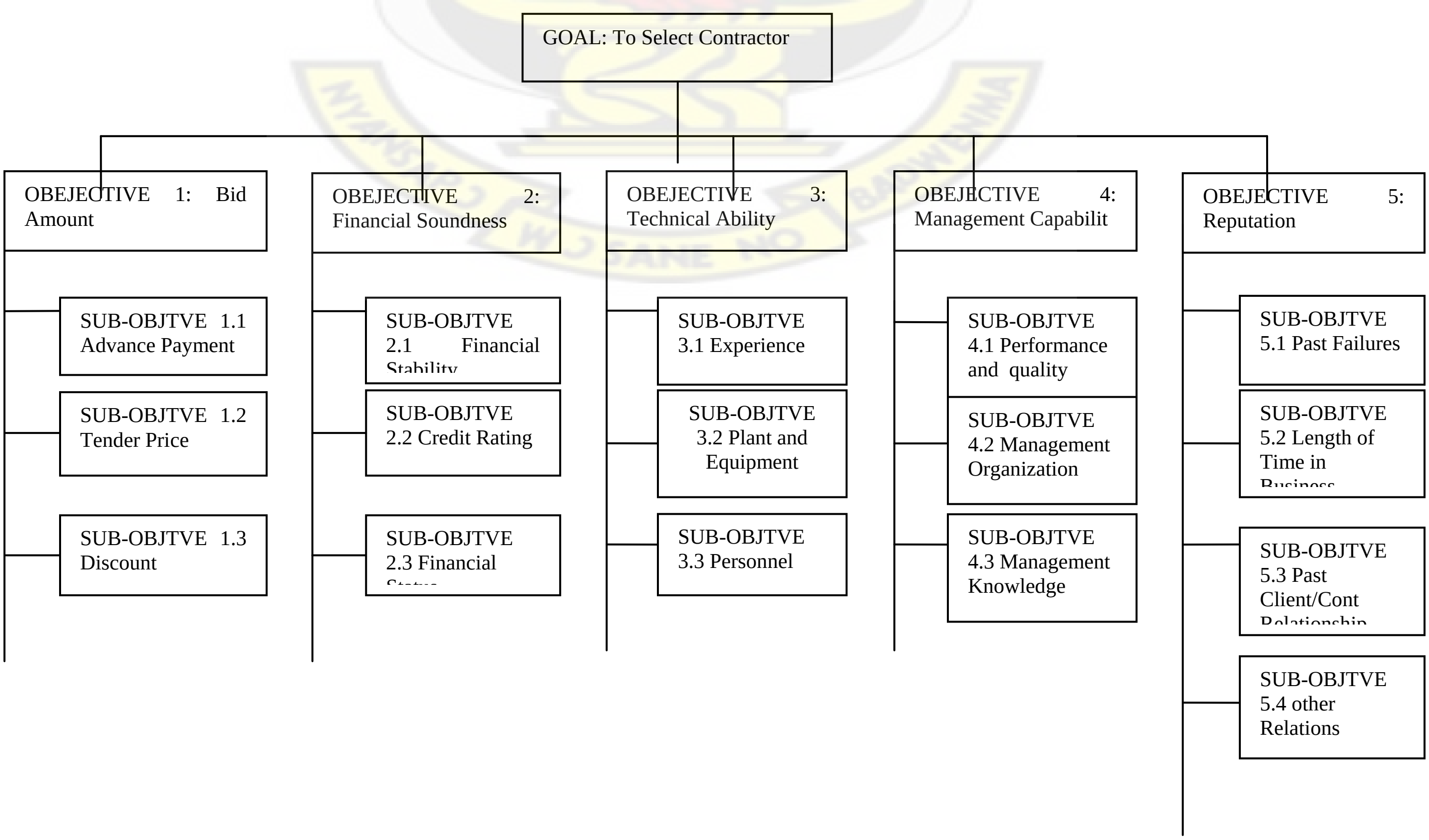


Figure 2.7 portrays hierarchical diagram of goals and objectives considered for modeling an AHP based contractor selection. The AHP represents a framework with a uni-directional hierarchical relationship (Metin and Ihsan, 2007).

Table 2.4: Sample pair-wise comparison of concrete supplier selection objectives.

Pair-wise comparison of objectives	Average of pair-wise comparisons (on a percentile scale)
Cost versus Time	65 : 35
Cost versus Quality	57 : 43
Cost versus Services	65 : 35
Cost versus Risks	55 : 45
Time versus Quality	48 : 52
Time versus Services	61 : 39
Time versus Risks	52 : 48
Quality versus Services	64 : 36
Quality versus Risks	60 : 40
Services versus Risks	41 : 59

Table 2.5: Sample pair-wise comparison of concrete supplier selection sub-objectives.

Pair-wise comparison of sub-objectives	Average of pair-wise comparisons (on a percentile scale)
Cheaper price versus better discount	72 : 28
Cheaper price versus billing flexibility	68 : 32
Better discount versus billing flexibility	56 : 44
Timely delivery versus emergency capability	68 : 32
Timely delivery versus delivery flexibility	68 : 32

Emergency capability versus delivery flexibility	59 : 41
Pre-sales customer support versus logistics capacity	59 : 41
Pre-sales customer support versus post-sales customer support	57 : 43
Logistics capacity versus post-sales customer support	54 : 46
Compliance with specifications versus quality management systems	64 : 36
Compliance with specifications versus replacement attitude	68 : 32
Replacement attitude versus quality management systems	46 : 54
Performance track-record versus reputation	60 : 40
Performance track-record versus relationships	57 : 43
Performance track-record versus Information system	69 : 31
Reputation versus relationships	51 : 49
Reputation versus Information System	61 : 39
Relationships versus Information System	63 : 37

Tables 2.4 and 2.5 show pair-wise comparisons of objectives and sub-objectives respectively of a concrete supplier selection problem.

Mathematical Illustration

The AHP has four axioms, (1) reciprocal judgments, (2) homogeneous elements, (3) hierarchic or feedback dependent structure, and (4) rank order expectations.

Assume that one is given n stones, A_1, ..., A_n, with known weights w_1, ..., w_n, respectively, and suppose that a matrix of pair-wise ratios is formed whose rows give the ratios of the weights of each stone with respect to all others. Thus one has the equation:

$$Aw = \begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \vdots & \vdots & \cdots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix} = n \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix} = nw$$

where **A** has been multiplied on the right by the vector of weights $\boldsymbol{w}$. The result of this multiplication is $n\boldsymbol{w}$. Thus, to recover the scale from the matrix of ratios, one must solve the problem $\mathbf{A}\boldsymbol{w} = n\boldsymbol{w}$ or $(\mathbf{A} - n\mathbf{I})\boldsymbol{w} = 0$. This is a system of homogeneous linear equations. It has a nontrivial solution if and only if the determinant of $\mathbf{A}-n\mathbf{I}$ vanishes, that is, n is an eigenvalue of **A.** Now **A** has unit rank since every row is a constant multiple of the first row. Thus all its eigenvalues except one are zero. The sum of the eigenvalues of a matrix is equal to its trace, the sum of its diagonal elements, and in this case the trace of **A** is equal to n. Thus n is an eigenvalue of **A**, and one has a nontrivial solution. The solution consists of positive entries and is unique to within a multiplicative constant.

To make $\boldsymbol{w}$ unique, one can normalize its entries by dividing by their sum. Thus, given the comparison matrix, one can recover the scale. In this case, the solution is any column of **A** normalized. Notice that in **A** the reciprocal property $a_{ji} = 1/a_{ij}$ holds; thus, also $a_{ii} = 1$. Another property of **A** is that it is consistent: its entries satisfy the condition $a_{jk} = a_{ik}/a_{ij}$. Thus the entire matrix can be constructed from a set of n elements which form a chain across the rows and columns.

In the general case, the precise value of w_i/w_j cannot be given, but instead only an estimate of it as a judgment. For the moment, consider an estimate of these values by an expert who is assumed to make small perturbations of the coefficients. This implies small perturbations of the eigenvalues. The problem now becomes $\mathbf{A'}\boldsymbol{w'} = \delta_{max}\boldsymbol{w'}$ where δ_{max} is the largest eigenvalue of **A'**. To simplify the notation, we shall continue to write $\mathbf{A}\boldsymbol{w} = \delta_{max}\boldsymbol{w}$, where **A** is the matrix of pair-wise comparisons. The problem now is how good the estimate of w is. Notice that if $\boldsymbol{w}$ is obtained by solving this problem, the matrix whose entries are w_i/w_j is a consistent matrix. It is a consistent estimate of the matrix **A**. **A** itself need not be consistent. In fact, the entries of A need not even be transitive; that is, A_1 may be preferred to A_2 and A_2 to A_3 but A_3 may be preferred to A_1. What we would like is a measure of the error due to inconsistency. It turns out that A is consistent if and only if $\delta_{max} = n$ and that we always have δ_{max} □= n.

Since small changes in a_{ij} imply a small change in $\delta_{\max}$, the deviation of the latter from n is a deviation from consistency and can be represented by $(\delta_{\max} - n)/(n-1)$, which is called the *consistency index (C.I.)*. When the consistency has been calculated, the result is compared with those of the same index of a randomly generated reciprocal matrix from the scale 1 to 9, with reciprocals forced. This index is called the *random index (R.I.)*. The following gives the order of the matrix (first row) and the average R.I. (second row):

n	1	2	3	4	5	6	7	8	9	10
Random Consistency Index (R.I.)	0	0	.52	.89	1.11	1.25	1.35	1.40	1.45	1.49

The ratio of C.I. to the average R.I. for the same order matrix is called the *consistency ratio (C.R.)*. A consistency ratio of 0.10 or less is positive evidence for informed judgment.

The relations $a_{ji} = 1/a_{ij}$ and $a_{ii} = 1$ are preserved in these matrices to improve consistency. The reason for this is that if stone #1 is estimated to be k times heavier than stone #2, one should require that stone #2 be estimated to be $1/k$ times the weight of the first. If the consistency ratio is significantly small, the estimates are acceptedδ; otherwise, an attempt is made to improve consistency by obtaining additional information. What contributes to the consistency of a judgment are (1) the homogeneity of the elements in a group, that is, not comparing a grain of sand with a mountain; (2) the sparseness of elements in the group, because an individual cannot hold in mind simultaneously the relations of many more than a few objects; and (3) the knowledge and care of the decision maker about the problem under study.

Figure 2.8 shows five areas to which we can apply to the paired comparison process in a matrix and use the 1—9 scale to test the validity of the procedure. We can approximate the priorities in the matrix by assuming that it is consistent. We normalize each column and then take the average of the corresponding entries in the columns.

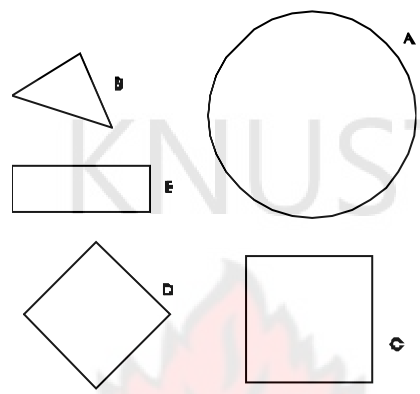


Figure 2.8 : Five figures drawn with appropriate size of area. The object is to compare them in pairs to reproduce their relative weights.

The actual relative values of these areas are A=0.47, B=0.05, C=0.24, D=0.14, and E=0.09 with which the answer may be compared. By comparing more than two alternatives in a decision problem, one is able to obtain better values for the derived scale because of redundancy in the comparisons, which helps improve the overall accuracy of the judgments.

The AHP method has been criticized by some academics because: (i) of the scale used (Poyhonen *et al*, 1997), (ii) it requires redundant information from the DM (Islei & Lockett, 1988), (iii) the occurrence of rank reversals and (iv) the comparison of two criteria represented by two totally different scales (Belton & Gear, 1983, 1985; Belton, 1986; Stewart, 1992).

2.8.5 ANALYTICAL NETWORK PROCESS (ANP)

Many decision problems cannot be structured hierarchically because they involve the interaction and dependence of higher level elements on a lower level element (Saaty, 1996). Structuring a problem involving functional dependence allows for feedback among clusters. This is a network system.

The ANP is a generalization of the AHP (Saaty, 1996) and allows for complex interrelationships among decision levels and attributes. The ANP feedback approach replaces hierarchies with networks in which the relationships between levels are not easily represented as higher or lower, dominated or being dominated, directly or indirectly (Meade and Sarkis, 1999). For instance, not only does the importance of the criteria determine the importance of the alternatives as in a hierarchy, but also the importance of the alternatives may have impact on the importance of the criteria (Saaty, 1996).

A system with feedback can be represented by a network where nodes correspond to the levels or components (Saaty, 1980). The elements in a node (or level) may influence some or all the elements of any other node. In a network, there can be source nodes, intermediate nodes and sink nodes. Relationships in a network are represented by arcs, and the directions of arcs signify dependence (Saaty, 1996). Interdependency between two nodes, termed outer dependence, is represented by a two-way arrow, and inner dependencies among elements in a node are represented by a looped arc (Sarkis, 2002a). ANP provides a way to input judgments and measurement to derive ratio scale priorities for the distribution of influence among the factors and group of factors in the decision.

ANP models have two parts: the first is a control hierarchy or network of objectives and criteria that control the system under consideration; the second are the many sub-networks of influences among the elements and clusters of the problem, one for each control criterion.

Interdependence can occur in several ways: (1) uncorrelated elements are connected, (2) uncorrelated levels are connected and (3) dependence of two levels is two-way (i.e.bi-directional). By incorporating interdependencies (i.e. addition of the feedback loops in the model), a 'supermatrix' will be developed. The supermatrix adjusts the relative importance weights in individual matrices to form a new 'overall' matrix with the eigenvectors of the adjusted relative importance weights (Meade and Sarkis, 1998).

The process of ANP comprises four major steps (Chung *et al*, 2006):

Step 1: Model construction and problem structuring

The problem should be stated clearly and decomposed into a rational system like a network. The structure can be obtained by the opinion of decision makers through brainstorming or other appropriate methods.

Step 2: Pairwise comparisons matrices and priority vectors

In ANP, like AHP, decision elements at each component are compared pairwise with respect to their importance towards their control criterion, and the components themselves are also compared pairwise with respect to their contribution to the goal. Decision makers are asked to respond to a series of pairwise comparisons where two elements or two components at a time will be compared in terms of how they contribute to their particular upper level criterion (Meade and Sarkis, 1999). In addition, if there are interdependencies among elements of a component, pairwise comparisons also need to be created, and an eigenvector can be obtained for each element to show the influence of other elements on it. The relative importance values are determined with Saaty's 1-9 scale (Table 1).

A reciprocal value is assigned to the inverse comparison; that is, $aij=1/aji$, where aij (aji) denotes the importance of the ith (jth) element. Like AHP, pairwise comparison in ANP is made in the framework of a matrix, and a local priority vector can be derived as an estimate of relative importance associated with the elements (or components) being compared by solving the following equation:

$$A \times w = \lambda_{max} \times w \quad (1)$$

where A is the matrix of pairwise comparison, w is the eigenvector, and λ_{max} is the largest eigenvalue of A. Saaty (1980) proposes several algorithms for approximating w. the following three-step procedure by Chung *et al*,(2006) is used to synthesize priorities;

1. Sum the values in each column of the pairwise comparison matrix.

2. Divide each element in a column by the sum of its respective column. The resultant matrix is referred to as the normalized pairwise comparison matrix.

3. Sum the elements in each row of the normalized pairwise comparison matrix, and divide the sum by the n elements in the row. These final numbers provide an estimate of the relative priorities for the elements being compared with respect to its upper level criterion.

Priority vectors must be derived for all comparison matrices.

