RELIABILITY OF THE ENGINEERS ESTIMATE

IN SELECTIVE TENDERING FOR

BUILDING WORKS

(A Case for Kaduna State)

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September, 1982

DECLARATION

I hereby declare that this thesis has been prepared by me and that it is a record of my own research work. It has not been presented in any previous application for a higher degree.

All quotations are indicated and the sources of information are specifically acknowledged by means of references.

Sig:----------

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September, I982.

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We certify that we have read this thesis and in our opinion it conforms to acceptable standards of scholarly presentation and is fully adequate in scope and quality, as a thesis for the degree of Master of Science in Construction Management.

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ABSTRACT

This research work deals with the investigation of the reliability or otherwise of the engineer's estimate in selective tendering for building works. The term 'engineer's estimate' as used in this work means the estimated cost of a building normally prepared for the client by his construction cost consultants just before or during tender period,based on the same tender documents given to selected tenderers. In this work, the bills of quantities forms part of the tender documentation. This estimate is also referred to as comparative or pre-tender or QS estimate.

The investigation is limited to pre-contract stages of the building process. As a result of this, the investigation dealt mainly with the question of how reliable the engineers estimate is to the client, in terms of getting responsible tenders and awarding the contract within not more than +10 percent difference from the engineers estimated cost.

It has been discovered during the investigation that clients rely heavily on the engineers estimate to the extent that for a contractor to win a contract for building works, his tender should not differ by more than +10 percent of the engineers or QS estimate. In addition to this, it has also been discovered that strict reliance on the engineers estimate, especially in cases where the trend of tenders reveal otherwise, might result in unpleasant post contract problems such as escalation of costs and possible delay or abandonment of the project. This is because the engineers estimate is not 100 percent reliable. As such, in cases where majority of tenders received differ very significantly from the engineers estimate, then the accuracy or otherwise of the engineers estimate should be looked into. Recommendations on how to improve the reliability of the engineers estimate are proposed in the conclusions.

In general, this work has helped to bring out some problems in tendering as well as preparation of tender documents and pricing. It is hoped that the result of this research will be of immense benefit to the Government, various members of the Construction Industry and the general public.

INSPIRATION

"When a business firm attempts to mod its whole policy to meet the prices of its competitor, that business is entering a labyrinth, the centre of which is the chamber of despair, Highest quality never can be given nor obtained at the lowest prices. If a price must be sacrificed, quality must be sacrificed. If quality is sacrificed, Society is not truly served."

H. T. Carvey

DEDICATION

TO

ADAMA

ACKNOWLEDGEMENTS

Thanks be to Allah for giving me the courage to undertake this course almost nine years after getting my first degree. I am also grateful to Him for sparing my life and that of my driver during the terrible car accident I had on my way to one of the lectures at the beginning of this course.

I would also like to thank the several people who helped in one way or the other during this research work. The following persons need special mention:

(I) Dr. D.A. Muazu - PhD, MNIOB The Supervisor for his tremendous help in terms of advises, contributions and constructive review comments throughout the preparation of this dissertation. His untiring efforts and readiness to help and answer questions/problems at any time are invaluable.

(2) Mr. A.A. Husseini B.Sc, M.Sc - The Co-Supervisor for his several suggestions and valuable advise.

(3) Mr. J.O. Kolawole B.Sc, M.Sc - For his advise especially in the statistical analysis and his help in providing some reference books to the researcher.

(4) Mr. T.C. Mogbo B.Sc,M.Sc, ARICS - For several suggestions and very useful discussions.

(5) Alhaji M.B. Abubakar B.Sc, ANIQS and Alhaji Yahaya Abubakar B.Sc, ANIQS both of Shehu Giwa and Partners for their professional assistance.

(6) Messrs S.Oke and S. Aroyehun Secretary and Printer respectively of Shehu Giwa and Partners for typing and printing the draft often at odd times.

(7) The various firms contacted in the course of this investigation especially those who supplied information.

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ABREVIATIONS

ARCON	-	Architects Registration Council of Nigeria
BOQ	-	Bills of Quantities
CIOB	-	Chartered Institute of Builders London
COREN	-	Council of Registered Engineers of Nigeria
FMBN	-	Federal Mortgage Bank of Nigeria
IQS	-	The Institute of Quantity Surveyors London
Kg	-	Kilogram
m	-	Metre
NIA	-	Nigerian Institute of Architects
NIOB	-	The Nigerian Institute of Builders
NIQS	-	The Nigerian Institute of Quantity Surveyors.
NJCC	-	National Joint Consultative Committee of Architects, Quantity Surveyors and Builders
NNN	-	New Nigerian Newspapers
QS	-	Quantity Surveyor
RIBA	-	The Royal Institution of British Architects London
RICS	-	The Royal Institution of Chartered Surveyors London

GLOSSARY

(I) The Client: is the person or persons who wants a building or buildings, who commissions the project and is responsible for paying for it. He is sometimes called the "building owner" and, in the R.I.B.A. form of contract, becomes the Employer. These terms, however, are inappropriate for the period before a building or a building contract (exists).

(2) The Client's designer is an architect, engineer or other specialist who translates the client's needs into specific building proposals. He will usually be the leader of a design team of architects, engineers, quantity surveyors, artists and other specialists who collectively evolve the design. The client may sometimes also be considered as a partner in the team as he must be consulted on all major decisions.

(3) Professional Advisers include not only the professional members of the design team but also others whose advice is not limited to the processes of building but may be necessary for the client to decide whether to build and, if so, what to build. Such advisers may include an estate and valuation surveyor, an accountant, a banker, an industrial engineer or other expert in the use of the particular client's resources.

(4) A general Contractor who, with his own employees normally does building work in several different skills or trades.

(5) A Specialist contractor who normally restricts the work of his own employees to one type of skill or trade or to a group of closely related skills or trades.

(6) A main contractor who is responsible to the client for the execution of the whole of the building contract, whether or not he performs any or all of the building operations with his own employees.

(7) A sub-contractor who is responsible for only part of a building and whose direct responsibility is to the main contractor and not to the client.

(8) Tender Documents

Documents submitted for the information of tenderers: documents, such as specifications, might be included which would not necessarily become contract documents if the tender were accepted

(9) Tender Figure

The sum of money forming part of the tender

(IO) Tender

The sum of money, time and other conditions required by the tenderers to carry out the specified building work.

(II) Tendering

A tender is usually an offer to do certain specific building work for a specified consideration. The term "tendering" should therefore logically mean "offering." However, although the term "tender" is in fact usually used to mean "an offer", the term "tendering" is commonly used to include all the processes of selecting a contractor (of which an offer may form part), which precede the arrangement of a contract. This more general meaning is adopted here, when only part of this process is intended, the appropriately narrower term is used.

(I2) Cost and Price

Cost is the amount paid by the purchaser. Price is the amount demanded by the vendor. In a building project the client purchases a building service from the contractor: the client's cost is the same as the contractor's price. A contractor also purchases some building service from a sub-contractor; the contractor's cost is the same as the sub-contractor's price.

(I3) Contract Sum

The formal meaning usually given to this term is the sum which is written into the contract document and described as "the contract sum," The R.I.B.A. form of contract qualifies this sum with the words "or such other sum as shall become payable hereunder....." It is this other sum which is payable in the final account which is in fact the true contract sum. It is often important to differentiate between the formal contract sum and the final contract sum.

(I4) Management

The generic term 'management' means: The person carrying out the function of general management and responsible for making the decision to tender and for carrying our adjudication'.

(I5) Estimating

Estimating is a technical function within the building commercial field

(I6) Estimator

A person carrying out the estimating function in a building organisation. Such a person may be a specialist or he may carry out the estimating function in conjunction with other functions, such as quantity surveying, general management, etc.

(I7) Adjudication

Adjudication is the action taken by management to convert an estimate into a tender.

(I8) All-In Labour Rate

An all-in labour rate is a compounded rate which includes payments to operatives and the cost which arise directly form the employment of labour. Variable cost, such as travelling time or abnormal overtime, are excluded.

(I9) All-In Mechanical Plant Rate

An all-in mechanical plant rate is a compounded rate which includes the costs originating from the ownership or hire of plant together with operating costs.

(20) All-In Material Rate

The all-in rate for a material or component includes the cost of material delivered to site, waste, unloading, handling, storage and preparing for use.

(2I) General Overheads

The cost of administering a company and providing off-site services. The allocation of general overheads to projects and to the company as a whole is decided by management as part of management policy.

(22) Project Overheads

The cost of administering a project and providing general plant, facilities and site-based services.

CHAPTER ONE

I. INTRODUCTION

I : I General Background

The Nigerian Construction Industry has experienced a very rapid expansion since the end of the civil war and especially the emergence of the oil boom in the early seventees (70s). This trend has since continued with the resultant effect that strains and stresses are being felt in all the sectors of the Industry.

McCarthy (2I) while writing on the problems of the Nigerian Contractor states that "in the Northern states, statistics for the years I964-I967 shows that there was never more than ₦5,000,000 worth of building works being constructed for the Government, i.e. public as opposed to private construction, at any time during those four years throughout the whole former Northern Region." At the time of his writing i.e. I973 he "estimates that in the North Central State (now Kaduna State) alone the amount of public building works exceeds sixteen million naira ₦I6,000,000. In the six Northern States collectively the total exceeds eighty million naira ₦80,000,000. Compare this enourmous figure with the five million naira before the start, of the current plan." He hasten to state that "these figures are for building works only. They do not include the large sums being spent on roads, bridges, dams and water supplies."

McCarthy wrote this in I973 when he referred to building works amounting to eighty million naira in the then six Northern states as enourmous. By I982, the total financial commitments to building works in the North is far more than what McCarthy estimated in I973.

As a result of this rapid expansion in the Industry, and the acute shortage of trained manpower to cope with the situation, various semi-skilled professionals and contractors have infiltrated the Industry. This state of affairs was appropriately described by the Chief Surveyor FMBN Mr. S.K. Jagun (I5) when he states that "And when one considers the key words of this paper namely 'Finance' and 'contracts' the mind boggles at the thought of the brief-case carrying brigades of contractors (or emergency contractors) trooping round the corridors of power, ready to append their signatures to anything which translates into naira and kobo." This is the unfortunate situation which characterises the contractors side of the industry today.

On the side of the professional members of the design team it could be noticed that inspite of the existence of both statutory and professional bodies some of which have legal backings such as the Council of Registered Engineers (COREN), The Architects Registration Council (ARCON), Nigerian Institute of Architects (NIA), Nigerian Institute of Builders (NIOB), Nigerian Institute of Quantity Surveyors (NIQS) and the Surveyors Licencing Registration Board, members of the design team are not left out of this predicament.

Many unqualified and inexperienced people could be found both in governments and private organisations carrying out jobs which should normally be handled by qualified and experienced personnel. The professional firms and organisations who are lucky to have qualified and experienced staff heading them are not altogether absolved from these lapses. This is because Most of them take more projects than they can handle satisfactorily and the senior staff have hardly enough time to cross-check what their assistants have prepared. Owete (28) in his address to the NIQS on contract awards states that "---------- I have purposely used the words proper 'performances' in my last sentence because it has been alleged that some Quantity Surveyors either lack the ability to prepare or do not excercise enough deligence in preparing their comparative estimates."

On the other hand, the clients are always in the habit of pushing the professionals to produce their documents sometimes within unreasonably short periods of time.

Coupled with these problems is the lack of adequate data on construction costs. Agbaroji (I.) while emphasising the use and advantage of price data states that "collection of sufficient data is paramount. Analysis is made easier and more meaningful provided the data are the type required."

It is within these conflicting and sometimes unfavourable conditions that the researcher tries to answer the following questions? How reliable is the engineers estimates? Or to put the question in more elaborate terms: What degree of reliability should the client attach to the estimates of cost and time given to him by his Construction Cost Consultants in terms of the possible tenders to be received.

I : 2

NEED FOR THE WORK

Most clients in Nigeria and many other countries rely heavily on the pre-tender estimates given to them by their cost advisers while making awards for their contracts. It is a general practice that before a contractor's tender is considered suitable for acceptance by the tenders board the tender figure should not differ by more than ± 10% of the comparative engineer's estimates

The realisation of this reliance by clients on the engineers estimates makes medium sized contractors who are not sure of the accuracy of their estimates to try and have an idea of how much the engineers estimate is, so that they could tell their estimators to price within the ± 10% range so as to increase their chances of winning the contract.

Because of this reliance by most clients and some contractors on the engineers pre-tender estimates, there is a need for a scientific investigation into the reliability or otherwise in the preparation of pre-tender estimates by the clients cost advisers.

I : 3

OBJECTIVES OF THE RESEARCH

The main objectives of the Research are to:

(a) Arrive at a method of preparing reliable engineers estimates

(b) Provide a guide to building owners as to what degree of reliability could be attached to engineers estimate.

I : 4 Scope and Limitations

The type of engineers estimate used for this study is the estimate prepared by the clients consultants on the basis of the tender documents given to the various contractors. This is preferred because other types of estimates such as approximate estimates cannot form a good basis of comparison since the contractors will base their tenders on a much more detailed documents than those available at the time of the preparation of approximate estimate.

The study has covered the reliability of the engineers pre-tender or comparative estimate up to the time of the receipt and opening of tenders and the subsequent award of the contract. This is generally known as the pre-contract period. Post-Contract problems are not investigated in this work.

In order to minimise the number of differences in prices due to geographical locations the work is limited to Kaduna State. Most of those interviewed i.e. the contractors and Consultants as well as professionals in government and other organisations are those based in Kaduna State on projects located in Kaduna State.

The work is futher based on selective tendering as it is the only method which minimises the differences in terms of the capabilities of those invited to tender. It provides for competent contractors who have good estimators and would not be teleguided by possible leakages of the engineers estimates.

The study is further limited to building works, such as residential buildings, institutions, offices, hospitals etc. Civil engineering works such as dams, roads, bridges, airports etc are not covered by this work since their tender documentation are in many respects not as elaborate and exact as those of building works.

The tender documentations for the buildings covered by this work include bills of quantities measured in accordance with the 5th edition of theStandard Method of Measurement of Buildings Works. This is considered to be the best form of tender documentation as it provides all the tenderers with the same quantities on which to base their tenders.

Finally, the study is limited to the investigation of the reliability of the engineers or QS estimate of consts only. Quoted completion periods are not investigated because it has been discovered that in most cases, the tender figures are not very much related to quoted completion periods. In theory, this should not be the case. It is for this reason that clients hardly ask their professional advisers about how long it will take to construct a building but rather how much will the building cost. All the projects to be investigated therefore, are those expected to be completed within normal completion periods. Projects required to be acellerated or with special time requirements will not be investigated.

5 Methodology for the Measurement of Reliability

The engineers estimate consists of the estimated cost of a building based on the tender documents. This estimate is normally given to the client before or during receipt of tenders from the various contractors invited to tender.

From this estimate the client expects two things if the estimates is to be relied upon.

These are:

(a) Expects to receive tenders and award the contract within not more than ± 10% difference from the engineers estimate.

(b) Expects to have the project satisfactorily completed with little or no difference from the engineers estimate of cost.

Random samples will therefore be taken of various projects to compare the engineers pre-tender estimates and the tenders received and using the statistical technique of the chi-square tests at 90 percent confidence levels together with some other mathematical analysis determine what degree of reliability could be attached to engineers estimate with respect to tenders received.

In agreeing with our methods of measurement of reliability by means of comparing the tender sums with the engineers estimate. Agbaroji (I) states that "Reliability refers to consistency, it is measured by the extent to which rates, prices or tender sums agree with each other, in other words by the variability of price."

He enumerated the units for the comparison as follows:

(a) Unit rates in bills of quantities

(b) total price or cost of a functional element in bills of quantities

(c) total price or cost of a trade or work section, eg. excavation, concretework etc.

(d) price or cost of a whole building eg. a two bedroom bungalow

(e) tender sums for a given project

In this work it has been decided to use the last unit which is tender sums for a given project. After the tests we will be able to determine what degree of reliability could be attached to engineers estimate with respect to tenders received and subsequent contract sum.

I;6 Synopsis

This work is divided into four main chapters.

Chapter I - Introduction starts by giving a general background of the research, explains the needs for the research and the objectives or what is expected to be achieved by the research, and discusses the scope and liminations of the study. The chapter ends by explaining the methodology followed during the research.

Chapeter 2 - Literature Review starts by discussing reliability, various types of estimates tender documents with bills of quantities forming part, types of tenders with particular reference to selective tendering, pricing or estimating techniques, tender preparation and tendering strategies. The chapter ends with a summary of the discussions.

Chapter 3 - Field Investigations and Analysis deals with data collection, data analysis and discussions on the various observations made during the field tests.

Chapter 4 - Conclusion and Recommendations deals mainly with conclusions drawn from the Literature Review and Field Investigations and analysis. Some recommendations based on the conclusions will be made.

CHAPTER II

2.0 LITERATURE REVIEW

2.I RELIABILITY of prepared Estimates

As stated earlier, the engineers estimate refers to the pre-tender estimate prepared for the clients or building owner by his construction Cost Consultants. The question then is how reliable are these estimates?

Reliability could be ascertained from the clients point of view if the estimate satisfies his needs.

Luder (19) suggested that clients requirement for their buildings are:

"the RIGHT building at the RIGHT cost at the RIGHT time"

These three basic requirements are what an average client requires from his professional advisers:- Architects, engineers and quantity surveyors.

It therefore follows that the degree of reliability which should be attached to the engineers estimate is the extent to which that estimate helps the client as to the probability of achieving his objectives within that estimate

2:I:I The Right Building

According to Luder(19) "the right building is related to design. It is possible to obtain the construction method right, the lowest cost, the building time reduced to the absolute minimum, but unless the design and layout of the building is right, the client is provided with the cheapest and quickest building, but a building that does not meet his requirements. A building that may not be used properly, that will be a festering sore for as long as he owns or occupies it."

Luder further asserts that "Low Cost, ease and speed of construction are passing advantages - inflation and the passage of time soon reduce those issues to little more than good or bad memories. But the badly designed building is there for a very long time a living indictment to those responsible for creating it".

Luders assertions and observations are not only applicable in the UK where he lives but virtually throughout the world and especially in Nigeria where the pressure to design and construct buildings quickly are very high especially since the emergence wealth generated by oil.

In fact Luder went further to narrate the past experience in the UK which are very similar to what Nigeria is recently experiencing when he states that "Recent history is littered with examples of the pressures from commercial interests to build quicker, cheaper, and allegedly easier and the price we have all paid,and for which we are now blamed as an industry is an increasing number of sub-standard, unsatisfactory - in some cases unacceptable buildings."

In agreeing with this observation, one quickly remembers the recent case of the Barnawa Federal Low Cost houses which were constructed in a rush during the military administration. These buildings which costed millions to build are now being demolished at a cost of over four million naira as a result of the incidence of some of them collapsing and killing several lives and causing damages to properties.

Another case is the rejection by prospective tenants/purchasers of the recently completed Federal Government Low Cost houses in some states because they do not suit the requirements of the people in those areas.

2:I:2 Right Cost

The second requirement of the client is that related to Cost. Luder (I9) defines the right Cost in the following terms, "If the right building is concerned primarily with design, the right Cost rests more and more, rightly or wrongly with the Quantity Surveyor, that strange creature who used to prepare the Bills of Quantities and sometimes gave tentative cost estimates, who is now cost controller, adviser, or even overseer of everyone else.

However, the right cost for the client is rarely, if ever the cheapest building - the lowest competitive tender. Nor the most expensive on the basis that what is expensive must be good.

The right cost is the lowest final cost to provide the client with the right building - the building he requires within an acceptable time."

From this we can understand that the engineers estimate will only be reliable as far as the client is concerned, if it agrees with the right cost i.e. final cost of the right building at the right time. It therefore follows that comparing with the accepted tender which this work deals with will go along way towards achieving the clients needs in terms of right cost.

2:I:3 The Right Time

Luder (I9) elaborated further on the right time in the following terms "The relationship between design and construction is particularly significant in relation to time. There are buildings that can be built quickly, others more slowly. Nevertheless, the best things are rarely created in a rush overnight. Very few if any of the great or even the good buildings of the past we now revere and preserve, would in anyway have met the requirements of rapid construction. In a very short time, speed of building become's of little or no importance. Any advantage disappers rapidly with the passage of time."

He further suggests as follows, "Yet neither are the best buildings necessarily those that take the longest to build. The relationship between right building, right cost and the right time is a subtle one, that can only be decided in relation to particular cases, each building and clients requirements on their merits. Economic presures, particularly in times of high inflation produce a situation where quick buildings may be cheaper, but in normal times, the client usually pays extra for a building compeleted faster than the optimum time required, taking into account all the circumstances. We must not ignore the need for speed, but it is merely a means to an end and if the end is wrong then what price speed?".

In agreeing with this analysis of clients needs, McCanlis (20) asserts that "On initiating a building project, a client will want to be assured that he will:

(a) get the building he wants, of the right quality and form for his needs.

(b) be able to take possession of the building at the time he needs it

(c) pay the optimum economic price for the building.

Having now established and defined the three basic requirements of the client i.e. right building, right cost and right time and having stated that the degree of reliability which should be attached to engineers estimate is the degree to which it helps the client in predicting these requirements, it follows that a study of the engineers estimate as well as the contractors tender will facilitate the assessment of their reliability.

2:2 Engineers Estimates

The term 'engineers' estimate as used in this work describes the estimated cost of a building normally prepared for or on behalf of the client by professional advisers just before or during tendering.

In Nigeria and most British Commonwealth Countries, the engineers estimate is usually prepared by Quantity Surveyors.

In this work, emphasis would be stressed on building works such as offices, residential buildings, hospitals, institutional buildings etc. Civil engineering works will not be covered because their methods of tender documentations, pricing and tendering are to some extent different from those of building works.

In aggreeing with this assertion, Seely (3I) states that "In a building contract the bill of quantities will constitute a contract document whereas in the majority of cases the specification will not. Consequently the bill of quantities in a building contract will invariably be far more detailed, with much lengthier descriptions than that operating in civil engineering work." He further stated that "The contractor, when pricing a civil engineering bill of quantities, will need to refer constantly to the specification for detailed information on the billed items, and must generally include for any necessary temporary work and incidental labours."

There are two types of estimates normally prepared for the client before the contract is awarded. These are:

(a) Approximate estimates or Preliminary estimates

(b) Pre-tender or comparative estimates or later stage estimate.

In accepting this subdivision, James(I6) while attempting to classify the various pre-contract approximate estimating methods states that "Single purpose Estimates are aimed at fore-casting cost and these can be further subdivided into Preliminary Estimates, which establish broad financial feasibility of the project and later stage estimates which will produce a figure comparable with that of the lowest tender."

According to Seely (30) "the function of approximate or Preliminary estimating is to produce a forecast of the probable cost of a future project before the building has been designed in detail and contract particulars prepared. In this way the building client is made aware of his likely financial commitements before extensive design work is undertaken." He asserts that "no approximate estimate can be any better than the information on which it is based". He further asserts that" realistic approximate estimating can be achieved only when there is full cooperation and communication between architect, quantity surveyors and building clients from the inception of the scheme". He suggests that "It is advisable to dissuade the architect from reporting forecasts of cost to the building client until some drawings, even preliminary sketches, have been prepared and an inspection made of the site. There is a distinct possibility that the building client will endeavour to obtain an independent check on the preliminary cost figures and it is accordingly unwise to supply a high 'cover' figure.

On the other hand the submission of too low a figure can lead to recriminations, as the first figure is the one that the building client will always remember."

It can therefore be seen that approximate estimates are normally prepared at the preliminary design stage of the project or at its inception.

These estimates are meant to give the client a guide as to his possible financial commitments on the project as per his initial brief and the designers preliminary sketch. Various methods have been developed for preparing these approximate estimates depending on the information available at the time the estimates are to be prepared, the type of building, location etc. The following are the principal techniques currently in use for the preparation of approximate estimates:

(I) Unit method

(2) Superficial or floor area method

(3) Cube method

(4) Storey - Enclosure method

(5) Approximate Quantities

(6) Elemental Cost Analysis

(7) Comparative Estimates

(8) Interpolation method.

These types of estimates are only approximate and are meant to serve only as a guide to the client as to his probable pre-tender, tender and/or final construction cost. The approximate estimates thus do not form a basis of comparision with the tenders to be submitted by the contractors since they are not based on the same documents. They would not, therefore, be considered in this work.

Pre-tender estimates are normally based on the complete tender documents which are given to the contractors on which the contractors will also base their tenders. They are also sometimes referred to as comparative estimates since their main objective is to serve as a guide to the client as to probable tenders to be received. They are therefore compared with the tenders received for the purpose of evaluating the acceptability or otherwise of the tenders and in this work they will be referred to as Engineers Estimates.

Before going into the detailed mechanics of the preparation of both the engineers estimates and the contractors tenders an explanation of the tender documents on which these two estimates are based becomes pertinent at this juncture.

2:3 Tender Documents

In preparing the comparative estimates, the engineer uses the same tender documents issued to the various tenderers. These documents include the bills of quantities, specifications, drawings and contract conditions. Mogbo (24) asserts that "In principle, British tender documentation is of general application in Nigeria with little or no modifications. .Essentially, it comprises drawings, bills of quantities, specifications, forms of agreement and conditions of contract."

However, in practice, the tender documents could be said to be made up of two main parts:

(I) Bills of Quantities - This consists of the form of Tender, Articles of Agreement, Contract Conditions, Preliminaries, Trade Preambles and measured quantities.

(2) Drawings - Consists of Architectural, Structural Electrical, Mechanical and other Services drawings and specifications.

2:3:I Bills of Quantities and Drawings

Mogbo(**24**) while writing about Bills preparation states that "Bills of quantities are provided in many major, medium sized and small projects. Owing to an acute shortage of qualified and registrable quantity surveyors in Government Ministries, eighty percent of the briefs are handled by consultants. Presentation of the briefs vary from one Consultant to the other. The trade by trade method is prevalent but of recent, the elemental format is being adopted by some professional offices."

However, some of the observations made during this investigation reveals that Government Ministries especially Kaduna State Ministries of Education, Works and Health and even Ahmadu Bello University tender their small and medium sized projects on the basis of drawings and specifications only.

Such tender documentation has many disadvantages as the contractors will have to prepare their own quantities themselves. Due to differences in quantities, their tender figures based on this type of tender documetation shows very large differences and sometimes the clients had to re-tender the projects on the basis of bills of quantities in-order to obtain reliable estimates and minimise the large variations on tender figures.

