A STUDY INTO PRE-DESIGN CONSTRUCTION PROJECT COST PREDICTION IN GHANA

By

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CERTIFICATION

I hereby declare that this submission is my own work towards the MSc and that, to the best of my knowledge, it contains no material previously published by another person or material which has being accepted for the award of any other degree of the University, except where due acknowledgment has been made in the text.

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ABSTRACT

Most often than not, prospective clients rely on the building professionals to determine the feasibility and viability of a proposed project. This they do by asking for designs and subsequently the probable costs. If this initial cost is too high it will discourage the client from proceeding further with the scheme and so the potential commission is lost and if it is too low, it may result in abortive designs, dissatisfaction on the part of the client and shoddy works. In an attempt to arrive at this initial estimate within the shortest possible time, certain cost predicting methods are normally used, these methods often than not result in large variations and deficiencies which ultimately affect the accuracy of our initial cost estimates. The objectives of this research are to identify these existing methods, assess their effectiveness and above all attempt to develop a mathematical cost model for estimating the initial cost of building projects. In order to achieve these objectives, there was the need to review relevant related research works of other authors. This review of literature, informed the design of the research. A field work was carried out by administering twenty-eight well-structured questions to eighteen practicing building consultancy firms with good standing in five regions of Ghana namely Ashanti, Greater Accra, Brong Ahafo, Upper West and Northern, during the process of which personal interviews were conducted to further solicit the views of these professionals. A detailed cost analysis on twenty-five (25) completed building projects was done and the results were used to develop a cost model using SPSS12.0 which states that Total Cost = -203,688 + 99.15 (Floor Area) + 43,919.71(Building Height).Among the key findings were that floor area and total building height contribute 36.4% of the cost of building. Cost models were found not to be in use in cost estimating in Ghana hence, there is no interest in the development of such models by building professionals. It was established that the

most commonly used cost predicting methods were cost per square metre of floor area, unit and elemental cost methods with the former dominating. It was realised that quantity surveyors and architects most often do not visit proposed sites before designs and cost estimating and this has significant effects on initial cost. It was found out that condition/nature of site causes the highest variability between initial and final construction costs with time overrun being the least. It was therefore recommended that more research work be done on the floor area method of cost prediction so as to correct the deficiencies associated with its usage. Quantity surveyors should have elemental cost analysis and cost plans of various types of projects executed before in their respective offices for easy cost comparisons with proposed projects since cost planning is more appropriate method for cost estimating. It was further recommended that there must be cost data publications of all past projects of various kinds in the different regions in Ghana stating their actual costs of construction and time of completion which will serve as a guide when estimating for such similar types of projects. Architects and quantity surveyors must endeavour to visit proposed sites, have the designs evaluated before arriving at the final decision. Professionals must develop the interest in cost model development to derive the benefits that accrue from their use.

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LIST OF ABBREVIATIONS

A.E.S.L: Architectural and Engineering Services Limited

B.R.R.I: Building and Road Research Institute

COBRA: Construction, Building and Real Estate Research

GetFund: Ghana Education Trust Fund

Gh.I.S: Ghana Institution of Surveyors

IKA: Isaac Kwadwo Amankwaa

KNUST: Kwame Nkrumah University of Science and Technology

NUFFIC: Netherlands Universities Foundation for International Co-operation.

PWD: Public Works Department

R.I.B.A: Royal Institute of British Architects

RICS: Royal Institute of Chartered Surveyors

SIF: Social Investment Fund

SMM7: Standard Method of Measurement of Building Works, 7th edition.

SPSS: Statistical Package for Social Sciences

T&G: Tongue and Groove

DEDICATION

This research work is dedicated to the entire Maalinyuur Family, whose moral and spiritual support, encouragement and love has brought me this far in my educational pursuit.

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CHAPTER ONE

INTRODUCTION

1.1 Background

One of the first questions a client who wants a building erected will ask a building professional is “how much it will cost”?: The next question in his mind will be “how accurate is this figure”?. If this price estimate is too high it may discourage the client from proceeding further with the scheme and so the potential commission will be lost and if it is too low, it may result in an abortive design, dissatisfaction on the part of the client and shoddy works (Ashworth, 1994).

The initial estimate often carries the burden of being the cost limit for the project and the financial budget for the client and forms the basis upon which decision making; initial appropriation and economic feasibility studies are made (Hen Li et al, 2005). The reliability of this estimate is questioned because it is frequently produced within a restricted time limit and in most cases with a shortage of relevant and historical price data on which it can be based. Kwakye (1997) added that this preliminary estimate provides an early indication of the probable cost of a construction project and is one of the important pieces of information that will influence the client’s decision to engage in the construction project. It is therefore important that these estimates are adequately prepared as incorrect estimates give a project a bad start.

From the foregoing analysis of the importance or effects of a pre-design estimates one can not but agree that the viability of a propose project mostly depends on the client’s budget as against the pre-design estimates and this has the influence of affecting the client’s decision to either embark on the project or not since the budget and for that matter the pre-design estimate represent the maximum expenditure or limit on the amount the client is prepared to spend on the project. This cost limit is normally established before the commencement of the construction project. It is important to control this cost at the design stage so that the eventual tender figure can be predicted with a degree of certainty.