Step 3: Supermatrix formation

The supermatrix concept is similar to the Markov chain process (Saaty, 1996). To obtain global priorities in a system with interdependent influences, the local priority vectors are entered in the appropriate columns of a matrix. As a result, a supermatrix is actually a partitioned matrix, where each matrix segment represents a relationship between two nodes (components or clusters) in a system (Meade and Sarkis, 1999). Let the components of a decision system be C_k, $k=1,2,\ldots,n$, and each component k has m_k elements, denoted by $e_{k1}, e_{k2},\ldots,e_{k m_k}$. The local priority vectors obtained in Step 2 are grouped and located in appropriate positions in a supermatrix based on the flow of influence from a component to another component, or from a component to itself as in the loop. A standard form of a supermatrix is as in (2) (Saaty, 1996).

$$
\begin{array}{cc}
 & \begin{array}{ccc} C_1 & C_k & C_n \end{array} \\
 & \begin{array}{ccccccccccccc} e_{11} & e_{12} & \cdots & e_{1\,m1} & \cdots & e_{k1} & e_{k2} & \cdots & e_{k\,mk} & \cdots & e_{n1} & e_{n2} & \cdots \; e_{n\,mn} \end{array} \\
\mathbf{W} = \begin{array}{cc}
C_1 & \begin{array}{c} e_{11} \\ e_{12} \\ \vdots \\ e_{1\,m1} \end{array} \\
\vdots & \vdots \\
C_k & \begin{array}{c} e_{k1} \\ e_{k2} \\ \vdots \\ e_{k\,mk} \end{array} \\
\vdots & \vdots \\
C_n & \begin{array}{c} e_{n1} \\ e_{n2} \\ \vdots \\ e_{n\,mn} \end{array}
\end{array} &
\begin{bmatrix}
W_{11} & \cdots & W_{1k} & \cdots & W_{1n} \\
\vdots & & \vdots & & \vdots \\
W_{k1} & \cdots & W_{kk} & \cdots & W_{kn} \\
\vdots & & \vdots & & \vdots \\
W_{n1} & \cdots & W_{nk} & \cdots & W_{nn}
\end{bmatrix}
\end{array}
$$

(2)

As an example, the supermatrix representation of a hierarchy with three levels as shown in Figure 2.3 (a), is follows (Saaty, 1996).

$$\mathbf{W_h}=\begin{bmatrix} 0 & 0 & 0 \\ W_{21} & 0 & 0 \\ 0 & W_{32} & I \end{bmatrix} \quad (3)$$

where W_{21} is a vector that represent the impact of the goal on the criteria, W_{32} is a matrix that represents the impact of criteria on each of the alternatives, *I* is the identity matrix, and entries of zeros corresponding to those elements that have no influence.

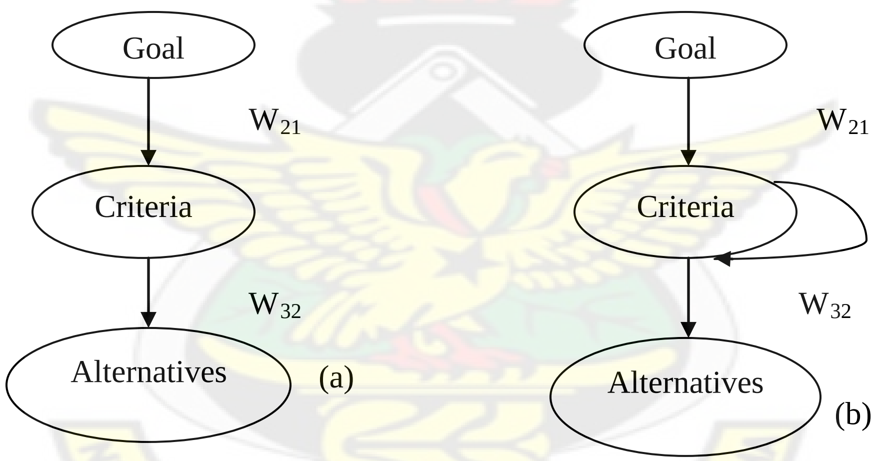


Figure 2.9: Hierarchy and Network Diagrams

(a) a Hierarchy; (b) a Network (Chung *et al*, 2006; Momoh and Zhu, 2003)

For the above example, if the criteria are interrelated among themselves, the hierarchy is replaced by a network as shown in Figure 2.9(b). The entry of Wn given by W22 would indicate the interdependency, and the supermatrix would be (Saaty, 1996).

$$\mathbf{Wn}=\begin{bmatrix} 0 & 0 & 0 \\ W_{21} & W_{22} & 0 \\ 0 & W_{32} & I \end{bmatrix} \quad (4)$$

Note that any zero in the supermatrix can be replaced by a matrix if there is an interrelationship of the elements in a component or between two components. Since there usually is interdependence among clusters in a network, the columns of a supermatrix usually sum to more than one. The supermatrix must be transformed first to make it stochastic, that is, each column of the matrix sums to unity. A recommended approach by Saaty (1996) is to determine the relative importance of the clusters in the supermatrix with the column cluster (block) as the controlling component (Meade and Sarkis, 1999). That is, the row components with nonzero entries for their blocks in that column block are compared according to their impact on the component of that column block (Saaty, 1996). With pairwise comparison matrix of the row components with respect to the column component, an eigenvector can be obtained. This process gives rise to an eigenvector for each column block.

For each column block, the first entry of the respective eigenvector is multiplied by all the elements in the first block of that column, the second by all the elements in the second block of that column and so on. In this way, the blocks in each column of the supermatrix are weighted, and the result is known as the weighted supermatrix, which is stochastic.

Raising a matrix to powers gives the long-term relative influences of the elements on each other. To achieve a convergence on the importance weights, the weighted supermatrix is raised to the power of 2*k*+1, where *k* is an arbitrarily large number, and this new matrix is called the limit supermatrix (Saaty, 1996). The limit supermatrix has the same form as the weighted supermatrix, but all the columns of the limit supermatrix are the same. By normalizing each block of this supermatrix, the final priorities of all the elements in the matrix can be obtained.

Step 4: Selection of best alternatives

If the supermatrix formed in Step 3 covers the whole network, the priority weights of alternatives can be found in the column of alternatives in the normalized supermatrix. On the other hand, if a supermatrix only comprises of components that are interrelated, additional calculation must be made to obtain the overall priorities of the alternatives. The alternative with the largest overall priority should be the one selected.

For complicated decision problems, the analytic network process (ANP) is highly recommended since ANP allows interdependent influences specified in the model. The strict hierarchical structure of the AHP may need to be relaxed when modeling a more complicated decision problem that involves interdependencies between elements of the same cluster or different clusters. This requires the generic analytic method – the analytic network process (ANP) – that can evaluate multidirectional relationship among decision elements (Saaty, 1988; Meade and Sarkis, 1998).

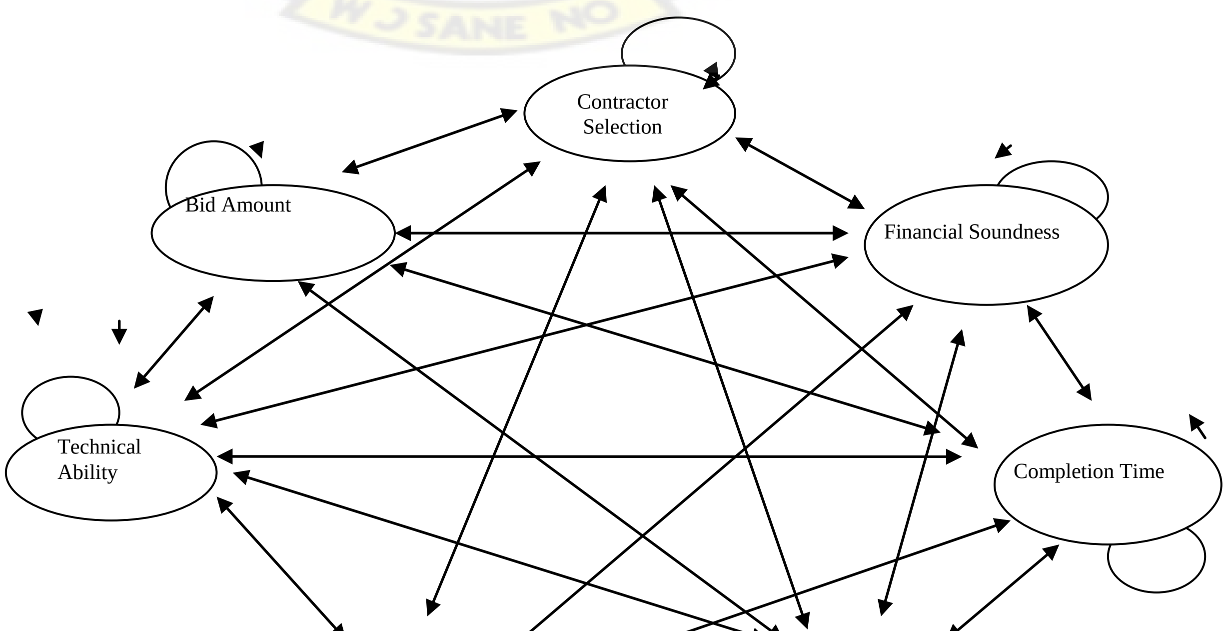


Figure 2.10: A Single Network of Contractor Selection Problem

Figure 2.10 is an illustration of network of interrelationship between criteria in a contractor selection problem.

2.8.6 MULTI- ATTRIBUTE UTILITY THEORY

This is a systematic multi-criteria decision analysis technique for contractor selection and bid evaluation based on utility theory and which permit different types of contractor capabilities to be evaluated (Hatush and Skitmore, 1998). Multi-criteria utility theory generally combines the main advantages of simple scoring techniques and optimization models. Further, in situations in which satisfaction is uncertain, utility functions have the property that expected utility can be used as a guide to rational decision-making (Hatush and Skitmore, 1998).

Multiple attribute utility theory (MAUT) uses the concept of utility to determine a DM's real preferences, judgments and attitudes towards risk (Keeney & Raiffa, 1993). This approach asks DMs a large number of hypothetical lottery-type questions in order to discover their real preferences. MAUT requires DMs to provide exact numbers (i.e. probability values) so that their utility functions can be derived. Hatush & Skitmore (1998) used MAUT to solve a contractor selection problem (CSP).

Multi- Attribute Utility Function

All decisions involve choosing one, from several, alternatives. Typically, each alternative is assessed for desirability on a number of scored criteria. What connects the criteria scores with desirability is the utility function. The most common formulation of a multicriteria utility function is the additive model (Keeney and Raiffa, 1993):

$U_i^m = \sum_{i=1}^{m} W_j U_{ij}$, *for all* i =1

where Ui is the overall utility value of alternative i

$u$ij is the utility value of the jth criterion for the ith alternative

Uij = u(Xi), for 1≥i≥n and 1≥j≥m

Xi = (xij), for 1≥i≥n and 1≥j≥m. Xi designates a specific value of xij.

n is the total number of criteria

m is the total number of alternatives

wj is the relative weight of the jth criterion

The advantage of an additive form is its simplicity. In order to determine the overall utility function for any alternative, a decision-maker need only determine n unidimensional utility functions for that alternative.

However, DMs may not give consistent answers to lottery type questions. Another disadvantage of MAUT is that the decision-making process takes a long time and becomes tedious if there are numerous criteria. The method also to some extent pre-supposes that DMs are very good at probability theory, which may not be the case in reality.

2.8.7 FUZZY SET THEORY (FST)

The use of fuzzy set theory allows the decision makers to express their assessment of contractors' performance on decision attributes in linguistic terms rather than as crisp values. The method is useful when the selection criterions are full of uncertainty and imprecision due to subjectivity of human judgment.

The DM estimates linguistically the degree of importance of each criterion to the proposed project. The DM rate each contractor on all the criteria using linguistic variables such as Excellent, Good, Satisfactory, Fair and Awful. These linguistic variables are then used for fuzzy calculations. Once all the required data are collected from the user (client), this information is translated into the fuzzy calculations. The criterion ratings are then combined with the criterion weights for all criteria to produce total weight for each contractor for a given project (Okoroh, 1996). Formula:

$$R_{ave} = \frac{\sum_{i=1}^{n} Ri \times Wi}{\sum_{i=1}^{n} Wi}$$

Where R_{ave} = fuzzy set representing the overall weighted rating of an alternative.

R_i = fuzzy set representing the ratings of the alternative based on a particular criterion.

W_i = fuzzy set representing the weight (or relative importance) assign to that particular criterion.

All operations in the above equation are fuzzy arithmetic operations (Okoroh, 1996).

This technique is suitable for the evaluation of bids where there are conflicting objectives and for sensitivity testing with several stakeholders (keeney and Raiffa, 1993). It is also suitable for selection of construction equipment, prequalification of contractors and selection of construction and project managers.

2.8.8 MULTICRITERIA COMPLEX PROPORTIONAL ASSESSMENT

This method takes into account the values and significances of criteria, the versions are arranged in rows according to their preference (Zavadskas and Kaklauskas, 1996).

The process of determination of the system of criteria, its significances and numerical values of the interested parties under investigation is based on the use of various expert and other methods, recommendations, price lists, reference books, specifications and other documents. The analysis results of interested parties being compared are presented in the form of matrices in which the rows denote the interested parties under investigation, whereas the columns express their criteria. (Zavadskas and Kaklauskas, 1996).

Zavadskas and Kaklauskas (1996) determined the efficiency of interested parties in five stages:

Stage 1: the weighted normalized decision making matrix D is formed. This is to receive dimensionless weighted values from the comparative indexes. When the dimensionless values of the indexes are known, all criteria, originally having different dimensions, can be compared.

Formula, $d(i, j) = \frac{x(i,j).q(i)}{\sum_{j=1}^{m} x(i,j)}$, i= 1,2,……….n; j = 1,2,…………m.

(1)

Where x (i, j) is the value of the ith criterion in the jth alternative of a solution; n is the number of criteria; m is the number of alternatives compared; q(i) is significance of the ith criterion.

q (i) = $\sum_{j=1}^{m} d(i,j)$, I = 1, …………n; j = 1,………….m.

(2)

Stage 2: the sums of weighted normalized indexes describing the jth version are calculated. The versions are described by minimizing indexes S (-j) and maximizing indexes S (+j). The lesser value of the minimizing indexes is better. The greater value of the maximizing indexes is better. Formula; S (+,j) = $\sum_{i=1}^{n} d(+,i)$;

S (-,j) =$\sum_{i=1}^{n} d(-,i)$; i = 1,………..n; j = 1,………….m.

(3)

The values S (+,j) and S(-,j) express the degree of goals attained by the interested parties in each alternative contractor.

The sums of pluses S (+,j) and minuses S (-,j) of all alternative contractors are always respectively equal to all sums of significances of maximizing and minimizing criteria.

S (+) = $\sum_{j=1}^{m} S(+,j) = \sum_{i=1}^{n} \sum_{j=1}^{m} d(+,i,j)$,

S (-) = $\sum_{j=1}^{m} S(-,j) = \sum_{i=1}^{n} \sum_{j=1}^{m} d(-,i,j)$, i = 1,………..n; j = 1,………….m.

(4)

Stage 3: The significances (efficiency) of comparative versions are determined on the basis of describing positive (pluses) and negative (minuses) characteristics. Relative significance Q (j) of each contractor a (j) is found according to the formula;

Q (j) = S (+,j) + $\frac{S(-,\min)\sum_{j=1}^{m} S(-,j)}{S(-,j)\sum_{j=1}^{m}\frac{S(-,\min)}{S(-,j)}}$, j = 1,………….m.

(5)

Stage 4: The priority determination of contractors. The greater the Q (j), the higher the efficiency (priority) of the contractor i.e. Q (1) > Q (2) implies contractor 1 have higher efficiency than contractor 2.