This research is based on contract with bills of quantities forming part of the tender documents.

The bills of quantities is normally prepared from the drawings before going to tender. Incidentally, it is not surprising to find that even at tender stage some of these architectural and engineers drawings are still at the preliminary design stages. This lack of adequate drawings at the time of preparing the pre-tender estimate tend to reduce the reliability of the engineers estimate as well as that of the tenderer.

However, it should be borne in mind that incomplete drawings affect the reliability of the engineers estimate only to the extent that the pre-tender estimate may not properly predict the final construction cost since many variations could arise during construction.

Incomplete drawings may affect the reliability in terms of tenders to be received only to the extent that some of the descriptions of items in the bill may be incomplete and vague resulting in different prices quoted by tenderers.

Information contained in the bills of quantities especially the priciseness of the information greatly affects the accuracy of pricing. This assertion was confirmed by Professor Bennett (6) when he asserts that "We envisage for the future much smaller bills of quantities. This will be achieved by including only those items which have significant effect on contractors' costs and which they can realistically price on the basis of costing information."

The type of descriptions given in bills of quantities in this country vary from one form to the other although they are generally based on the British Standard Method of Measurement of Building Works. Many attempts are being made especially in the UK to standardise bill descriptions.

Quality of information rather than quantity is one of the most important factors which help the estimator while pricing the bills of quantities In accepting this assertion Bennet (6) states that "We recognise that we can improve the accuracy of estimating and the valuation of variations by providing better information instead of more detailed information"

This could only be achieved through the provision of accurate bills of quantities based on complete drawings and specifications.

This assertion is confirmed by Trickey (I 4) when he states that "Traditional procedure , where, on any but the smallest project, Bills of quantities form part of the tender documentation are well known and unquestionably more sophisticated than parrallel procedures in other countries. Costs to contractors of tendering are reduced, the quantitative risks in tendering are removed , competition is ensured and post contract changes are allowed at a fair and controllable cost." He commented on the difficiencies in bills preparation as follows.

"Unfortunately, and as the result of deficiences and competing interests in professional offices, a good system has been abused. Bills of quantities are often prepared from incomplete and unresolved designs and conceal the fact by virtue of their apparently complete state, one not borne out when drawings are required by the contractor on site."

2:3:2 Implications and preparations of the Bills of Quantities

Wainwright (4I) on bills of quantities states that "contract which is based upon bills of quantities has the drawings, bill of quantities, and form of agreement as the contract documents. The bill of quantities is usually prepared for the client by a professional quantity surveyor, whose fee is paid by the client. Several copies of the bill of quantities are prepared and sent out to the builders who are tendering for the work, to assist them with their estimating.

The bill of quantities specifies the material and method of work to be used as well as the quantities of work to be done - in fact, the bill of quantities contains all the information that will affect the price. Any errors that may occur in the preparation of the bills of quantities will be rectified in the final account, so that the risk of errors by builders when preparing their quotations is considerably reduced." On the advantages and uses of the bills of quantities Wainwright asserts that "When the contract is signed the bill of quantities and prices become part of the contract agreement, and will be used in the preparation of the final account and in the settlement of any variations. The provisions of bills of quantities leads to accurate tendering, as all the tenderers have identical documents from which to work and considerably reduces the costs of estimating for building work."

2:3:3 Composition of the bills of quantities

The bill of quantities is divided into sections, which are each based upon traditional trades. Each section is subdivided for easy reference. A trade bill of quantities for a building project would be divided up as follows:-

(I) Preliminaries (2) Excavation and Earthwork
(3) Concrete work (4) Brickwork and Blockwork
(5) Roofing (6) Carpentry and Joinery
(7) Steel and Metalwork (8) Plumbing and Engineering Installations (9) Electrical Installations
(IO) Plaster work and other finishes (II) Glazing
(I2) Painting and Decorating (I3) Drainage.

As stated previously, the information supplied in a bill of quantities is guaranteed accurate to the builder; any errors that may occur in descriptions and/or quantities or the omission of an item, will be treated as a variation and will be adjusted in the final account. The right under the contract to rectify errors does not, however, extend to the builder's errors in the computation of the contract sum. The client's quantity surveyor will check a builder's priced bill of quantities very carefully before recommending the parties to sign a contract based upon the priced bills. The builders attention will be drawn to any errors and he will be asked if he wishes either to amend the errors or to stand by the original offer. Once the contract is signed, the contract bills and all the rates, cash extensions and totals are considered accepted by both parties. The quantity surveyor should make every effort to check the builder's computations, but the builder would not succeed in an action for professional negligence against the surveyor in the event of errors of computation occurring in the contract bills. Unit rates and computation are the sole responsibility of the builder.

All bills of quantities prepared for contracts based upon the standard Form of Building Contract are prepared in accordance with the rules of the Standard Method of Measurement of Building Work. This documents, drawn up between the Royal Institution of Chartered Surveyors and the National Federation of Building Trades Employers, provides a uniform basis for the measurement of building works, and embodies the essentials of good practice. The standard Method of Measurement has many advantages for the builder who knows that each element of a building will be measured in the bill of quantities in a standard unit of measurement.

Samples of some extracts from a typical bills of quantities are as attached (See Appendices I - VIII)

These could briefly be explained as follows:

Appendix I is an extract from a typical contract conditions in the bills of quantities. It defines the contract obligations which bind both the client and the contractor.

Appendix II is a typical Summary page of the conditions listing the various clauses on which each tenderer will fill in the tendered price for complying with the various contract conditions clauses.

Appendix III is an extract of a page from the Preliminaries clauses of the bills of quantities. It describes the various temporary works which the contractor is expected to perform but which do not form part of the finished building. Columns for putting in the various prices for complying with this section is provided.

Appendices IV & V are extracts from typical pages of Trade Preambles section of the bills of quantities. They explain in detail the various specifications of the various trades on materials and workmanship and state the various deviations from the standard method of measurement of building works.

Appendices VI & VII are extracts from the measured quantities sections of the bills of quantities showing the various columns for filling in the tendered rates and column for extensions.

Appendix VIII is the general Summary page which will be filled after the pricing is completed and the tender sum transferred to Form of Tender.

Wain-wright (42) suggests that tender documents should consists of the following:

(a) Two copies of the complete bills of quantities together with any additional copies or sections which may have been requested

(b) Prints of general arrangement drawings, sufficient to indicate the character, shape, and disposition of the works, which will be used simply to explain the nature of the scheme.

(c) Instructions for the return of the tender

(d) Two copies of the Form of Tender

(e) One addressed envelope for the return of the Form of Tender, with an endorsement naming the contract.

(f) If the tender is based upon a contract with a fluctuations clause, the date on which basic prices are to be determined. This date should be some days before the date for the submission, in order to avoid hurried last-minute alterations, On contracts based upon the RIBA form, I963 Edition, a date ten days before the date for the delivery of tenders is given.

Attached appendices IX and X are for items(c)and(d)above. That is appendix IX shows a typical instruction for the return of the tenders together with other instructions to the various contractors.

Appendix X pages FT/2 and FT/3 is a typical form of tender item(d) above.

2:4 Types of Tendering

A tender is an offer made by a contractor to construct a building in accordance with the conditions of contract within a quoted period for a sum of money. The acceptance of this offer by the building owner or his authorised representative constitutes a binding contract between them.

There are various procedures for obtaining tenders but the most common are:-

(a) Selective tendering

(b) Open tendering

(c) Tenders for negotiated contracts

This work will mainly be based on selective tendering which is the most common type of tendering procedure currently being used in the country.

Wainwright (42) explained the various types of tendering as follows:

2:4:I Selective Tendering

Under this method, competitive tenders are obtained by drawing up a short list of contractors and inviting them to submit a quotation. This short list can be drawn up in two ways:

(a) Either the employer's professional advisers naming suitable contractors or an advertisement is put in the national dailies and technical press, which sets out brief details of the proposed scheme and requests contractors who wish to be considered for inclussion in the short list to apply. The object of the selection is to make a list of firms, any one of which could be entrusted with the contract.

After this the contractor chosen will simply be the one who submits the lowest tender.

The size of the short list may be limited to the small number of firms who satisfy all the requirements. When this is not possible the National Joint Consultative Committee of Architects, Quantity Surveyors and Builders recommends an average list of six names with fewer for smaller works and more for larger contract, but with an absolute maximum of twelve. One or two names should be added to replace any firms on the list who do not accept the invitation.

The procedure outlined in the Code of Procedure for selective Tendering (26) is as follows:

Once it has been decided that a contractor is to be selected by competitive tender a short list of suitable tenderers should be drawn up either from the employer's approved list of contractors or from an ad hoc list of contractors of established skill, integrity, responsibility and proven competence for work of the character and size contemplated.

The following scale should be taken as a guide in determining the number of tenders to be invited:

Table On Number of Tenderers to be Invited in Selective Tendering

TABLE 2A

Size of contract	Maximum number of tenderers
Up to ₦100,000	5
₦100,000 - ₦500,000	6
₦500,000 - ₦1,000,000	8
Over ₦1,000,000	6

Source: NJCC Code of Procedure for Selective Tendering (1977)

It should be appreciated that because of the cost of preparing tenders the larger the tender lists become the greater will be the cost of abortive tendering, and this must be reflected in building prices. Regard should also be paid to contract such as specialist engineering contracts involving relatively high tendering costs and it is recommended that for such contract the maximum number of tenderers for contract values above ₦500,000 should be reduced to six and four respectively. When the list has been settled, one or two further names should be appended in order that they may replace any firms on the list that do not accept the preliminary invitation.

When selecting the short list the following are among the points which should be considered:

(a) the firm's financial standing and record:

(b) whether the firm has had recent experience of building at the required rate of completion over a comparable contract period.

(c) the firm's general experience and reputation in the area in question:

(d) whether the management structure of the firm is adequate for the type of contract envisaged; and

(e) whether the firm will have adequate capacity at the relevant time.

Approved lists should be reviewed periodically to exclude firms whose performance has been unsatisfactory, and to allow the introduction of suitable additional firms.

2:4:2 Open Tendering

This method is often used by Governments, States, Federal or Local Government, and government parastatals to obtain tenders for building works. The employer advertises in the national dailies or on their notice boards an open invitation to contractors to apply to the employer or his architect for the necessary documents, and gives brief details of the proposed works. One of the conditions in the advertisement is usually that the tenderer must pay a non-refundable deposit according to the project but usually ranges from ₦50 - ₦I,000. This provision is normally made to deter persons applying for documents out of mere curiosity.

It is always stated in the advertisement, and always in the tender documents, that the employer does not bind himself to accept the lowest or any tender. This advertisement does not legally bind the employer in any way, but is merely an invitation to persons to make an offer, this is necessary because an offer must be unconditionally accepted before a contract can be made.

Indiscriminate requests to tender of this nature are generally unprofitable, since they often lead to poor - quality building and the preparation of such tenders throws upon the industry an unnecessary burden of time, effort, and expense. Contractors can be awarded work under this system which they are ill-equiped to carry out financially and practically. Although the defence may be made that no special tender need be accepted; committee spending public money is naturally tempted to accept the lowest offer.

2:4:3 Tenders for Negotiated Contracts

This method of tendering is usually used for building work of a very difficult nature where the magnitude of the contract may not be known at first or where early completion is most important. Under a contract of this nature there is usually no time to wait for drawings and bills of quantities to be prepared. There is always the danger that a price obtained in this way might be higher than against competition, however, intelligent use of a negotiated price may even result in a lower price.

Jobs with difficult phasing programmes are the obvious cases where a negotiated price should be considered, but it has other uses. By negotiating contracts it is possible to retain the services of firms which have been found satisfactory in the past.

Another method of selection is the Serial System which can result in very keen prices. Here selected contractors are invited to tender for one building - a school, for example on the bassis that the successful tenderer will be asked to build several other schools at the same rates. Naturally this encourages, keener prices than for a single school, since the contractor will be able to organise his men and materials on the basis of an expected programme, and carry out this work more efficiently. Furthermore, experience gained on the earlier jobs will be useful later on, so long as the contracts are basically similar.

This system of obtaining tenders has many advantages for the architects and quantity surveyors, since they are able to accurately estimate the cost of other jobs well in advance, on the basis of the known rates.

Although the serial type of negotiated tender can be based upon accurate bills of quantities, many negotiated contracts are arranged on a prime cost basis, with one contractor. There are three types of prime-cost contracts in current use the cost plus, cost plus Fixed Fee, and Target Cost with Fluctuating Fee.

2:4:4 Differences between "Estimating" and "Tendering"

The Estimating Practice committee of the Institute of Builders(I3) differentiates estimating and tendering as follows: "Estimating is the technical process of predicting costs of construction.

Tendering is a seperate and subsequent commercial function based upon the estimate. The responsbility of estimators should be limited to the proper preparation of the estimated cost of projects. Management is responsible for providing information on previous costs, production outputs, building techniques and clerical assistance which are essential pre-requisites of good estimating practice. They are also responsible for the conversion of estimates into tenders and for obtaining work for their organisation."

McCanlis (20) while writing about the various factors which govern the choice of a contractor enumerates the following guidelines;

2:5 Principles of Selecting a Contractor:

If the client decides not to assume direct responsibility for construction himself, he will need to select a contractor with the appropriate experience and special knowledge to assume that responsibility.

The basic problem of selection is to predict which contractor of those available, is most likely to achieve the client's objectives. The process of comparing contractors in order to make this prediction is a competitive process.

2:5:I Competition in relation to tendering for building works

(a) Principles of competition in tenders.

Competition involves comparison with reference to certain standards or criteria. Before setting up a competition, therefore, it will be necessary to establish the standards or criteria required and to be able to compare contractors with reference to these forms.

Some of these standards can be easy to define and measure with precision and others much more difficult. Price, and time of construction, for example, can be objectively measured; quality of workmanship and organisation are more difficult to measure and depend partly on subjective judgement for their assessment.

It is for this reason that the engineers estimate of price and time is being used in this study. The estimate of cost to the client is used as a criteria for comparison with tender figures submitted by competing contractors.

A factor which follows from this difference in ease of measurement is difference in ability to demonstrate fairness. A selection based on easily measureable criteria can generally be seen to be fair by specialist and laymen alike; but a selection based on criteria requiring the judgement of a trained specialist cannot be so readily demonstrated to a layman.

(b) Formal, informal and implied competition

Formal competition is usually fully documented and is based on a criterion (or criteria) that can be objectively measured. Price is the most common of these. Informal competition occurs when contractors are compared on factors that cannot be so easily measured or documented. An example would be interviewing contractors to assess their organization and co-operativeness. The adoption of competitions and selective tendering for this study minimises the effect of informal competition and allows us to compare contractors on the basis of price.

2:5:2 Selection factors not related to building

A particular building project is only a means to an end for the client, he has a need and has decided a building project will contribute to satisfying this need. However apart from his need which will be satisfied by the completed building project, the client may sometimes have other requirements which may be satisfied by the selection of a particular contractor, even though there may be other contractors equally, or better, qualified to produce the required building. The client's reasons for this selection may be unrelated to building.

These, and many other factors can be quite legitimate criteria for selecting certain contractors. Such requirements should be looked upon as part of the client's brief. However, it is very important that the client should be advised if selection of such a contractor is likely to have any adverse effect on the building project. If a client is aware of the extent of any economic or technical disadvantages that may result from such a choice he can then judge which of his requirements should be predominant.

2:5:3 Selection factors related to building

The most important factors in selecting a contractor are those relating to the technology and economics of building and to consider these the client will usually need professional advice. Each contractor available should be considered from three aspects:-

(a) Has he the potential resources necessary to be capable of performing the services required?

(b) Is he likely to apply these resources adequately to the contract and are there any reasons why he should not do so?

(c) What are the contractor's specific proposals for the contract and are they reasonable?

All these three aspects should be considered even if only informally. A contract may legally bind a contractor to fulfil all the client's requirements, but he may still fail to do so. In the event of such failure the client may have legal redress by way of damages but this would be a very incomplete compensation; the client would still not have the right building at the right time and price.

Consideration of all relevant factors is the best guarantee that the client will get what he wants.

2:5:4 Price as a criterion of selection

Price, as has been seen, can be established by a formal competition as part of the process of selecting a contractor or it could be agreed by negotiation with a contractor already selected. However, if it is established it should be reasonable in the circumstances.

If a price is too high the project may have to be modified or abandoned. Although the client will normally seek a low price, this must be done with discretion as a price that is too low may inhibit the attainment of the client's other objectives of quality and speed.

The more efficiently a contractor can organize his work the lower his costs can usually be and he may therefore be able to quote a lower price. A low price however, does not always imply efficiency. It may be the result of lowered profit margines due to market conditions or to bad estimating.

Price can also be regarded as a cause as well as an effect. The money represented in a price is a fundamental resource which releases all other resources. The more money that is available for construction, the more are the resources that can be deployed. An unrealistically low price can inhibit proper building. The level of the optimum price for a particular project must be related to all the relevant circumstances.

2:5:5 Pre-contract Processes in Building Works

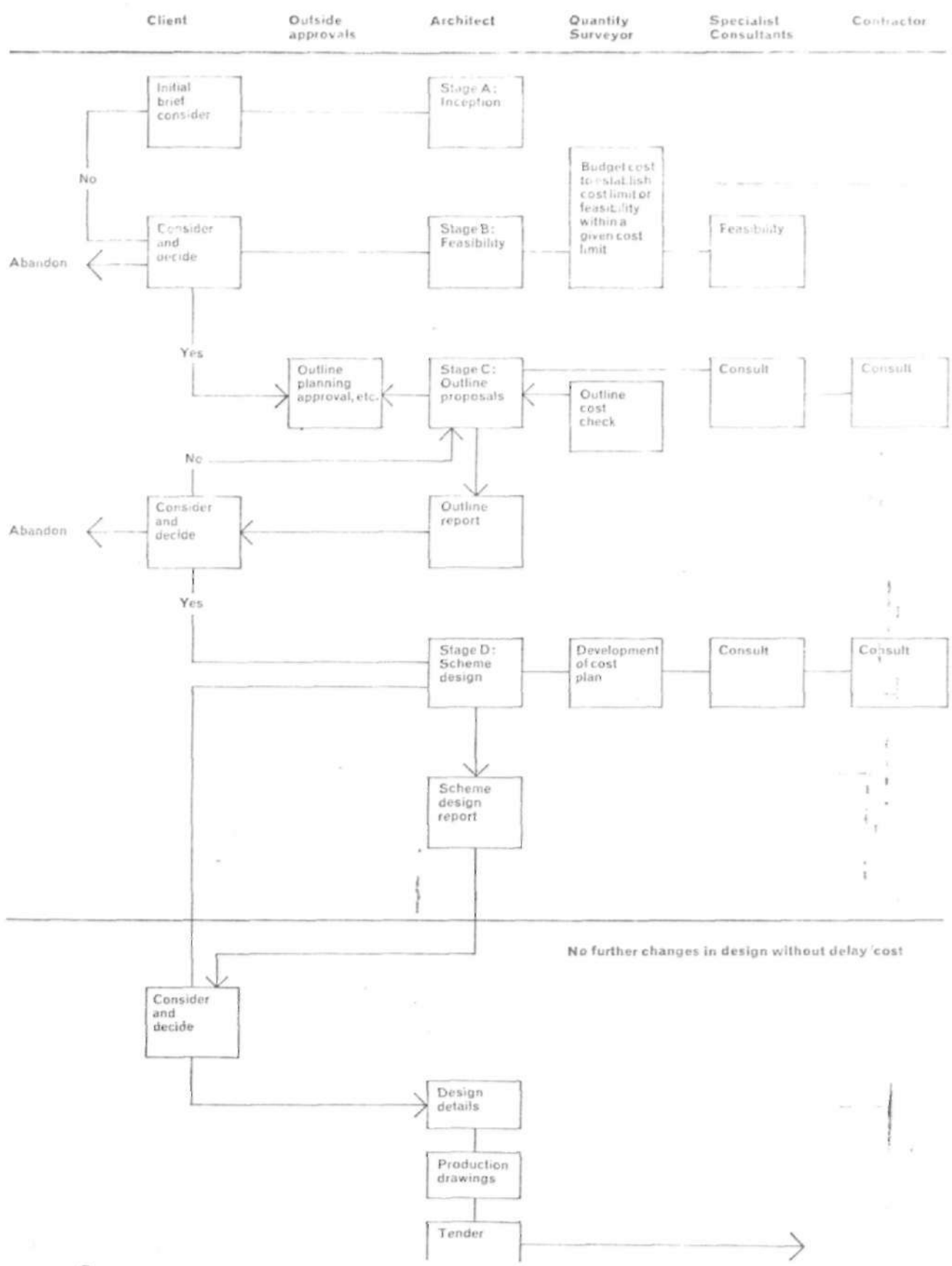
Before going into the techniques of pricing be it for the purpose of tender preparation or arriving at comparative estimate or engineers estimate, it becomes pertinent here to explain the various processes in a tabular from which both the client and members of the design team go through before the tender documents are ready for tendering or preparation of the engineers estimate.

Attached tables 2A and 2B show these processes in a flow chart starting from stage A to stage F.

Stage A is the inception stage which involve mainly the initial clients brief to the Architect.

Stage B-Feasibility involves the Architects, Specialist Consultants and the Quantity Surveyor in establishing budget Costs and cost limits. The client may decide to abandon the project if not feasible at this stage but if he decides otherwise then we move to stage C during which the Architect will prepare outline proposals. The Quantity Surveyor will then prepare an approximate estimate based on the outline proposal. A report is then prepared by the Architect and sent to the client for approvals before going to stage D - Scheme Design. At this stage the Architect sorts our design details and prepares production drawings before moving to stage E-Detail Design.

Flow chart showing the pre-contract processes of a building project upto the tender period

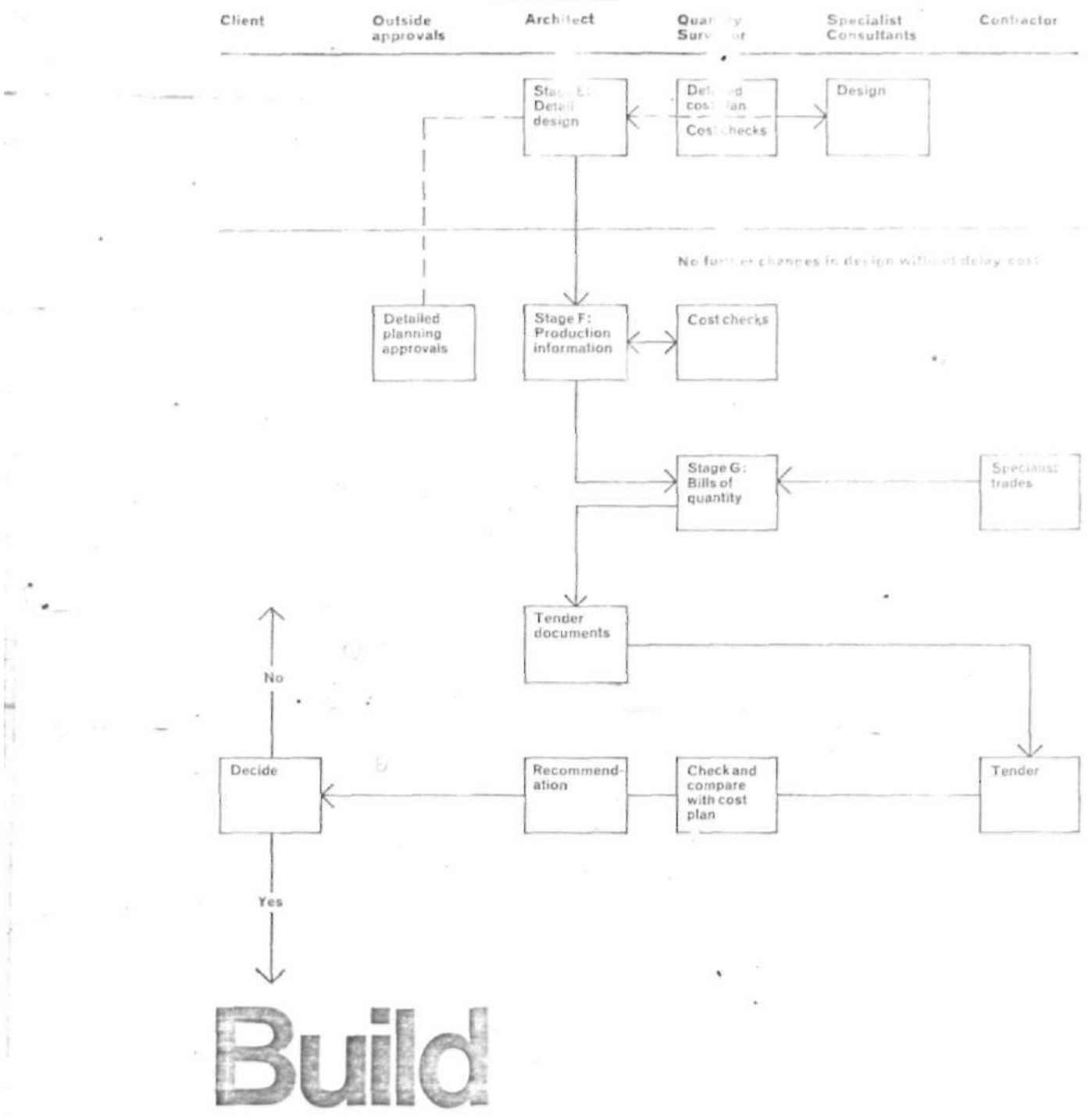


Source: NJCC - Clients guide - The role of the client in the design of buildings.
R.I.B.A. Publication Ltd London (1978)

Flow chart showing the pre-contract processes of a building project upto the tender period

Page 36 B

Table 2B



Source: NJCC - Client's guide - The role of the client in the design of buildings
R.I.B.A. Publications Ltd London (1978)

At stage E detailed cost plan and cost checks will be made by the Quantity Surveyor and the specialist Consultants will prepare their design. Changes in design are restricted at this stage since it may affect cost or cause delay in the design process.

At stage F Production information will be made by the Architect and the Quantity Surveyor will make further cost checks. Planning approvals will be obtained from appropriate authorities.

Stage G - Bills of quantities deals with the production of the final tender documents which is the bills of quantities which is prepared by the Quantity Surveyor. The Architect may then incorporate some outline drawings which together with the bills form the tender documents.