1.2 Problem Statement

Most often than not, prospective clients rely on the building professionals to take the decision as to whether to embark on a proposed construction project or not. This the client does by asking for the designs and subsequently the probable cost. The initial estimated cost is what the client will always remember. If this price estimate is too high it will discourage the client from proceeding further with the scheme and so the potential commission is lost and if it is too low, it may result in an abortive design, dissatisfaction on the part on the client and shoddy works (Ashworth, 1994). In an attempt to arrive at this estimate within the shortest possible time, certain cost predicting methods are used. These methods have long been in use however with deficiencies that ultimately affect the accuracy of the estimates. These methods, often than not, results in large variations and deficiencies in cost estimates. This is confirmed by (Marr, 1977), that the error of cost estimation at the design stage may be as high as ±20 to 40 percent of the final project cost. Nicco-Annan (2006) reported that for a limited survey of office buildings in Accra, Ghana, by a non-banking financial institution, cost overruns between 60 to 180%.Laryea (2010), in his paper presented to COBRA, observed that consultants cost estimates in Ghana overrun on the average by 40%. It is therefore necessary for research to be conducted to properly establish these deficiencies in these methods and to also identity factors which bring about the variability between the estimated cost and the final cost, so that they can be catered for at the cost prediction stage.

1.3 Aim and Objectives

The aim of this research work is to develop a pre-design construction project cost predicting model for the Ghanaian construction industry.

The specific objectives are:

- To identify factors that cause variability in initial and final costs.
- To identify the existing methods used in pre-design construction project cost predictions in Ghana.
- To verify the effectiveness of these methods.
- To develop an appropriate cost model for pre-design construction project cost predictions.

1.4 Benefits of the Study

The benefits to be derived from the research are as follows:

- The model when developed is going to help facilitate the Ghanaian method of predicting initial pre-design construction cost. It is going to establish the first ever initial cost predicting model in Ghana, base on which other researchers can develop other cost predicting models.
- The research is going to help unravel some of the factors that affect initial construction cost, and hence will draw estimators' attention to inculcate the effects of those factors in their initial estimates to nullify or reduce the end effects.
- The research findings also serves as the researcher's contribution to existing knowledge, and should form the basis for other related further research works.

1.5 Scope

This work seeks to find out the existing methods used by quantity surveyor/estimators in predicting initial pre-design construction cost. The scope of the research is limited to only single story sandcrete block buildings because of the complex cost analysis and factor considerations involved with storey buildings as the height increases, and since the research aims at generating a simple cost model, other complex structures were not considered.

1.6 Methodology

The research method which is detailed in Chapter 3 was classified into the followings;

Desk Study: This was done by examining existing methods and reviewing other relevant literature on cost predictions. Detailed examination of evaluation reports by consultants, priced bills of quantities, and the final certificates of completed projects were also done.

Field Survey: This involved the field work which was carried out by the use of well structured closed ended questionnaire, which were taken round to the professionals to gather expert information from them.

1.7 Data Collection and Questionnaire Administration

The expert to whom questionnaire were given included quantity surveyors and architects. This is because when it comes to initial cost analysis and prediction it is the quantity surveyor who plays the key role, the architect will always wants to know this figure to help him not to design out of budget or not over design.

Historical Analysis of cost data: Detailed analysis of elemental cost breakdown of bills of completed projects was done. This involved cost planning analysis of these completed projects to find out if any correlation and trend between the various elements existed.

1.8 Statistical Analysis of Data

This involved the use of relevant statistical formulae such as correlation coefficients, regression analysis using (SPSS 12.0), and test of significance to corroborate the survey results. The relative importance of the major factors that affect the initial cost of construction in Ghana, their interdependency and test of significance were also tested.

1.9 Model Development

The development of the model was based on the historical cost analysis that was carried out on twenty-five completed past projects. The various costs were brought to the present value because of the varying years of completion, by using BRRI construction cost indices up to May, 2009, to cater for the effects of inflation. The various total costs were plotted using the (SPSS 12.0) and the regression analysis was run, where the regression factors were determined and, from that the necessary statistical analysis were done to arrive at the mathematical equation.

1.10 Guide to the Thesis

The thesis was presented in Six (6) chapters as follows:

Chapter1: gives the background of the research and outlines the aims and objectives. It also states the benefits, scope and method of the research.

Chapter2: looks at the available literature on the various methods of initial cost predictions and basic approaches to cost estimation.

Chapter3: shows the general approach to the research.

Chapter4: shows the research data analysis and background to model development

Chapter5: gives the general overview of the principle of regression analysis and its application in the model development.

Chapter6: contains the conclusions drawn from the research, the researcher's contribution to knowledge and recommendations for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The client's budget represents the maximum expenditure or limit on the project he is prepared to spend. This preliminary cost which is normally established before the commencement of the construction process is dependent on the amount of money the client has available for spending on the project and the agreed approximate estimate prepared by the design team. It is one of the important factors that influence the client's decision to engage in the project because it establishes the probable financial commitment prior to final designs and documentation. It also provides the design team with early cost information which influences the design solutions in respect of construction, type of specification, finishes, etc. Unfortunately, this preliminary estimate is generally prepared on scanty cost information though its accuracy to a large extent depends on the availability of reliable historical cost data. The importance of preliminary estimate cannot be overemphasized as wrong estimates give the project a bad start which can lead to shoddy works and abandonment, hence lose of value for money by prospective clients. Most often than not any client who wants a building erected would want to know his financial commitments upon which the feasibility of the project depends. An early price estimate which is too high may discourage the client from proceeding further with the project and so the potential interest is lost.

The accuracy of this initial estimate is important because it serves as the budget limit for the client base on which planning and probably fund sourcing are done. To the design team it helps in controlling cost so as not to over design out of budget and to also ensure that the eventual tender figure can be predicted with a degree of certainty.

Hence it is therefore necessary that in an attempt to produce these preliminary estimates within the shortest possible time amidst the rather scanty historical cost data, as is normally the practice, the appropriate initial cost predicting procedures and methods are used.

2.2 Costs Associated with Constructed Facilities

The costs of a constructed facility to the owner include both the initial capital cost and the subsequent operation and maintenance costs. Each of these major cost categories consists of a number of cost components.