Stage 5: contractors utility degrees are calculated using the formula;

N (j) = [Q (j): Q (max)]. 100%

(6)

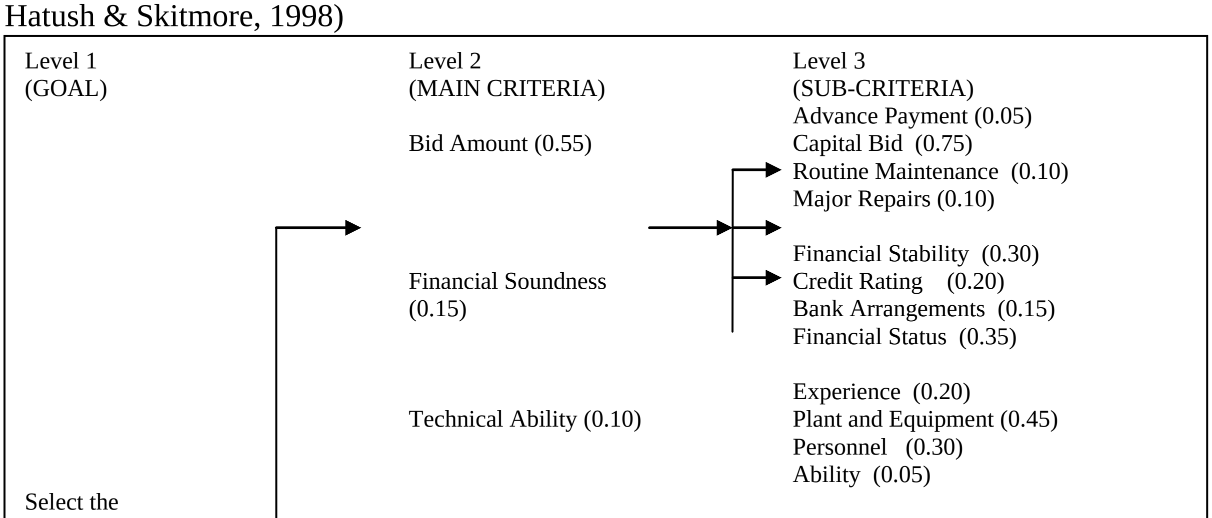
2.8.9 EVIDENCIAL REASONING (ER)

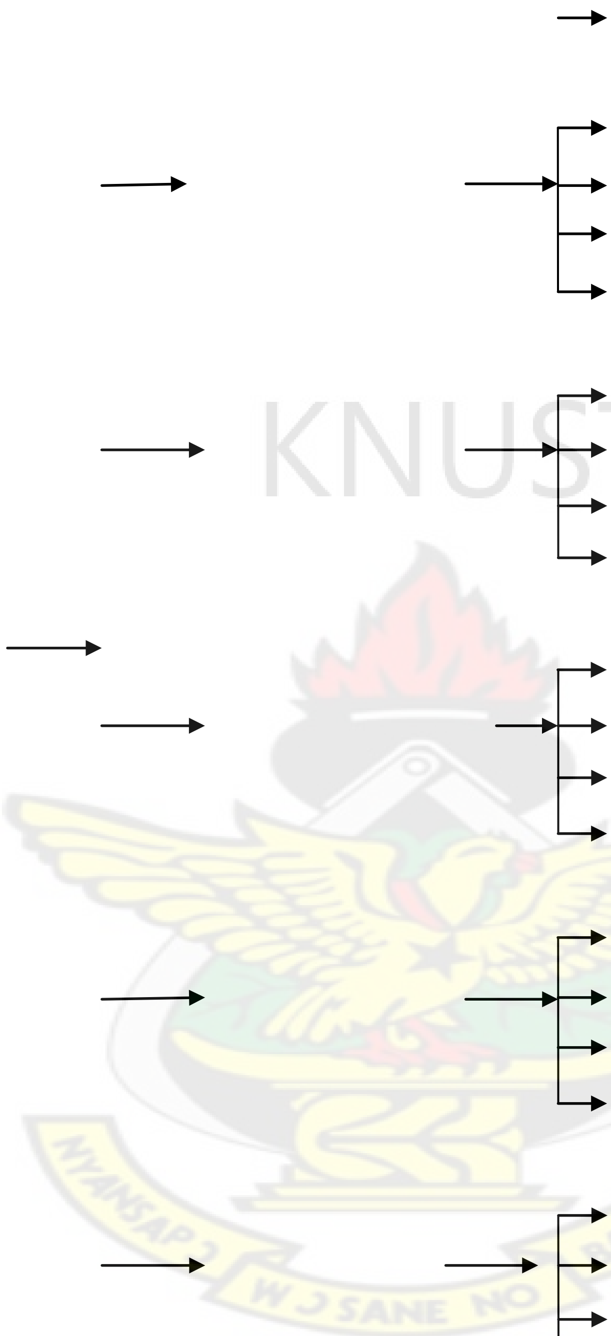
The ER approach uses the concept of `degree of belief (DoB)' as a preference elicitation tool. The DoB can be described as the degree of expectation that an alternative will yield an anticipated outcome on a particular criterion. An individual's DoB depends on their knowledge of the subject and their experience. The use of the DoB can be justified by the fact that human decision making involves ambiguity, uncertainty and imprecision. That is, individuals can convey judgments in probabilistic terms with the help of their knowledge and real life experience. Probability has long been used to deal with uncertainty and risk in decision problems; it can be a powerful tool to overcome the imprecision and ambiguity of human decision making.

Decision problems are usually structured in a hierarchical order (refer Fig.2.7). In the first level, the goal of the problem is stated. In the second level, there are several criteria, each of which has a different contribution to measuring and helping achieve the overall goal.

Then, some of these criteria may be broken down into further sub-criteria. The process (i.e. disaggregating main criteria into sub-criteria, and then sub-criteria into sub, sub-criteria) continues up to the point where DMs are able to make practical assessments (on these lower level criteria). Once the subdivision of criteria is complete, DMs evaluate each alternative based on the lowest level criteria. In order to find out how well an alternative performs across all criteria, the lowest level criteria assessments need to be first transformed to their relevant upper levels and ultimately, to the top-level goal. This requires an appropriate MCDM method. The ER approach is such a method that cannot only combine both qualitative and quantitative assessments, but can also handle uncertain and imprecise information or data.

Figure: 2.11 Herarchical display of the CSP Showing Criteria and Sub-criteria (source: Hatush & Skitmore, 1998)





Implementation of the ER Approach

The ER approach can be described as a hierarchical evaluation process in which all decision criteria are aggregated into one (i.e. the goal of the problem). As the ER algorithm has previously been well-explained (Yang & Sen, 1994; Yang, 2001), the ER process is briefly described here in a stepwise manner:

1. Display a decision problem in a hierarchical structure;

2. Assign weights to each (main) problem criterion and also to their sub-criteria (if any);

3. Choose a method for assessing a criterion either quantitatively or qualitatively;

4. Transform assessments between a main criterion and its associated sub-criteria if they are assessed using different methods (i.e. quantitative and qualitative);

5. Evaluate each alternative based on the lowest (i.e. bottom) level criteria in the hierarchical structure;

6. Quantify qualitative assessments at the top level if necessary and determine an aggregated value for each alternative;

7. Rank alternatives based on this aggregated value and (normally) choose the highest rank (Holt *et al.*, 2001).

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CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter describes the procedures that were used in this study for achieving the set objectives. How the relevant information/data was obtained is contained in this chapter. Sampling method and size, questionnaire distribution and data collection methods are discussed.

3.2 RESEARCH PROCEDURE

The procedure for this research was initially an extensive literature search on existing work on contractor selection variables and methods and later a survey using postal questionnaire approach, augmented with informal interviews. The information gathered is then analyzed using statistical techniques.

1. Literature search at libraries and on the internet from journals, magazines, publications, research thesis and relevant textbooks on contractor selection.
2. Questionnaire survey using sampling methods on Quantity Surveying, Architectural and Engineering firms registered with their mother institution in Ghana as at January, 2009 and also major construction client in Ghana.
3. Analysis of questionnaire using statistical techniques.

3.3 SAMPLE SELLECTION

The purpose of sampling is to gain information about the population by observing a proportion of that population. The three random sampling conditions will be maintained to ensure the selection of a fair representation from consultants. These conditions are:

1. Each firm has the same probability (opportunity) of being selected.
2. The sample size reflected the characteristics of the population i.e. each firm selected come from the same population.
3. Each firm will be selected independently of any other firm.

The consultancy firms used in the survey are Architectural, Engineering and Quantity Surveying firms practicing in Ghana as at January, 2009 and also based in the Greater Accra region. Greater Accra is chosen because it has a high concentration of consultancy firms among all the regions in Ghana, and also considering the short time available for the research.

A mixed approach was used for sampling because of the numbers of each group required for the consultants and the nature of client institutions.

A simple random sampling method was adopted for the architects and census for both engineers and Quantity Surveyors. The clients were selected from a preliminary survey for those that have in-house project management units.

Table 3.1: Classification of registered consulting firms

Consulting firm	National Total	Greater Accra Region
Architecture$_1$	163	130
Engineering$_2$	124	114
Quantity surveying$_3$	63	49
Total	350	293

Source: 1-GIA, 2-GIE, 3-GhIS (January, 2009)

3.4 LOCATION OF FIRMS

Majority of the consulting firms are located in the Greater Accra Region, example 130 out of the 163 Architectural firms, 49 out of the 63 Quantity Surveying firms and 114 out of the 124 Engineering firms are located in the Greater Accra Region.

The client institutions were identified through a preliminary survey to find those institutions routinely involved in construction and also has project management units in-house.

3.5 SAMPLE SIZE

The total number of registered consultants based in the Greater Accra Region is 293 registered with the various institutions.

The sample size was determined using the formula:

$n = n^1 / (1 + n^1 /N)$, (Kish, 1965)

Where n = sample size

$n^1 = S^2/V^2$

N = total population

V = standard error of sampling distribution (0.05)

$V^2 = (0.05)(0.05) = 0.0025$

S = maximum standard deviation of the population elements

$S^2 = P(1-P) = 0.5(1-0.5) = 0.25$

P = proportion of the population elements that belong to the defined category.

Calculating 95% confidence limit for the proportion of the population elements that belong to the defined category; $1 - \alpha = 0.95 \Rightarrow \alpha = 0.05$ i.e. $Z\alpha_{/2} = 0.025$

Standard error Se = 0.05

95% confidence limit:

$P \pm Z\alpha_{/2}$ Se $= 0.5 \pm 1.96\ (0.05)$

$= 0.5 \pm 0.098$

The 95% confidence interval will be from (0.5 – 0.098) to (0.5 + 0.098) = 0.402 to 0.598.

Rounding to two (2) decimal places gives 0.40 to 0.60

This means that there is a 95% probability that the proportion of the population chosen for the study is between 40% to 60% within a total error of 0.098

With the large sampling error, a larger sample should be used. Allowing for possible low response rate, a response rate of 45% is assumed.

Response rate, 45% = n/K, where K is the total number of questionnaires for each sample.

The above formula was applied to each group to determine the sample size for each group of consultants from the professional institutions.

3.6 SAMPLING

Questionnaires were sent to randomly selected Architectural firms, all Quantity Surveying firms and Engineering firms and the clients involved in construction in Ghana based in the Greater Accra region.

3.7 CONSULTANTS

Samples were selected from the list of registered consultants obtained from the various institutes or institution.

3.7.1 Architectural firms

There were 130 Architectural firms from the Greater Accra Region on the list as at January 2009. Substituting 130 into the Kish formula, a sample size of 57 is required. Substituting n = 57 into 45% = n/K.

45% = 57/K

K = 57/0.45 = 126.67.

A total of 127 questionnaires were sent out for the architects.

3.7.2 Engineering firms

There were 114 Engineering firms from the Greater Accra Region on the list as of January 2009. However, only 91 out of the 114 are directly involved in construction, the area of interest of this study. Substituting 91 into the Kish formula, a sample size of 48 is obtained. Substituting n = 48 in 45% = n/K.

45% = 48/K

K = 48/0.45 = 106.67

A total of 107 questionnaires were required for the engineers, but the total number on the list is 91 registered firms are available in the Greater Accra Region. Therefore 91 questionnaires were sent out for the engineering firms.

3.7.3 Quantity surveying firms

There were 49 Quantity Surveying firms from the Greater Accra Region on the list as of January 2009. Substituting 49 into the Kish formula, a sample size of 33 is required. Substituting n = 33 into 45% = n/K.

45% = 33/K

K = 33/0.45 = 73.33

A total of 74 questionnaires were required for the Quantity Surveying firm, but only 49 registered firms are available in the Greater Accra Region. Therefore 49 questionnaires were sent out for the Quantity Surveying firms.

3.8 CLIENTS

Thirty institutions were identified, during preliminary interviews, as routinely involved in construction works in Ghana and were selected for the survey.

3.9 DEVELOPING THE QUESTIONNAIRE

The questionnaire were developed and structured to be able to achieve the objectives of the study. The questions were designed to find the experience of the consultants and for the clients, background and experience were both found. Respondents were asked to rank contractor selection variables obtained from literature review on a scale of 1-5 and also indicate their opinion on the best methods of evaluation of contractors.

3.10 DISTRIBUTION OF THE QUESTIONNAIRE

Most of the questionnaires were addressed and posted to the respondents using the addresses obtained from institutes and institution, others were sent by email. The clients questionnaires were personally distributed. Self addressed and stamped envelopes were added to encourage high response rate. Very low response was experienced in 4 weeks of collection from the consultants. Phone calls were made for the location of firms and further personal distribution and collection of questionnaires to consultants was done.

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CHAPTER FOUR

ANALYSIS AND DISCUSSION OF SURVEY RESULTS

4.1 ANALYSIS OF RESPONSE

The questionnaires were distributed to client institutions that have project management units with construction professionals and professional consultancy firms made up of architectural, engineering and quantity surveying firms in active practice in the Greater Accra region of Ghana as of January, 2009 because of reasons stated in chapter three under location of firms. Tables 4.1 and 4.2 below show the institutions respondents belong to and their responses to the survey questionnaire.

Table 4.1: Number of Questionnaires Issued, Returned and Percentage Returned

Institutions	Number Issued	Number Returned	% Returned
Clients	30	19	63.33
Architecture	127	38	29.92

Q. Surveying	49	33	67.35
Engineering	91	37	40.66
Total	297	127	42.76

4.2 CLIENT INSTITUTIONS

These are public or private organizations that usually commission and finance construction projects. Thirty institutions were identified, during preliminary interviews, as routinely involved in construction and questionnaires were distributed to them as client institutions. These institutions had their headquarters in Accra and through their addresses were located and served with questionnaires. Nineteen (19) were returned properly filled. This gives a percentage response rate of 63.33. This encouraging high response rate is perhaps due to the fact that most of these client institutions were easy to locate in Accra.

Table 4.2: Institutions Respondents Belong To

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Client Institution	19	15,0	15,0	15,0
	Consultancy	108	85,0	85,0	100,0
	Total	127	100,0	100,0	

4.3 CONSULTANT INSTITUTIONS

A total of 267 questionnaires were distributed to consultants in the following way: Architectural firms 127, Engineering firms 91 and Quantity Surveying firms 49 as shown in Table 4.1. The number for each group of firm was determined in chapter 3, using the Kish formula.

One Hundred and Eight (108) of the total questionnaires to consultants were returned properly filled. This gives a 40.45 percentage response rate which meets the minimum target response rate of 40.00 percent in the survey design indicated in chapter 3.

On the whole, a total of 297 questionnaires, for both clients and consultants, were distributed and 127 were returned, properly filled. That gives a response percentage of 42.76.

4.4 ANALYSIS AND DISCUSSION OF QUESTIONNAIRE

The responses to the questionnaire were analyzed, discussed and inferences made out of these. The statistical program used for the analysis is the SPSS 13.

4.4.1 Respondents Job Title and Professional Affiliation

Table 4.3 shows response to question 1. The survey shows that 22.0 percent of the questionnaires were answered by Managing Directors, 12.6 percent by Project Managers, 19.7 percent by Project Architects, 19.7 percent by Project Quantity Surveyors, 15.0 percent by Project Engineers and 10.2 percent by others. The title of respondents, who described themselves as others, was either Partners or Estate Managers. One respondent did not indicate any job title.