This is the stage which we have dealt with so far. The next remaining stages deal with pricing of the tender documents either for the purpose of tender preparation or engineers pre-tender estimate which will be compared with the tenders for the purpose of making recommendation to the client for the award of the contract.

2:6 Pricing of the Tender Documents

The clients cost adviser normally prices the bills of quantities on behalf of the client to arrive at the engineers estimate. The method of pricing is similar to that of the contractors except that the Quantity Surveyor has the additional advantage of the fact that he prepared the documents and by the time the tender documents are ready, he must have acquanted himself with all the problems which might affect the estimate such as the site, complexity of the project, Cost of some special components etc.

In agreering with this assertion, Lee(I8) asserts that "For the present the tenderers for a project are provided with uniform bills of quantities prepared by a private quantity surveyor and given a time target, usually from three to six weeks, to fill in the rates against these quantities supplied and extend them out to form competitive tender.

It is useful to bear in mind at this stage that the private quantity surveyor on the project had already prepared cost plans and estimates and had at least six months of fruitful discussion with the design consultants, knowing exactly how difficult the job is, what the prices of specified components are, where they can be obtained from and what peculiar or capacities these components possess. In short, in order to arrive at a project estimate to be presented to the owner for discussions, the private quantity surveyor would have priced his own bills of quantity long before the time of tender submission.

And yet the tenderers are given only six weeks at maximum to understand the implications of the project, to find out prices and behavioural patterns of specified components, to work out Unit price build-ups and to arrive at tender sums that must reflect their total commitment of resources for the next two years."

Inspite of these seeming advantages which would have added to the degree of reliability of the engineers estimate, there are other people who still hold the view that the reliability of the engineers estimate is in doubt. This could be seen from the research carried out by the Sussex Branch of the IQS (39). Part of the research states that, "Practices vary widely in respect to the pricing bills of quantities during the tender period by the private offices issuing the tender documents. In one or two instances where this is done some offices have made direct approaches to sub-contractors expected to be selected by the contractors. By and large private offices claim not to have enough resources to price well enough to warrant the cost. Contractor mark-up does not appear to be known to most respondents, this being the area which makes the pricing exercise of questionable value. Local authority respondents said that they did not have the resources to engage in sophisticated exercise such as producing a comparative tender."

Skoyles (34) while writing about the influence of the QS on Europe, identifies these two types of estimates i.e. clients estimate and contractors tender when he states that "Two principal methods of technical accounting are to be found. One using an independent consultant, a descendent of the "measurer" who had developed further skills to give a service covering control of prices (or clients costs), from inception to completion; this service is practised principally in the UK and Eire. The other system involves a technician/measurer working usually for the builder but in some areas also for the designer and gives a service limited solely to providing data for tendering and accounting for the post tender changes in the original bid, i.e. settling the variations. The former uses disciplines organised into learned societies having high standards of traihing. The people who practice the latter system are mainly technicians and with the exception of France, have little national contact with others who follow the same calling and few opportunities exist for post graduate development of their careers."

Thus the two quantity surveyors or estimators will base their estimates on the same tender documents. The procedure each of them follows is virtually the same except that whereas the private surveyor works for the client and therefore tries to help the client in achieving his objective of having the right building at a minimum cost and time, the estimator working for the contractor is also trying to help the contractor to achieve his objective of making optimum profit.

Thus the breakdown of any engineers estimate or contractors tender will show that it is made up of the following costs:

(a) Labour

(b) Materials

(c) Plant

(d) Overheads

(e) Profits

The following unit price build up will help to elaborate on this:

2:6:4 Examples of Price Build up

Each unit rate consists of cost of materials, labour, plant, overhead and profit. If concrete is taken as an example, the materials components of concrete depending on the various mixes is given on the table below.

TABLE 2B - BREAKDOWN OF MATERIAL COMPONENTS IN CONCRETE

Concrete Mixes	Materials per Cubic metre of concrete					
Nominal mix	Cement I442 Kg/m3		Sand I602, Kg/m3		Aggregate I442 Kg/m3	
	Tonnes	Cu.m	Tonnes	Cu.m	Tonnes	Cu.m
I:I:2	0.52	0.36	0.58	0.36	I.05	0.73
I:I½:3	0.39	0.27	0.64	0.40	I.I5	0.80
I.2.3	0.36	0.25	0.80	0.50	I.08	0.75
I:2:4	0.30	0.2I	0.69	0.43	I.23	0.85
I:3:6	0.22	0.I5	0.72	0.45	I.30	0.90
I:4:8	0.I7	0.I2	0.74	0.46	I.34	0.93

Source - "Practical Builders' Estimating by W. Howard Wainwright" Hutchinson Educational Ltd London (I970)

Suppose the description in the bills of quantities is as follows:

Concrete(I:2:4 mix 20mm aggregate in trench foundations over 3oomm thick per cub.m

(Assuming we are using 5/3½ mixer continuously)

The price build up will be as follows:

Source - Estimating File of Shehu Giwa & Partners for July, I982

(a)	Cement 0.30 tonnes @ ₦I40 per tonne, ready for use and off loaded	₦42.00
(b)	Concreting sand 0.43 cub.m at ₦I4.50 per cu.m	6.24
(c)	20mm Aggregate 0.85 cub.m @ ₦34.50 per cub.m	29.33
(d)	5% Stockpile waste on cement	2.I0
(e)	I0% Stockpile waste on sand	0.62
(f)	I0% Stockpile waste on aggregate	2.93
		₦83.22

A 5/3½ mixer working continously will produce about I.2m^3 of concrete in an hour

(g) Cost of labour gang working a 5/3½ mixer continuously is as follows:

I driver/filler

I. filler

2 wheelers

I speaker

5 hours labourer at ₦0.75 per hour = 3.75

∴ labour cost to produce I.2m^3 = ₦3.75

therefore cost per one m^3 = $\frac{3.75}{I.2}$ = ₦3.I3

C/F ₦ 86.35

	B/F	₦86.35
Cost of hiring mixer including transportation to site and fuel per day ₦100.00		
Therefore hourly cost of 5/3½ mixer = ₦100 / 8 = ₦12.50		
Cost per cub.m = ₦12.50 / 1.20		10.42
Net unit rate per cub.m of concrete		₦96.77
Add 25% overhead and profit		₦24.19
Gross unit rate to be inserted against concrete		
1.2.4-20mm aggregate per cub.m		₦120.96

2.7 Composition of Unit Rates

The preparation of any type of estimate can be divided into three identifiable stages:

(a) The establishment of all - in rates of key items, for examples:
A rate per hour for the employment of labour, An operating rate per hour (or per day, per week etc) for an item of plant, A cost per unit for material delivered and unloaded at the site. This process involves the comparison of the various quotations and the selection of the one to be used in the estimate

(b) Use of the all - in rates so established and production standards to calculate unit rates to be set against the items of the Bills of Quantities. Rates from sub-contractors' quotations have to be transfered to the main Bills and the Bills totalled.

(c) The calculation and addition of project overheads and the preparation of reports for consideration by management.

It is wise to calculate the unit rates for groups of items as soon as all the relevant information is available. Cost of labour and plant can usually be estimated after the site visit has beem made and the pre-tender construction programme agreed. In the case of materials and sub-contractors, it will be necessary to await for the receipt of quotations.

2.7.I All - In Hourly Rate of Labour

The labour element of cost is made up of wages and emoluments paid to operatives and statutory costs which are incurred automatically as a result of the employment of labour. The main items to be considered are:

(a) The basic or current wage rate (for either craftsman, labourer or mechanical plant operator)

(b) payments required by the Working Rule Agreement (plus rates, tool money, dirty money, etc)

(c) Allowances to cover guaranteed time

(d) Sick pay schemes

(e) Employers' liability insurance

(f) Training levey

(g) National Insurance

(h) Pensions

(j) Holidays with pay schemes

(k) Allowances to cover redundancy

(l) Wage related benefits

} The costs of these items are affected by absenteeism. Allowance must be made for this.

2.7.2 Composition of Mechanical Plant Rate

When plant is already owned, the cost should include allowances for:

(i) A capital sum based on the purchase price and expected economic life

(ii) Return on capital

(iii) Administration and depot cost

(iv) Labour for maintenance and related overheads

(v) Materials for maintenance

(vi) Insurances

(vii) Road fund licence.

Running Cost

Additions must be made to hirer's' quotations or standing cost for running cost including:

(a) Emoluments of the operator

(b) Fuel

(c) Oil

(d) Grease

(e) Other consumable stores

2.7.3 Material Element in Building

The material element should include allowances for:

(a) The sum quoted by the supplier (or the stated P.C Sum) after the deduction of discounts

(b) An allowance for waste such as conversion waste, cutting waste, application waste, stockpile waste, residue waste and transit waste.

(c) Subsidiary fixing materials

(d) Packing and crates if these are to be charged,or the cost of returning them to the supplier

(d) Labour for unloading and storing.*

2:7:4 General Overheads

This could include

(a) Director's fees (managing directors)

(b) Salaries of head office staff

(c) Wages of non productive site staff

(d) Insurance

(e) Rent on yard

(f) Motor-car running expenses

(g) Electricity and airconditioning cost of the office

(h) Printing and stationary

(i) Advertising

(j) Postage and telephones

(k) Furniture and fixtures

(l) Bank charges

(m) Auditor's fees

When estimates are prepared for the submission of a tender the estimated profit required should be included. Profit margins are usually expressed as a percentage of the money to be expended to finance a building contract.

Wainwright (4I) asserts that the profit to be included can be influenced by many factors, which are collectively referred to as the market conditions. These might include

(I) Quantity of work in hand

(2) Future commitments

(3) Placing in previous tendering

(4) Possibility of future work from the same source

(5) Assessment of the degree of competition

2.7.5 Profit

When estimates are prepared for the submission of a tender the estimated profit required should be included. Profit margins are usually expressed as a percentage of the money to be expended to finance a building contract.

Wainwright (41) asserts that the profit to be included can be influenced by many factors, which are collectively referred to as the market conditions.
These might include.

(I) Quantity of work in hand

(2) Future commitments

(3) Placing in previous tendering

(4) Possibility of future work from the same source

(5) Assessment of the degree of competition.

Despite the above similarities, unit rates inserted in the bills of quantities are not always the same for different projects. Many inexperienced estimators sometimes think that rates in the bills in one project could be applied to another project without adjustments. There are many factors which cause variations in the unit rates of one project from that of another.

Agbaroji (I) identifies causes of variability in unit rates or total cost of part or a whole building as follows:-

(i) Location

(ii) building type or function

(iii) site conditions

(iv) local conditions-scarcity of projects in a locality at a particular time could cause temporary decrease in prices and wages, and vice versa

(v) prevailing market conditions

(vi) measurement factor: no two quantity surveyors will arrive at the same set of quantities for the same building.

(vii) Pricing factor: again no two estimators or quantity surveyors will arrive at the same total or tender sum by pricing identical bills of quantities

(viii) date of tender

(ix) contract value

(x) organisational factor e.g. size of firm and type of firm, whether indigenous or foreign-controlled.

Appendix XVI to XVIII are some extracts from a priced bills of quantities submitted by a contractor

Preparation of Tenders for Building Works

On receipt of the tender documents, the Contractor would normally pass these documents to the estimating department.

Wainwright (4I) outlines the various procedures which the estimator should follow after the receipt of the documents as follows: "The estimator studies the documents and lists all prime cost and provisional sums, and marks the quantities which the firm normally sub-lets. After carefully studying the drawings and the bills of quantities, an estimator of experience will have an approximate idea of the cost of the building.

He then visits the site, accompanied by the other members of the firm's management, where they discuss the project. They consider particularly possible difficulties of access to the site; the storage of materials (which is very important on confined city sites); adjoining premises; type of ground, necessity for temporary roads, hoardings, compounds and enclosures; the arrangement and siting of temporary offices and welfare buildings; the availability of water for construction, and the availability of labour in the area.

At this stage a decision should be made whether to proceed with the tender any further; the decision will be made after the study of several other factors, such as the financing of the job, the proportion of the firm's own work to sub-let work, the time required to complete the contract, and known future commitments.

After the decision to proceed, the estimator extracts the sub-contractor's work from a copy of the bills of quantities and when these have been photocopied they are despatched to the sub-contractors with a covering letter setting out all the relevant information about the contract. Pages from the preliminaries section of the bills of quantities and all preamble clauses pertaining to sections which affect the sub-contractors are copied and forwarded with the actual quantities. Very often three or four prices are obtained for each section of the sub-let work. It is good practice to always keep one copy of the complete bill of quantities in the office, as this is extremely useful for reference when dealing with queries, and also helps to reduce the risk of errors.

The estimator then looks through the bills of quantities making careful notes of all the materials for which he will require special quotations. Quotations are not normally required for every material; the prices for such commodities as bricks, cement and aggregates, which are used every day on most contracts, will be known. However, there are contracts, where quotations are required for even these everyday materials; this would occur for example, when preparing a tender for a building to be erected outside the normal area of operation of the company. Another case would be a tender for building of such magnitude that generous trading discounts could be obtained because of the quantities of materials to be ordered.

The estimator then begins work on the analysis of the unit rates, for which no information is required, and gradually, as the quotations for materials are returned, the unit rates are analysed so that, by about two days before the date for the submission of the tender, the estimator should have the rate analysis work completed. When material quotations are received they should be carefully scrutinised, as very often delivery dates are more important than the cheapest price. When all the items are priced,the bills of quantities are extended and totalled by comptometers, sub-contractors' quotations which are likely to be accepted if the tender is successful are inserted, and a total estimate for the contract is thus obtained.

When this stage of the work is completed the estimator will present his estimate to the directors of the company who will covert it into a tender. This should always be the final responsibility of the managing director. It is useful for the estimator to present his estimate in the form of schedule, giving the managing director all the relevant information at a glance

Alternatively the percentages to be allowed for overheads and profits could be agreed between the managing Director and the estimator and included in his analysis of unit rates. This is the most common practice in this country

A typical layout showing tender analysis for reporting to the management is shown in the following page.

* 2:8:I Tender Analysis TABLE 2C

Tender for:	Gross labour rates:
Date due	Graftsman:
Date of completion:	Labourer:

Preliminaries:	₦
Labour	₦
Materials	₦
Plant:	₦
Net value of firm's own work	₦
Add for overheads:	₦
Add for profit	₦
Approved sub-contractors:	₦
Add for profit	₦
Nominated sub-contractors	₦
Nominated suppliers:	₦
Provisional sums:	₦
Total of estimate	₦

The above table shows breakdown of the whole tender figure and it helps management in knowing major and relevant information regarding the tender.

A careful study of the above table for tender analysis reconfirms our earlier statemnet that the tender figure is made up of the following costs:

(a) Labour

(b) Materials

(c) Plant

(d) Overheads

(e) Profit

* Table taken from Practical Builders Estimating by H. Wainwright. Hutchinson Educational Ltd London (I970)

These could also be divided into two broad divisions since items a - d inclusive are costs incurred by the contractor whereas item e is the contractors profit or mark-up.

In agreeing with these two identifiable broad divisions Muazu (25) in his address to the building students states that "When tendering a project, the Contractor compiles the most accurate cost estimate possible of the work specified by the tendering documents. On a lump-sum contract the contractor's mark-up added to his cost estimate makes his final tender amount."

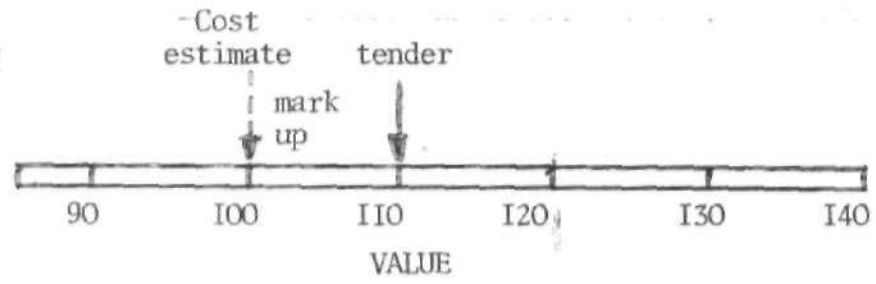
The unit rates inserted in the bills of quantities therefore includes the above two broad costs.

It therefore, follows that any estimate whether prepared by the clients cost adviser or by the contractor must take into account these two types of values.

Experience has, however, shown us that inspite of the fact that the estimates take these two values into consideration on the same project and with the same tender documents, variations still exist between the engineers estimate and the contractors tender. Variations also occur between the tenders themselves. Apart from arithmetical errors, these variations must be traced into either differences in the calculation of the actual cost or in the allowance for mark-up. Skitmore (23) while writing on the question "why do Tenders vary"? explained these variations using the attached graphs.

FIG. 2C GRAPH ON THE EFFECT OF
COMPONENT VARIABILITY ON TENDER VARIABILITY

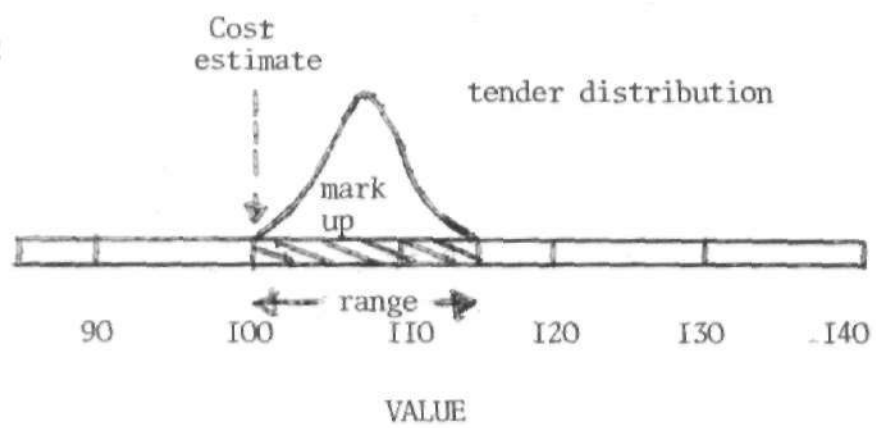
I



MODEL I

Fixed Cost estimate and mark-up

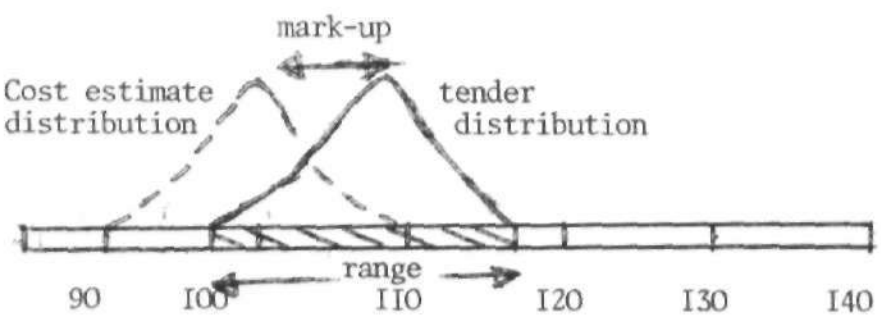
2



MODEL 2

Fixed Cost estimate
Variable Mark up

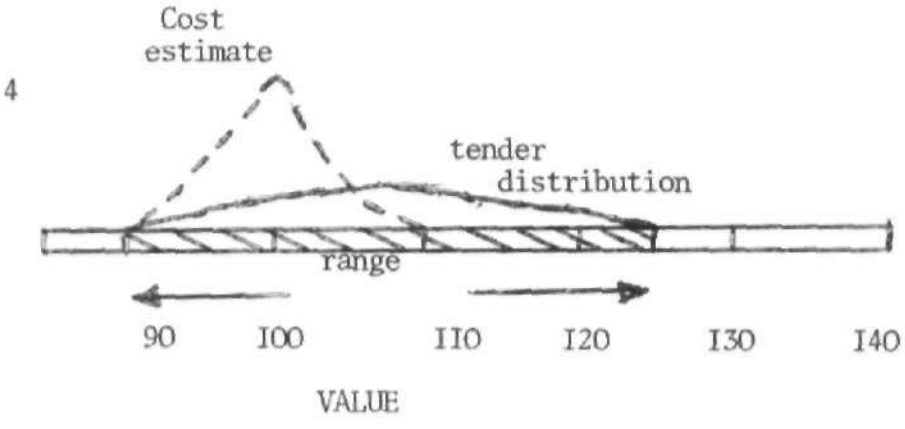
3



MODEL 3

Variable Cost estimate, fixed mark-up

4



MODEL 4

Variable Cost estimate and mark-up

Source: The Chartered Quantity Surveyor - Journal of the Royal Institution of Chartered Surveyors London Dec. 1981 PP. 128 & 129

Model I shows the theoretical but absurd position where the cost estimates and mark-up are fixed for each tenderer, resulting in idential tenders. Model 2 indicates the classical view, where the cost estimates are assumed to be equal, mark-ups being drawn from a distribution of markups, in this example between 0 per cent and I5 per cent but most probably around 7.5 per cent.

Model 3 illustrates the position where the cost estimate is variable and the mark-up is fixed, an assumption often made by simulators in investigating the effects of low cost estimates. The variability in the cost estimate in this model is taken to be around + I0 per cent. The effect of the fixed mark-up in this case can be seen to simply shift the distribution up the value scale.

Finally model 4 indicates the composite position where both the cost estimate and mark-up are considered as variables. Using the same distributions and ranges of values the tender distribution has become much flatter because of the combined variabilities.

It may be noted that only in model I, the absurdity, is the tender value a single determinable figure. Models 2-4 are probabilistic in that a range of possible values is obtainable. There is not factual evidence, however, to support the notion that probabilities can be assigned to any of the values in the distributions, the probabilistic models displayed having been for demonstration purposes only.

While model I is abusrd, model 2 and 3 are intuitively regarded as false. Cost estimates can differ for many reasons including relative efficiency, errors, ability to calculate his cost estimate several times over, it is highly unlikely he would chance variations, and the effect of perceived uncertainty.

Mark-up on the other hand is recognised by the CIOB (I3) and others as being the only manipulative strategic variable in a competitive environment. It is appropriate at this stage therefore to regard model 4 as intuitively "correct".

From this analysis it can therefore be seen that in actual fact the pricing of the direct cost and the mark varies from one estimator to the other.

Park (29) however, felt that variations in direct costs are minimum if they do exist. He states this in the following words "Most contractors are able to estimate, at least with reasonable accuracy, what their direct costs on a job will be. And taking a single job, most of the competing contractors can also be expected to encounter roughly the same costs of performing the work; they are all subjected to the same costs of operation, have access to the same labour supply, use the same types of equipment, obtain supplies and materials from the same sources, and have somewhat comparable, if not equal, supervisory capabilities."

Taking Nigeria as a whole, these assertion made by Park can hardly be correct. However, if we narrow ourselves to Kaduna State and using selective tendering, we might have tenderers virtually on the same conditions stated by Park and hence the variations are mainly in the area of mark-up.

2:9 Tendering Strategy

Tendering strategy deals with the strategy which contractors adopt in order to win contracts. Park (29) felt that the area to make strategic decisions when tendering is in the mark-up. He defined strategy and emphasised its importance for success in contracting in the following terms:

"Strategy involves making competitive decisions; the more competitive an industry the greater the need for making sound strategic decisions, Nowhere is this need greater than in construction contracting where competitive pressures, are probably more intense than in any other industry. Competitive bidding especially, offers abundant opportunities for the application of strategy. For in competitive bidding, the contractor is faced with two seeminly in-compatible and contradictory objectives: He must bid high enough to make a profit yet low enough to get a job both at the same time."

He enumerated some techniques which management could adopt while making stragetic planning as cost control procedures, overhead costs and break even analysis, bid analysis, statistics and probability theory, operations research, the theory of games and risk evaluation.

He further enumerated some points which he feel should be noted for successful contracting as follows:

2:9:I The Principles of Successful Contracting

The contractor who succeeds is the one who knows his capabilities, establishes his objective, and works his way step by step towards it. The following thirteen general principles have been suggested by a number of successful contractors as being particularly important in running a profitable contracting business.

(I) Be selective in choosing jobs to bid

(2) Before bidding a job, analyse it carefully and objectively

(3) Exercise particular care in estimating

(4) Include a realistic markup in all bids

(5) Establish effective cost control and cost reporting procedures

(6) Maintain adequate cash reserves and working capital at all times.

(7) Employ the best supervisory personnel available

(8) Control overhead costs carefully

(9) Develop a strong technical competence and a knowledge of the market to be served

(IO) Maintain good public relations

(II) Be alert for ways to improve the operation

(I2) Use subcontracts for specialized work

(I3) Try to obtain at least part of the work through negotiation.

SUMMARY

From this Literature Review we can draw the following conclusions.

(I) The term engineers estimate" as used in this work refers to the pre-tender or comparative estimate of Costs prepared for the client by his construction Cost Consultants who, in this country, are often referred to as Quantity Surveyors.

(2) Clients rely heavily on the engineers estimate to the extent that it is generaly believed that for a contractors tender to deserve consideration it must fall within ±I0% of the QS estimate.

(3) Reliability of engineers estimate can be measured by means of comparing the various tender figures with the engineers estimate.

(4) The engineers estimate as well as the contractors tender are based on tender documents which comprise bills of quantities, architectural and engineers drawings.

(5) Selective tendering is the best form of tendering method since it allows for a selection of competent contractors to tender for the work.

(6) Those who believe that the engineers or QS estimate is reliable do so because they feel that the QS prepared the tender documents and by the time the documents are ready he should have acquinted himself with the complexity of the project, nature of site and costs of various components of the building. On the other hand the contractor is given only three or four weeks within which to understand the nature of the project and price it. This period, they believe, is too short for this.

(7) Pricing techniques by both private quantity surveyors and contractors estimators vary but the end result or the tender figure in either case is made up of two major parts viz the actual cost of carrying out the works plus the contractors profit or markup. The actual cost could be further subdivided into four ie the costs of labour, materials plant and overheads.

(8) Despite the fact that all tenders or engineers estimate are made up of these two major parts variations between them still occur. There are those who feel that the actual cost of the works should be constant with only profit or mark-up being the variable factor and there are those who believe that the reverse is the case.

Majority of people however, believe that both the actual cost and the mark-up vary from one tenderer to the other.

In selective tendering, however, variations in actual cost of the work is minimal since all the contractors are chosen on the basis that they are all competent for the work and incur virtually the same costs of operations. This is why selective Tendering is chosen for this work.

(9) The strategy often adopted by contractors is believed to be in the area of mark up since the contractor must price low enough to get the job and yet high enough to make a profit both at one and the same time. This strategy must also be teken care off in the preparation of the engineers estimate.