The capital cost for a construction project includes the expenses related to the initial establishment of the facility:

- Land acquisition, including assembly, holding and improvement
- Planning and feasibility studies
- Architectural and engineering designs
- Construction, including materials, equipment and labour
- Field supervision of construction
- Construction financing
- Insurance and taxes during construction
- Owner's general office overhead
- Equipment and furnishings not included in construction
- Inspection and testing

The operation and maintenance cost in subsequent years over the project life cycle includes the following expenses:

- Land rent, if applicable
- Operating staff

- Labour and material for maintenance and repairs
- Periodic renovations
- Insurance and taxes
- Financing costs
- Utilities
- Owner's other expenses

The magnitude of each of these cost components depends on the nature, size and location of the project as well as the management organization, among many considerations. The owner is interested in achieving the lowest possible overall project cost that is consistent with its investment objectives.

It is important for design professionals and construction managers to realize that while the construction cost may be the single largest component of the capital cost, other cost components are not insignificant (Skitmore and Ng, 2003).

From the owner's perspective, it is equally important to estimate the corresponding operation and maintenance cost of each alternative for a proposed facility in order to analyse the life cycle costs. The large expenditure needed for facility maintenance, especially for publicly owned infrastructure, are reminders of the neglect in the past to consider fully the implications of operation and maintenance cost in the design stage.

In construction budgets, there must be an allowance for contingencies for unexpected costs occurring during construction. The amount of contingency is based on historical experience and the expected difficulty of a particular construction project. Estimates of expected construction cost must be considered in five different areas:

- Design development changes,
- Schedule adjustments,
- General administration charges (such as wage rates),

- Differing site conditions for those expected, and
- Party requirements imposed during construction, such as new permits.

In this research, the focus is on the estimation of construction cost, with only occasional reference to other cost components.

Cost estimating is one of the most important steps in project management. A cost estimate establishes the base line of the project cost at different stages of development. A cost estimate at a given stage of project development represents a prediction provided by the cost engineer or estimator on the basis of available data (Crosby, 1981).

2.3 Basic Approaches to Cost Estimation

Virtually all cost estimation is performed according to one or some combination of the following basic approaches:

- Production function
- Empirical cost inference
- Unit costs for bill of quantities.

2.3.1 Production Function

The relationship between the output of a process and the necessary resources is referred to as the production function. In construction, the production function may be expressed by the relationship between the volume of construction and a factor of production such as labour or capital.

A production function relates the amount or volume of output to the various inputs of labour, material and equipment. The amount of output, Q, may be derived as a function of various input factors x_1, x_2 ...x_n, by means of mathematical and/or statistical methods.

Thus, for a specified level of output, we may attempt to find a set of values for the input factors so as to minimize the production cost (Ahuja and Campbel, 1987).

2.3.2 Empirical Cost Inference

Empirical estimation of cost functions requires statistical techniques which relate the cost of constructing to a few important characteristics or attributes of the system. The role of statistical inference is to estimate the best parameter values or constants in an assumed cost function, usually by means of regression analysis techniques.

2.3.3 Unit Costs for Bill of Quantities

A unit cost is assigned to each of the tasks as represented by the bill of quantities. The total cost is the summation of the products of the quantities multiplied by the corresponding unit costs. The unit cost method is straightforward in principle but quite laborious in application. The initial step is to break down or disaggregate a process into a number of tasks. Collectively, these tasks must be completed for the construction of a facility. Once these tasks are defined and quantities representing these tasks are assessed, a unit cost is assigned to each and then the total cost is determined by summing the costs incurred in each task. The level of detail in decomposing into tasks will vary considerably from one estimate to another (Clark and Lorenzoni, 1978).

2.4 Types of Construction Cost Estimates

The required levels of accuracy of construction cost estimates vary at different stages of project development, ranging from ball park figures in the early stage to fairly reliable figures for budget control prior to construction. Since design decisions made at the beginning stage of a project life cycle are more tentative than those made at a later stage, the cost estimates made at the earlier stage are expected to be less accurate. Generally, the accuracy of a cost estimate will reflect the information available at the time of estimation.

Construction cost estimates may be viewed from different perspectives because of different institutional requirements. In spite of the many types of cost estimates used at different stages of a project, cost estimates can best be classified into three major categories according to their functions. A construction cost estimate serves one of the three basic functions: Design, Bid and Control. For establishing the financing of a project, either a design estimate or a bid estimate is used (Berthouex, 1972).

2.4.1 Design Estimates

For the owner or its designated design professionals, the types of cost estimates encountered run parallel with the planning and design as follows:

- Screening estimates (or order of magnitude estimates)
- Preliminary estimates (or conceptual estimates)
- Detailed estimates (or definitive estimates)
- Engineer's estimates based on plans and specifications

For each of these different estimates, the amount of design information available typically increases.

In the planning and design stages of a project, various design estimates reflect the progress of the design. At the very early stage, the screening estimate or order of magnitude estimate is usually made before the facility is designed, and must therefore rely on the cost data of similar facilities built in the past. A preliminary estimate or conceptual estimate is based on the conceptual design of the facility at the state when the basic technologies for the design are known. The detailed estimate or definitive estimate is made when the scope of work is clearly defined and the detailed design is in progress so that the essential features of the facility are identifiable. The engineer's estimate is based on the completed plans and specifications when they are ready for the owner to solicit bids from construction contractors.

In preparing these estimates, the design professional will include expected amounts for contractors' overhead and profits (Crosby, 1981).

2.4.2 Bid Estimates

For the contractor, a bid estimate submitted to the owner either for competitive bidding or negotiation consists of direct construction cost including field supervision, plus a mark-up to cover general overhead and profits. The direct cost of construction for bid estimates is usually derived from a combination of the following approaches:

- Subcontractor quotations
- Quantity take-offs
- Construction procedure.