Table 4.3: Job Titles of Respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Managing Director	28	22,0	22,2	22,2
	Project Manager	16	12,6	12,7	34,9
	Project Architect	25	19,7	19,8	54,8
	Project QS	25	19,7	19,8	74,6
	Project Engineer	19	15,0	15,1	89,7

	Others	13	10,2	10,3	100,0
	Total	126	99,2	100,0	
Missing	System	1	,8		
Total		127	100,0		

The client institutions also had construction professionals answering the questionnaire. As a result of that there were 33.1 percent of architects, 29.1 percent of engineers and 34.6 percent of quantity surveyors as respondents with 3.1 percent as others. Table 4.4 below shows the professional affiliation of respondents.

The client institutions have these construction professionals in-house perhaps because they recognize their importance in giving quick advice on technical and cost issues before the engagement of consultants or contractors on projects. They may also provide service on smaller projects where the client may not need to employ the service of a similar professional at short notice and no extra cost to the client.

Table 4.4: Respondents Professional Affiliation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Architecture	42	33,1	33,1	33,1
	Engineering	37	29,1	29,1	62,2
	Quantity Surveying	44	34,6	34,6	96,9
	Others	4	3,1	3,1	100,0
	Total	127	100,0	100,0	

The questionnaire was designed to be answered by respondents who are professionals with experience in the Ghanaian construction industry routinely involved in contractor evaluation and selection for clients. This target was achieved from the statistics presented in Table 4.4 above as 96.9% of the respondents were either involved in architecture, engineering or quantity surveying.

4.4.2 Experience of respondents

Table 4.5 Shows response to question 3

Table 4.5: Years of Experience of Respondents in Construction Industry in Ghana

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-5 Years	13	10,2	10,2	10,2
	6-10 Years	30	23,6	23,6	33,9
	11-15 Years	28	22,0	22,0	55,9
	16-20 Years	14	11,0	11,0	66,9
	Over 20 Years	42	33,1	33,1	100,0
	Total	127	100,0	100,0	

From Table 4.5 above, 10.2 percent have 0-5 years experience, 23.6 percent have 6-10 years experience, 22.0 percent have 11-15 years experience, 11.0 percent have 16-20 years experience and 33.1 percent have over 20 years experience. The survey shows that the majority of respondents were very experienced in the construction industry in Ghana.

From the experience of the respondents, it can be inferred that the sample provides a realistic profile that can be used to represent the general practice of contractor evaluation factors and selection methods of selection in Ghana.

From Tables 4.3, 4.4 and 4.5, it indicates that, most of the questionnaires were answered by people who were construction professionals, experienced and have theoretical and practical knowledge in contractor evaluation and selection.

4.4.3 Provision of consultancy services after the introduction of the Public Procurement Act

Tables 4.6 and 4.7 show the responses to questions 4 and 5.

Table 4.6: Provision of Service to Any Client over Last 5 Years in Ghana

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	119	93,7	93,7	93,7
	No	8	6,3	6,3	100,0
	Total	127	100,0	100,0	

Table 4.6 shows that 93.7 percent of respondents (clients and consultants) have provided consultancy services to clients in Ghana since the introduction of the Public Procurement Act, 2003 (Act 663).

Table 4.7: Provision of Service to Any Public Procurement Entity since PPA 2003(ACT 663)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	106	83,5	83,5	83,5
	No	21	16,5	16,5	100,0
	Total	127	100,0	100,0	

Table 4.7 also shows that 83.5 percent of the respondents have provided service to a public procurement entity in Ghana after the introduction of the Public Procurement Act 2003 (Act 663).

The response to these questions indicate that the respondent have provided consultancy service to clients, both private and public, since the introduction of the Public Procurement Act. It can therefore be inferred that the respondents have knowledge about the requirements of the law in terms of contractor evaluation and selection.

4.4.4 Type of contract (procurement) service provided by respondents

Table 4.8 shows response to question 6

Table 4.8: Procurement Type Used In Service to Client

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Traditional	96	75,6	80,7	80,7
	Design And Build	4	3,1	3,4	84,0
	Turn Key	2	1,6	1,7	85,7
	Management Contract	8	6,3	6,7	92,4
	Traditional, Design & Build	8	6,3	6,7	99,2
	All Methods	1	,8	,8	100,0

	Total	119	93,7	100,0	
Missing	System	8	6,3		
Total		127	100,0		

The survey shows the procurement type used in the service provided to various clients. It indicates that 75.6 percent of the services were traditional, 3.1 percent were design and build, 1.6 percent were Turnkey, 6.3 percent Management Contract, 6.3 percent were both traditional and design and build, 0.8 percent All Methods.

The statistics above indicates that traditional contract is still the predominant procurement method in practice in Ghana. This is probably because the government is still the largest client whom most of the consultants provide service to. The government has still yet to fully embrace modern management methods of procurement such as design and build, management contract, turnkey etc.

4.4.5 Opinion of respondents on Public Procurement Act 2003 (Act 663)

Table 4.9 shows response to question 7

Table 4.9: Performance of PPA (Act 663, 2003) In Selection of Contractors

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Absolutely Yes	8	6,3	6,5	6,5
	Yes But Not Absolute	106	83,5	86,2	92,7
	Not At All	1	,8	,8	93,5
	Do Not Know	8	6,3	6,5	100,0
	Total	123	96,9	100,0	
Missing	System	4	3,1		
Total		127	100,0		

The study showed that, in the opinion of respondents, 6.3 percent think the Public Procurement Act 2003 (Act 663) has been absolutely satisfactory in the evaluation and selection of contractors. 83.5 percent think it has been satisfactory but not absolute. 0.8

percent thinks it has not been satisfactory at all and 6.3 percent do not know how it has performed so far.

It can therefore be inferred from respondents that the Public Procurement Act 2003 (Act 663) has proved satisfactory, although not absolute.

4.4.6 Type of construction works

Table 4.10 shows response to question 8. The survey shows the type of construction work service provided to various clients. It indicates that 85.0 percent of the services were buildings, 3.1 percent were roads, 7.9 percent buildings and roads, 0.8 percent water and sewage, 1.6 percent was both roads and dams and bridges.

Table 4.10: Type of Construction Involved In

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Buildings	108	85,0	86,4	86,4
	Roads	4	3,1	3,2	89,6
	Water And Sewage	1	,8	,8	90,4
	Buildings And Roads	10	7,9	8,0	98,4
	Roads And Dams & Bridges	2	1,6	1,6	100,0
	Total	125	98,4	100,0	
Missing	System	2	1,6		
Total		127	100,0		

The statistics above indicate that building work is the predominant service provided by respondents in Ghana. This may include new buildings and/or building maintenance. Perhaps, the reason why most respondents are involved in buildings is that the government is still the major provider of infrastructure in roads, water and sewage, dams and bridges. The government of Ghana has agencies such as the Ghana Highway Authority, Urban Roads Feeder Roads, Ghana Water Company etc. to provide consultancy services on behalf of the government. With building however, the government selects consultants to provide services through competition (expression of interest) where most private consultants are involved in.

4.4.7 Effects Of Contractor Selection On Construction Projects

Tables 4.11, 4.12 and 4.13 indicate the opinion of construction professional in Ghana on the extent to which stated construction problems are attributable to constructor selection.

Table 4.11: Time Overrun Due To Contractor Selection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High	61	48.0	48.0	48.0
	Medium	56	44.1	44.1	92.1
	Low	10	7.9	7.9	100.0
	Total	127	100.0	100.0	

Table 4.12: Cost Overrun Due To Contractor Selection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High	50	39.4	39.4	39.4
	Medium	52	40.9	40.9	80.3
	Low	25	19.7	19.7	100.0
	Total	127	100.0	100.0	

Table 4.13:Quality Of Product Due To Contractor Selection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High	72	56.7	57.1	57.1
	Medium	42	33.1	33.3	90.5
	Low	12	9.4	9.5	100.0
	Total	126	99.2	100.0	
Missing	System	1	.8		
Total		127	100.0		

48.0%,39.4% and 56.7% of professionals think the problems of time overrun, cost overrun and quality of final construction project respectively were highly due to contractor selection, whiles 44.1%, 40.9% and 33.1% think same problems respectively were partly due to contractor selection. As noted by Nerija and Audrius, (2006), selecting a construction contractor is a major decision which may influence the progress and success of any construction project. These figures goes to support the assertion of researchers such as Latham (1994) that contractor selection problems still lead to extensive delays in the planned schedule, cost overruns and serious problems in quality.

4.4.8 Weights Assigned To Financial Or Technical Evaluation

Tables 4.14 and 4.15 answer question 11 on whether financial or technical evaluation should be allocated more weight in selecting a contractor in the opinion of Ghanaian construction professionals.

Table 4.14: Weight Of Price/Financial Evaluation In Selection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High	43	33.9	33.9	33.9
	Low	84	66.1	66.1	100.0
	Total	127	100.0	100.0	

Table 4.15: Weight Of Technical/Quality Evaluation In Selection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	High	110	86.6	86.6	86.6
	Low	17	13.4	13.4	100.0
	Total	127	100.0	100.0	

From Tables 4.14 and 4.15, Ghanaian construction professionals do not think financial evaluation should be allocated higher marks in evaluation to select a contractor for a project but rather higher marks should be allocated to technical evaluation with non-financial consideration such as the experience of the contractor on similar projects, technical competence, available technical staff for project, available plant/equipment for project, management team etc. Researchers and practitioners have realized that lowest-price is not the promising approach to attain the overall lowest project cost upon project completion (Chee *et al*, 2001). This is confirmed by Chan *et al* (2001) that it is essential that the contractor engaged in a building project possesses the appropriate knowledge and ability to manage the project, as it highly impacts the project performance. The Award Criteria for Housing Service Contracts, Appendix A, South Bedfordshire UK states, The Employer having regard to the nature of the services and the complexity of the Contract will predetermine the relative importance of quality and price. For them evaluation will be carried out using the following procedure:

1. Give a maximum Quality Sub Total Score of 60 points.
2. Give a maximum score of 40 points for financial submissions.
3. Calculate the total quality score with the price score for each tender to produce total scores.

The selection based on the low price basis can be one of the reasons for project completion delays, poor quality and/or financial losses, etc.(Hatush and Skitmore, 1998) and several clients have recently focused on deriving ‘optimum’ or best value from such selection exercises rather than merely relying on apparent cost-saving economies from purely price-based selections (Palaneeswaran *et al*. 2003 and 2004).

4.4.9 Evaluation Criteria for Contractor Selection.

Responses to question 12.

Table 4.16 below shows the response of respondents on their preferred method of selection.

Table 4.16 Preferred Evaluation Criteria for Contractor Selection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single Criteria	6	4,7	4,7	4,7
	Multi Criteria	121	95,3	95,3	100,0
	Total	127	100,0	100,0	

From Table 4.16, only six (6) respondents, making up 4.7 percent of the total respondents choose single criteria as their preferred method of evaluation for selecting a contractor for a given project.

All other respondents (121), making up 95.3 percent of the total respondents choose multi criteria as the evaluation criteria that will select the best contractor for a given project. This indicates that the preferred criteria of evaluation by Ghanaian construction professionals is the multi criteria method of evaluation and subsequent selection of contractors for a project as suggested by Hatush and Skitmore (1998), Faridah (2007), Chee, Holt and Phil (2001). In competitive and risky environment contractor selection must be performed according to multiple attributes (Zenonas *et al*, 2008).

Except where clients have an identified single criterion, such as a fixed price or fixed completion date, several criteria relating to contractor's. likely performance (such as technical experience, structure of the organization, financial stability, past performance and safety records) need to be considered in selecting contractors (Hatush and Skitmore, 1998).

4.4.10 Multi Criteria Selection Methods

Illustrated below are responses to questions on multi criteria selection methods (question 13).

From Table 4.17 below, 55.1 percent of respondents do not know about the multi criteria selection methods, 20.5 percent heard about methods, 11.8 percent read about methods, 8.7 percent know about the methods and 3.9 percent did not indicate any of the options provided.

Table 4.17: Knowledge of Multi-criteria Selection Methods

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Do Not Know About Methods	70	55,1	57,4	57,4
	Heard About Methods	26	20,5	21,3	78,7
	Read About Methods	15	11,8	12,3	91,0
	Know About Methods	11	8,7	9,0	100,0
	Total	122	96,1	100,0	
Missing	System	5	3,9		
Total		127	100,0		

From the statistics above, it implies that the majority of respondents, 55.1 percent, do not know about the stated multi criteria selection methods. Only 41 percent have either heard, read or know about the methods.

Only 50 respondents answered the question on the application of the listed multi criteria selection methods. Among respondents that answered the question on the application of the listed multi criteria selection methods, 58.0 % never applied any of the methods in evaluation and selection, 38.0 % ever applied one of the methods in evaluation and selection whiles 4.0% apply one of the method in all projects. Table 4.18 below illustrates the distribution of the statistics.

Table 4.18: Application of Multi-criteria Selection Methods in Ghana

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	29	22,8	58,0	58,0
	On Some Projects	19	15,0	38,0	96,0
	On All Projects	2	1,6	4,0	100,0
	Total	50	39,4	100,0	
Missing	System	77	60,6		
Total		127	100,0		

The results indicate that respondents who read or heard or know about the methods used it on some project. It may therefore be inferred that as more of the respondents know about the methods, the methods would be applied in evaluation and selection in Ghana.

4.4.11 Recommendation of multi-criteria selection methods

Table 4.19 gives responses to question 15

Table 4.19: Recommendation of Multi-criteria Selection Methods

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	AHP	5	3,9	23,8	23,8
	ANP	5	3,9	23,8	47,6
	MAUT	2	1,6	9,5	57,1
	COPRAS	4	3,1	19,0	76,2
	FST	2	1,6	9,5	85,7
	ER	2	1,6	9,5	95,2
	NONE	1	,8	4,8	100,0
	Total	21	16,5	100,0	
Missing	System	106	83,5		
Total		127	100,0		

Only 20 respondents, out of the total 127, made a recommendation of the multi criteria selection methods listed. Five (5) recommended the Analytical Hierarchy Process (AHP), another five (5) recommended the Analytical Network Process (ANP), four (4) - COPRAS and two each for MAUT, FST and ER. These statistics, coupled with the fact that most respondents indicated they do not know about the methods, may not be enough to make a conclusion on the multi-criteria selection method preferred by Ghanaian construction professionals.

4.5 FACTORS CONSIDERED IN CONTRACTOR EVALUATION AND SELECTION

A set of variables were selected from literature and respondents asked to rank their importance on a scale of 1-5 with 1 representing not important, 2- slightly important, 3- important, 4- very important and 5- extremely important. The statistical technique used, in determining that the variables considered by respondents in this research have common underlying factors, is factor analysis. Factor analysis is used, in this study, to determine whether these variables can be reduced to a smaller set of factors (Chris, 2004).

4.6 FACTOR ANALYSIS

Factor Analysis is a statistical technique used to identify a relatively small number of factors that explain observed correlations among variables (Marija, 2003). It is primarily used for data reduction or structure detection.

4.6.1 ASSUMPTIONS

Factor analysis is designed for continuous variables.

The variables should be normally distributed.

There is a good linear relation between variables.

Underlying dimensions or factors are responsible for the observed correlation.

4.6.2 USES OF FACTOR ANALYSIS

Factor Analysis is used when you have measured people on several continuous variables and you wish to see whether these variables can be reduced to a smaller set of variables (Chris, 2004). Factor analysis can be used to identify any set of variables that correlate well with each other but less well with other items. Factor Analysis can be used to reduce a large number of correlated variables to a more manageable number of independent factors that you can then use in subsequent analysis (Marija, 2003).

4.6.3 TYPES OF FACTOR ANALYSIS

Exploratory factor analysis is used to explore the factor structure in a set of data. This is what is available in SPSS which this study is using. Factors are not known in advance but are discovered during factor analysis.

Confirmatory factor analysis is a more complex procedure used to test specific theories about the nature of hidden processes.

4.6.4 HOW FACTOR ANALYSIS WORKS

Factor Analysis identifies sets of inter-correlated items by using a process called Factor Extraction. In factor extraction, hypothetical variables are placed in the best position to capture the pattern of inter-correlations in the correlation matrix.