Generally

It is on the basis of these points that the researcher carried out field investigation using the engineers or QS estimate and the various contractors tender figures to see to what extent a client could rely on the engineers cost estimate in terms of the various tender figures received.

The following chapter therefore, deals with the results of the various field investigations and observations made.

CHAPTER III

3:0 FIELD INVESTIGATIONS AND ANALYSIS

Investigations to ascertain the reliability or otherwise of the engineers estimate were carried out in two parts: questionnaire and data collection and analyses.

3:I Observations from Questioneer

Firstly, a questionnaire (See Appendix XIII pages Q/I to Q/8) was prepared and interviews conducted with some private Quantity Surveying and Architectural firms, Government Ministries and parastatals and some construction contracting companies.

Out of over twenty appointments for interviews made, only ten granted full interview and answered all the questions asked. The rest either answered only few questions or failed to grant the interview as arranged.

3:I:I ANALYSIS OF RESPONSES FROM THE QUESTIONEER

About 80 percent of those interviewed are professional members of the design team. The remaining 20 percent are administrators in charge of private constructions firms and government Ministries and parastatals dealing with construction projects.

55 per cent of those interviewed are Consulting Quantity Surveying and Architectural firms, 30 per cent are building Construction firms and I5 percent Government Ministries and parastatal. Over 60 percent of these organisations interviewed have existed for over 5 years.

70 per cent of those interviewed believed that the engineers estimate is reliable, I0 per cent felt that it is fairly reliable whereas the remaining 20 per cent believe that it is unreliable. Most of those who believe in the reliability of the engineers estimate as prepared by experts who in their opinion are well versed in construction costs. It is therefore taken for granted that whatever they prepare should be accurate and reliable.

Most of the remaining 20 per cent who believe that the engineers estimate is not reliable do so because of some unpleasant experiences which they came across during one or two cases in which the tenders received far exceeds the engineers estimates as a result of which they had to retender or abandon the projects. Others do so because the projects were completed at figures which far exceeds the engineers estimates.

The last group of those who do not believe in the reliability of the engineers estimates are mainly contractors who feel that the Consultants who prepare the engineers estimates hardly visit sites to know the difficult conditions and expenses incurred by building contractors on site. They believe that the building contractor is the one whose estimate should be relied upon because he receives feed back on costs from site and is much more practical and realistic in pricing since he runs much more risk than the consultant in case of mistakes in pricing. They feel that if the contractor quotes low prices and wins the project he may not be able to complete the project satisfactorily and if he quotes very high he will not win the tender.

They also argue that the contractor has to pay heavy non-refundable deposits and pay heavy fees for pricing or employ full time quantity Surveyor or estimator solely for the preparation of their tenders. As regards engineers estimates being prepared by consultants, they feel it is only an academic excercise and that consultants do not excercise care and deligence since they have nothing to lose if their estimates are not accurate. However, most of the consultants do not agree with this view since they feel that they have up to date records of cost information on most building materials and components. They believe that they have more qualified staff to handle preparation of the estimates than most contractors offices. They feel that they also have a lot to loose if their estimates are inaccurate since it will affect their chances of getting further jobs from the client.

Taking the engineers estimate as IOO per cent most of the respondents believe that 55 per cent of the tenders received, from their experience are lower than the engineers estimate whereas 45 per cent of the tenders are higher than the engineers estimate. However, with regards to the engineers estimate compared with the final construction cost the respondents believe that only IO per cent of the projects they were involved in were completed within the engineers estimate or slightly lower while 90 per cent of the projects are completed at a much higher cost than the engineers estimate with 20 per cent of the projects costing as much as 30 per cent or more over and above the engineers estimate.

50 per cent of those interviewed replied that most of those incharge of preparation of estimates and tenders keep up to date records of building materials cost. 40 per cent said 'no' while the remaining IO per cent who are mostly not involved in preparation of estimates or tenders said they didn't know.

Most of the respondents feel that 80 per cent of tenders based on selective tendering involve more than six contractors with virtually all those who are invited to tender actually accepting the invitation and submitting tenders. This shows that contractors in this country rarely decline invitation to tender for projects which might be as a result of demand for building contracts far exceeding supply. This may be of advantage to the clients since it encourages keener competitions with possible reduction in tender prices.

Only 50 per cent of those interviewed believe that tender documents are adequate 20 per cent felt they are fairly adequate whereas the remaining 30 percent believe that tender documents for most building works in this country are not adequate or complete. 80 per cent of the respondents believe that the inadequacy results from incomplete architectural and structural drawings while only 20 per cent attributed the inadequacy to the bills of quantities. Even these 20 percent feel that the inadequacy in the bills of quantities stem from the fact that drawings are not adequate with a few of them blaming some quantity surveying firms for producing shubby bills of quantities with vague descriptions and sometimes enclosing too many prime cost (PC) and provisional Sums.

80 per cent of those interviewed felt that contractors are only given between one to three weeks within which to prepare and submit their tenders. 50 per cent of the respondents feel that this period is not enough for contractors to accurately price their bills of quantities obtain quotations from sub-contractors for works which they intend to sublet, and obtain materials and components prices from some suppliers. Most of those who gave these views are quantity surveyors working for some reputable construction companies in Kaduna State.

This assertion was confirmed by some specialist subcontractors such as electrical and structural steel subcontractors who feel that their materials prices are not stable and sometimes they are asked by some of their regular customers to quote for sections of the bills of quantities relating to their works. They said that if they don't have the specified materials in their stock they have to sometimes travel to Lagos or write or phone their overseas suppliers to obtain current prices before they could quote. They feel that they need about two weeks to do this properly and send it to the main contractor who would in turn add his profit and prepare his own prices. Similar situations are expressed by some suppliers especially of aluminium and steel windows and doors.

60 per cent of the respondents feel that contractors win less than IO per cent of the projects they tendered for which shows that there are many cases of abortive tenders. This might be due to the fact, earlier stated, that contractors quote for almost every project they are invited to quote for.

Allowances to cover overheads and profit vary from one estimator to the other with 70 per cent of the respondents allowing between II per cent to 20 percent of the project cost as overhead. 50 per cent of the respondents apply the same percentage to cover profit.

60 per cent of the respondents prefer selective tendering as a better tendering method than either open tendering or tender for negotiated contracts. Majority of those who favoured selective tendering are reputable contractors, Consultants and private organisations who feel that selective tendering is the only way to ensure competitive tenders and good quality worksmanship. The few i.e. 20 per cent who supported open tendering are government officials and newly established construction firms who see open tendering as the only means by which they can have an opportunity to prove their potential capabilities.

Over 80 per cent of those interviewed feel that contract preliminaries and Trade preambles sections of the bills of quantities are not understood very well by most tenderers and clients alike. This results in enormous differences quoted by tenderers for these sections and sometimes failure to read the implications of the contract conditions especially as it relates to fluctuation and insurance lead to many tenderers not making allowances for complying with these sections. The conditions of contract however, makes it compulsory to the contractor to comply with all the provisions of both the conditions and preliminaries and trade preambles whether he quoted for them or not. The tender figure is deemed to include some money for complying with these provisions.

Informal discussions carried out with the respondents shows that 90 percent of them feel that the engineers estimate forms the main basis of selecting a contractor during contract award. It is a general view that majority of the tenders are award ed at a figure within ±10 per cent of the engineers estimate with those on the 0 to minus 10 per cent taking a leading position. They believe that tenders are only awarded at a figure higher than the engineers estimates only if no other reputable tenders below the engineers estimate is received. This seems to agree with our theory as discussed during Literature Review in Chapter II. It also confirms the general opinion that the engineers estimate is reliable since it is being relied upon to make contract awards. It is used as a reference point for determining whether a contractors tender deserves to receive tender boards consideration or not.

3:2 Chi-Squared Tests of Some Selected Tenders

In addition to the interview, relevant data and files were collected for some building projects some of which were either completed or under construction. Thus all the projects whose data were considered relevant are those which have passed through the pre-contract or tender stages whose tender documents include bills of quantities and were tendered on selective bases. The names of those who tendered for the projects together with their tender figures were recorded in descending order of the tender figures.

The pre-tender or Quantity Surveyors (QS) or engineers estimate (as is called in this work) for each of the projects was also recorded.

The raw data together with analysis of the various tenders and estimates for the projects investigated are shown on the following pages.

Histograms were drawn for each of the project to give a quick and clear picture of the differences between the various tender figures themselves and the engineers estimates.

Chi-Square tests were also carried out between the observed values or tender figures and the expected values or engineers estimate, to test scientifically the validality of the assumption that the engineers estimate is reliable.

All the tests were carried out at a level of Significance equal to 0.10 or 90% confidence level. The degrees of freedom are based on the theory that it equal the number of observations less one.

A brief discussion on the theory behind the Chi-Square test is as follows:

3:2:I The Chi-Squared Test

Harper described the chi-squared test in the following terms: "The X^2 distribution is used to test if an observed series of values differs significantly from what is expected (significant meaning "statistically significant i.e. the difference cannot be explained as being probably due solely to chance."

X^2 is a numerical figure associated with a particular group of observations. The formula for finding this figure from a given group of observed values is:

$$X^2 = \sum \frac{(\text{Actual - Expected value})^2}{\text{Expected value}}$$

If the actual results are exactly as expected then (Actual-Expected) = 0 for each item in the series, and X^2 works out at zero. On the other hand, the bigger the difference between actuals and expected, the bigger the X^2 becomes.

NB. Dividing by the expected value simply brings the squared difference into proportion eg a difference of IO when 40 was expected is a very much 'bigger' difference than one of IO when 4000 was expected.

3:2:2 The X^2 distribution

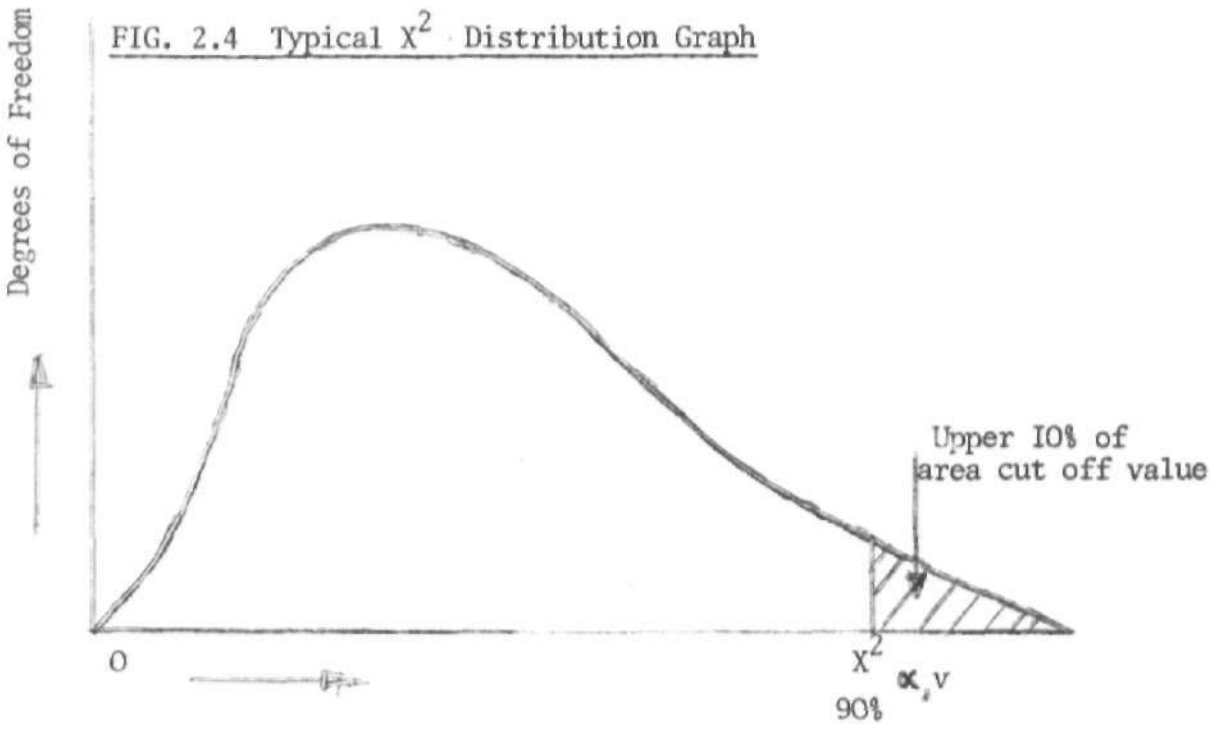
Let us consider throwing a perfectly good die 600 times and repeating this 600 - throw cycle over and over again, finding X^2 for each cycle. Now the number of cycles in which we would have each face falling upwards exactly 100 times (X^2 therefore equalling 0) would be virtually none. More frequently a difference of between 5 and 10 from the expected value of 100 would arise (if say, there were a difference of 5 for every face then $X^2 = \frac{5^2}{100} + \frac{5^2}{100} + \frac{5^2}{100} + \frac{5^2}{100} + \frac{5^2}{100} + \frac{5^2}{100} = 1.5$

Very rarely differences of, say, 20 would arise and if they did, again assuming they did for every face then

$X^2 = \frac{20^2}{100} \times 6 = 24$

If this is carried out enough times all the X^2 could be put into a distribution from which a frequency curve as that below could be prepared.

FIG. 2.4 Typical X^2 Distribution Graph



At some point towards the extreme right of the curve we can draw a line that cuts off the upper IO percent of the total area eg. we can find a value such that 90 percent of the ascertained values of X^2 will lie between this number and 0.

3:2:3 Using the X^2 distribution

The above curve was formed as a result of using a perfectly goqd die. Assume we now use a die the perfection of which is in some doubt. We throw it 600 times and compute X^2 from the results. What if our figure lies above 90 percent cut-off value on the distribution. We are then faced with the usual dilenma ie is our result one of the I in 20 that can arise with a good die, or is our die not so good? Clearly, we would only be wrong once in twenty times if we elected to say such a die was not a good one. In other words, we can use our X^2 distribution to test whether a group of differences between actual and expected results is statistically significant.

NB. The X^2 test is based on the fact that if the value of X^2 computed from the observed data exceeds the cut-off values in the table the difference between actual and expected results are unlikely (at chosen level of confidence) to be due solely to chance.

3:3:0 ANALYSES OF TENDERS

3:3:I Tenders Received for Agronomy Building A,B,U, Zaria

Client: Ahmadu Bello University Zaria

Consultant QS: Shehu Giwa & Partners Kaduna

Date: March I979

S/No	Name of Tenderers	Tender Figure (₦)	Completion period (weeks)	Percentage Difference from QS estimate
A	Civ-Eng. Constr. Co.Ltd	I,0I7,283.37	60	-9.I5
B	A.G. Ferrero & Co. Ltd	I,086,824.90	52	-2.94
C	Zaria Nasara Ent.Co.Ltd	I,I32,I54.88	5I	+I.II
D	B. Stabilini & Co. Lrd	I,I34,740.80	60	+I.34
E	Alh. Mustapha Danrka & Sons	I,I52,096.90	65	+2.89
F	Q. S. Estimate	I,II9,7I4.46	54	0
G	Contract Sum	I,080,206.62	5I	-3.53

TABLE 3:3:IA

The above table is for tenders received on the building of the office block for Department of Agronomy, Faculty of Agriculture A.B.U. Zaria in March, I979.

Five contractors were selected to tender, their names and tender figures in descending order together with quoted completion periods were shown, The QS or engineers estimate is recorded together with the contract sum.

A column showing the percentage difference between tender figures and QS estimates is included.

The analyses shows that

(a) Tenders not lower than -I0% of the engineers estimate 40%

(b) Tenders not higher than +I0% of the engineers estimate 60%

(c) Tenders within ±I0% of the engineers estimate I00%

(d) Tenders lower than the engineers estimate 40%

(e) Tenders higher than the engineers estimate 60%

(f) Difference between QS estimate and contract sum - 3.53%

In this case, all the tenders are within ±I0% of the engineers estimate. It can therefore be seen that the engineers estimate is reliable to the extent that all the tenders could be expected to fall within ±I0% of the engineers estimate. A closer look at the analyses would reveal the significant difference between tenderer A and the engineers estimate, so also with the other tenders. It could also be observed that the contract was awarded at a figure lower than the engineers estimate.

A histogram of the tender figures is drawn below to give a pictorial view of the relationship of the various tenderers with the engineers estimate and between the tenders themselves.

FIG. 3.3.IB HISTOGRAM OF TENDERS FOR AGRONOMY BUILDING

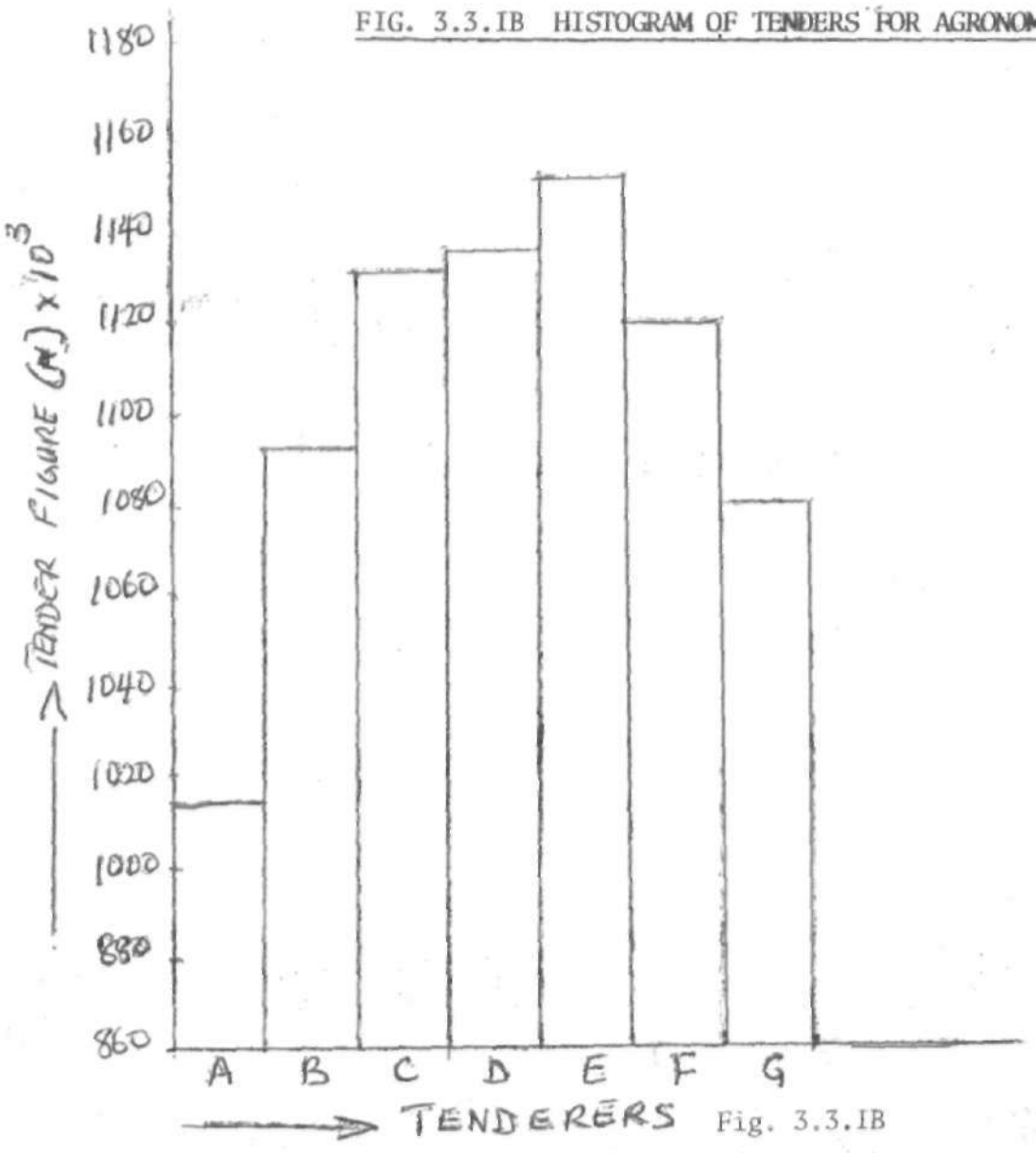


Fig. 3.3.IB

The above histogram show that most of the tenders with the exception of tenderer A are very close to each other and to the engineers estimate. A closer study of the priced bills of quantities showed that tenderer A priced his preliminaries very low. Contractor C won the contract at his corrected tender figure which is 3.53% lower than the engineers estimate but with his quoted completion period.

A further analyses using chi-square X^2 is tabulated below to further test the reliability of the engineers estimate with respect to tenders received.

Chi-Squared Test on Agronomy Building

S/No	A	B	C	D	E
Observed Value Oi	IOI7	I087	II32	II35	II52
Expected(QS)Value ei	II20	II20	II20	II20	II20
Oi - ei	-I03	-33	I2	I5	32
$(Oi - ei)^2$	I0609	I089	I44	225	I024
X^2 value $\frac{(Oi-ei)^2}{ei}$	9.47	0.97	0.I3	0.20	0.9I

TABLE 3:3:IC

Calculated $X^2 = \sum \frac{(Oi - ei)^2}{ei}$ = II.68

Critical $X^2_{0.I0,4}$ = 7.779

Oi here represents observed or actual value which in this case is the various tender figures received in thousands of naira.

ei means expected value or engineers or QS estimate.

X^2 means the calculated chi-squared value obtained by addition of $\frac{(oi-ei)^2}{ei}$ values of the various tenders.

$X^2$0.I0,4 means Critical chi-squared value at 0.I0 level of significance and 4 degrees of freedom (see X^2 table Appendix XV).

Since the calculated value of II.68 is higher than the critical value of 7.779 we conclude that the difference between the engineers estimate and the tenders received cannot solely be atributed to mere chance and that the difference is statistically significant at the chosen level of significance of I0% or 90% confidence level. We therefore reject the hypothesis that the engineers estimate is reliable with respect to all the tenders to be received.

However, a closer study of the table shows that the rejection of this assumption is mainly due to tenderer 'A' whose X^2 value accounts for over 80% of the total value. Its elimination brings our calculated value to 2.2I but the critical value will then be 5.25I, the degrees of freedom will be 3 instead of 4.

Elimination of tenderer 'A' leads to acceptance of the assumption that the engineers estimate is reliable. Note that the expected value is the engineers estimate whereas the observed value is the tender figures. All the figures are in thousands.

3:3:2 Tenders Received for IO - Storey Office Block at Kaduna

Client: New Nigeria Newspapers Ltd Kaduna

Consultants QS: Adesoye & Partners Kaduna

Date: May I978

S/No	Name of Tenderer	Tender Figure (₦)	Completion period (weeks)	Percentage Difference from QS estimate
A	Arewa Const. Ltd	6,700,000.00	80	+6.72
B	Songhai Ltd	7,335,9I2.00	80	+I6.85
C	Kier Niger Ltd	7,574,353.29	IIO	+20.64
D	G. Cappa Ltd	7,6I7,8I9.79	I30	+2I.34
E	Wolf & Miller (Nig)Ltd	8,I29,678.95	95	+29.49
F	Kueppers (Nig) Ltd	8,957,830.90	98	+42.68
G	Necco Ltd	II,352,464.I2	89	+80.82
H	Q.S. Estimate	6,278,290.00	-	0
J	Contract Sum	6,700,000.00	I20	+6.72

TABLE 3:3:2A

The above table is for tenders received for the NNN Ltd office building at former cultural centre Kaduna. The above result is for the second tenders called because the first tender had to be cancelled since all of them were much higher than the QS estimate. It was during the retendering period that contractor A, the lowest tenderer participated in the tenders and was subsequently awarded the contract at 6.72% higher than the QS estimate.

From the column of the percentage difference between the various tender figures and the QS estimate, it could be seen that the QS estimate is extremely low resulting in all the tenders being higher than the QS estimate.

The following observations could be made from the analyses:

(a) Tenders not lower than -IO% of engineers estimate = 0%

(b) Tenders not higher than +IO% of engineers estimate = I4%

(c) Tenders falling between ±IO% of engineers estimate = I4%

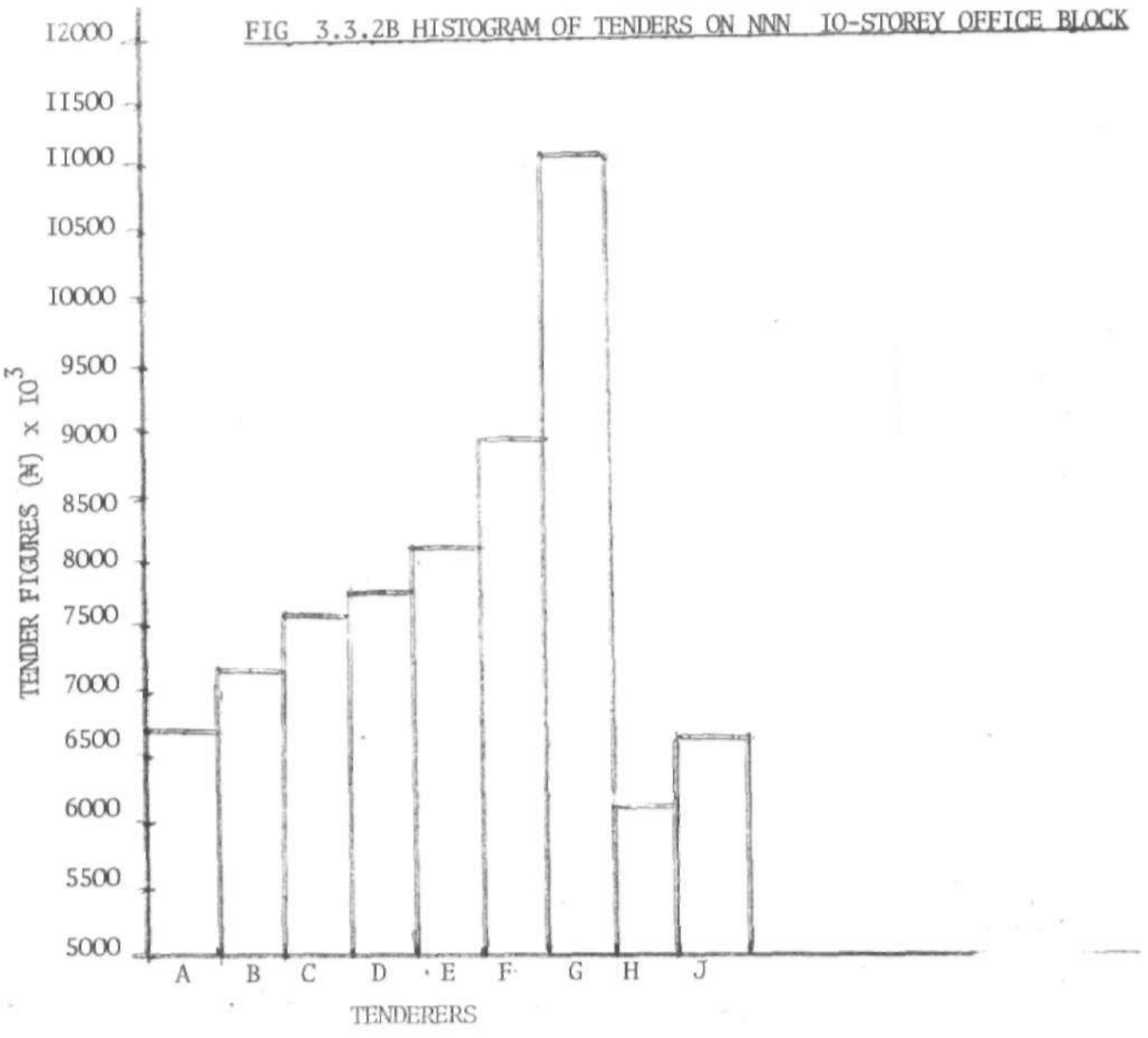
(d) Tenders lower than engineers estimate = 0%

(e) Tenders higher than engineers estimate = IOO%

(f) Difference between QS estimate and contract sum = +6.72%

A histogram of the various tender figures is drawn below:

FIG 3.3.2B HISTOGRAM OF TENDERS ON NNN IO-STOREY OFFICE BLOCK



The above histogram clearly shows the large differences between QS estimate and the various tenders.