The contractor's bid estimates often reflect the desire of the contractor to secure the job as well as the estimating tools at its disposal. Since only the lowest bidder will be the winner of the contract in most bidding contests, any effort devoted to cost estimating is a loss to the contractor who is not a successful bidder.

Projects of certain type and size should be published in commercial publications on cost data which can be used to facilitate cost estimates from quantity take-offs. However, the contractor may want to assess the actual cost of construction by considering the actual construction procedures to be used and the associated costs if the project is deemed to be different from typical designs.

2.4.3 Control Estimates

Both the owner and the contractor must adopt some base line for cost control during the construction. A budget estimate must be adopted early enough for planning long term financing of the facility. Consequently, the detailed estimate is often used as the budget estimate since it is sufficiently definitive to reflect the project scope and is available long before the engineer's estimate. As the work progresses, the budgeted cost must be revised periodically to reflect the estimated cost to completion.

The bid estimate is usually regarded as the budget estimate by the contractor, which will be used for control purposes as well as for planning construction financing. The budgeted cost should also be updated periodically to reflect the estimated cost to completion as well as to insure adequate cash flows for the completion of the project (Crosby, 1981).

2.5 Historical Cost Data

Preparing cost estimates normally requires the use of historical data on construction costs. Historical cost data will be useful for cost estimation only if they are collected and organized in a way that is compatible with future applications. The information must be updated with respect to changes that will inevitably occur. The format of cost data should be organized according to the current standard of usage in the organization.

Construction cost data should be published in various forms by organizations. These publications are useful as references for comparison. Basically, the following types of information should be available:

- Catalogues of vendors' data on important features and specifications relating to their products for which cost quotations are either published or can be obtained.
- Periodicals containing construction cost data and indices.
- Commercial cost reference manuals for estimating guides which should contain unit prices on building construction items.
- Digests of actual project costs which should provide descriptions of design features and costs of actual projects by building type.

Historical cost data must be used cautiously. Changes in relative prices may have substantial impacts on construction costs which have increased in relative price. Unfortunately, systematic changes over a long period of time for such factors are difficult to predict. Errors in analysis also serve to introduce uncertainty into cost estimates. It is difficult, of course, to foresee all the problems which may occur in construction and operation of facilities. There is some evidence that estimates of construction and operating costs have tended to persistently understate the actual costs. This is due to the effects of greater than anticipated increases in costs, changes in design during the construction process, or over optimism.

Since the future prices of constructed facilities are influenced by many uncertain factors, it is important to recognize that this risk must be borne to some degree by all parties involved, i.e., the owner, the design professionals, the construction contractors, and the financing institution. It is to the best interest of all parties that the risk sharing scheme implicit in the design/construct process adopted by the owner is fully understood by all. When inflation adjustment provisions have very different risk implications to various parties, the price level changes will also be treated differently for various situations (Berthouex, 1972).

2.6 Cost Indices

Since historical cost data are often used in making cost estimates, it is important to note the price level changes over time. Trends in price changes can also serve as a basis for forecasting future costs. The input price indices of labour and/or material reflect the price level changes of such input components of construction; the output price indices, where available, reflect the price level changes of the completed facilities, thus to some degree also measuring the productivity of construction.

A price index is a weighted aggregate measure of constant quantities of goods and services selected for the package. The price index at a subsequent year represents a proportionate change in the same weighted aggregate measure because of changes in prices (McNeil, 1981).

2.7 Methods of Initial Price Forecasting

During the first half of the twentieth century, six methods of initial price estimating were developed, which are still much the same today (Brook, 1998).

2.7.1 Conference Estimate

This is a technique used for the preparation of an early price estimate .It is based on a collective view of a group of individuals, and may at this stage not quantified in any particular way .The group concerned must have the relevant experience of estimating the cost of similar projects. It is applicable where historical cost data is not appropriate and offers a qualitative view point to reinforce or otherwise a measured estimate (McNeil, 1981).

2.7.2 Single-Rate Method

Preliminary estimates which adopt the single rate method in their preparation are as indicated below.

2.7.2.1 Superficial Floor Area Method

With this method, the area of each floor is measured from the internal dimensions of the building with no deductions made for internal walls, stairs and lift zones and compared to previous similar building cost is per square area (Berthouex, 1972).

Brook (1998), states that adjustment can be made for location and inflation, but specification adjustment is much more difficult. He further stated that subjective judgments are made for size, shape, number of storeys, services ground conditions and standard of finishes, with separate assessment made for external works.

Ashworth (1994) also stated that;

i) Considerations must be given to storey height, plan shape and methods of construction when deciding on the rate to use.
ii) In situation where only the usable space is given, to this area must be added circulation and other non-usable space.
iii) For projects with different standards or types of accommodation, price these independently using different rates.
iv) Price item of work which cannot be related to the floor area at separate all-inclusive rates.

The huge range in the superficial area rates give surveyors some problems and can only be used as guide's prices, and only be adjusted to suit local conditions on the basis the surveyor's personal experience and skills. This method is the mostly widely used method in Ghana and other countries. In the UK priced bills of quantities for previous buildings are the primary source of data used to predict the price of a proposed building during the design. One form of analysis frequently used to provide the rates needed to price early designs is the standard form of cost analysis. The data used to make a tender price prediction is obtained by analysing the priced bills of quantities of a previous similar contract to give the rates at a coarser level of detail than that of the bill and more appropriate to the amount and type of information available during design.