4.6.5 FACTOR ROTATION

Factors are not placed in the best position at the factor extraction stage to enable you interpret the data for mathematical reasons. Therefore, they have to be rotated so that they are in the best possible position to enable you interpret the results with ease. There are 2 types of rotations; orthogonal and oblique rotations.

In orthogonal rotation, factors are forced to be independent (not correlated) with each other, whiles in oblique rotation, factors may correlate with each other. It must be noted that, in large sample size and robust underlying dimensions being measured, there is likely to be little difference between the outcomes of an orthogonal and an oblique rotation (Chris, 2004).

Factors are actually referred to more correctly as components in the SPSS tables because principal components analysis is being carried out (Chris, 2004). Factor analysis and principal component analysis each produce something different. Factor analysis produce factors while principal component analysis produce components. Factor analysis is used if the purpose of the research is to understand the theoretical relationship between the variables.

4.7 STEPS TO CARRY OUT FACTOR ANALYSIS

Create (compute) correlation matrix

Extracting factors

Rotating factors

Calculating factor scores

Interpreting the results of the analysis

4.7.1 COMPUTING THE CORRELATION MATRIX

4.7.1.1 THE KAISER-MEYER-OLKIN MEASURE OF SAMPLING ADEQUACY

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is an index that compares the sizes of the observed correlation coefficients to the sizes of the partial correlation coefficients. It is a statistic which indicates the proportion of variance in the variables which is common variance i.e. which might be caused by underlying factors. From Marija (2003),

$$\text{KMO} = \frac{\sum\sum_{i \neq j} r_{ij}^2}{\sum\sum_{i \neq j} r_{ij}^2 + \sum\sum a_{ij}^2},$$

The numerator $\sum\sum_{i \neq j} r_{ij}^2$ is the sum of all of the squared correlation coefficients.

The denominator $\sum\sum_{i \neq j} r_{ij}^2 + \sum\sum a_{ij}^2$ is the sum of all of the squared correlation coefficients plus the sum of all of the squared partial correlation coefficients.

If the ratio is close to 1.0, it means that all of the partial correlation coefficient are small, compared to the ordinary correlation coefficients. This indicates that the variables are linearly related. Small values of KMO measure tell you that the factor analysis of the variables may not be a good idea since observed correlations between pairs of variables cannot be explained by the other variables.

Kaiser (1974) declares KMO measures in the 0.90's as marvelous, 0.80's as meritorious, 0.70's as middling, 0.60's as mediocre, 0.50's as miserable and below 0.50's as unacceptable.

Higher KMO values (close to 1.00) generally indicate a factor analysis may be useful with the data. A value of less than 0.50 indicates the results of the factor analysis probably will not be very useful.

4.7.1.2 THE BARTLETT'S TEST OF SPHERICITY (BTS)

The Bartlett's Test of Sphericity (BTS) is used to test the null hypothesis that the observed data are a sample from a multivariate normal population in which all correlation coefficients are 0. This test requires the assumption of multivariate normality and is very sensitive to deviations from the assumption. It is better off relying on the KMO measure (Marija, 2003).

The Bartlett's Test of Sphericity indicates whether the correlation matrix is an identity matrix, which would indicate that the variables are unrelated. The significance level gives the results of the test. Very small values (less than 0.05) indicate that there are probably significant relationships among the variables whiles a significant value greater than 0.10 indicates that, the data is not suitable for factor analysis.

4.7.2 ESTIMATING THE FACTORS

Mathematical model for factor analysis is like a multiple regression equation, each variable is expressed as a linear combination of factors that are not actually observed (Marija, 2003). The general model for the i^{th} standardized variable is

$$X_i = A_{i1}F_1 + A_{i2}F_2 + \cdots\cdots + A_{ik}F_k + U_i, \text{ where}$$

F's are common factors, U is a unique factor and A's are the coefficients or loadings used to combine K factor. The unique factors are assumed to be uncorrelated with each other and with the common factors. The factors are in turn inferred from the observed variables and are estimated as linear combinations of the variables. This equation differs from the usual multiple regressions because the factors are not single independent variables.

In Principal Component Analysis (PCA), linear combinations of the observed variables are formed. The first principal component is the combination that accounts for the largest amount of variance in the sample. The second principal component accounts for the next largest amount of variance and is uncorrelated with the first in that order.

4.7.2.1 Number Of Factors Selected

As many principal components as there are variables can be calculated by the SPSS and nothing will be gained if all the variables are replaced by principal components or factors. The researcher has to determine how many factors are needed to adequately represent the data i.e. to represent the observed correlations.

The SPSS default for number of factors to be used is based on the principal component analysis solution where the number of factors to be used is chosen with the goal of explaining as much variance as possible using fewer factors as possible.

4.7.2.2 Communalities

The proportion of variance explained by the common factors is called the communality of the variable. It is the percentage of variable's variance explained by factors. This is obtained by summing the squares of the variances multiplied by 100 of each common factor for each variable. Communality can range from 0-1, where 0 implies that common factors do not explain any of the variance and 1 implies that all the variance is explained by the common factors. The variance that is not explained by the common factors is attributed to the unique factor for each variable.

The principal component analysis starts with as many components as there are variables, so the components together explain all of the observed variability in each of the variables. That is why in the communality table, the column labeled initial always has value 1.0 for the communality of each variable. Reducing the factors to a smaller number reduce the communalities for each of the variables. That gives the extraction communality on the column labeled extraction on the communalities table.

4.7.3 MAKING FACTORS EASIER TO INTERPRETE (ROTATION)

The correlation pattern between factors and variables are very important because they are used to interpret the factors. It is the absolute value of the correlation coefficient that matters. Large negative correlations are as desirable as large positive correlations.

The purpose of rotation is to achieve what is called a simple structure. In a simple structure, each factor has large loadings in absolute value for only some of the variables, making it easier to identify. It is desirable that each variable have large loadings for only a few factors, preferably one. This helps to differentiate the factors from each other. If several factors have high loadings on the same variables, it is difficult to determine how the factors differ. It should be noted that, rotation does not affect the goodness of fit of a factor solution. Communalities and percentage of total variance accounted for remain the same. The percentage variance accounted for by each of the factors, however, change.

4.7.4 COMPUTING FACTOR SCORES

After factors have been identified and found to be sufficiently useful, then factor scores can be calculated for each case. Factor scores represent how much of each factor a variable has.

4.7.4.1 METHODS OF CALCULATING FACTOR SCORES

There are various methods of calculating factor scores but only three are available in SPSS. These are 1. Regression, 2. Anderson- Rubin and 3. Bartlett. All three results in scores with mean of 0.

The regression factor scores have variance equal to the squared multiple correlations between the estimated factor scores and the true factor values (always1 for principal components). The regression method factor scores can be correlated even when factors are orthogonal.

The Anderson-Rubin method always produces uncorrelated scores with a standard deviation of 1, even if the original factors are correlated.

The Bartlett method factor scores minimize the sum of squares of the unique factors over the variables. They can also be correlated even when factors are orthogonal.

All three methods result in the same scores if principal component extraction is used (Marija, 2003).

4.7.4.2 FACTOR/COMPONENT SCORE COEFFICIENTS

The SPSS gives coefficients for regression factor scores in the component score coefficient matrix. The factor score for case j for factor k is $\hat{F}_{jk} = \sum_{i=1}^{p} W_{ji} X_{ik}$, where W's are factor score coefficients for a factor, X's are variables and where all variables are standardized.

4.7.5 INTERPRETING THE RESULTS OF THE ANALYSIS

The results of factor analysis (after factor rotation) indicate the amount of variance between the variables that each factor accounts for, and provides loadings of all the variables on each factor (Chris, 2004). The convention is to take seriously any loading that equal to 0.50. According to Comrey and Lee (1992), factor loadings of over 0.71 can be considered excellent, 0.63 to 0.70 very good, 0.55 to 0.62 good, 0.45 to 0.54 fair, and 0.32 to 0.44 poor.

The last step is to label the factors as principal component analysis can only identify sets of inter-correlated variables, it is up to the researcher to interpret what these sets are and to give them a name (Chris, 2004).

4.8 CRONBACH'S ALPHA COEFFICIENT

Cronbach's alpha is a statistic used to calculate the reliability of a measurement scale (Chris, 2004). If questions designed to measure variables are doing their job well, then the questions are expected to reasonably correlate highly. If there is little or no relationship between how respondents score on one of the questions and how they score on others, it suggests that, it cannot be claimed that the questions are measuring the same construct (Chris, 2004).

$\propto = \frac{N.\bar{C}}{\bar{N} + (N-1)\cdot\bar{C}}$, where α = Cronbach's alpha, $\bar{C}$ = Average inter-item covariance among items, N = Number of items, $\bar{N}$ = Average variance

The size of Cronbach's alpha is a function of two things: the average correlation between a set of items and the number of items. The use of Cronbach's alpha is common when questionnaires are developed for research in organizations, and an alpha coefficient of 0.70 is usually taken as the minimum level acceptable (Chris, 2004). If an alpha is less than this, the indication is that the items are unlikely to be reliably measuring the same thing.

4.9 RESULTS OF FACTOR ANALYSIS OF RESEARCH

Sixty-Seven variables were listed from literature as variables considered in selecting contractors. Construction professionals were asked to rank the variables' importance, in their opinion, as indicated earlier. The rankings of the 127 received responses were entered into SPSS and analyzed. The correlation matrix of the 67 variables was created and the matrix is shown in Appendix 5.

4.9.1 RELIABILITY TESTS

Cronbach's alpha is used to test the reliability of the questions in measuring the same construct. The Cronbach's alpha score of 0.977 (Table 4.20) obtained for this test indicate that the question was measuring the same construct in this study. The respondents were either measuring highly or lowly for each variable. Appendix 2 is the item-total statistic Cronbach's alpha score if each variable is deleted from the table. The score remains high if any particular variable is dropped from the list of variables.

Table 4.20: Cronbach's Alpha Test

Cronbach's Alpha	N of Items
,977	67

Table 4.21 below show the KMO measure of sampling adequacy and Bartlett's test of sphericity.

Table 4.21: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,868
Bartlett's Test of Sphericity	Approx. Chi-Square	7452,892
	df	2211
	Sig.	,000

From table 4.21 above the overall KMO measure of 0.868 for the data indicate that it is reasonable to go ahead with the factor analysis. The observed correlations between pairs of variables can be explained by other variables in the data i.e. the variables are linearly related. The Bartlett's Test of Sphericity significance level of 0.00 from table 4.21 above indicate that the data is suitable for factor analysis and that there is significant relationship between the variables and also suggest that the correlation (Appendix 5) matrix was not an identity matrix.

4.9.2 EXTRACTION OF FACTORS

After establishing that the variables are linearly related from the KMO and Bartlett's tests above, the factors that explain the observed correlation were looked for. As indicated earlier, observed correlations between variables result from the sharing these factors. This study is to identify these factors and to find a small number of easily interpretable factors that represent the variables.

4.9.2.1 THE MATHEMATICAL MODEL

Each contractor selection variable is expressed as a linear combination of the factors. Example, the tender price variable might be expressed as;

Tender price = a(F1) + b(F2) + c(F3) + ……+ $U_{\text{Tender price}}$ where the F's are common factors, a, b, c are the coefficients used to combine the factors and U is a unique factor because it is that part of tender price that cannot be explained by the common factors. The unique factor U represents both the variable specific component and the error.

The factors are in turn inferred from the observed variables and are estimated as linear combinations of the variables. Example, F1 = W1 (tender price) + W2 (discount provision) + W3 (maintainance cost) + ……….W67 (correspondence of type of contract to contractor's requiment), where the W's are factor score coefficients.

4.9.2.2 EXTRACTION METHOD

The method used for extracting the factors is the principal component analysis where linear combinations of observed variables are formed. The first principal component (factor) is the combination that account for largest amount of variance and the second principal component (factor) account for the next largest amount of variance and is uncorrelated with the first. As many components as there are variables are first extracted as shown in table 4.22 below. This is the default for principal component analysis extraction.

Table 4.22, which is a table of the total variance explained of the contactor selection variables, is divided into 4 main columns comprising Component, Initial Eigenvalues, Extraction Sums of Squared Loadings And Rotation Sums of Squared Loadings.

The component column indicates the components extracted initially by the principal component analysis method.

On the initial Eigenvalues column of this analysis, the first component accounted for 42.613% of the variance in the sample. The second component accounted for 5.131% of the variance in the sample and the third component accounted for 4.202% of the variance in the sample. Successive components explain progressively smaller portions of the total sample variance (Table 4.22) and all are uncorrelated with each other.

Since principal component analysis is used in extraction, the final percentage of variance that is explained is the same as the initial percentage for the same number of factors. This can be seen in Table 4.22 in the column labeled Extraction Sums of Squared Loadings.

Table 4.22: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	28,551	42,613	42,613	28,551	42,613	42,613	15,296	22,830	22,830
2	3,438	5,131	47,744	3,438	5,131	47,744	10,454	15,603	38,433
3	2,815	4,202	51,946	2,815	4,202	51,946	5,181	7,733	46,166
4	2,544	3,797	55,743	2,544	3,797	55,743	4,317	6,444	52,610
5	2,207	3,294	59,037	2,207	3,294	59,037	4,306	6,428	59,037
6	1,910	2,850	61,887						
7	1,798	2,683	64,571						
8	1,500	2,239	66,809						
9	1,414	2,111	68,920						
10	1,351	2,016	70,936						
11	1,266	1,889	72,825						
12	1,208	1,804	74,629						
13	1,079	1,610	76,239						
14	,989	1,476	77,715						
15	,957	1,428	79,143						
16	,868	1,295	80,438						
17	,809	1,208	81,646						
18	,760	1,134	82,780						
19	,708	1,057	83,837						
20	,650	,970	84,808						
21	,623	,930	85,738						
22	,605	,902	86,640						
23	,569	,850	87,490						
24	,554	,826	88,316						
25	,508	,758	89,074						
26	,485	,724	89,798						
27	,450	,671	90,470						
28	,420	,627	91,097						
29	,399	,595	91,692						

30	,368	,550	92,241						
31	,348	,519	92,761						
32	,332	,495	93,255						
33	,299	,446	93,702						
34	,289	,431	94,132						
35	,277	,413	94,546						
36	,268	,400	94,945						
37	,250	,373	95,318						
38	,232	,347	95,665						
39	,223	,333	95,998						
40	,209	,312	96,310						
41	,201	,300	96,610						
42	,192	,287	96,897						
43	,176	,263	97,160						
44	,163	,244	97,404						
45	,154	,230	97,633						
46	,147	,219	97,852						
47	,138	,206	98,058						
48	,131	,196	98,254						
49	,120	,179	98,433						
50	,109	,163	98,596						
51	,108	,161	98,758						
52	,096	,144	98,902						
53	,093	,139	99,041						
54	,083	,124	99,165						
55	,071	,106	99,271						
56	,066	,098	99,369						
57	,062	,093	99,462						
58	,055	,082	99,544						
59	,051	,076	99,620						
60	,048	,071	99,691						
61	,042	,062	99,753						
62	,038	,057	99,810						
63	,038	,056	99,866						
64	,031	,046	99,913						
65	,023	,035	99,948						
66	,020	,030	99,978						
67	,015	,022	100,000						

Extraction Method: Principal Component Analysis.

4.9.2.3 NUMBER OF FACTORS EXTRACTED

For simplicity, the SPSS standardize all variables and factors with mean of 0 and variance of 1. In the Total column, under the initial eigenvalue column (Table 4.22) there are the total variances explained by each factor. The column labeled % of variance is the percentage of total variance attributable to each factor. Example, factor 1 has total variance of 28.551, which is 42.613% of the total variance of the 67 factors, factor 2 has total variance of 3.438, which is 5.131% of the total variance of the 67 factors. The Cumulative % column is the sum of the percentage variances for that factor and the factors that precede it in the table. From Table 4.22 it is seen that about 52% of the total variance is explained by the first three factors. The factors are arranged in decreasing order of total variance explained. It must be noted that the goal of this factor analysis is to explain as much variance as possible using a few factors as possible.