A further analysis using chi-squared test was carried out and the results tabulated below:

Chi-Squared Test

S/No	A	B	C	D	E	F	G
Observed Oi	6700	7336	7574	7618	8130	8958	11,352
expected ei	6278	6278	6278	6278	6278	6278	6278
Oi - ei	422	1058	1296	1340	1852	2680	5074
$(Oi - ei)^2$	178084	1119364	1679616	1795600	3429994	7182400	25745476
Calculated X^2	28.37	178.30	267.54	286.01	546.34	1144.06	4100.90

TABLE 3:3:2C

Calculated X^2 = 6551.52

Critical $X^2_{0.10,6}$ = 10.645

It could clearly be seen from the above table that enourmous differences are observed in the X^2 value. The calculated X^2 value of 6551.52 is much higher than the critical value of only 10.645. This shows that there is a very significant difference between the engineers estimate and the various tenders resulting in the unreliability of the engineers estimate.

These large differences are observed in all the tenders showing clearly that something must be wrong with the QS estimate. The contract was however, awarded to the lowest tender i.e. tenderer 'A' who is closer to the QS estimate. This project, awarded in 1978 has not been completed uptill now despite the fact that the client has already spent over ₦9 million and is likely to spend between one and two million naira before the project is finally completed. The project has now been terminated and the contractor is at the moment out of business and the company is from all indications, going to be declared bankrupt.

Though this project might not be the sole cause of the possible banckruptacy of the contractor but from discussions with some of their staff it contibuted to it. The predicament which both the client and the contractor find themselves in might not have been unconnected with the unquestionable reliability on the engineers estimate.

It could be noticed that the contract might be completed at a figure much higher than most of the tenders received at the time of contract award inspite of the fact that no substantial variations occur. Most of the additional payments are as a result of fluctuations being claimed by the contractor. The rate at which the work was being carried out is extremely low as a result of which the client has been loosing heavily in terms of expected rents from the offices. Incidentally no liquidated damages have been recovered by the client.

This is a clear indication that the clients needs in terms of the right cost and right time are not at all being satisfied by the low engineers estimate.

3:3:3 Tenders Received for a Packaging Factory at Kaduna

Client: New Nigeria Packaging Co. Ltd Kaduna

Consultant QS: Shehu Giwa & Partners Kaduna

Date: July, I982

S/No	Name of Tenderer	Tender Figure (₦)	Completion period (weeks)	Percentage Difference from QS Estimate
A	A.G. Ferrero & Co. Ltd	I,723,337.65	44	-3.73
B	B. Stabilini & Co. Ltd	I,779,749.30	52	-0.58
C	Modaco Ltd	I,838,697.05	60	+2.7I
D	Cappa & D'Alberto Ltd	I,873,042.00	40	+4.63
E	Conital Constr. Ltd	I,936,022.II	65	+8.I5
F	Sisk Nig. Ltd	I,952,I89.90	65	+9.05
G	Songhai Ltd	2,I2I,973.00	65	+I8.53
H	Road & Bldg Const. Ltd	2,6I9,733.27	56	+46.44
I	Q.S. Estimate	I,790,I68.I4	52	0
J	Contract Sum	I,690,76I.50	52	-5.55

TABLE 3:3:3A

The above table is for tenders received on the factory buildings for the New Nigeria Packaging Co. Ltd. Names of tenderers, tender figures, completion periods and percentage difference between the various tender figures and the engineers estimate and contract sum are also included. The contract was awarded after negotiation to contractor B at a figure of -5.55% lower than the engineers estimate after he agreed to give a 5% discount on his tender figure.

From the column of the percentage differences between the various tenders and the QS estimates, the following observations could be made:

(a) Tenders not lower than -IO% of engineers estimate = 25%

(b) Tenders not higher than +IO% of engineers estimate = 50%

(c) Tenders falling between ±IO% of engineers estimate = 75%

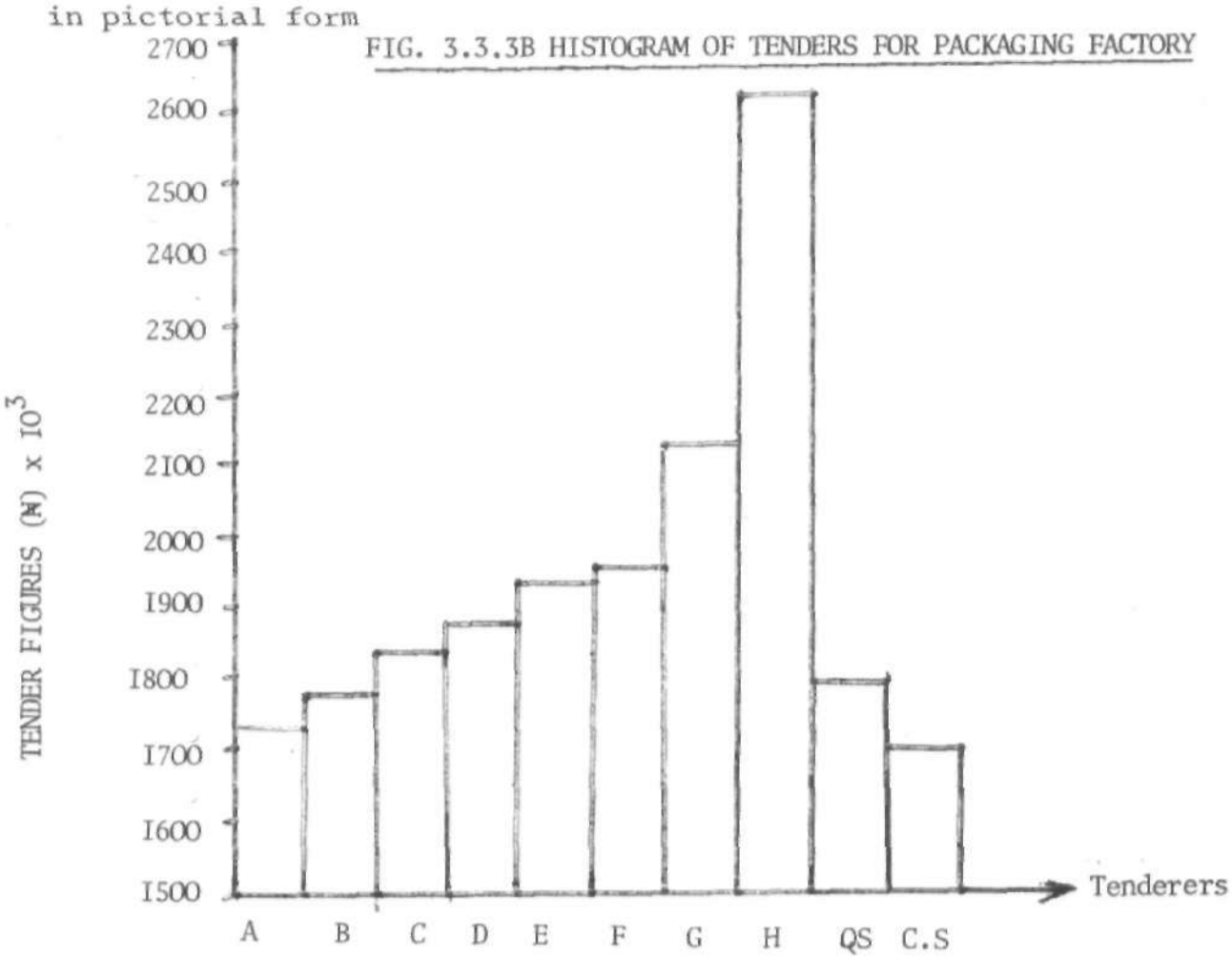
(d) Tenders lower than engineers estimate = 25%

(e) Tenders higher than engineers estimate = 75%

(f) Difference between QS estimates and contract sum = -5.55%

A histogram is drawn below to further show these differences in pictorial form

FIG. 3.3.3B HISTOGRAM OF TENDERS FOR PACKAGING FACTORY



The above histogram shows that there are significant differences between engineers estimate and the various tenders. Tenders G & H are very high compared with the engineers estimate.

A further analyses using the chi-squared (X^2) test is shown below:

Chi-Squared Test on Packaging Factory

S/No	A	B	C	D	E	F	G	H
Observed Oi	I723	I780	I839	I873	I936	I952	2I22	2620
expected ei	I790	I790	I790	I790	I790	I790	I790	I790
Oi - ei	-67	-I0	49	83	I46	I62	332	830
(Oi - ei)	4489	I00	240I	6889	2I3I6	26244	II0224	688900
$\frac{(Oi - ei)^2}{ei}$	2.5I	0.06	I.34	3.85	II.9I	I4.66	6I.58	384.86

TABLE 3:3:3C

Calculated X^2 = 480.77 = $\sum \frac{(Oi-ei)^2}{ei}$

Critical $X^2_{0.I0,7}$ = I2.0I7

From this analysis it could be seen that the calculated X^2 value of 480,77 is much higher than the critical value of I2,0I7 obtained from the X^2 table. This is a clear indication that there are very significant differences between the engineers estimate and the various tenders. A closer examination of the X^2 values shows that tenderer H alone accounts for over 80 percent of the difference. His elimination however, does not lead to acceptance of the reliability of the engineers estimate with respect to all the tenders to be received.

3:3:4 Tenders Received for an Office Block/Banking Hall at Kaduna

Client: Federal Mortgage Bank Ltd Kaduna

Consultant QS: Adebayo Baruwa & Partners Kaduna

Date: December, I98I

S/No	Name of Tenderer	Tender Figure (₦)	Completion period (weeks)	Percentage Difference between QS estimate
A	Arewa Const. Ltd	8,007,384.I0	I09	-II.43
B	Songhai Ltd	8,390,780.00	I30	-7.I9
C	Arbico Ltd	8,405,I45.34	I20	-7.04
D	New Nigeria Const.Co.Ltd	8,4I3,730.20	96	-6.94
E	Road & Bldg.Const. Ltd	8,9I0,I3I.40	87	-I.45
F	Technoexportstorey	I0,270,5I0.00	9I	-I3.60
G	Q.S. Estimate	9,04I,2I0.I0	I30	0
H	Contract Sum	8,405,I45.34	I20	-7.04

TABLE 3:3:4A

The above table is for tenders received on office Development of the Federal Mortgage Bank Ltd Kaduna. Names of the tenderers, their tender figures and completion periods are tabulated. The last column is an analyses showing the percentage difference between the various tenders and QS or engineers estimate. The following observations could be made from the analyses:

(a) Tenders not lower than -I0% of the engineers estimate 67%

(b) Tenders not higher than +I0% of the engineers estimate 0%

(c) Tenders within ± I0% of the engineers estimate 67%

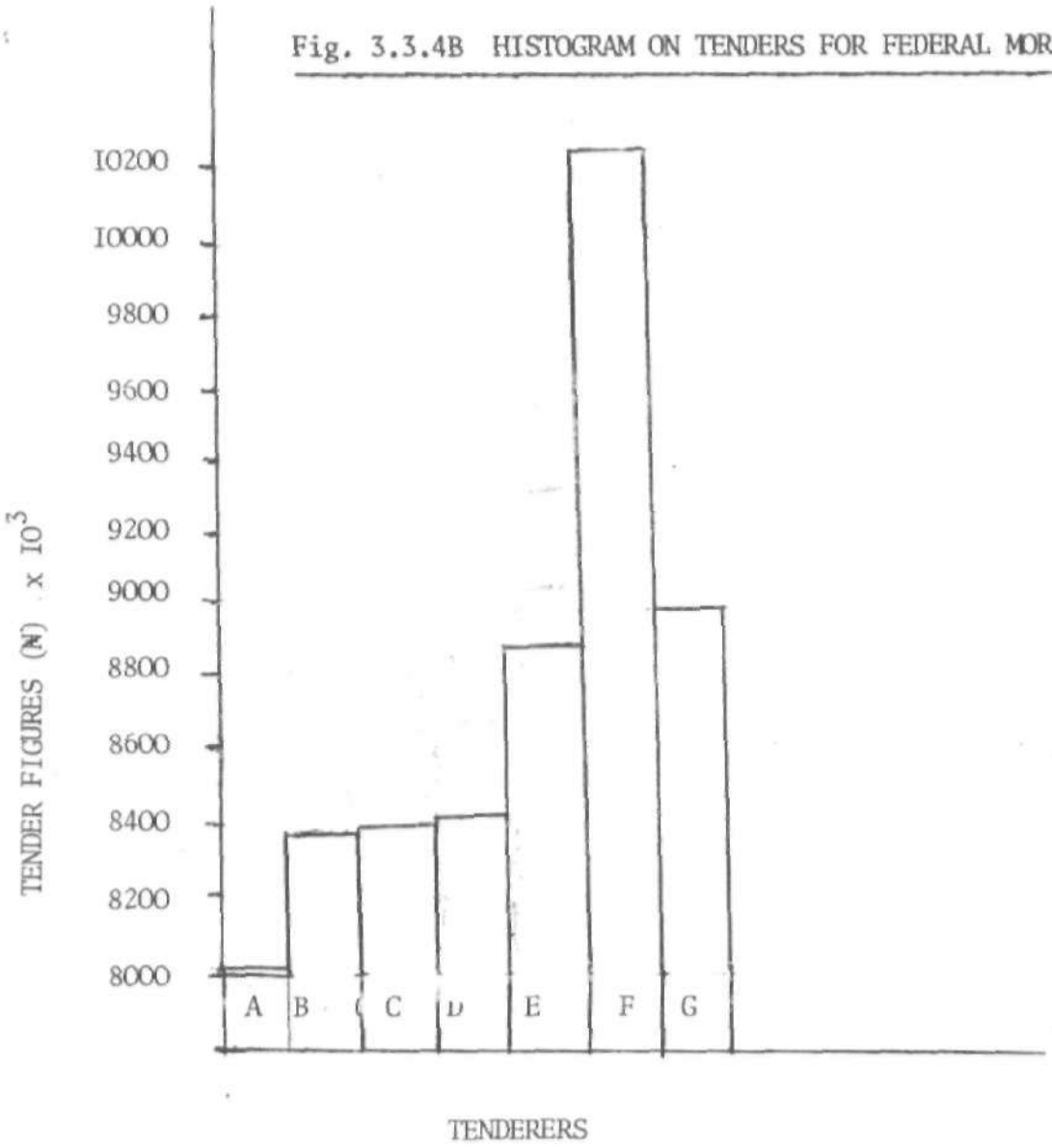
(d) Tenders lower than engineers estimate 83%

(e) Tenders higher than engineers estimate I7%

(f) Difference between contract sum and engineers estimate -7.04%

A histogram is drawn below to further show the relationship of the various tender figures and the QS estimate.

Fig. 3.3.4B HISTOGRAM ON TENDERS FOR FEDERAL MORTGAGE BANK



From the above histogram it could be seen that tenderer 'A' is very low compared with all the other tenders. Incidentally it is the same company whose tender is also the lowest in the case of NNN office Block. Tenderer 'F' is also extremely on the high side. The client was initially attacted by this low tender and could have awarded the contract to tenderer 'A' but for the wide publicity given by the NNN in the contractors non performance on their project.

A further analysis using the chi-squared test is carried out below:

Chi-Squared Test

S/No	A	B	C	D	E	F
Observed Oi	8007	839I	8405	84I4	89I0	I027I
expected ei	904I	904I	904I	904I	904I	904I
Oi - ei	-I034	-650	-636	-627	-I3I	I230
$(Oi-ei)^2$	I069I56	422500	404496	393I29	I7I6I	I5I2900
$X^2 = \frac{(Oi-ei)^2}{ei}$	II8.26	46.73	44.74	43.48	I.90	I67.34

TABLE 3:3:4C

Calculated X^2 = 422.45 $= \sum \frac{(Oi-ei)^2}{ei}$

Critical $X^2_{0.I0,5}$ = 9.236

From the above chi-square test it could be seen that the calculated chi-squared value of 422.45 is much higher than the Critical value of 9.236 obtained from the X^2 table. This indicates that there is a very significant difference between the engineers estimate and the various tenders. A closer study of the analyses however, shows that tenderers 'A' and 'F' alone account for about 68% of this difference.

In this case it could be seen that the engineers estimate is rather on the high side since it is higher than all the other tender figures with the exception of tenderer F.

3:3:5 Tenders Received for Faculty of Education Building Phase II

Client: Ahmadu Bello University Zaria

Consultant QS: Adesoye & Partners Kaduna

Date: November, I975

S/No	Name of Tenderer	Tender Figure (₦)	Comple-tion period (weeks)	Percentage Difference from QS estimate
A	S.G. Bonomi Ltd	7I5,633.40	48	-27.88%
B	D'Alberto & Bogialla Ltd	793,8I3.70	60	-I9.07%
C	Edilit Ltd	824,I33.47	65	-I6.22%
D	B. Stabilini & Co. Ltd	857,I98.08	60	-I4.46%
E	Rufai & Sons Ltd	864,97I.43	40	-II.82%
F	Cubitts Nig. Ltd	887,700.00	52	-9.5I%
G	N N C C Ltd	900,347.35	52	-8.22
H	E.M. Micheletti & Sons Ltd	9I8,I37.90	65	-6.40
J	A.G. Ferrero & Co. Ltd	978,93I.33	70	-0.06
K	Q. S. Estimates	980,94I.75	-	0
L	Contract Sum	7I5,633.40	48	-27.88%

TABLE 3:3:5A

The above table is for tenders received on ABU Faculty of Education Building Phase II. The names of the tenderers together with their tender figures and completion periods are tabulated above. A column showing the percentage difference between the engineers estimate and the various tenders is introduced.

The following observations could be made from the table:

(a) Tenders not lower than -I0% of engineers estimate =44%

(b) Tenders not higher than +I0% of engineers estimate = 0%

(c) Tenders falling within ± I0% of engineers estimate =44%

(d) Tenders lower than the engineers estimate =I00%

(e) Tenders higher than the engineers estimate 0%

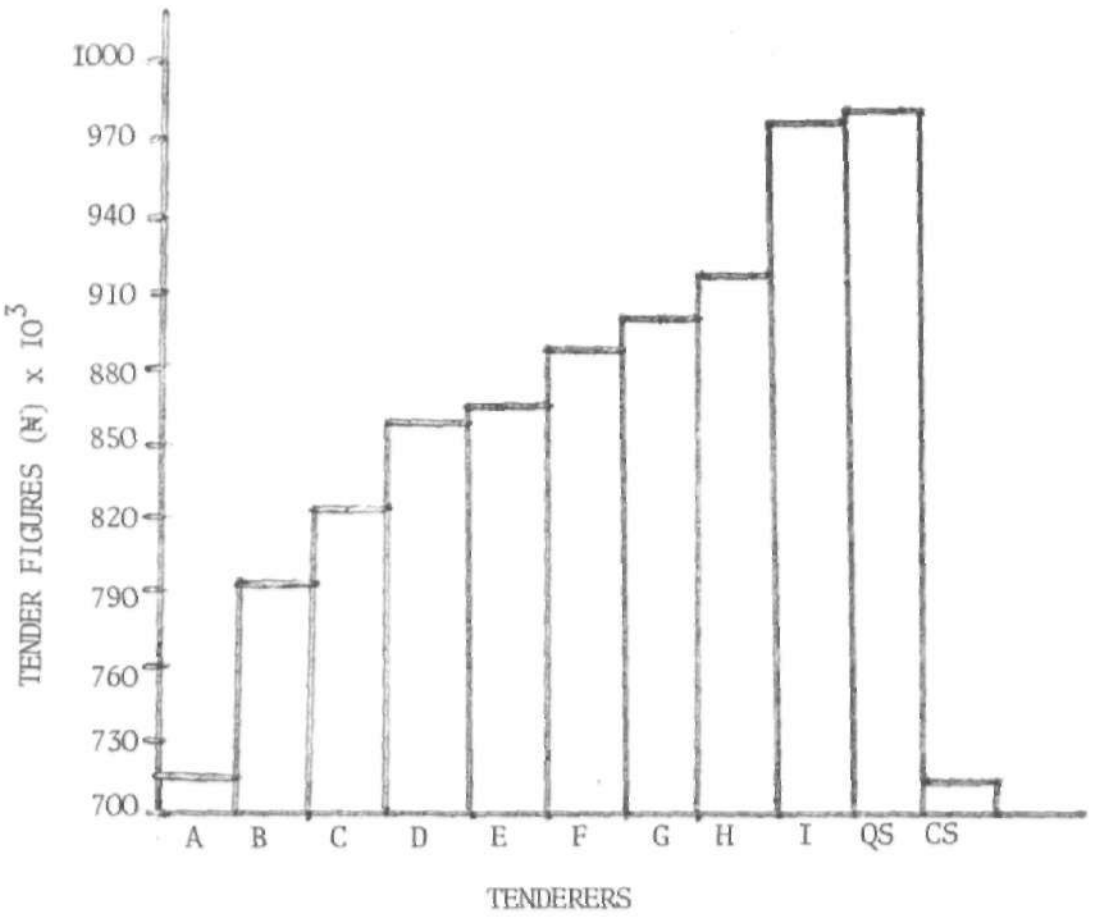
(f) Difference between contract sum and engineers estimate -27.88%

It could be seen that all the tenders are lower than the engineers estimate. This results from the fact that the QS submitted his pre-tender estimate at the time of tender documents submission. It is after a few months from the time of the submission of the QS estimate that the client called for tenders. It is within this time interval that the then military administration announced a sudden reduction in the price of cement and relaxation on the customs duty on cement and many of the building materials. This resulted in all the tenderers pricing lower than the QS estimate. The consultant QS noted this in his report and recommended the lowest tenderer i.e. tenderer 'A' whose tender is 27.88% lower than the QS estimate.

In normal situation this tender might not be recommended since it does not fall within ± I0% of the engineers estimate and it has the largest difference from the QS estimate.

A histogram is drawn below to show the difference between the various tenders and the engineers estimate:

FIG. 3.3.5B HISTOGRAM ON TENDERS FOR FACULTY OF EDUCATION PHASE II



The above histogram clearly shows the ascending orders of the various tenders with tenderer 'A' showing the largest difference from the QS estimate.

A further analyses using the chi-squared test was carried out and tabulated below:

Chi-Squared Test

S/No	A	B	C	D	E	F	G	H	J
Observed Oi	7I6	794	824	857	865	888	900	9I8	979
expected ei	98I	98I	98I	98I	98I	98I	98I	98I	98I
Oi - ei	-265	-I87	-I57	-I24	-II6	-93	-8I	63	-2
$(Oi-ei)^2$	70225	34969	24649	I5376	I3456	8649	656I	3969	4
$\frac{(Oi-ei)^2}{ei}$	7I.59	36.65	25.I3	I5.67	I3.72	8.82	6.69	4.05	0.00

TABLE 3:3:5C

Calculated X^2 = I8I.32 $= \sum \frac{(Oi-ei)^2}{ei}$

Critical $X^2_{0.I0,8}$ = I3.362

The above chi-squared test clearly shows that there are significant differences between between the engineers estimate and the various tenders. However, the difference in changes of the prices of building materials as stated earlier might have accounted for this. It should in addition, be noted that not all the contractors responded quickly to changes in prices resulting from government measures. This could be noticed from the last two highest tenderers H and J who still tendered close to the unadjusted QS estimate. It also emphasises the need for QS's to price the tender documents at the same time with the various tenders if their estimates are to be reliable.

In this case, the calculated chi-squared value of I8I.32 is higher than the critical value of I3.362 obtained from the chi-squared table. This therefore leads to rejection of the assumption that the engineer's estimate is reliable with respect to all the tenders based on selective tendering falling within ±I0% of the QS estimate.