2.7.2.2 Superficial Perimeter Method

Southwell (1971) realizing that floor area was the greatest single variable –correlated price produced a formula that combined the floor area with the length of the building perimeter. The wall/floor area ratio is a very important factor in the economic design of buildings and can produce more accurate results than when using the floor area alone; however, this method has not been used in practice due to surveyors reluctance to adopt to change.

2.7.2.3 Cube Method

This method was used extensively at the beginning of the century but has since been superseded because of its inherent disadvantages. In some European countries like Germany, architects and engineers are familiar with building costs expressed as cubic meter prices. All architects offices used to keep 'cube book' for future estimating purposes. Once the contract was signed its cost would be divided by the cubic content and entered into the office price book.

The cost of a new project could then be determined by calculating its volume and selecting an appropriate rate from the book. The rules of measurements for the cubic content of a building were defined by the R.I.B.A (1954) some of the disadvantages of this method are that

(i) Allowances for flat area pitched roofs and the measurement to foundation depth are very arbitrary and do not correlate cost.

(ii) It does not provide any indication of the amount of usable floor area.

(iii) It produces a large cubic quantity that will increase the possibility of further inaccuracy.

(iv) It takes no account of the number of storey or plan shape

(v) The application of cube rates from previous does not work quite well as in the superficial area method.

It is also known that building cost correlates better with superficial floor area than with volumes (Ashworth, 1994).

2.7.2.4 Unit Method

The method consisting of choosing a standard unit of accommodation and multiplying by an appropriate cost per unit, the unit may represent, say

Schools-cost per pupil place

Hospital-cost per bed place

Car parks-cost per car space (McNeil and Hendrickson, 1982)

This method is commonly used by national bodies such as educational and health services at the inception stage of construction (Brook, 1998). This technique is based on the fact that, there is a close relationship between the cost of construction and number of functional units it accommodates. However, adjustment will have to be made for varying site conditions, specification changes, and inflation. This method suffers from lack of precision, and at best can only be a rather-blunt-tool for establishing general guidelines.

2.7.2.5 Story-Enclosure Method

To overcome the many disadvantages the other single-price methods of initial cost prediction, James (1954) devised a new method using the following rules of calculations;

i) Twice the area of the lowest floor

ii) The area of the roof measured on plan

iii) Twice the area of the upper floor plus an addition of 15% for the first floor, 30% for the second floor, 45% for the third, etc.

iv) The area of the external walls

This method attempted to take into account;

i) Plan shape

ii) Total floor area (by measuring each floor)

iii) Vertical positions of the floor (by using different multipliers for each floor)

iv) Storey heights (ratio of roof areas for external wall area)

v) Overall building height (ratio of roof area to external wall area)

vi) Extra cost of providing usable floor areas below ground (by using multipliers).

It was claimed to perform better in terms of accuracy than the other single-price methods, however lack of use meant that it was not possible to verify this. The weighting used is highly subjective and unlikely to every building. The limitation of the single rate approach were very much apparent since 1954, however ingeniously it might be applied.

2.7.3 Multiple-Rate Method

Preliminary estimates which adopt the multiple rate method in their preparation are as indicated below.

2.7.3.1 Elemental Cost Method

The first stage of cost planning can be used to determine the approximate cost of construction project. This method attempt to make use of the cost analyses from other similar projects by sharing the total cost amongst the various elements to get the per unit element cost. It provides cost advice during the design process and gives the client better value for money. Adjustment will however need to be made for inflation and significant specification changes. Construction professionals are becoming adept at using this method in initial cost prediction, and have adopted basic principles for computer systems. A spread sheet template stores the information and effect of changes reflected immediately they are made (Ashworth and Skitmore, 1982).

Computers are now used to produce sophisticated budgets for clients at the early design stages. Two forms of this method exist; the first being the elemental cost planning also known as "designing to cost', where the project is designed within a framework of a cost limit; the other known as the "comparative cost planning" or "costing a design" where alternative designs can be examined within an economic context (Brook, 1998).

2.7.3.2 Analytical Cost Method

This happens to be the traditional method of construction price prediction. It is used for determining unit rates by examining individual resources and the amount needed for each unit of work. This method takes a lot of time and data required is more. If the design technology for a facility has been specified, the project can be decomposed into elements at various levels of detail for the purpose of cost estimation. The unit cost for each element in the bill of quantities must be assessed in order to compute the total construction cost. This concept is applicable to both design estimates and bid estimates, although different elements may be selected in the decomposition (Brook, 1998).

For design estimates, the unit cost method is commonly used when the project is decomposed into elements at various levels of a hierarchy as follows;

Preliminary Estimates: The project is decomposed into major structural systems or production equipment items, e.g. the entire floor of a building or a cooling system for a processing plant.

Detailed Estimates: The project is decomposed into components of various major systems.

Engineer's Estimates: The project is decomposed into detailed items of various components as warranted by the available cost data..

For bid estimates, the unit cost method can also be applied even though the contractor may choose to decompose the project into different levels in a hierarchy as follows:

- **Subcontractor quotations**: The decomposition of a project into subcontractor items for quotation involves a minimum amount of work for the general contractor. However, the accuracy of the resulting estimate depends on the reliability of the subcontractors since the general contractor selects one among several contractor quotations submitted for each item of subcontracted work.

- **Quantity take-offs**: The decomposition of a project into items of quantities that are measured (or taken off) from the engineer's plan will result in a procedure similar to that adopted for a detailed estimate or an engineer's estimate by the design professional. The levels of detail may vary according to the desire of the general contractor and the availability of cost data.

Construction Procedures: If the construction procedure of a proposed project is used as the basis of a cost estimate, the project may be decomposed into items such as labour, material and equipment needed to perform various tasks in the projects.