The eigenvalue-greater-than-two criterion, suggesting that only factors that account for variances greater than two should be included in the factor extraction, was applied in the factor extraction. Eigenvalues are the variances of the factors. This works best for this solution because individual variables have variance of 1 as can be seen in the correlations matrix in appendix 5 using eigenvalue-greater-than-one would have resulted in 13 factors being extracted which would have been high considering that the aim is to extract as few as possible factors. The convention of component matrix coefficients greater than or equal to 0.50 to be shown was adopted. As a result, only factor scores greater than 0.50 are shown on component matrix in table 4.23 And the rotated component matrix in table 4.25

With The eigenvalue-greater-than-two criterion, five factors were extracted which will be explained in due course.

Table 4.23: Component Matrix(a)

	Component				
	1	2	3	4	5
Conductoflabourrelationship	,875				
Flexibilityofmanagement	,855				
Effectivenessofcommunication	,852				
Motivationofteam	,816				
Standardofworkmanship	,801				
Appropriateorganizationalstructure	,800				
Qualityassurance	,792				
Aftercompletionservices	,789				
Organizationandmanagementcapabilities	,788				
Valueaddedservices	,787				
Promptremedyingofdefects	,782				
Reliabilityofbuildingfirm	,782				
Degreeofcooperation	,782				
Capacityofcompany	,777				
Siteorganisation	,774				
Calibreofstaff	,772				
Relationswithsubcontractorsandstatutoryauthorities	,759				
Operationalprocedures	,759				
Abilitytoformulatepracticalprogram	,758				
Quilityoffinalbuildingproject	,746				
Procedureforinspectionofwork	,745				
Suitabilityofproposedworkprogramme	,734				
Abilitytomaintainprogram	,727				
Methodologyformanagingsubcontractors	,724				
Problemswithpaymenttosubcontractors	,724				
Cashflowforecast	,722				
Aestheticandfunctionalcharacteristics	,720				
Innovationandflair	,712				

	1	2	3	4	5
Insuranceprovision	,702				
Familiaritywithlocationofproject	,701				
Technicalaltenatives	,695				
Technicalcompetence	,681				
Equalityinserviceprovisiontostaff	,680				
Numberofstaff	,672				
Methodstatement	,666				
Environmentalaspects	,665				
Experienceoftheteam	,653				
Marketingplan	,648				
Healthandsafetyprocedures	,644				
Workprogram	,628				
Attentiontositewelfareandsafety	,628				
Extentofuseofsubcontractors	,619				
Correspondenceoftypeofcontracttoclientrequirement	,617				
Buildupofrates	,573				
Pastclientcontractorrelationship	,572				
Arithmeticalaccuracy	,567				
Financialstability	,552				
Maintainancecost	,547				
Correspondencetypeofcontracttocontractorrequirement	,546				,511
Understandingoflocallanguage	,542				
Advancepayment	,541				
Plantandequipmentholding	,533				
Availabletechnicalstaffforproject	,520				
Acceptabilityofprofitmargin	,506				
classificationofcompany					
Pastfailures					
Satisfactorysettlementofaccountsonpastprojcts					
Experienceofcompanywithsimilarprojects					
Accesstocredit					
Availableplantandequipmentforproject		,589			
Previousexperienceofcompany	,533	,567			
Locationofcompany			,601		
Litigationhistoryofcompany			,554		
Countryoforigin					
Discountprovision					
EstimatedcostofprojctlTenderprice					
Durationofconstruction					

Extraction Method: Principal Component Analysis.
a 5 components extracted.

4.9.2.4 RELATIONSHIP BETWEEN VARIABLES AND FACTORS

Using the coefficients in the components matrix in table 4.23, produced by the principal components analysis, each variable can be expressed as a linear function of the factors. Example, the previous experience of company variable can be expressed as;

Previousexperienceofcompany = 0.533 (factor 1) + 0.567 (factor 2) + $U_{previousexperienceofcompany}$

The coefficients 0.533 and 0.567, also known as factor loadings, tell how much weight is assigned to factor 1 and factor 2 for variable Previousexperienceofcompany. The variable correlates highly with factor 1 and factor 2. The factor loading coefficients are also the correlation coefficients between the factors and the variables since the factors are uncorrelated with each other (orthogonal rotation).

4.9.2.5 COMMUNALITIES

Table 4.24 shows the communalities of the variables, which shows the proportion of variance explained by the common factors. For principal component analysis, the column labeled initial has values of 1 for the communality of each variable because all the factors together explain all of the observed variability in each of the variables. Reducing the factors to 5 reduce the communalities of each variable as shown in the extraction column. Because factors are uncorrelated in this research, the total proportion of variance explained for a variable is the sum of the variance proportions explained by each factor. Example, the common factors together explain 66.8% of the Available Technical Staff for Project variable.

Table 4.24: Communalities

	Initial	Extraction
Estimatedcostofprojct]Tenderprice	1,000	,375
Discountprovision	1,000	,222
Maintainancecost	1,000	,469
Buildupofrates	1,000	,378
Arithmeticalaccuracy	1,000	,343
Advancepayment	1,000	,358
Acceptabilityofprofitmargin	1,000	,269
Satisfactorysettlementofaccountsonpastprojcts	1,000	,288
Financialstability	1,000	,534
Accesstocredit	1,000	,394
Cashflowforecast	1,000	,640
Problemswithpaymenttosubcontractors	1,000	,652
Extentofuseofsubcontractors	1,000	,527
Promptremedyingofdefects	1,000	,653
Technicalcompetence	1,000	,655
Numberofstaff	1,000	,544
Abilitytoformulatepracticalprogram	1,000	,644
Plantandequipmentholding	1,000	,596
Innovationandflair	1,000	,579
Technicalaltenatives	1,000	,580
Availabletechnicalstaffforproject	1,000	,668
Availableplantandequipmentforproject	1,000	,695
Organizationandmanagementcapabilities	1,000	,693
Relationswithsubcontractorsandstatutoryauthorities	1,000	,691
Degreeofcooperation	1,000	,656
Capacityofcompany	1,000	,698
Calibreofstaff	1,000	,717
Aftercompletionservices	1,000	,677
Pastfailures	1,000	,473

Pastclientcontractorrelationship	1,000	,616
classificationofcompany	1,000	,414
Experienceoftheteam	1,000	,574
Previousexperienceofcompany	1,000	,623
Experienceofcompanywithsimilarprojects	1,000	,468
Siteorganisation	1,000	,654
Conductoflabourrelationship	1,000	,809
Effectivenessofcommunication	1,000	,758
Flexibilityofmanagement	1,000	,807
Motivationofteam	1,000	,747
Marketingplan	1,000	,552
Operationalprocedures	1,000	,590
Durationofconstruction	1,000	,527
Workprogram	1,000	,636
Abilitytomaintainprogram	1,000	,630
Methodstatement	1,000	,542
Methodologyformanagingsubcontractors	1,000	,565
Suitabilityofproposedworkprogramme	1,000	,613
Quilityoffinalbuildingproject	1,000	,707
Standardofworkmanship	1,000	,745
Aestheticandfunctionalcharacteristics	1,000	,676
Qualityassurance	1,000	,708
Procedureforinspectionofwork	1,000	,615
Environmentalaspects	1,000	,613
Attentiontositewelfareandsafety	1,000	,638
Healthandsafetyprocedures	1,000	,606
Reliabilityofbuildingfirm	1,000	,662
Appropriateorganizationalstructure	1,000	,681
Valueaddedservices	1,000	,680
Equalityinserviceprovisiontostaff	1,000	,538
Insuranceprovision	1,000	,623
Familiaritywithlocationofproject	1,000	,731
Understandingoflocallanguage	1,000	,619
Litigationhistoryofcompany	1,000	,466
Locationofcompany	1,000	,605
Countryoforigin	1,000	,626
Correspondenceoftypeofcontracttoclientrequirement	1,000	,600
Correspondencetypeofcontracttocontractorrequirement	1,000	,618

Extraction Method: Principal Component Analysis.

4.9.3 ROTATION

From the component matrix, Table 4.23, it can be seen that some of the variables are more highly correlated with some factors than others. In order to make it easier to assign meaning to the factors, it is ideal to see groups of variables with large coefficients for one factor and small coefficients for the others.

The component matrix is therefore rotated to achieve simple structure, where each factor has large loadings in absolute value for only some of the variables, making it easier to identify.

Varimax orthogonal rotation is used in this research as it is the most frequently used rotation method (Marija, 2003). Table 4.25 shows the rotated component matrix after varimax rotation and after the variables have been sorted by the absolute values of the loadings. To make it easier to identify factors, the display of small coefficients (less than .5) was suppressed. In tables 4.23 and 4.25 correlations less than 0.5 are not shown. Five (5) sets of variables are seen in table 4.25. Twenty-three variables are highly correlated to factor 1, Fifteen, three, five and five variables correlate highly with factors 2, 3, 4 and 5 in that order.

Figure 4.2 is a three-dimensional plot of the first three components to examine the success of the orthogonal rotation. The variables are plotted, using the factor loadings as the coordinates. The SPSS produces a plot of the first three factors when the factor solution involves three or more factors. The coordinates in figure 4.2 are the factor loadings for the varimax-rotated solution. It can be seen that the factors have very strong clusters of variables associated with them.

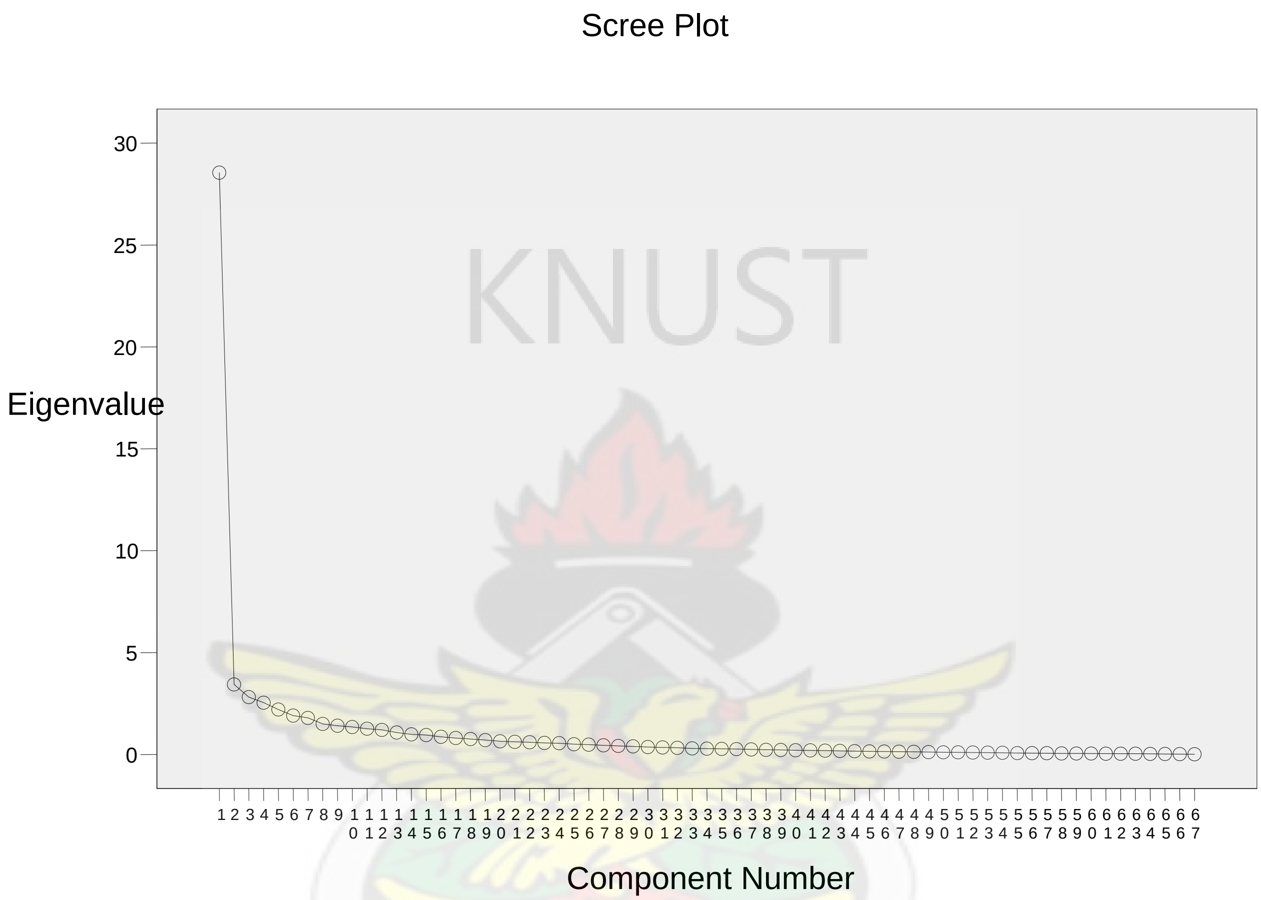
Table 4.25: Rotated Component Matrix(a)

	Component				
	1	2	3	4	5
Flexibilityofmanagement	.786				
Motivationofteam	,764				
Relationswithsubcontractorsandstatutoryauthorities	,757				
Environmentalaspects	,740				
Conductoflabourrelationship	,737				
Effectivenessofcommunication	,703				
Aftercompletionservices	,701				
Problemswithpaymenttosubcontractors	,675				
Innovationandflair	,665				
Valueaddedservices	,661				
Attentiontositewelfareandsafety	,661				
Appropriateorganizationalstructure	,660				
Degreeofcooperation	,656				
Healthandsafetyprocedures	,656				
Aestheticandfunctionalcharacteristics	,654				
Marketingplan	,629				
Equalityinserviceprovisiontostaff	,608				
Pastclientcontractorrelationship	,600				
Maintainancecost	,600				
Methodologyformanagingsubcontractors	,575				
Technicalaltenatives	,568	,502			
Siteorganisation	,559				
Operationalprocedures	,518				

Suitabilityofproposedworkprogramme					
Extentofuseofsubcontractors					
Advancepayment					
Satisfactorysettlementofaccountsonpastprojcts					
Acceptabilityofprofitmargin					
Arithmeticalaccuracy					
Standardofworkmanship		,694			
Technicalcompetence		,691			
Experienceofcompanywithsimilarprojects		,651			
Qualityassurance		,643			
Quilityoffinalbuildingproject	,530	,637			
Capacityofcompany		,630			
Abilitytomaintainprogram		,622			
Previousexperienceofcompany		,596			
Cashflowforecast		,586			
Calibreofstaff		,582			
Abilitytoformulatepracticalprogram		,563			
Organizationandmanagementcapabilities		,561			
Promptremedyingofdefects	,525	,551			
Experienceoftheteam		,515			
Procedureforinspectionofwork	,502	,512			
Methodstatement					
classificationofcompany					
Buildupofrates					
Numberofstaff					
Reliabilityofbuildingfirm					
Accesstocredit					
Availableplantandequipmentforproject			,805		
Availabletechnicalstaffforproject			,737		
Plantandequipmentholding			,641		
Financialstability					
Pastfailures					
Durationofconstruction				,670	
EstimatedcostofprojctlTenderprice				,588	
Workprogram				,540	
Correspondencetypeofcontracttocontractorrequirement				,539	
Insuranceprovision				,523	
Correspondenceoftypeofcontracttoclientrequirement					
Countryoforigin					,709
Locationofcompany					,686
Understandingoflocallanguage					,650
Litigationhistoryofcompany					,636
Familiaritywithlocationofproject					,624
Discountprovision					

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 11 iterations.

Figure 4.1: Scree Plot of Factors (Components)



When the factors were rotated, the cumulative percentage of explained variance did not change. However, the variance attributed to individual factors did. The variance is reallocated across the factors as shown in Table 4.22. It would be seen that the first factor accounted for 42.61% of the variance after extraction and 22.83% after rotation. Likewise the second factor which accounted for 5.13% of the variance after extraction had 15.60% after rotation.