3:3:6 Tenders Received for Laboratory Building at Kaduna

Client: Federal Department of Agriculture Kaduna

Consultant QS: Mogbo & Co Kaduna

Date: August, I980

S/No	Name of Tenderer	Tender Figure (₦)	Comple-tion period (weeks)	Percentage Difference from QS Estimate
A	Alh. Ali.Dan Hassan & Sons	743,496.00	49	-7.06
B	Gamma Constr. Ltd	754,087.08	47	-5.74
C	Scancilla Const. Ltd	759,9I2.87	30	-5.0I
D	Jagal Constr. Co.Ltd	782,949.49	26	-2.I3
E	Zazzau Gen. Tradg. Co.Ltd	804,976.45	75	+0.62
F	George Anthony Ltd	8I2,08I.26	54	+I.5I
G	Arewa Constr. Ltd	846,034.29	48	+5.75
H	Q.S. Estimate	800,000.00	52	0
J	Contract Sum	804,976.45	75	+0.62

TABLE 3:3:6A

The above table is for tenders received on the Laboratory building at Kaduna. Names of the various tenderers, tender figures and quoted completion periods are tabulated above. An analyses column showing the percentage differences between the various tender figures and the QS estimates are shown . The following observations could be made:

(a) Tenders not lower than -I0% of the engineers estimate 57%

(b) Tenders not higher than +I0% of the engineers estimate 43%

(c) Tenders falling within ±I0% of the engineers estimate I00%

(d) Tenders lower than the engineers estimate 57%

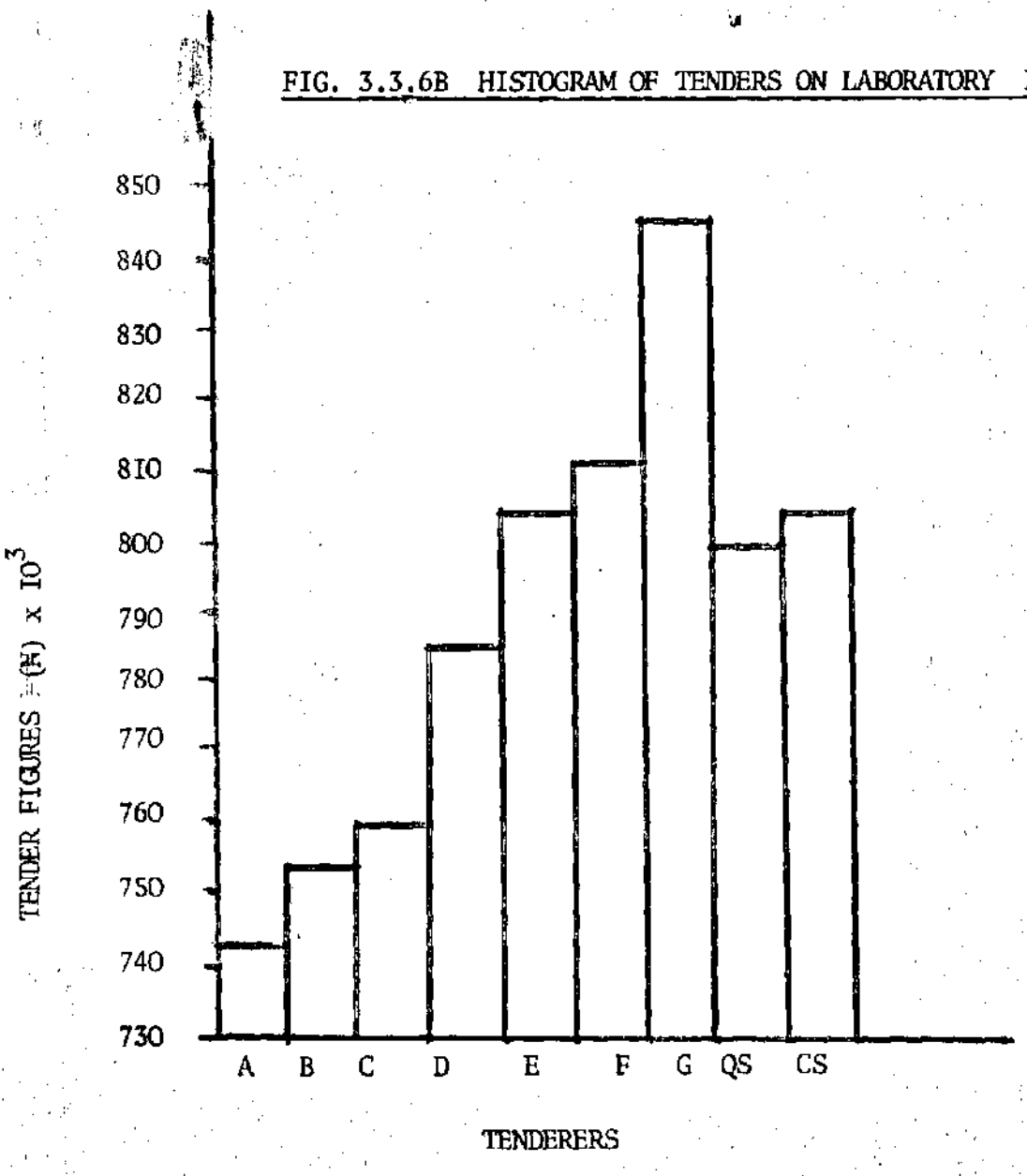
(e) Tenders higher than the engineers estimate 43%

(f) Difference between contract sum and engineers estimate +0.62%

Thus all the tenders fall within ± I0% of the engineers estimate as expected from our literature review.

A histogram of the various tender figures together with the engineers estimate and contract sum are drawn below:

FIG. 3.3.6B HISTOGRAM OF TENDERS ON LABORATORY BUILDING



The above histogram clearly shows the relationship of the various tender figures.

A further analyses by means of chi-squared test is carried out and the result tabulated below:

Chi-Squared Test

S/No	A	B	C	D	E	F	G
Observed Oi	743	754	760	783	805	8I2	846
expected ei	800	800	800	800	800	800	800
Oi - ei	-57	-46	-49	-I7	5	I2	46
$(Oi-ei)^2$	3249	2II6	I600	289	25	I44	2II6
$\frac{(Oi-ei)^2}{ei}$	4.06	2.65	2.00	0.36	0.03	0.I8	2.65

TABLE 8:3:6C

Calculated X^2 = II.93 = $\sum \frac{(Oi-ei)^2}{ei}$

Critical $X^2_{0.I0,6}$ = I0.645

From the above chi-squared table it could be seen that the calculated chi-squared value of II.93 is only slightly higher than the critical value of I0.645 obtained from the chi-squared table. This shows that there are differences between the engineers estimate and the various tender figures but the differences are not very significant,

The contract was awarded to contractor E at his tender figure which is only 0.62% higher than the QS estimate.

3:3:7 Tenders Received for KICL Office Building at Kaduna

Client: Kaduna State Investment Company Ltd.

Consultant QS: QU-ESS Partnership Kaduna

Date: May I978

S/No	Name of Tenderer	Tender Figure (₦)	Completion period (weeks)	Percentage Difference from QS Estimate
A	Nasidi Bros Ltd	2,277,657.72	52	-5.I0
B	Giamapoli Constr. Ltd	2,30I,I60.00	78	-4.I2
C	Songhai Ltd	2,502,485.00	I00	+4.27
D	E.M.Michelletti & Sons Ltd	2,5I8,037.95	I05	+4.92
E	D'Alberto & Giampolia Ltd	2,558,536. 7I	86	+6.6I
F	A.G. Ferrero & Co. Ltd	2,636,675.75	90	+9.86
G	N. N. C. C. Ltd	2,649,636.70	I04	+I0.40
H	Vicinanza Const. Ltd	2,862,743.00	I20	+I9.28
I	Kueppers Nig. Ltd	3,383,I30.00	85	+40.96
J	Q.S. Estimate	2,400,000.00	-	0
K	Contract Sum	2,499,537.95	I05	+4.I5

TABLE 3:3:7A

The above table is for tenders received on the office Building at Kaduna for Kaduna State Investment Co. Ltd. The names of the various tenderers i.e. items A to I are tabulated together with their tender figures and quoted completion periods.

Another column showing the percentage difference between the various tender figures and the engineers estimate is also included. The following observations could be made:

(a) Tenders not lower than -IO% of engineers estimate 22%

(b) Tenders not higher than ±IO% of engineers estimate 44%

(c) Tenders falling within +IO% of engineers estimate 66%

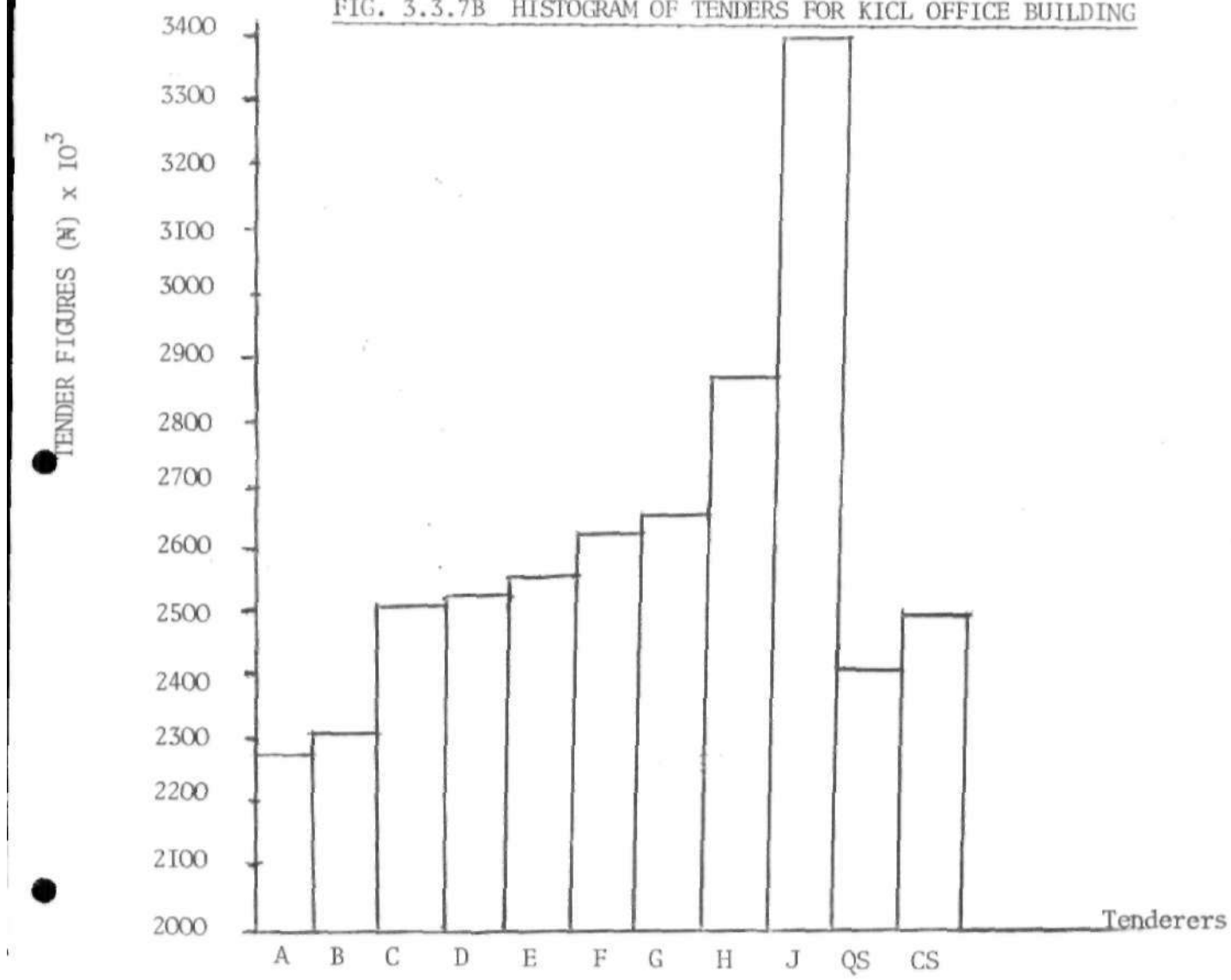
(d) Tenders lower than engineers estimate 22%

(e) Tenders higher than engineers estimate 78%

(f) Difference between contract sum and engineers estimate +4.I5%

A histogram of the various tender figures and engineers estimate are drawn below:

FIG. 3.3.7B HISTOGRAM OF TENDERS FOR KICL OFFICE BUILDING



A further analysis using chi-squared test is shown below:

Chi-Squared Test

S/No	A	B	C	D	E	F	G	H	I
Observed Oi	2278	230I	2502	25I8	2559	2637	2650	2863	3383
expected ei	2400	2400	2400	2400	2400	2400	2400	2400	2400
Oi - ei	-I22	-99	I02	II8	I59	237	250	463	983
$(Oi-ei)^2$	I4884	980I	I0404	I3924	2528I	56I69	62500	2I4369	966289
$\frac{(Oi-ei)^2}{ei}$	6.20	4.08	4.34	5.80	I0.53	23.40	26.04	89.32	402.62

TABLE 3:3:7C

Calculated X^2 = 572.33 $= \sum \frac{(Oi-ei)^2}{ei}$

Critical $X^2_{0.I0,8}$ = I3.362

From the above chi-squared test it could be seen that the calculated X^2 value of 572.33 is much higher than the critical value of I3.362 obtained from the chi-squared table.

This therefore means that there is a very significant difference between the engineers estimate and the various tenders. A closer look at the analyses shows that tenderers H & J account for 85% of the difference. Their elimination however, does not lead to acceptance of the reliability of the engineers estimate in terms of all the tenders received.

The contract was awarded to contractor 'D' at a contract sum very close to his tender. The contract sum is 4.I5% higher than the engineers estimate. The building has since been completed and occupied.

3:3:8 Tenders Received for Civil Works of Funtua Brick Factory

Client: Funtua Brickworks Limited

Consultant QS: Shehu Giwa & Partners Kaduna

Date: June, I98I

S/No	Name of Tenderer	Tender Figure ₦	Completion period (weeks)	Percentage Difference from QS Estimate
A	A.G. Ferrero & Co. Ltd	I,462,532.90	54	-7.I8
B	Miller Burckley Nig. Ltd	I,538,057.77	54	-2.39
C	Kaduna Constr. Co. Ltd	I,599,II6.00	54	+I.49
D	Barade Constr. Ltd	I,638,248.00	54	+3.97
E	Q.S. Estimate	I,575,652.78	54	0
F	Contract Sum	I,538,057.77	54	-2.39

TABLE 3:3:8A

This table is for tenders received on the Civil Works i.e. building works excluding civil engineering works and mechanical installations of Funtua Brick Factory. The tenders were submitted in June, I98I.

The result of the tender is tabulated above. Items A to D are the building contractors whereas E and F are QS or engineers estimate and contract sum respectively.

A column showing the percentage difference between the various tenders received and the engineers estimate is included.

The following observations could be made:

(a) Tenders not lower than -IO% of engineers estimate = 50%

(b) Tenders not higher than +IO% of engineers estimate = 50%

(c) Tenders within ±IO% of engineers estimate =IOO%

(d) Tenders lower than engineers estimate = 50%

(e) Tenders higher than engineers estimate = 50%

(f) Difference between QS estimate and contract sum - 2.39%

In this case all the tenders are within ± IO% of the engineers estimate. It can therefore, be seen that the engineers estimate is reliable to the extent that all the tenders could be expected to fall within ± IO% of the engineers estimate.

The highest difference is observed between the lowest tenderer A and the QS estimate. A closer examination of the tender documents reveals that the difference arose from the fact that this tenderer altered the discription of the external works such as parking area where he changed the specification from asphalt surfacing to colas surfacing which is cheaper. This was pointed out by the consultant QS in the tender report. The contract was awarded to tenderer B at - 2.39% lower than the QS estimate.

A histogram of the tender figures is drawn below to give a pictorial view of the relationship of the various tenders with the engineers estimate and between the tenders themselves.

FIG. 3.3.8B HISTOGRAM OF TENDERS OF FUNTUA BRICK FACTORY

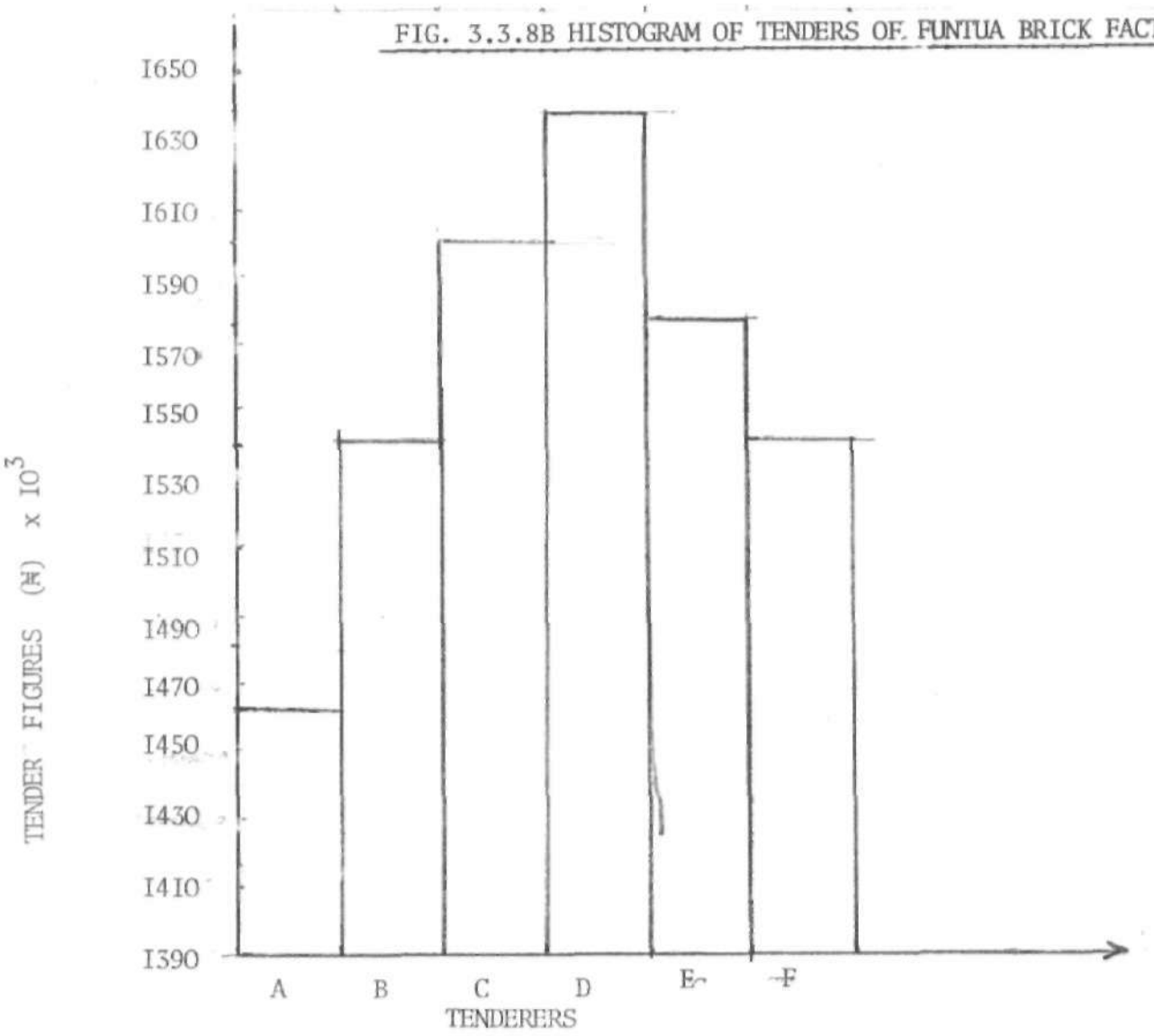


Table 3:3:8B

The above histogram shows that most of the tenders are rather close or the difference between each tender and the next higher tender looks rather even. The reason for the lower tender figure of tenderer 'A' though considered to be the most experienced and most capable out of the four tenderers has already been explained.

A further analyses using chi-square test is shown below to further test the reliability of the engineers estimate with respect to tenders received:

Chi - Squared Test

S/No	A	B	C	D
Observed Oi	I463	I538	I599	I638
expected ei	I576	I576	I576	I576
Oi - ei	-II3	-38	23	62
$(Oi-ei)^2$	I2769	I444	529	3844
$\frac{(Oi-ei)^2}{ei}$	8.IO	0.92	0.34	2.44

TABLE 3:3:8C

Calculated $X^2 = \sum \frac{(Oi - ei)^2}{ei} = II.80$

Critical $X^2_{0.IO,3} = 5.25I$

Since the calculated value of II.80 is higher than the Critical value of 5.25I, we reject the hypotheses and conclude that the differences between the engineers estimate and the tenders received cannot solely be atributed to chance and that the difference is statistically significant at the chosen level of significane of IO% or 90% conficence level.

As in case 3:3:I, elimination of tenderer A which shows significant difference, leads to the acceptance of the hypothesis since the calculated X^2 value will be 3.7 as against the Critical value of 4.505 since the degrees of freedom will be 2 instead of 3.

Ahmadu Bello University

3:3:9 Tenders Received for a 6-Storey Office Block at Kanta Road Kaduna

Client: New Nigerian Development Co. Ltd. (N.N.D.C.)

Consultant QS: QU-ESS Partnership Kaduna

Date: April, 1977

S/No	Name of Tenderer	Tender Figure (₦)	Completion period (weeks)	Percentage Difference from QS Estimate
A	D'Alberto & Bogialla	2,483,067.I3	8I	-0.68
B	Adewale Bello Const. Ltd	2,566,269.58	78	+2.65
C	Vicinanza Constr. Ltd	2,6I2,439.79	I04	+4.50
D	Cubitts Nig. Ltd	2,893,036.99	78	+I5.72
E	N.N.C.C. Ltd	3,04I,565.05	78	+2I.66
F	Edilit Ltd	3,4I4,366.95	I05	+36.57
G	Q.S. Estimate	2,500,000.00	72	0
H	Contract Sum	2,483,067.I3	8I	-0.68

TABLE 3:3:9A

The above table is for tenders received on the 6-storey Office Block (now called Turaki House) at Kanta Road Kaduna in April I977. The client is NNDC Ltd. Items A to F inclusive are for the various tenders whereas G and H represent the engineers or QS estimate and the contract sum respectively.

The last column shows the percentage difference between the various tenders received and the engineers estimate. The following observation could be made from the table.

(a) Tenders between not lower than -I0% of engineers estimate I7%

(b) Tenders not higher than +I0% of engineers estimate 33%

(c) Tenders falling within ± I0% of engineers estimate 50%

(d) Tenders lower than engineers estimate I7%

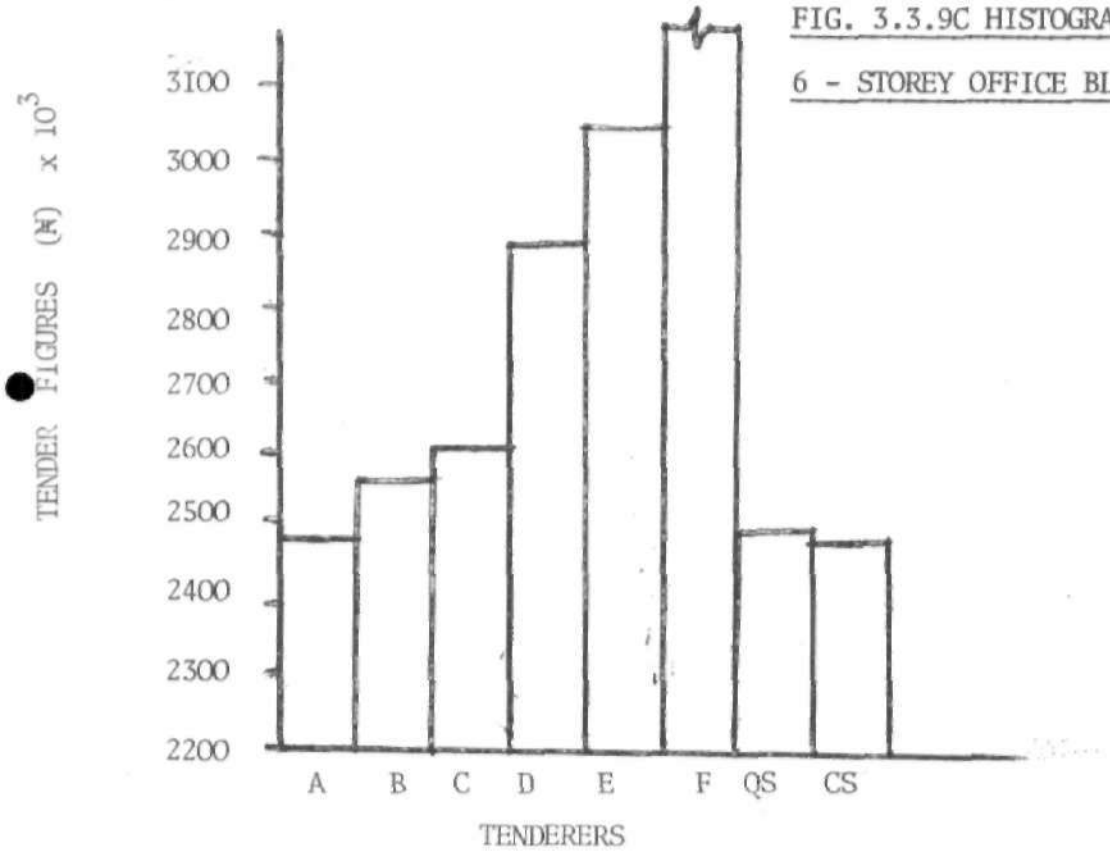
(e) Tenders higher than engineers estimate 83%

(f) Difference between QS estimate and contract Sum -0.68%

In this case only half of the tenders are within ± I0% of the engineers estimate. Only tenderer 'A' submitted tender lower than that of the Consultant. He was therefore awarded the contract at his tender figure which is 0.68% lower than the engineers estimate. The project has now been completed and occupied.

A histogram of the tender figures is drawn below to give a pictorial view of the relationship of the various tenders with the engineers estimate and between the tenders themselves.

FIG. 3.3.9C HISTOGRAM OF TENDERS FOR 6 - STOREY OFFICE BLOCK



This histogram shows the significant difference between the engineers estimate and tenderers D,F and F.

A further analysis using the chi-squared test is tabulated below:

Chi-Squared Test

S/No	A	B	C	D	E	F
Observed Oi	2483	2566	26I2	2893	3042	34I4
expected ei	2500	2500	2500	2500	2500	2500
Oi - ei	-I7	66	II2	393	542	9I4
$(Oi - ei)^2$	289	4550	I2544	I54449	293764	835396
$\frac{(Oi - ei)^2}{ei}$	0.I2	I.74	5.02	6I.78	II7.5I	334.I6

TABLE 3:3:9C

Calculated X^2 = 520.33 = $\sum \frac{(Oi-ei)^2}{ei}$

Critical $X^2_{0.I0,5}$ = 9.236

Oi = observed value or tender figure

ei = expected value or engineers estimate

This chi-squared tests shows that there is significant difference between the engineers estimate and the tenders received. This difference is more pronounced on tenders D,E and F.