Estimate Based on Engineer's List of Quantities

The engineer's estimate is based on a list of items and the associated quantities from which the total construction cost is derived. This same list is also made available to the bidders if unit prices of the items on the list are also solicited from the bidders. Thus, the itemized costs submitted by the winning contractor may be used as the starting point for budget control.

In general, the progress payments to the contractor are based on the units of work completed and the corresponding unit prices of the work items on the list. Hence, the estimate based on the engineers' list of quantities for various work items essentially defines the level of detail to which subsequent measures of progress for the project will be made (Skitmore and Ng, 2003).

2.8 Cost Models

This aspect tries to examine the types and characteristic of cost models. It also looks at the historical backgrounds leading to the development and use of cost models.

2.8.1 Model Defined

A model is representations of something either as a physical object which is usually smaller than the original object or as simple description of the object which might be used in calculations (Oxford English Dictionary, 1998).

"Model is a representation of reality," Cost modelling is defined as dealing with the constant transformation of cost expressions during the stages of planning, recording and control of a building project including those relative to time (Brandon, 1987). The role of most cost models is to predict a future situation and interact with other decision-making processes to add an economic dimension to the problem which is mostly design and investment. Whatever the form of modelling used it is to increase understanding and/or to predict or influence the future.

There is mounting evidence to suggest that realistic estimate of the lowest tenderer's bid can be achieved with far fewer items than normally provided in a bill of quantity model measured under SMM7 (Brandon,1987). The usefulness of models is to assist those who are responsible for forecasting building costs in an attempt to improve their performance. The development of cost models and their wider applications to aspects of construction pricing do have the following advantages.

i) It generates useful information for better informed decisions making.

ii) Information generated is more reliable and thereby introducing greater confidence into the decision-making process.

iii) Cost information can be provided quickly.

iv) It provides suitable cost information at an early stage within the design process.

v) It helps in the provision of cost advice in more reliable and informed manner by considering variable factor (Ashworth, 1988).

2.8.2 Characteristics of Good Cost Model

According to Ashworth (1994), a good cost model should possess the following characteristics.

i) Data requirements should be freely available in the appropriate form and amount.

ii) The model should allow for continuous updating by incorporating new data that become available.

iii) The model should be capable of evolving to suit the needs of changing situation that is prevalent in the construction industry.

iv) The model should accurately and reliably represent that which it is attempting to predict.

2.8.3 Development in Building Cost and Price Modelling

According to Raftery (1991), there are three major generations of model development;

i) First Generation Models

This began in the late 1950's and continued up to 1960, which was characterized in the United Kingdom by a procedural (elemental cost planning approach and in the USA by bidding models).This cost analyses which was suitably updated for time, quantity and quality formed the basis of elemental cost pricing today.

ii) Second Generation Models

It began in the mid-1970 and thus characterized by intensive use of regression analyses of cost modelling and forecasting on both sides of the Atlantic (Buchanan, 1973, Gould, 1970, Kouskoulas and Koehn, 1974, McCaffer, 1975, Raftery 1991, Wiles, 1976).

Regression analysis is a technique that will find a formula or mathematical model which best describes data collected. It is used in situations where the relationships between variables are not unique, where a particular value of one variable always corresponds to the same value of the variables. Simple linear regression technique is a statistical technique which attempts to quantify the relationship between two variables whereas multiple regression analysis relates three or more variables (Ashworth, 1994, Bowen 1982a, 1982b, 1984).

iii) Third Generation Models

Development of such models began in the early 1980's, and has two central characteristics, the willingness to admit the existence of uncertainty and imprecision and a desire to take account of this by carrying out probabilistic estimates frequently based on Monte Carlo techniques (Wilson 1978).The second characteristic is computer linked, it is current interest in artificial intelligence and knowledge based computer systems (Brandon and Newton 1986).Interestingly the most commonly used pre-design model in the UK is still the first generation floor-area model. However, the contribution of second and third generation models is important in that they have forced academics and professionals alike to seek ways to make use of the existing cost. Professionals and clients are most familiar with the first-generation floor-area model. Therefore, one logical course of action would be to incorporate the experience from the second, third generation models into an improved version of this first-generation model.

In all these, the purpose of a model should be paramount, that is solving the real world problems of predicting building price and exploring in same detail the various economic implications of varying design strategies (Raftery, 1991).

2.8.4 Types of Modelling Techniques

According to Raftery (1987), the building cost models are classified into three distinct types;

(i) Element-based floor-area models.

(ii) Regression models and,

(iii) Probabilistic models.

a. Element-Based Floor-Area Model

This technique was developed in 1962 in the UK, where accepted tenders were broken into various elemental categories such as substructure, finishes, services etc. This technique of cost planning was further expanded by Ferry and Brandon (1980). The shortcoming of the area method is that cost is influenced by factors other than floor area alone (Heng Li et al, 2005).

b. Regression Model

The most popular, useful and applicable technique, however, is that of multiple regression analysis (Ashworth, 1994).This is a statistical technique that will find a formula or mathematical model that best describes the data available (Norusis, 2004).

This technique is used in those situations where the relationships between the variables is not unique, in the sense that a particular value of one variable always corresponds to the same value of the other variables. Examples of these include: a regression cost model for public school buildings (Al Momani,1996), Skitmore and

Ng (2003) developed regression models for forecasting actual construction time and cost when client, sector, contractor selection method, contractual arrangement and project type are known while contract period and contract sum are estimated, in Hong Kong, Heng Li,et al (2005) have developed a cost model for predicting the cost of office buildings and they cited Kouskoulas and Koehn (1974) who also developed a pre-design cost estimation model using regression analysis.

c. Probabilistic Model

For this method, the most generally applied technique is the Monte Carlo simulation which is based on simulating activities overtime and thus a life history of the system to be studied.