Component Plot in Rotated Space

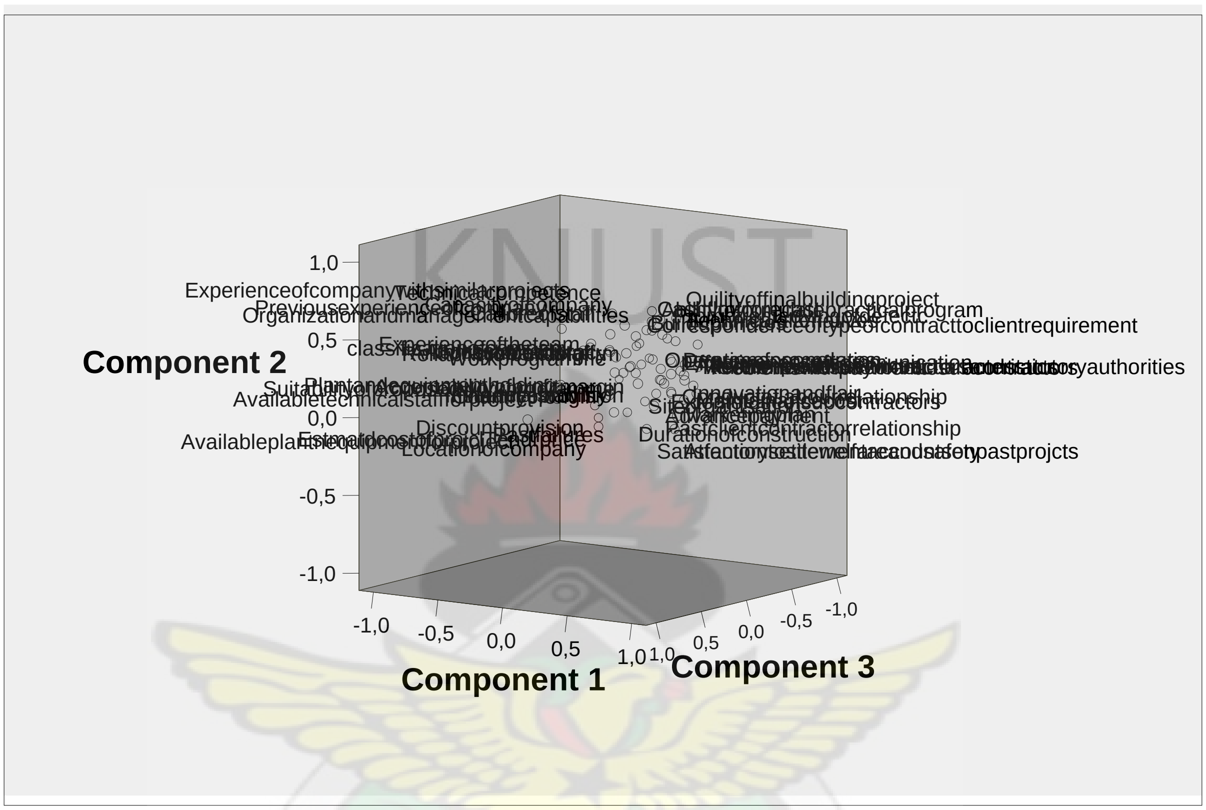


Figure 4.2 Component Plot in Rotated Space

4.10 RESULTS

The 67 contractor selection variables in this study were designed to find those among them that correlate highly with each other. This was distributed to 297 construction professionals and 127 were returned. A factor analysis (principal component analysis) with varimax rotation was used to investigate how these variables correlate with each other and for that matter indicate how the variables can be reduced to a smaller number of factors that can represent the variables.

In this study, the eigenvalues produced in the extraction were examined on both the total variance explained table and the scree plot (Figure 4.1) with the following results; 5 factors, representing about 59% of the variables' variance, were extracted to represent 51 out of the 67 variables. The 5 factors with eigenvalues greater than two are reported here. Factor loadings, after varimax rotation is shown in Table 4.25 as the rotated component matrix table.

4.10.1 FACTOR 1 : MANAGERIAL FACTORS

Factor 1 is comprised of 23 of the variables with 5 of them (the first five) loading excellently with 0.71and above, 11 of them very good with loadings of 0.63-0.70. The next 6 of the variables were good with loadings of 0.56-0.61. The last 4 loaded fairly with scores of 0.50-0.52. Factor 1 shared four variables with factor 2. Shared variables were allocated to the factors according to where it loaded higher.

The 23 extracted variables after rotation with factor loadings (in bracket), were as follows;

Flexibility of management (0.786), Motivation of team (0.764), Relations with subcontractors and statutory authorities (0.757), Environmental aspects (0.740), Conduct of labour relationship (0.737), Effectiveness of communication (0.703), After completion services (0.701), Problems with payment to subcontractors (0.675), Innovation and flair (0.665), Value added services (0.661), Attention to site welfare area and safety (0.661), Appropriate organizational structure (0.660), Degree of cooperation (0.656), Health and safety procedures (0.656), Aesthetic and functional characteristics (0.654), Marketing plan (0.629), Equality in service provision to staff (0.608), Past client/contractor relationship (0.600), Maintenance cost (0.600), Methodology for managing subcontractors (0.575), Technical alternatives (0.568), Site organization (0.559), Operational procedures (0.518).

These set of 23 variables accounted for 22.83% of the variances, after rotation of the factors (Table 4.22), and are generally concerned about managerial , environmental and health & safety issues.

The importance of managerial factors in construction is confirmed by Stukhart (1995). Thus, in order to award and successfully manage effective contracts, organizations must have disciplined, capable, and mature contract management processes in place. This is confirmed by Chan *et al* (2001) that it is essential that the contractor engaged in a building project possesses the appropriate knowledge and ability to manage the project, as it highly impacts the project's performance.

4.10.2 FACTOR 2 : QUALITY AND STANDARDS FACTORS

Factor 2 comprised of 15 variables, 6 of them loading very good with scores of 0.63-0.69, 7 good with scores of 0.55-0.62 and the last 2 with fair loadings of 0.50-0.51.

The 15 extracted variables after rotation for factor 2, with factor loadings, were as follows

Standard of workmanship (0.694), Technical competence (0.691), Experience of company with similar project (0.651), Quality assurance (0.643), Quality of final building project (0.637), Capacity of company (0.630), Ability to maintain program (0.622), Previous experience of company (0.596), Cash flow forecast (0.586), Calibre of staff (0.582), Ability to formulate practical program (0.563), Organization and management capabilities (0.561), Prompt remedying of defects (0.551), Experience of the team (0.515), Procedure for inspection of work (0.512).

Quality management is a critical component in the successful management of construction projects (Hellard,1995; Abdul-Rahman, 1997; Love *et al*., 1999).

Odeh and Batinah (2002), affirms this when they stated "To improve the present situation, authors suggest different kinds of improvement to the contracts incentive for good quality and awarding capabilities more than just the price".

4.10.3 FACTOR 3 : RESOURCE AVAILABILITY FACTORS

Factor 3 is comprised of 3 variables with two of them (first two) loadings excellently with 0.71 and above, and the other one very good with a loading of 0.64.

The 3 extracted variables after rotation for factor 3, with factor loadings, were as follows;

Available plant and equipment for project (0.805), Available technical staff for project (0.737), Plant and equipment holding (0.641).

Efficient production of building projects depends on the availability of the right resources at the right time. construction programmes usually define the resources required (information, operatives, staff, materials, plant, sub-contractors' and suppliers' requirements) in terms of time, skill and quantity. The resource requirements of projects must be planned to ensure economic use of expensive resources (CIB, 1991).

4.10.4 FACTOR 4: DURATION AND COST FACTORS

Factor 4 is comprised of 5 variables with the first one rated very good (0.67) the second one rated good and the last three with rating of fair.

The 5 extracted variables after rotation for factor 4, with factor loadings, were as follows; Duration of construction (0.670), Estimated cost of project tender price (0.588), Work program (0.540), Correspondence type of contract or requirement (0.539), Insurance provision (0.523).

The construction duration, and thus the speed with which building proceeds (construction speed), plays an important role in the commercial success of a construction project (Bordoli and Baldwin, 1998). In this connection, a construction duration that is too long, as well as one that is too short, can have a negative impact on the project's success. For this reason, planning the construction duration must be included in addition to cost and quality planning as one of the major tasks of construction project management, particularly since all three areas are closely linked (Nkado, 1995, Walker, 1995). Ellis and Herbsman (1991) outlined the importance of time/cost to determine the winning bidder in highway construction contracts, where the criteria to be considered in selection are bid prices and contract time (the road user's cost is applied to the contract time).

According to the Charted Institute of Building (CIB, 1991), from commencement to completion of a project, the management of the work involves the control of progress in terms of time, cost, resource and quality.

4.10.5 FACTOR 5: LOCATION FACTORS

Factor 5 is comprised of 5 variables with 4 of them (first four) loadings very good, and the other one with a loading of 0.62.

The 5 extracted variables after rotation for factor 5, with factor loadings, were as follows; Country of origin (0.709), Location of company (0.686), Understanding of local language (0.650), Litigation history of company (0.636), Familiarity with location of project (0.624).

By location factors in this study in meant contractor selection variables relating to different geographical locations. The effect of different geographical locations on construction projects is so important that researchers use a term 'location factor' to represent its cost implication. According to AACE International Recommended Practice No. 28R-03, "A location factor is an instantaneous (i.e., current—has no escalation or currency exchange projection),overall total project factor for translating the total cost of the project cost elements of a defined construction project scope of work from one geographic location to another. This factor recognizes differences in productivity and costs for labor, engineered equipment, commodities, freight, duties, taxes, procurement, engineering, design, and project administration. The cost of land, scope/design differences for local conditions and codes, and differences in operating philosophies are not included in a location factor”. Location factors provide a way to evaluate relative cost differences between two geographic locations (AACE, 2006).

In most studies of contractor selection, selection variables are assumed to be independent of each other. Apparently, these variables are likely to affect each other. For example, Fong and Choi (2000) used a sample of 13 respondents to identify and prioritize eight ‘un-correlated’ criteria (tender price, financial capability, past performance, past experience, resources, current workload, past relationship and safety performance) for contractor selection. In fact they found out that, the eight criteria are interrelated to a certain extent. For example, good past experience may lead to good safety performance if the past experience includes good safety records. Good past performance and experience is good evidence of successful projects, which in turn results in strong financial capability. Resources and financial capability may be positively correlated. Tender price may be negatively related to other criteria.

A survey of 53 major U.K. construction client organizations in 1994 by Holt *et al* revealed their perceived importance of factors influencing their choice of contractors. The Results indicate the five most important factors are: contractors' *current workload*, contractors' past experience in terms of *size of projects completed*, contractors' management resource in terms of—*formal training regime*, time of year—*weather* and contractors' past experience in terms of catchment, i.e. *national or local*.

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CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

Selecting the best contractor is a complex decision process for construction professionals. It requires a large number of variables to be simultaneously measured and/or evaluated. Many of these variables are related to one another in a complex way. Selection variables very often conflict insofar as improvement in one often results in decline of another(s) (Sonmez et al, 2001).

Of utmost importance is to avert project implementation failure due to the contractor's inability to undertake or complete the works. Therefore, a uniform set of guidelines in selecting a contractor is essential to ensure that pricing and background of the bidder is thoroughly assessed and the best selected for award to ensure the successful implementation of the project (Faridah, 2007).

Quite often construction projects that are behind schedule, project cost changes and inappropriate quality are a direct outcome of the selection of an inadequate contractor (Nerija and Audrius, 2006).

This study sought to find the preferred selection criteria, whether single or multi criteria, and method in Ghana. The variables used in evaluation and selection of contractors are many and often have common underlying factors. Factor analysis is used in finding those variables that have common underlying factors in Ghana according to the opinion of construction professional.

5.2 CONCLUSIONS

Within the aims and objectives set out in this study to find from the opinion of Ghanaian construction professionals the significant factors considered in selecting contractors and the methods of selection, the following conclusion can be drawn from the analysis in the preceding chapter.

1. The majority of construction professionals (client and consultants) in Ghana think the public procurement act 2003 (Act 663) is satisfactory in selecting constructors for projects although not absolute.
2. Most respondents are of the opinion that contractors' selection can affect the time of delivery, cost of project and the quality of final building product.
3. Respondents prefer multi criteria methods of selection than single criteria.
4. In allocating proportion of marks to either financial or technical evaluation most respondents will allocate more marks to technical evaluation than financial evaluation.
5. There is a need for a contractor selection technique that is capable of considering multiple criteria, however the majority of professionals do not know about multi-

criteria selection methods in this study such as ANP, AHP, MAUT, etc. the few that knew about them applied them in contractor selection.

6. Most of the variables used in selecting contractors have common underlying factors and therefore correlate very well with each other. As a result the 67 variables used in this study was reduced to five common factors represents 59% of the variances of the variables.
7. The common factors were named; Managerial factors (23 variables), Standards and Quality factors (15 variables), Resource Availability factors (3 variables), Time and Cost factors (5 variables) and Location factors (5 variables).

5.3 RECOMMENDATIONS

From the analysis and discussions in the preceding chapter, the following recommendation is made for consideration:

The few professionals that knew about the multi-criteria selection methods used it. This suggest that if the selection methods are known by construction professionals they will apply the methods. These multi-criteria selection methods should therefore be made known to construction professionals to help select 'best' contractors for clients to achieve project objectives through seminars and conferences by stakeholders.

5.4 FURTHER RESEARCH

With the government of Ghana being a major player in the Ghanaian construction industry, it should take the initiative and encourage other stakeholders to study into the multi-criteria selection methods and determine which is/are suitable for any type of contract and type of client or stakeholder involved.

5.5 SUMMARY

Contractor selection is a vital task for a client to have his project completed within budget, on schedule and with good quality. The goal of multi-criteria contractor selection is to enable the selection of the "best" contractor from the set of available options through the assessment of multiple selection objectives. The right selection of suitable contractors is highly beneficial to construction clients in the following ways;

I. To achieve target cost,
II. To achieve project delivery on time,
III. To ensure better quality of final product,
IV. To ensure value for money, and
V. Avoid risk.

The tasks of comparing available options (contractors) and good decision making, in selection, using multiple-criterion approaches are accepted the best in contractor selection in Ghana.

Using factor analysis, it was determined that there were common underlying factors among the 67 contractor selection variables which were reduced to 5 common factors making up 59% of the variances of all the variables.

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APPENDICES

APPENDIX 1

QUESTIONNAIRE

Please tick or fill in the blanks to the question below;

1) Which is your job title?

   Managing Director [ ] Project Manager [ ] Project Architect [ ] Project Quantity Surveyor [ ] Project Engineer [ ] Others [ ] (specify)

   ……………………

2) Which professional field do you belong to?

Architecture [ ] Engineering [ ] Quantity Surveying [ ]

Others [ ] (specify)……………………..

3) What is your experience in the construction industry?

0-5 years [ ] 6-10 years [ ] 11-15 years [ ] 16-20 years [ ] Over 20 years [ ]

4) Have you provided services as a consultant to any client in Ghana over the last five years?

Yes [ ] No [ ]

5) Have you provided service as a consultant to any public procurement entity since the introduction of the Public Procurement Act, 2003 (Act 663)?

Yes [ ] No [ ]

6) What type of contract (procurement) was used in your service to the client?

Traditional contract [ ] Design and build [ ] Turnkey [ ] Management contract [ ]

Others [ ] (specify)......................

7) In your opinion, has the Public Procurement Act, 2003 (Act 663) proved satisfactory in the selection of contractors?

Absolutely Yes [ ] No at all [ ]

Yes but not absolute [ ] Do not know [ ]

8) Which of the following type of construction works are you usually involved in?

Building [ ] Roads [ ] Dams and bridges [ ] Water and Sewage [ ]

Others [ ] (specify)……………………………………

9) Below are some problems that are usually associated with construction projects. In your opinion, to what extent are these problems attributable to the selection of the contractor?