In this case therefore, the engineers estimate cannot be relied upon with respect to all the tenders to be received but is only reliable in 3 out of six cases or 50%

3:3:IO Tenders Received for Audio Visual Block

Client: A.E.R.L.S./ A. B. U. Zaria

Consultant QS: Shehu Giwa & Partners Kaduna

Date: November, I980

S/No	Name of Tenderers	Tender Figure ₦	Completion period (weeks)	Percentage Difference from QS
A	Zazzau Gen.Trading Co.Ltd	535,84I.70	36	-I6.28
B	Edlit Ltd	594,I96.90	56	-7.I7
C	Alh. Yusufu Samaru	622,I52.49	54	-2.80
D	A.G. Ferrero & Co. Ltd	688,395.85	39	+7.55
E	B. Stablini & Co. Ltd	689,7I6.05	39	+7.76
F	E.M. Micheletti & Sons Ltd	693,544.65	45	+8.35
G	Q.S. Estimate	640,074.8I	52	0
H	Contract Sum	622,I52.49	54	-2.80

TABLE 3:3:IOA

The above table is for the Building of Audio Visual Block for Agricultural Extension and Research Liason Services of A.B.U. Zaria. The building was constructed at Samaru.

Nos A to F represent the various tenderers received whereas Nos G & H are the engineers or QS estimate and the contract sum respectively. The last column represents the percentage difference of the various tender figures from the engineers estimate.

Observations made from the above table are recorded in the next page.

(a) Tenders not lower than -IO% of engineers estimate 33%

(b) Tenders not higher than +IO% of engineers estimate 50%

(c) Tenders falling between ± IO% of engineers estimate 83%

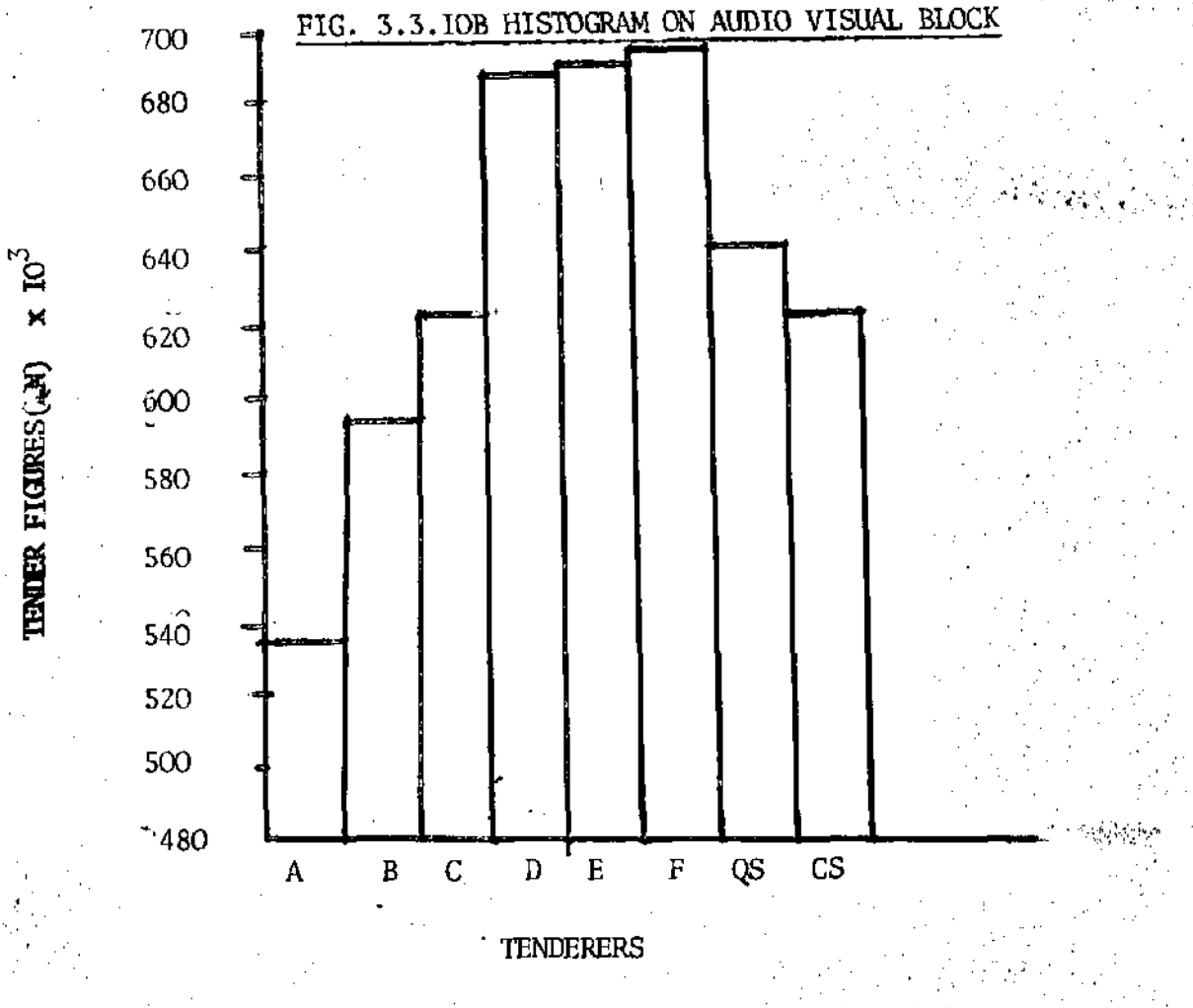
(d) Tenders lower than engineers estimate 50%

(e) Tenders higher than engineers estimate 50%

(f) Difference between QS estimate and contract sum -2.80%

A histogram of the various tender figures together with the engineers estimate is drawn below:

FIG. 3.3.IOB HISTOGRAM ON AUDIO VISUAL BLOCK



The above histogram shows the distinct difference between the lowest tenderer 'A' and the engineers estimate. Tenderer C, the 3rd lowest tenderer is closer to the engineers estimate and he was awarded the contract at his tender figure. Tenderers D,E and F who are all expatriate contractors have their tenders very close to each other.

A further analysis using chi-squared test is shown below:

Chi-Squared Test

S/No	A	B	C	D	E	F
Observed Oi	536	594	622	688	690	694
expected ei	640	640	640	640	640	640
Oi - ei	-I04	-46	-I8	48	50	54
$(Oi - ei)^2$	I08I6	2II6	324	2304	2500	29I6
$\frac{(Oi - ei)^2}{ei}$	I6.9	3.3I	0.5I	3.60	3.9I	4.56

TABLE 3:3:IOC

Calculated X^2 = 32.79 = $\sum \frac{(Oi-ei)^2}{ei}$

Critical X2
O,IO,5 = 9.236

From the above table it could be seen that the calculated X^2 value which equals 32.79 is higher than the critical X^2 value of 9.236 obtained from the X^2 table. This therefore implies that there are significant differences between the engineers estimate and the various tenders. A closer study of this analysis shows that tenderer 'A' accounts for more than 50% of this X^2 value. Their priced bills of quantities shows that most of the rates are unrealistically low which leads to their disqualification.

Elimination of tenderer 'A' however, will not in this case lead to the acceptance of the hypothesis that the engineers estimate is reliable with respect to all the tenders received.

3:3:II Tenders Received for Amenity Hospital at Kaduna

Client: Kaduna State Ministry of Health

Consultant QS: Adesoye & Partners: Kaduna

Date: September, I977

S/NO	Name of Tenderer	Tender Figure ₦	Completion period (weeks)	Percentage Difference from QS Estimate
A	Songhai Ltd	4,28I,843.34	I04	-0.42
B	United Const.Eng & Dev. Co. Ltd	4,295,I82.84	78	-0.II
C	A.G. Ferrero Co.Ltd	4,680,I0I.97	I04	+8.84
D	Edilit Ltd	4,865,947.99	I00	+I3.I6
E	Cubitts Nig. Ltd	5,058,56I.00	9I	+I7.64
F	Q.S. Estimate	4,300,000.00	I08	0
G	Contract Sum	4,28I,843.34	I04	-0.42

TABLE 3:3:IIA

The above table, for tenders received on a hospital building project at Kaduna shows the names of the various tenderers together with their quoted tender figures and completion periods. Another column sbowing the percentage difference between the various tender figures and engineers estimate is introduced. From this analyses the following observations could be made:

(a) Tenders not lower than -IO% of engineers estimate =40%

(b) Tenders not higher than +IO% of engineers estimate =20%

(c) Tenders falling within ± IO% of engineers estimate =60%

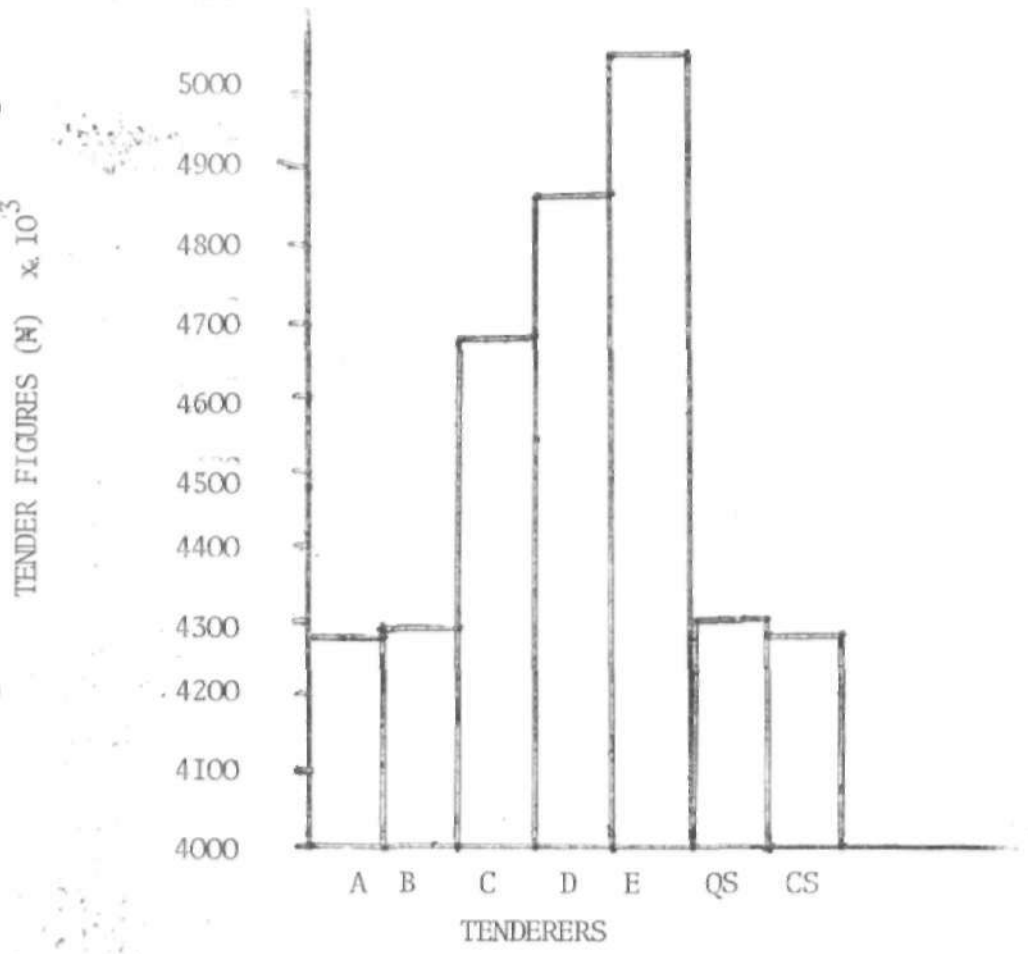
(d) Tenders lower than engineers estimate =40%

(e) Tenders higher than engineers estimate =60%

(f) Difference between contract sum and engineers estimate =0.42%

A histogram is drawn below to give a pictorial relationship between the various tender figures and the engineers estimate.

FIG. 3.3.IIB HISTOGRAM OF TENDERS ON AMENITY HOSPITAL



The above histogram clearly shows that tenderers A & B are very close to the engineers estimate but tenderers C,D and E show significant difference.

A further analyses of the various tender figures using chi-squared test is carried out below:

Chi-Squared Test

S/No	A	B	C	D	E
Acutal Oi	4282	4295	4680	4866	5059
expected ei	4300	4300	4300	4300	4300
Oi - ei	-I8	-5	380	566	759
$(Oi - ei)^2$	324	25	I44,400	320,356	576,08I
$\frac{(Oi - ei)^2}{ei}$	0.08	0.0I	33.58	74.50	I33.97

TABLE 3:3:IOC

Calculated $X^2 = \sum \frac{(Oi - ei)^2}{ei} = 242.I4$

Critical $X^2_{0.IO,4} = 7.779$

The above chi-squared test shows that the calculated X^2 value of $242.I4$ is much higher than the critical value of 7.779 obtained from the X^2 table. This therefore, shows that there is a very significant difference between the engineers estimate and the various tenders. As stated earlier this difference is much more noticeable on tenderers C,D and E

This test shows that the engineers estimate is not reliable in terms of all the tenders received falling within ± IO% of the engineers estimate.

3:4:I SUMMARY OF ANALYSIS

In addition to the above projects analysed so far ie. cases 3:2:I to 3:2:II additional data were collected and analysed for nine more projects all in Kaduna State. The result of the analyses together with those of the previous projects are tabulated in the table below:

No	Project Title	COMPARISON WITH ENGINEERS ESTIMATE IN PERCENTAGES							
		0 to -10%	0 to +10%	+10% —	Lower	Higher	Difference	Calculated X2	Critical X2 0.10
I	Agronomy Building ABU	40	60	100	40	60	-3.57	11.7	7.78
2	10 Storey Office Block NNN	-	14	14	-	100	+6.72	6551.5	10.65
3	Packaging Factory Kaduna	25	50	75	25	75	-5.55	480.8	12.02
4	Fed. Mortagage Bank Kaduna	67	-	67	83	17	-7.04	422.5	9.24
5	Faculty of Education Phase II	44	-	44	100	-	-27.88	181.3	13.36
6	Laboratory Fed.Dept of Agric	57	43	100	57	43	+0.62	11.9	10.65
7	KICL Office complex	22	44	66	22	78	+4.15	572.3	13.36
8	Brick Factory Funtua	50	50	100	50	50	-2.39	11.8	5.25
9	6-Storey Office Block NNDC	17	33	50	17	83	-0.68	520.3	9.24
10	Audio Visual Block ABU	33	50	83	50	50	-2.80	32.8	9.24
11	Amenity Hospital Kaduna	40	20	60	40	60	-0.42	241.1	7.78
12	Extension to Curing House FCFS	14	29	43	14	86	+0.88	66.7	10.65
13	3-Bedroom Bungalow LERIN	17	58	75	25	75	0	28.7	13.38
14	Plant Science Building ABU	50	13	63	75	25	-4.97	115.6	12.02
15	Film Studio/Conference Hall	71	-	71	71	29	-3.56	21.0	10.65
16	Bakery NNDC Ltd	25	25	50	50	50	-1.91	9.6	5.23
17	Central Stores ABU	13	37	50	50	50	-12.18	57.5	12.02
18	Clinic LERIN	55	27	82	55	45	-1.12	36.2	15.99
19	Warehouse Kafanchan	20	-	20	40	60	-6.73	22.2	7.78
20	Central Stores LERIN	45	18	63	55	45	-0.16	36.9	15.99
	TOTAL	705	571	1276	919	1081	-68.59	9432.4	212.28
	Divide By	20	20	20	20	20	20	20	20
	AVERAGE PERCENTAGE	35	29	64	46	54	-3.43	471.6	10.61

-Table 3.4A

3:4:2 OBSERVATIONS FROM THE ANALYSES

The following observations could be made from the summary of all the analysis in Table 3:4:A:

(a) An average of 35% of all the tender figures analysed are lower than engineers estimate but not lower than IO%. That is to say they fall between O to -IO% difference from the engineers estimate.

(b) However, the total percentage of tender figures lower than the engineers estimate is 46%. Thus only II% of the low tenders are lower than -IO% of the engineers or QS estimate.

(c) Out of all the projects analysed an average of 54% are higher than the engineers estimate, but only an average of 29% of those higher fall within O to +IO% higher than the engineers estimate. Thus 25% are higher than +IO% of the engineers estimate.

On the whole an average of 64% of all the tender figures analysed fall within ± IO% difference from the engineers estimate.

A study of the column dealing with the percentage difference between engineers estimates and contract sums shows that out of the twenty projects analysed all but one or 95% of them were awarded at ± IO% difference from the QS or engineers estimate. This reconfirms our finding during Literature review that clients only consider tenders for awards if they fall within ± IO% of the engineers or QS estimates.

A closer study of this column further reveals that out of the twenty projects analysed only four of them or 20% were awarded at a figure slightly higher than the QS or engineers estimate. The remaining 80% were awarded at contract sums lower than the engineers estimate but only one or 5% lower than -I0% of the engineers estimate and even this case is a special one as it arose from government measures which brought down the prices of materials between the time the QS submitted his estimates and the time the documents were sent out to tenderers. The average of the percentage difference between QS or engineers estimate and contract sums for all the projects is - 3.43%

All the calculated chi-squared values are higher than their corresponding critical values with most cases showing very large differences. In accordance with the chi-squared theory therefore, this means that there are very significant differences between QS or engineers estimates and the various tender figures. In most cases the cause of these differences are as a result of one or two contractors quoting either very low or very high tender figures.

It should be noted that all the analyses are based on tender figures i.e monetary value or sum of money quoted by the various tenderers for the works. Although quoted completion periods are tabulated together with the various tender figures, the time element is not analysed. This follows from the fact that although theoretically quoted tender figures should be based to some extent on quoted completion periods, this has not been the case in this country for over 80% of the projects.

Most tenderers just quote atractive completion periods to win contracts but later don't stick to this periods because very few clients bother to enforce their right with respect to completion periods such as liquidated damages etc. A clear case here is the IO - storey office building (case 3:3:2) in which the successful tenderer quoted 80 weeks completion period but the consultants consider this period too short and recommended I20 weeks. The project was not completed even after 200 weeks and the client couldn't recover even one naira as liquidated damages until an independent committee they set up to investigate the project advised them as to their rights. Also more than 80% of the projects analysed were completed behind schedule.

These are some of the reasons why the researcher failed to analyse the quoted completion periods as practically they have little or no effect on the various tender figures.

Finally, the following chapter will look into these observations and together with the Literature Review in Chapter two arrive at Conclusions which will incorporate some recommendations.

CHAPTER IV

4.0 CONCLUSIONS AND RECOMMENDATIONS

The Literature Review and Field Investigations and Analysis carried out provide the following conclusions:

(a) Clients rely heavily on the engineers or quantity surveyors estimate to the extent that over 95 percent of contracts for building works are awarded to contractors whose tenders do not differ by more than ± 10 percent of the engineers or QS pre-tender estimate. 80 percent of the contracts however, are awarded to tenderers whose tender figures are lower than the engineers estimate.

(b) A building owner could be 90 percent confident that he will receive tenders and award contracts at a contract sum which does not differ by more than ± 10 percent of the engineers estimate. However, his choice of a contractor on the basis of selective tendering could only be 64 percent of those invited with only 35 percent of all the contractors having their tender figures not lower than - 10 percent and only 29% of the contractors having tender figures not higher than + 10 percent of the engineers estimate. The average percentage difference between the engineers estimates and contract sums for building works is - 3.43 percent.

Majority of the engineers estimates are around the centre of the scale with 46 percent of all tenders analysed being lower than the engineers estimate and 54 percent of the tenders being higher.

(c) There is a need for clients to request for critical re-examination of the engineers estimate especially in cases where majority of tenders differ significantly from the engineers estimate. If majority of the tenders are very much higher than the QS estimate then the QS should recheck his estimate. Strict adherence to the general idea that contracts will only be awarded at figures close to the engineers estimate especially where the trend of tenders reveal otherwise may result in delay or abandonment of the project and subsequent price escalation (See Case 3.3.2 pages 78-81) Similarly if all the tenders are very much lower than the engineers estimate, then the client should ask his construction cost adviser to recheck his estimates if he failed to do so by himself. Such excercise might result in substantial financial saving for the client.

(d) There is a need to look into the various causes of significant differences which occur between various tender figures and engineers estimate and between the tenders themselves. These differences are expected to be smaller in selective tendering since all the contractors are chosen on the basis that they are all capable of executing the project. This investigation based on selective tendering still shows very significant differences among the various tenders in most cases.

(e) Most building contractors need to be more acquented with contract Conditions, Preliminaries and Trade Preambles section of the bills of quantities. This section has been found to be least understood by many contractors.

(f) Clients should reduce the amount of non-refundable deposits being charged from tenderers since these will be reflected on building costs.

(e) The accuracy of the Engineers or QS pre-tender or Comprative estimates in this country needs to be improved. This could be done by:

(i) Provision and maintenance of adequate and up to date data on the cost of building materials and components.

(ii) Need on the part of the designers be they architects or engineers to supply adequate and detailed drawings and specifications to the quantity surveyor for the purpose of preparing adequate tender documentation

(iii) The Quantity Surveyors should ensure the preparation of precise and relevant information in the bills of quantities

(vi) Clients should allow enough and adequate time to their Consultants for the preparation of complete and detailed tender documents. Enough time should also be given to the various tenderers for pricing bills of quantities.

(v) The Quantity Surveyor should prepare the engineers estimate at the same time as the contractors are preparing their own tenders and his estimate should be opened at the same time as the contractors tenders are being opened. This will take care of changes in market conditions and avoidance of leakages.

(vi) The engineers estimate should always be prepared by qualified and experienced cost advisers.

4.I Possible Areas of Further Research

This research work with regards to the Reliability or otherwise of the engineers estimate cannot be said to be final. It opens up new questions and as stated earlier the work is limited to pre-contract work only. One area of further research is that of investigating the reliability of the engineers estimate with respect to final Construction Cost.

Another area is that in which Completion Periods could be investigated. In this case quoted completion periods could be compared with final completion periods to test their reliability or otherwise.

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APPENDICES

(i) No Day work shall be undertaken without the prior sanction of the Architect/S.O. who shall,if permission be granted,define in writing the extent of the Contract to which Day-works shall apply.

(ii) where the work is within the province of any specialist trade and the said Institution and the appropriate body representing the employers in that trade have agreed and issued a definition of prime cost of daywork,the prime cost of such work calculated in accordance with that definition as last before issued together with percentage additions on the prime cost at the rates set out by the Contractor in the Contract Bills.

Provided that in any case vouchers specifying the time daily spent upon the work(and if required by the Architect the workmen's names)and the materials employed shall be delivered for verification to the Architect/S.O. or his authorised representative not later than the end of the week following that in which the work has been executed;

(d) The prices in the Contract Bills shall determine the valuation of items omitted;provided that if omissions substantially vary the conditions under which any remaining items of work are carried out the prices for such remaining items shall be valued under rule (b) of this sub-clause.

(5) Effect shall be given to the measurement and valuations of variations under sub-clause (4)of this Condition in Interim Certificates and by adjustment of the Contract Sum; and effect shall be given to the measurement and valuation of work for which a provisional sum is included in the Contract Bills under the said sub-clause in Interim Certificates and by adjustment of the Contract Sum in accordance with clause 30(5)(c) of these Conditions.

(6) If upon written application being made to him by the Contractor,the Architect/S.O. is of the opinion that a variation or the execution by the Contractor of work for which a provisional sum is included in the Contract Bills(other than work for which a tender made under clause 27(g) of these Conditions has been accepted)has involved the Contractor in direct loss and/or expense for which he would not be reimbursed by payment in respect of a valuation made in accordance with the rules contained in sub-clause (4)of this Condition and if the said application is made within a reasonable time of the loss or expense having been incurred,then the Architect/S.O.shall either himself ascertain or shall instruct the Quantity Surveyor to ascertain the amount of such loss or expense. Any amount from time to time so ascertained shall be added to the Contract Sum,and if an Interim Certificate is issued after the date of ascertainment any such amount shall be added to the amount which would otherwise be stated as due in such Certificate.

CONTRACT CONDITIONS (Contd)

A The articles of Agreement and conditions of Contract are set out in full in previous pages of this document. The Contractor should read each condition carefully and allow against the following listed clauses any sum or sums of money he may require for complying with all the requirements contained therein.

Clause

No

I Contractor's Obligations

2 Architect's/S.O Instructions

3 Contract Documents

4 Statutory obligations, notices, fees and charges

5 Levels and setting out of the Works

6 Materials,goods and workmanship to conform to description, testing and inspection.

7 Royalities and patent rights.

8 Foreman-in-charge

9 Access for Architect/S.O. to the Works

I0 Clerk of Works

II Variations,provisional and prime cost sums

I2 Contract Bills

I3 Contract Sum

I4 Materials and goods unfixed or off-site

I5 Practical completion and defects liability

I6 Partial possession by Employer

I7 Assignment or sub-letting

I8 Injury to persons and property,and Employer's indemnity.

Water

A Allow for providing all water required for the Works including that for sub-contractors. The water is to be clean fresh water.

B Allow for executing all temporary plumbing and paying all fees and charges incurred in the connection and supply of the water for building purposes and the removal of all temporary plumbing on completion.

C The Contractor shall make all necessary applications and pay all charges for permanent water supply to ensure that connections are effected in good time so as not to delay the completion of the Works.

Temporary works

D The Contractor shall ensure that all temporary electrical water and other installations are executed in accordance with the requirements of the Authorities concerned.

Temporary fencing and access roads

E Allow for any necessary temporary access roads,crossovers gangways,gates,entrances and the like as required, maintain and clear away and make good at completion.

F Allow for adequate temporary security fencing to the perimeter of the site,maintain and clear away and make good.

Welfare and safety

G Allow for providing adequate latrine accommodation and keeping same in a clean and sanitary condition to the satisfaction of the Health Authorities and clearing away latrine and soil whereever necessary and thoroughly disinfecting and making good all work disturbed.

H Allow for providing sheds and workshops for the use of the workmen on the site and maintaining and subsequently dismantling and carting away on completion and allow for providing and maintaining welfare and safety measures and amenities of a suitable standard approved by the Architect or required by the Authorities.

First aid box

J The Contractor is to provide on site a First Aid Box or Cupboard prominently marked with the words FIRST AID for the purpose of treating any of his employees injured on site. The contents of this box are to comply in all respects with the Factories Ordinance. The Contractor is to ensure that there is adequate stocks in the First Aid Box which is to be produced and opened for the inspection of the Architect on request.