These modelling techniques are not readily acceptable, as traditional deterministic approaches tend to be more readily accepted rather than ranges to which confidence limits are attached (Jaggar et al, 2002).Here the name “model” may well be a misnomer, the approach is normally a simple Monte Carlo evaluation of a construction cost compiled using the estimators subjective perceptions of probability distributions for each of a set of reasonably independent sub-systems (Raftery 1991).

Stages in model development

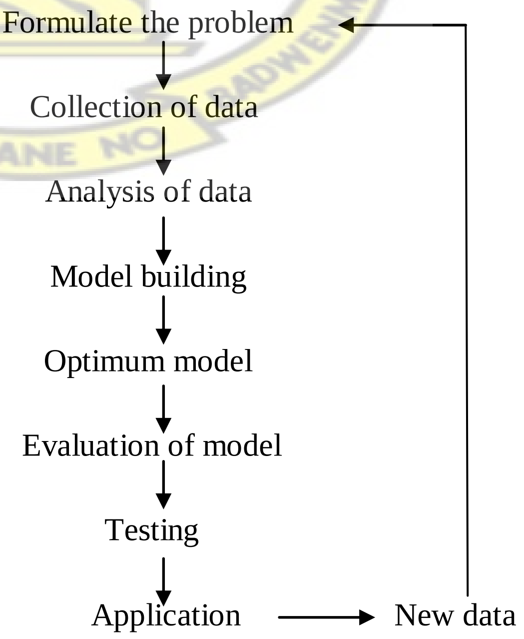

Figure 2.1: Conceptual Framework for the Assessment of Model Performance

Figure 2.1 above shows the process of model building (Ashworth, 1994).

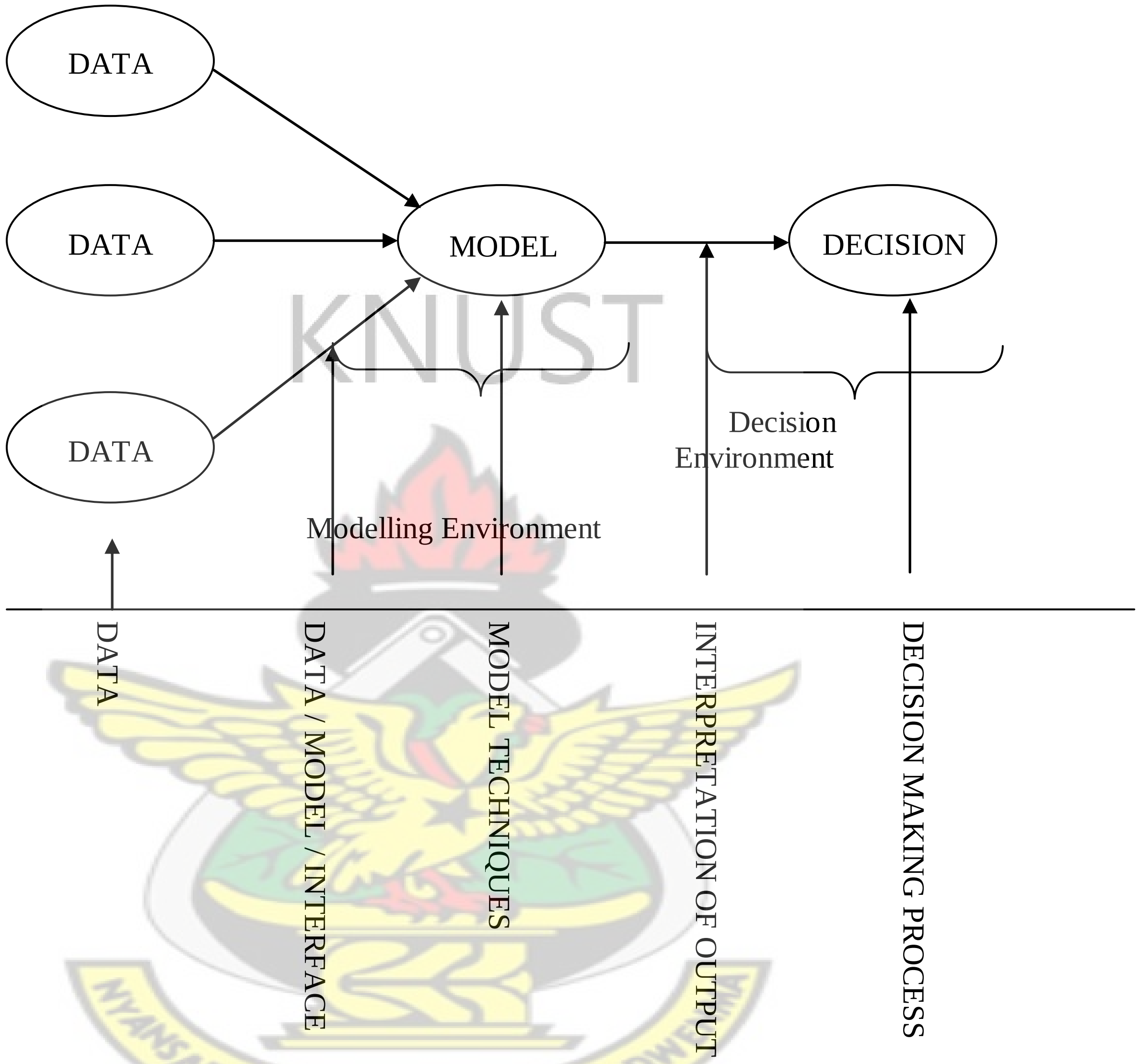

Figure 2.2: Conceptual Framework of Model

Figure 2.2 above shows the conceptual framework of a model which may be viewed as part of a chain which leads from raw data through some kind of model and output unto a decision maker. (Raftery, 1984a).