ITEM	PROBLEM	RATING		
		low	medium	high
a	time overrun			
b	cost overrun			
c	quality of product			

10) The following is a list of factors considered in contractor evaluation and selection. Rank on a scale of 1-5 the importance of the listed factors below in your opinion.

1- Not important, 2- slightly important, 3- important 4- very important, 5- extremely important.

NO.	FACTORS	RANKING				
		1	2	3	4	5
1	Estimated cost of project / Tender price					

2	Discount provision					
3	Maintenance cost					
4	Build up of the rates included					
5	Arithmetical accuracy					
6	Advance payment					
7	Acceptability of the profit margin					
8	satisfactory settlement of final accounts on past projects					
9	Financial stability					
10	Access to credit					
11	Cash flow forecast					
12	Problems with payment to subcontractors on past projects					
13	Extent of use of subcontractors					
14	Prompt remedying of defects					
15	Technical competence					
16	Number of staff					
17	Ability to formulate practical programs					
18	Plant and equipment holding					
19	Innovation and flair					
20	Technical alternatives					
21	Available technical staff for project					
22	Available plant/equipment for project					
23	Organization and management capabilities					
24	Relations with subcontractors and statutory authorities					
25	Degree of co-operation					
26	Capacity of company					
27	Caliber of staff					
28	After completion services					
29	Past failures					
30	Past client/ contractor relationship					
31	Classification of company					
32	Experience of the team					

33	Previous experience of company					
34	Experience of company with similar project					
35	Site organization					
36	Conduct of labour relationship					
37	Effectiveness of communication					
38	Flexibility of management					
39	Motivation of the team					
40	Marketing plan					
41	Operational procedures					
42	Duration of construction					
43	Work program					
44	Ability to maintain program					
45	Method statement					
46	Methodology for managing subcontractors					
47	Suitability of proposed work program					
48	Quality of final building project					
49	Standard of workmanship					
50	Aesthetics and functional characteristics					
51	Quality assurance					
52	Procedure for inspection of works in progress for compliance with design intended and quality					
53	Environmental aspects					
54	Attention to site welfare and safety					
55	Health and safety procedures					
56	Reliability of building firm					
57	Appropriateness of organizational structure					
58	Value added services					
59	Equality in service provision to staff					
60	Insurance provisions					
61	Familiarity with location of project					
62	Understanding of local language					
63	Litigation history of company					

64	Location of company					
65	Country of origin					
66	Correspondence of the type of contract to client's requirement					
67	Correspondence of the type of contract to contractor's requirement					
	Others					
68						
69						
70						
71						
72						
73						

11) Factors used in evaluating contractors are broadly divided into (a) price/financial evaluation and (b) technical/quality evaluation.

Indicate, by ticking, in your opinion which type of evaluation should carry more weight in selecting a contractor.

low	high

Price/financial

Technical/quality

12) Which method of evaluation do you think will select the ‘best’ contractor to obtain value for the client?

Single criteria i.e. bid price [ ]

Multi-criteria i.e. time/cost/quality [ ]

13) Listed below are multi-criteria methods used in the selection of contractors. Analytical Hierarchy Process (AHP), Analytical Network Process (ANP), Multi-Attribute Utility Theory (MAUT), Complex Proportional Assessment (COPRAS), Fuzzy Set Theory (FST) and Evidential Reasoning (ER).

Please indicate the extent to which you know about these methods.

Do not know about methods [ ] Heard about methods [ ]

Read about methods [ ] Know about methods [ ]

14) If you know about the methods listed in (13) above, have you ever applied any of the methods in the selection of contractors for a given project?

Never [ ] On some Projects [ ] On all projects [ ]

15) If you know about the methods listed in (13) above or ever applied any of them, which multicriteria technique will you recommend to use in selecting a contractor?

Analytical Hierarchy Process (AHP) [ ] Analytical Network Process (ANP) [ ]

Multi-attribute Utility Theory (MAUT) [ ] Multicriteria Complex Proportional Assessment (COPRAS) [ ] Fuzzy Set Theory (FST) [ ]

Evidential Reasoning (ER) [ ] None [ ]

Others [ ] (please state) ………………........

APPENDIX 2

CRONBACH'S ALPHA IF ITEM DELETED RESULTS

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
EstmatdcostofprojclTendrprice	223,01	1744,151	,325	,978
Discountprovision	225,46	1740,298	,244	,978
Maintainancecost	224,98	1724,279	,485	,977
Buildupofrates	224,60	1702,592	,601	,977
Arithmeticalaccuracy	224,28	1709,202	,556	,977
Advancepayment	224,86	1711,585	,608	,977
Acceptabilityofprofitmargin	224,98	1730,906	,432	,977
Satisfactorysettlementaccountsonpastprojcts	224,26	1727,662	,391	,978
Financialstability	223,82	1731,012	,466	,977
Accesstocredit	223,97	1735,987	,334	,978
Cashflowforecast	224,51	1703,811	,722	,977
Problemswithpaymenttosubcontractors	224,32	1699,360	,729	,977
Extentofuseofsubcontractors	224,91	1708,131	,637	,977
Promptremedyingofdefectc	224,38	1690,099	,770	,977
Technicalcompetence	223,38	1712,075	,741	,977
Numberofstaff	224,17	1710,354	,658	,977
Abilitytoformulatepracticalprogram	224,16	1702,439	,737	,977
Plantandequipmentholding	223,85	1732,826	,458	,977
Innovationandflair	224,41	1707,780	,643	,977
Technicalaltenatives	224,56	1704,133	,654	,977
Availabletechnicalstaffforproject	223,36	1737,302	,510	,977
Availableplantnequipmentforproject	223,48	1744,834	,350	,978
Organizationandmanagementcapabilities	223,74	1701,894	,794	,977
Relationswithsubcontractorsandstatutoryauthorities	224,28	1704,063	,759	,977
Degreeofcooperation	224,24	1689,464	,791	,977
Capacityofcompany	223,75	1695,610	,784	,977
Calibreofstaff	223,87	1708,065	,754	,977
Aftercompletionservices	224,46	1695,321	,818	,977

Pastfailures	224,05	1737,416	,379	,978
Pastclientcontractorrelationship	224,20	1732,810	,483	,977
classificationofcompany	223,89	1723,777	,486	,977
Experienceoftheteam	223,47	1723,438	,672	,977
Previousexperienceofcompany	223,67	1731,411	,495	,977
Experienceofcompanywithsimilarprojects	223,48	1733,974	,455	,977
Siteorganisation	224,28	1702,690	,767	,977
Conductoflabourrelationship	224,48	1687,346	,874	,977
Effectivenessofcommunication	224,31	1686,403	,859	,977
Flexibilityofmanagement	224,53	1689,275	,878	,977
Motivationofteam	224,51	1689,392	,841	,977
Marketingplan	224,85	1708,826	,657	,977
Operationaprocedures	224,30	1695,677	,820	,977
Durationofconstruction	223,11	1744,498	,307	,978
Workprogramme	223,54	1721,972	,596	,977
Abilitytomaintainprogramme	223,71	1706,393	,673	,977
Methodstatement	224,05	1716,207	,629	,977
Methodologyformanagingsubcontractors	224,31	1712,170	,661	,977
Suitabilityofproposedworkprogramme	224,00	1706,698	,718	,977
Quilityoffinalbuildingproject	223,61	1699,101	,733	,977
Standardofworkmanship	223,63	1699,561	,818	,977
Aestheticandfunctionalcharacteristics	224,21	1694,771	,694	,977
Qualityassurance	223,71	1696,323	,784	,977
Procedureforinspectionofwork	223,92	1696,703	,752	,977
Environmentalaspects	223,90	1710,605	,696	,977
Attentiontositewelfareandsafety	223,63	1726,514	,561	,977
Healthandsafetyprocedures	223,71	1720,765	,607	,977
Reliabilityofbuildingfirm	223,68	1695,267	,855	,977
Appropriateorganizationalstructure	224,41	1697,222	,774	,977
Valueaddedservices	224,60	1703,290	,763	,977
Equalityinserviceprovisiontostaff	224,82	1712,222	,669	,977
Insuranceprovision	223,75	1714,959	,668	,977
Familiaritywithlocationofproject	224,64	1707,674	,701	,977
Understandingoflocallanguage	225,01	1725,267	,504	,977
Litigationhistoryofcompany	224,39	1759,241	,059	,978
Locationofcompany	225,03	1739,848	,284	,978
Countryoforigin	225,06	1722,729	,536	,977
Correspondenceoftypeofcontracttoclientrequirement	224,14	1716,655	,528	,977
Correspondencetypeofcontracttocontractorrequirement	224,56	1718,458	,491	,977

APPENDIX 3

Component Matrix(a)

	Component				
	1	2	3	4	5
Conductoflabourrelationship	,875				
Flexibilityofmanagement	,855				
Effectivenessofcommunication	,852				
Motivationofteam	,816				
Standardofworkmanship	,801				
Appropriateorganizationalstructure	,800				
Qualityassurance	,792				
Aftercompletionservices	,789				
Organizationandmanagementcapabilities	,788				
Valueaddedservices	,787				
Promptremedyingofdefects	,782				
Reliabilityofbuildingfirm	,782				
Degreeofcooperation	,782				
Capacityofcompany	,777				
Siteorganisation	,774				
Calibreofstaff	,772				
Relationswithsubcontractorsandstatutory	,759				
Operationalprocedures	,759				
Abilitytoformulatepracticalprogram	,758				
Quilityoffinalbuildingproject	,746				
Procedureforinspectionofwork	,745				
Suitabilityofproposedworkprogramme	,734				
Abilitytomaintainprogram	,727				
Methodologyformanagingsubcontractors	,724				
Problemswithpaymenttosubcontractors	,724				
Cashflowforecast	,722				
Aestheticandfunctionalcharacteristics	,720				
Innovationandflair	,712				
Insuranceprovision	,702				
Familiaritywithlocationofproject	,701				

Technicalaltenatives	,695				
Technicalcompetence	,681				
Equalityinserviceprovisiontostaff	,680				
Numberofstaff	,672				
Methodstatement	,666				
Environmentalaspects	,665				
Experienceoftheteam	,653				
Marketingplan	,648				
Healthandsafetyprocedures	,644				
Workprogram	,628				
Attentiontositewelfareandsafety	,628				
Extentofuseofsubcontractors	,619				
Correspondenceoftypeofcontracttoclientr	,617				
Buildupofrates	,573				
Pastclientcontractorrelationship	,572				
Arithmeticalaccuracy	,567				
Financialstability	,552				
Maintainancecost	,547				
Correspondencetypeofcontracttocontract	,546				,511
Understandingoflocallanguage	,542				
Advancepayment	,541				
Plantandequipmentholding	,533				
Availabletechnicalstaffforproject	,520				
Acceptabilityofprofitmargin	,506				
classificationofcompany					
Pastfailures					
Satisfactorysettlementofaccountsonpastp					
Experienceofcompanywithsimilarproject					
Accesstocredit					
Availableplantandequipmentforproject		,589			
Previousexperienceofcompany	,533	,567			
Locationofcompany			,601		
Litigationhistoryofcompany			,554		
Countryoforigin					
Discountprovision					
EstimatedcostofprojctlTenderprice					
Durationofconstruction					

Extraction Method: Principal Component Analysis. a 5 components extracted.

APPENDIX 4

Component Score Coefficient Matrix

	Component				
	1	2	3	4	5
EstmatdcostofprojclTendrprice	-,040	-,052	,027	,210	,008
Discountprovision	-,008	-,021	,054	-,072	,113
Maintainancecost	,084	-,048	-,047	-,054	,062
Buildupofrates	-,025	,075	-,052	,026	,019
Arithmeticalaccuracy	-,006	,007	,031	,046	-,004
Advancepayment	,047	-,034	-,003	,057	-,035
Acceptabilityofprofitmargin	,009	,036	-,024	-,017	,013
Satisfactorysettlementaccountson	,072	-,099	,042	,011	,015
Financialstability	,048	,010	,115	-,096	-,114
Accesstocredit	-,056	,083	,042	-,099	,080
Cashflowforecast	,008	,085	-,014	-,100	,015
Problemswithpaymenttosubcontra	,064	,003	-,089	-,002	,023
Extentofuseofsubcontractors	,029	-,014	-,032	-,042	,120
Promptremedyingofdefectc	,008	,067	-,046	-,020	,018
Technicalcompetence	-,043	,126	,018	-,068	-,013
Numberofstaff	-,028	,039	,056	-,033	,054
Abilitytoformulatepracticalprogra	-,029	,079	-,061	,056	,027
Plantandequipmentholding	-,056	-,020	,163	,037	,042
Innovationandflair	,076	-,005	-,020	-,023	-,053
Technicalaltenatives	,043	,065	-,060	-,045	-,049
Availabletechnicalstaffforproject	-,032	-,049	,205	,039	-,014
Availableplantnequipmentforproje	-,049	-,072	,246	,037	,011
Organizationandmanagementcapa	-,012	,061	,017	,044	-,058
Relationswithsubcontractorsandst	,096	-,045	-,022	-,044	,009
Degreeofcooperation	,063	,011	,003	-,059	-,029
Capacityofcompany	-,028	,086	,025	,013	-,047
Calibreofstaff	-,041	,066	,057	,045	-,038
Aftercompletionservices	,070	-,001	-,028	-,028	-,020
Pastfailures	,065	-,067	,129	-,142	,028
Pastclientcontractorrelationship	,102	-,067	,070	-,168	,039
classificationofcompany	-,025	,076	,079	-,081	-,041

Experienceoftheteam	-,053	,060	,081	,022	-,012
Previousexperienceofcompany	-,092	,109	,092	-,033	,018
Experienceofcompanywithsimilar	-,096	,170	-,027	-,048	,029
Siteorganisation	,035	-,045	,080	,015	,002
Conductoflabourrelationship	,072	-,036	,037	-,029	-,011
Effectivenessofcommunication	,064	-,005	,016	-,039	-,026
Flexibilityofmanagement	,091	-,046	,016	-,037	-,010
Motivationofteam	,092	-,029	,009	-,043	-,044
Marketingplan	,082	-,045	,007	-,090	,048
Operationaprocedures	,013	,013	-,005	,001	,048
Durationofconstruction	-,007	-,055	,002	,226	-,047
Workprogramme	-,036	,034	,030	,152	-,081
Abilitytomaintainprogramme	-,016	,104	-,056	,027	-,043
Methodstatement	-,020	,045	,069	,022	-,052
Methodologyformanagingsubcont	,042	-,003	,003	,037	-,050
Suitabilityofproposedworkprogra	,020	-,001	,072	,028	-,066
Quilityoffinalbuildingproject	,013	,110	-,095	-,022	-,039
Standardofworkmanship	-,028	,118	-,061	-,006	,010
Aestheticandfunctionalcharacteris	,061	,055	-,101	-,044	-,026
Qualityassurance	-,009	,101	-,062	,004	-,017
Procedureforinspectionofwork	,001	,064	-,074	,034	,015
Environmentalaspects	,109	-,049	-,030	-,005	-,062
Attentiontositewelfareandsafety	,088	-,126	,021	,086	,007
Healthandsafetyprocedures	,082	-,100	,005	,081	-,010
Reliabilityofbuildingfirm	-,025	,022	,037	,070	,013
Appropriateorganizationalstructur	,060	-,040	,041	,009	-,026
Valueaddedservices	,061	-,045	,034	,036	-,039
Equalityinserviceprovisiontostaff	,057	-,054	-,011	,044	,021
Insuranceprovision	-,011	-,011	,018	,140	-,015
Familiaritywithlocationofproject	-,048	,002	-,014	,064	,177
Understandingoflocallanguage	-,007	-,054	-,033	,053	,198
Litigationhistoryofcompany	-,055	,043	-,091	-,023	,221
Locationofcompany	-,012	-,090	,076	-,021	,217
Countryoforigin	-,053	-,034	,007	,054	,225
Correspondenceoftypeofcontractt	-,070	,062	-,081	,149	,084
Correspondencetypeofcontracttoc	-,060	,045	-,119	,175	,102

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

APPENDIX 5

CORRELATION MATRIX