TRADE PREAMBLES (contd)

Excavation and Earthwork (contd)

Anti-termite treatment

A The Contractor shall destroy all ants,nest and vermin encountered during excavations.

B 'Dieldrex' anti-termite treatment shall consist of 'Dieldrex 20' Emulsion (manufactured by National Oil Company of Nigeria) diluted with water at the rate of one litre of the emulsion to 80 litres of water and applied with a spray gun at the rate 10 litres of the diluted emulsion per square metre,all in accordance with the manufacturer's instructions.

Deviations from the Standard Method of Measurement

C Prices for excavation and earthwork are to include for the following:-

(a) Excavating in whatsoever material may be met(except old foundations and rock,as previously defined)and for grubbing up and removing any drain pipes,roots and the like encountered

(b) Executing work in or underwater of any description and /or working in compressed air.

(c) Any working space required

(d) Work to curves

(e) Levelling,grading and consolidating by ramming or rolling bottom of excavations

(f) Keeping excavations free from all water including general water,water below the water level in the ground and spring or running water.

(g) Planking and strutting,special shoring and temporary sheet steel piling.

(h) Levelling,grading and consolidating by ramming or rolling filling.

(j) Blinding surface or filling with suitable small material as required to receive concrete or surfacing.

CONCRETE WORK

The following references apply to work under this section BS 12: 882,4466 and 4483, CP114, Part 2 1969.

Cement

General

A All cement used in the works shall be ordinary Portland cement or Rapid Hardening Portland cement complying with B.S.12. Sulphate resisting cement complying with B.S.4027 shall be used where preferred by the Structural Engineer and Architect.

Payment

B The Contractor shall not receive additional payment for the use of Rapid Hardening Portland cement unless he does so under specific instructions of the Structural Engineer and Architect.

Delivery to site

C Cement shall be delivered to the site in approved sealed containers which are to be clearly marked with the name of the manufacturer. Loose cement or cement delivered in damaged or unsealed containers is to be immediately removed from the site. Should any cement of a consignment fail or be found to be defective or not to comply in all respect with B.S.12, the Structural Engineer and Architect shall at their discretion be entitled to reject the whole or part of the consignment from which the defective cement was derived.

Storage

D The Contractor shall provide an adequate,waterproof,separate storage building for cement adjacent to the concrete mixing plant to protect the cement from damp or other deleterious influence.Such storage building shall either incoporate a damp proof course under the floor or shall have a timber floor raised at least 150mm clear of the ground.

Order of use

E Each consignment of cement shall be kept seperately and the Contractor shall use the consignments the order in which they were received. Cement shall be stored in drums or bags provided by the manufacturer and cement in drums or bags which have been opened shall be used immediately.

Test certificates

F The Contractor shall supply to the Structural Engineer and Architect test certificates for each consignment of cement delivered to the site.

				₦	k
	STANDARD BLOCK OF SIX FLATS TYPE III				
	SUBSTRUCTURE				
	Excavation and Earthwork				
A	Clear site of all scrub, bushes undergrowth, small trees not exceeding 600mm girth, large stones, rubish debris etc and remove from site	700	Sq. m		
B	Excavation to remove vegetable soil average I50mm deep and spread and level on site as directed	5I2	Sq. m		
C	Excavate oversite to reduce levels (provisional)	20	Cub.m		
D	Excavate trench for foundation starting from reduced level and not exceeding I.5m deep	I3	Cub.m		
E	Excavate pit for column base starting from reduced level and not exceeding I.5m deep	243	Cub.m		
F	Selected excavated material blackfilling around foundation	I27	Cub.m		
G	Selected excavated material to make up levels under floors (provisional)	20	Cub.m		
H	Remove surplus excavated material from site	I29	Cub.m		
J	Extra over excavation and disposal for excavating in rock (provisional)	I5	Cub.m		
K	Approved rock laterite hardcore bed wall rammed and consolidated in layers each layer not exceeding I50mm deep	282	Cub.m		
L	Dieldrex anti-termite treatment to surfaces of excavation and top of earth filling	709	Sq. m		
	CONCRETE WORK				
	Plain insitu concrete(I:IO-20mm aggregate) in:				
M	50mm Blinding	230	Sq. m		
		To collection		₦	

	SUBSTRUCTURE (Contd)			N	k
	Concrete work (Contd)				
	Plain insitu concrete(I:2:4-20mm aggregate) developing minimum 21N/sq.mm works strength at 28 days in				
A	Foundation	4	Cub.m		
	Reinforced insitu concrete(I:I½:3-20mm aggregate)developing minimum 26N/sq.mm works strength at 28 days in:				
B	Column base	II5	Cub.m		
C	Column	3	Cub.m		
D	Ground beam	9	Cub.m		
E	Step	I	Cub.m		
F	I50mm Bed	423	Sq. m		
G	I50mm Ramp	56	Sq. m		
	Mild steel bar reinforcement in column bases, columns etc				
H	25mm Diameter bar	I2276	Kg		
J	20mm Ditto	5578	Kg		
K	I6mm Ditto	255	Kg		
L	I2mm Ditto	I02	Kg		
M	I0mm Ditto	243	Kg		
N	I0mm Ditto in links and stirrups	200	Kg		
	High yield deformed steel bar reinforcement in column bases, columns etc (ptovisional)				
O	25 - I2mm Diameter bars	500	Kg		
	BRC Square mesh fabric reinforcement to B.S. 4483 Ref.No.A.I42 weighing 2.22 Kg per square metre lapped 200mm at all joints (measured nett) in:				
P	Bed	423	Sq. m		
Q	Ramp	56	Sq. m		
		To collection		N	

5NO STANDARD BLOCK OF SIX FLATS TYPE III
AT
IYAKA ROAD - KANO

GENERAL SUMMARY

	Page No			
Articles of Agreement, General Conditions Preliminaries and Trade Preambles	TP/39			
Demolitions	DM/ I			
Standard Block of Six Flats	BF/33	₦.....x5		
Block of Six boys Quarters	BBQ/I3	₦.....x5		
External works	EW/ 8			
			₦	
CONTINGENCIES				
Allow a Provisional Sum of ₦10,000.00 for Contingencies to be expended as directed			10,000	00
TOTAL OF TENDER CARRIED TO FORM OF TENDER			₦	

Name of Tenderer:----------

Address:----------

Date for completion: Within.....weeks of officially taking over the site.

INSTRUCTION TO PERSONS TENDERING

I. The following documents are herewith supplied to the Contractor:-

(a) Contract Documents including bills of Quantities
(b) Form of Tender

2. The Contractor should carefully read these instructions and should base his tender on all the above documents which will subsequently form the basis of the Contract Documents mentioned in the Conditions of Contract. Submission of a tender will be deemed sufficient proof that all the documents and these instructions have been read and fully understood and that all the provisions requirements and reasonable implications thereof have been included in or allowed for in the amount of the tender.

3. Upon receipt of the above documents the Contractor is to check the number of pages and should any be missing or in duplicate of if any writing or figures be indistinct or if any of the wording be ambiguous or the meaning or intention not clear, he is to notify the Quantity Surveyor and have the matter clarified and/or rectified before his tender is submitted. No claims for increases in the Tender figure will be entertained subsequent to its acceptance on the grounds of misinterpretation or misrepresentation.

4. The Contract Drawings can be inspected at the offices of Architects or Quantity Surveyors.

5. The tender is to be made out in INK on the official Form of Tender provided herewith. The Tender amount is to be written in words and Figures in the spaces provided and is to be signed in full by the Principal of the firm authorised to do so. The full name and address of the Contractor shall be printed in BLOCK letters or typed in the space provided below the signature.

6. The Form of Tender and other documents are to be submitted, enclosed and sealed in an envelope marked "Tender for

---

and addressed to:

---

to reach him not lat er than NOON on----------the

----------day of----------I9----------

7. A duplicate Form of Tender (if provided) is to be retained by the Contractor as his copy of the Tender he has submitted.

8. The lowest Tender will not necessarily be accepted.

FORM OF TENDER

TO ----------

Sir,

I. Having examined the Drawings, Articles of Agreement, Conditions of Contract and Bills of Quantities, relating to the erection and completion of the above and having visited and examined the site of the proposed works, or caused it to be visited on our behalf by a competent reliable person and, having acquired all requisite information relating thereto as affecting this Tender I/We, the undersigned, hereby offer to construct, execute complete and maintain the proposed works in strict accordance with the Contract Documents referred to above, for the total sum of:

----------₦----------

2. I/We undertake if our Tender is accepted to agree to a date for Possession which is within----------; weeks of signing the Contract and to complete the works within----------weeks reckoned from the date of Possession of the site and in the event of non-completion, I/We agree to pay Liquidated and Ascertained Damages if works remain incomplete after the above date subject to the Conditions of Contract relating to an extension of time, at the rate of ----------per week.

3. I/We also undertake, in the event of our Tender being accepted to enter into a Formal Contract, on being called upon to do so for the execution, completion and maintenance of the said works in the terms of the Contract Documents.

4. I/We agree that this Tender remain open for consideration for twelve weeks, and unless and until a formal agreement is prepared and execured, this Tender, together with your written acceptance thereof shall consitute a binding contract between us.

5. I/We further agree that any errors in my/our priced Bills of Quantities supporting my/our Tender will not affect the Tender price and that such errors shall be adjusted in accordance with the usual procedure.

DATED THIS----------DAY OF----------I9------

SIGNATURE OF CONTRACTOR:----------

NAME OF FIRM:----------

REGISTERED OFFICE:----------

NAME OF WITNESS:----------

OCCUPATION:----------

ADDRESS:----------

QUESTIONNAIRE ON THE RELIABILITY OF THE ENGINEERS ESTIMATE IN SELECTIVE TENDERING FOR BUILDING WORKS

I DATE:----------

2 LOCATION:----------

3 Name and Address of respondent (Optional)----------

---

4. Position or rank in the organisation
(Check one)

Partner/Manager	35%
Quantity Surveyor	45%
Engineer	5%
Architect	I5%
Others(Specify)	0%

5. Type of organisation:

Government	I5%
Consulting Quantity Surveying Firm	40%
Architectural Firm	I5%
Contractor	30%

6. For how long has the organisation been in operation
(Check one)

0 - 2 years	5%
3 - 5 Years	35%
More than 5 years	60%

7. What degree of reliability do you attach to QS Pre-tender estimate in terms of the tenders to be received

Very reliable	30%
Reliable	40%
Fairly reliable	I0%
Not reliable	20%

8. From your experience, in what range does the Quantity Surveyor's Pre-tender estimate compare generally with accepted tenders.

Lower than 70% of the pre-tender estimate			
7I	-	80%	0%
8I	-	90%	I0%
9I	-	I00%	45%
I0I	-	II0%	30%
III	-	I20%	I0%
I2I	-	I30%	5%
Over		I30%	0%

9. What range does the Quantity Surveyor's Pre-tender estimate (taken as I00%) compare generally with final construction costs?

Less than 70%			0%
70	-	80%	0%
80	-	90%	0%
90	-	I00%	I0%
I00	-	II0%	30%
I20	-	I30%	40%
Over		I30%	20%

IO Do most quantity surveyors/building estimators keep up to date records of costs of building materials?

Yes	50%
No	40%
Don't know	IO%

II How many contractors are normally invited to tender for projects based on selective tendering

Less than 2	0%
3 - 5	20%
6 - IO	40%
Over IO	40%

I2 How many contractors normally accept this invitation and quote for the projects.

None	0%
I - 3	0%
4 - 6	IO%
5 - 9	40%
All	50%

I3 Are tender documents normally adequate

Quite Adequate	20%
Adequate	30%
Fairly adequate	20%
Not Adequate	30%

I4 If not, do the inadequacy result from

Incomplete architectural drawings		40%
"	Structural "	40%
"	Service "	0%
"	Bills of Quantities	20%

I5 What is the time normally given to contractors within which to submit their tenders.

Less than one week	0%
I - 2 weeks	30%
2 - 3 weeks	50%
3 - 4 weeks	IO%
Over 4 weeks	IO%

I6 Do you consider this time adequate for the contractors to prepare reliable tenders

Yes	30%
No	50%
Don't know	20%

I7 How often do your estimators/worker ups make arithmetical errors while squaring your quantities/rates (tick one)

Always	0%
Frequently	IO%
Sometimes	40%
Very rare	20%
Rare	20%
Never	IO%

I8 What is the average percentage of arithmetical errors in estimating that are being made by your worker ups.

Less than		I% of total cost	50%
I	-	5%	30%
6	-	I0%	20%
II	-	I5%	0%
I6	-	20%	0%
Over		20%	0%

I9 From your experience, what is the average of tenders won by contractors compared with the number of projects they tendered for

Less than		I0%	60%
I0	-	30%	40%
30	-	50%	0%
Over		50%	0%

20 Do you include a fixed percentage to cover overheads in unit rates.

Yes	40%
No	20%
Don't know	0%
Variable percentage	40%

21 What percentage do you normally allow as overheads

Less than		10%	20%
11	-	20%	70%
21	-	30%	10%
Over		30%	0

22 Do you know your main competitors while tendering?

Yes	30%
No	20%
Not sure	50%

23 Do you take them into consideration while preparing your tender

Yes	60%
Sometimes	30%
No	0%
Don't know	10%

24 What tendering method do you normally prefer

Selective	60%
Open	20%
Negotiated	20%

25 What percentage do you normally add to your actual cost to cover profit

Less than		10%	20%
11	-	20%	50%
21	-	30%	20%
Over		30%	10%

26 Who makes decision about the percentage to add for overheads and profits

Board of Directors	0
Quantity Surveyor	60%
Project Manager	40%
Others please specify)	0

27 What is the staff strength of your department/ firm.

Less than 5 persons	0
5 - 10 "	0
10 - 20 "	30%
20 - 30 "	30%
30 - 40 "	10%
40 - 50 "	10%
Over 50 "	20%

28 Please indicate below how many of your estimating staff fall into the following categories

Clerk/Typists	10%
Worker ups	20%
Quantity Surveyors	40%
Builders	20%
Engineers	10%
Other (please specify)	0

29 What section of the bills of quantities do you think is least understood by most estimators

Contract Conditions	30%
Preliminaries and Trade Preambles	50%
Measured Quantities	20%

30 What is the educational attainment of the respondent?

Professional qualification(Please specify)	40%
University Graduate	50%
Polytechnic	IO%
A' Level	0%
WASC or GCE O' level	0%
Any other (please specify)	0%

3I Would you like to have a summary or abstract of the study (check one)

Yes	70%
No	0%
Don't know	30%

32 Please write the name and address of the person to whom the abstract/Summary should be sent:

---

33 Any other comments relevant to the study:

I WOULD LIKE TO ASSURE YOU AGAIN THAT ALL THE INFORMATION PROVIDED WILL BE HANDLED STRICTLY CONFIDENTIAL.

THANK YOU FOR YOUR VALUABLE TIME, CO-OPERATION AND COMMENTS.

Table 8

PERCENTAGE POINTS OF THE χ^2 DISTRIBUTION

Table of $\chi^2_{\alpha,\nu}$ = the 100 α percentage point of the χ^2 distribution for ν degrees of freedom



α =	.995	.99	.98	.975	.95	.90	.80	.75	.70	.50	.30	.25	.20	.10	.05	.025	.02	.01	.005	.001	= α
ν = 1	$.04^3393$	$.03^157$	$.03^628$	$.03^982$	$.00^393$	.0158	.0642	.102	.148	.455	1.074	1.323	1.642	2.706	3.841	5.024	5.412	6.635	7.879	10.827	ν = 1
2	.0100	.0201	.0404	.0506	.103	.211	.446	.575	.713	1.386	2.408	2.773	3.219	4.605	5.991	7.378	7.824	9.210	10.597	13.815	2
3	.0717	.115	.185	.216	.352	.584	1.005	1.213	1.424	2.366	3.665	4.108	4.642	6.251	7.815	9.348	9.837	11.345	12.838	16.268	3
4	.207	.297	.429	.484	.711	1.064	1.649	1.923	2.195	3.357	4.878	5.385	5.989	7.779	9.488	11.143	11.668	13.277	14.860	18.465	4
5	.412	.554	.752	.831	1.145	1.610	2.343	2.675	3.000	4.351	6.064	6.626	7.289	9.236	11.070	12.832	13.388	15.086	16.750	20.517	5
6	.676	.872	1.134	1.237	1.635	2.204	3.070	3.455	3.828	5.348	7.231	7.841	8.558	10.645	12.592	14.449	15.033	16.812	18.548	22.457	6
7	.989	1.239	1.564	1.690	2.167	2.833	3.822	4.255	4.671	6.346	8.383	9.037	9.803	12.017	14.067	16.013	16.622	18.475	20.278	24.322	7
8	1.344	1.646	2.032	2.180	2.733	3.490	4.594	5.071	5.527	7.344	9.524	10.219	11.030	13.362	15.507	17.535	18.168	20.090	21.955	26.125	8
9	1.735	2.088	2.532	2.700	3.325	4.168	5.380	5.899	6.393	8.343	10.656	11.389	12.242	14.684	16.919	19.023	19.679	21.666	23.589	27.877	9
10	2.156	2.558	3.059	3.247	3.940	4.865	6.179	6.737	7.267	9.342	11.781	12.549	13.442	15.987	18.307	20.483	21.161	23.209	25.188	29.588	10
11	2.603	3.053	3.609	3.816	4.575	5.578	6.989	7.584	8.148	10.341	12.899	13.701	14.631	17.275	19.675	21.920	22.618	24.725	26.757	31.264	11
12	3.074	3.571	4.178	4.404	5.226	6.304	7.807	8.438	9.034	11.340	14.011	14.845	15.812	18.549	21.026	23.337	24.054	26.217	28.300	32.909	12
13	3.565	4.107	4.765	5.009	5.892	7.042	8.634	9.299	9.926	12.340	15.119	15.984	16.985	19.812	22.362	24.736	25.472	27.688	29.819	34.528	13
14	4.075	4.660	5.368	5.629	6.571	7.790	9.467	10.165	10.821	13.339	16.222	17.117	18.151	21.064	23.685	26.119	26.873	29.141	31.319	36.123	14
15	4.601	5.229	5.985	6.262	7.261	8.547	10.307	11.036	11.721	14.339	17.322	18.245	19.311	22.307	24.996	27.488	28.259	30.578	32.801	37.697	15
16	5.142	5.812	6.614	6.908	7.962	9.312	11.152	11.912	12.624	15.338	18.418	19.369	20.465	23.542	26.296	28.845	29.633	32.000	34.267	39.252	16
17	5.697	6.408	7.255	7.564	8.672	10.085	12.002	12.792	13.531	16.338	19.511	20.489	21.615	24.769	27.587	30.191	30.995	33.409	35.718	40.790	17
18	6.265	7.015	7.906	8.231	9.390	10.865	12.857	13.675	14.440	17.338	20.601	21.605	22.760	25.989	28.869	31.526	32.346	34.805	37.156	42.312	18
19	6.844	7.633	8.567	8.907	10.117	11.651	13.716	14.562	15.352	18.338	21.689	22.718	23.900	27.204	30.144	32.852	33.687	36.191	38.582	43.820	19
20	7.434	8.260	9.237	9.591	10.851	12.443	14.578	15.452	16.266	19.337	22.775	23.828	25.038	28.412	31.410	34.170	35.020	37.566	39.997	45.315	20
21	8.034	8.897	9.915	10.283	11.591	13.240	15.445	16.344	17.182	20.337	23.858	24.935	26.171	29.615	32.671	35.479	36.343	38.932	41.401	46.797	21
22	8.643	9.542	10.600	10.982	12.338	14.041	16.314	17.240	18.101	21.337	24.939	26.039	27.301	30.813	33.924	36.781	37.659	40.289	42.796	48.268	22
23	9.260	10.196	11.293	11.688	13.091	14.848	17.187	18.137	19.021	22.337	25.918	27.141	28.429	32.007	35.172	38.076	38.968	41.638	44.181	49.728	23
24	9.886	10.856	11.992	12.401	13.848	15.659	18.062	19.037	19.943	23.337	27.096	28.241	29.553	33.196	36.415	39.364	40.270	42.980	45.558	51.179	24
25	10.520	11.524	12.697	13.120	14.611	16.473	18.940	19.939	20.867	24.337	28.172	29.339	30.675	34.382	37.652	40.646	41.566	44.314	46.928	52.620	25
26	11.160	12.198	13.409	13.844	15.379	17.292	19.820	20.843	21.792	25.336	29.246	30.435	31.795	35.563	38.885	41.923	42.856	45.642	48.290	54.052	26
27	11.808	12.879	14.125	14.573	16.151	18.114	20.703	21.749	22.719	26.336	30.319	31.528	32.912	36.741	40.113	43.194	44.140	46.963	49.645	55.476	27
28	12.461	13.565	14.847	15.308	16.928	18.939	21.588	22.657	23.647	27.336	31.391	32.620	34.027	37.916	41.337	44.461	45.419	48.278	50.993	56.893	28
29	13.121	14.256	15.574	16.047	17.708	19.768	22.475	23.567	24.577	28.336	32.461	33.711	35.139	39.087	42.557	45.722	46.693	49.588	52.336	58.302	29
30	13.787	14.953	16.306	16.791	18.493	20.599	23.364	24.478	25.508	29.336	33.530	34.800	36.250	40.256	43.773	46.979	47.962	50.892	53.672	59.703	30
40	20.706	22.164	23.838	24.433	26.509	29.051	32.345	33.660	34.872	39.335	44.165	45.616	47.269	51.805	55.759	59.342	60.436	63.691	66.766	73.402	40
50	27.991	29.707	31.664	32.357	34.764	37.689	41.449	42.942	44.313	49.335	54.723	56.334	58.164	63.167	67.505	71.420	72.613	76.154	79.490	86.661	50
60	35.535	37.485	39.699	40.482	43.188	46.459	50.641	52.294	53.809	59.335	65.227	66.981	68.972	74.397	79.082	83.298	84.580	88.379	91.952	99.607	60
70	43.275	45.442	47.893	48.758	51.739	55.329	59.898	61.698	63.346	69.334	75.689	77.577	79.715	85.527	90.531	95.023	96.388	100.425	104.215	112.317	70
80	51.171	53.539	56.213	57.153	60.391	64.278	69.207	71.145	73.018	79.334	86.120	88.130	90.405	96.578	101.880	106.629	108.069	112.329	116.321	124.839	80
90	59.196	61.754	64.634	65.646	69.126	73.291	78.558	80.625	82.511	89.334	96.524	98.650	101.054	107.565	113.145	118.136	119.648	124.116	128.299	137.208	90
100	67.327	70.065	73.142	74.222	77.929	82.358	87.945	90.133	92.129	99.334	106.906	109.141	111.667	118.498	124.342	129.561	131.142	135.807	140.169	148.629	100

For values of $\nu > 30$, approximate values for χ^2 may be obtained from the expression $\nu\left[1-\frac{2}{9\nu}\pm\frac{x}{\sigma}\sqrt{\frac{2}{9\nu}}\right]^3$, where $\frac{x}{\sigma}$ is the normal deviate cutting off the corresponding tails of a normal distribution. If $\frac{x}{\sigma}$ is taken at the 0.03 level, so that 0.01 of the normal distribution is in each tail, the expression yields χ^2 at the 0.98 and 0.01 points. For very large values of ν it is sufficiently accurate to compute $\sqrt{2\chi^2}$, the distribution of which is approximately normal around a mean of $\sqrt{2\nu-1}$ and with a standard deviation of 1. This table is taken by consent from *Statistical Tables for Biological, Agricultural, and Medical Research*, by R. A. Fisher and F. Yates, published by Oliver and Boyd, Edinburgh, and from Table 8 of Biometrika Tables for Statisticians, Vol. 1, by permission of the Biometrika Trustees.

Appendix (XV)

ARTICLES OF AGREEMENT, CONTRACT CONDTIONS PRELIMINARIES AND TRADE PREAMBLES

SUMMARY	Page No	₦	k
Articles of Agreement	AG/ 5		
Contract Conditions	CON/39	I6,700	00
Preliminaries	PREL/I3	I62,500	00
Trade Preambles	TP/58		

Articles of Agreement
Contract Conditions,
Preliminaries and
Trade Preambles.
Carried to GENERAL SUMMARY ₦ 329,500

PROPOSED SIX STOREY OFFICE BLOCK
FOR
N. N. D. C. LTD
AT MINNA

MAIN OFFICE BLOCK

GENERAL SUMMARY

	Page No	₦	k
Articles of Agreement, Contract Conditions, Preliminaries and Trade Preambles	TP/59	329,500	00
Main Office Block	SUM/I	205037I	I7
External works	SUM/EW/I	23II60	68
		₦26II03I	85
CONTINGENCIES			
Allow a Provisional Sum of ₦50,000.00 for contingencies to be expended as directed		50,000	00
TOTAL OF TENDER CARRIED TO FORM OF TENDER		₦266I03I	85

Name of Tenderer:----------

Address:----------

Date for completion within _____ weeks of officially taking over the site

	SUBSTRUCTURE (Contd)				₦	k
	CONCRETE WORK					
	Plain insitu concrete(I:IO-20mm aggregate) in					
A	50mm Blinding	303	Sq. m	5.20	I575	60
	Reinforced insitu concrete(I:2:4-20mm aggregate)developing minimum 2IN/sq.mm works strength at 28 days in:					
B	Column	7	Cub.m			
C	Foundation	I5	Cub.m			
D	Ground beam	7	Cub.m			
E	Thickening under bed	I	Cub.m			
F	Column base	I26	Cub.m			
G	Wall	I2	Cub.m	I20.00	2II20	00
H	Lift base	5	Cub.m			
J	Step	3	Cub.m			
K	I50mm Bed	688	Sq. m	II8.I5	I2759	45
L	I50mm Suspended slab	I5	Sq. m			
M	200mm Bed	60	Sq. m			
N	200mm Gutter side	89	Sq. m	24.20	3605	80
O	300mm Wall	6	Sq. m	36.30	2I7	80
	Mild steel bar reinforcement in columns, column bases steps etc					
P	IOmm Diameter bar in links and stirrups	I979	Kg	I.05	2077	95
	High yield deformed steel bar reinforcement in column bases,column,walls etc					
Q	32mm Diameter bar	2882	Kg			
R	25mm Diameter bar	3928	Kg			
S	20mm Ditto	9625	Kg	I.I5	2I8I8	95
T	I6mm Ditto	I632	Kg			
U	I2mm Ditto	906	Kg			
		To collection			₦ 63,I75	55

SHEHU GIWA AND PARTNERS