CHAPTER THREE

RESEARCH METHOD

3.1 Approach to the Research

This chapter describes the method or the steps adopted in a systematic order so as to organize the whole work properly. It is an attempt to arrange the research work in a methodical order, all directed towards the achievement of the aim and objectives.

The various procedures followed were as listed below,

a. Desk Study
b. Field Survey
c. Data Collection
d. Historical Analysis of Cost Data
e. Statistical Analysis of Data
f. Model Building
g. Conclusion

3.2 Desk Study

This involved detail examination of the existing methods and reviewing other relevant literature on construction cost predictions by other authors. The KNUST library and the internet, served as the major source of published literature in the form of the "quantity surveyor" the official magazine of the quantity surveying division of the Ghana Institution of Quantity Surveyors, text books and journals. Detailed examination of evaluation reports by consultants, priced bills of quantities, and the final certificates of completed projects were analysed.

3.3 Field Survey

The research was based on expert information through the administration of carefully structured questionnaire and interviews. The field design was considered for each objective as below:

Objective 1: To identify those factors that cause variability in initial and final costs.

Survey unit: These were the quantity surveyors and architects who are the key players as far as usage and prediction of initial cost are concern.

Survey tools: As part of the questionnaires, five factors which adversely affect the initial cost such as Nature/Condition of site, Inflationary trend etc were listed and the respondents were asked to rank them in order of their effects on the initial using a scale of 1 to 5,where 1=very important,2= important, 3=moderately important, etc.

Treatment to study unit: Detail analysis was done by using SPSS 12.0 to collaborate the results to further rank them in a proper order of magnitude in effects.

Measurement of results: Nature/Condition of site was first in the ranking which means it causes the highest effects on the initial cost with inflationary trend being the least.

Objective 2: To identify the existing methods used in pre-design construction project cost predictions in Ghana

Survey unit: This was directed to quantity surveyors and architects. This is because issue of pre-design cost predictions at the initial stage lies mostly with the architect and the quantity surveyor, whichever method to be used largely also depends on the quantity surveyor.

Survey tool**:** Nine (9) existing methods in use for initial cost prediction were tabulated using A, B C, etc and the respondents were asked to rank them in order of familiarity and usage using a scale of 1 to 3, where 1=Very familiar, 2=familiar and 3=not familiar.

Treatment to survey unit: The analysis of the results was done using SPSS 12.0 where further ranking was carried out with the focus on scale (1), very familiar and the order of ranking was done using first, second, third, etc.

Measurement of results: Superficial floor area method was first in the ranking followed by unit and elemental methods, which means that the most common methods in use by both quantity surveyors and architects in Ghana for initial cost prediction at the pre-design stage are the superficial floor area, unit and elemental cost methods respectively, but the former is predominantly used.

Objective 3: Verifying the effectiveness of existing method

Survey unit: Here preference was still given to the quantity surveyors and architects in the since that they can really testify the effectiveness of these existing cost predicting methods because accordingly they are into the application of the methods.

Survey tools: A questionnaire was set to find out the accuracy of initial cost estimates in Ghana especially when the superficial floor area method is used and the respondents were asked to choose among such alternatives as very, fairly and near accurate, and this was supported by another questionnaire to find out how significant was the difference between the initially estimated and the final costs.

Treatment to survey unit: The various responses were collated and analysed using the Statistical Package for Social Scientists version 12.0 for both questionnaires and a descriptive statistic was used to verify the response rates.

Measurement of results**:** 80% of the respondents agreed that the initial costs estimates in Ghana are fairly accurate and 62.5% said there is a significant difference between the initial and final estimates which means that cost overruns are common in our situations.

Objective 4: To attempt to develop an appropriate cost model for pre-design building project cost prediction.

Survey unit**:** Twenty-five completed building projects which included schools, teacher's quarters, etc with varying years of completions were used. Regression analysis was used. All past costs were brought to their present value by using BRRI Cost Indices. The costs, floor areas and respective total building heights of the projects were input in SPSS 12.0 and regression analysis were done base upon which the model was developed.

Treatment to survey unit**:** Statistical package, SPSS 12.0 to run a regression analysis to obtain the cost model.

Measurement of survey unit**:** The model developed states that;

Total Cost = -203,688 + 99.15 (Floor Area) + 43,919.71 (Building Height), and the model indicated that floor area and total building height contribute only 36.4% of the total initial estimated cost of building, hence this model cannot be successfully used to predict the initial cost of building.

3.4 Data Collection and Questionnaire Administration

Well structured closed-ended questionnaires were designed, vetted and tested. These questionnaires were set in line with the specific objectives and the aim. A total of forty (40) questionnaires in all were set and administered. The researcher covered five (5) out of the total of ten (10) regions in Ghana which were: Ashanti, Brong Ahafo, Greater Accra, Upper West, and Northern regions, and in each region Architectural and. Engineering Service Limited (A.E.S L) was considered together with some private firms. This was because most of the practicing firms are concentrated in Greater Accra and Ashanti, and for regional balance, Northern and Upper West were also considered. It was also assumed that as far as initial cost estimating practices were concerned, what happened in these five regions would be a reflection in the other regions. The experts to whom the questionnaires were administered included; quantity surveyors and architects in the various consultancy firms.

Aside this, cost was also collected from completed projects for cost analysis and cost planning and this was also used in the derivation of the cost equation.

3.5 Sample Size

The questionnaires were to be distributed in such a way that the total respondents would be a fair representative of the total population. In order to achieve this, a sample size formula propounded by Kish, was used as follows:

Kish Formula

This formula is given as:

$$n = \frac{n1}{1 + {n1}/{N}}$$

Where,

n = sample size

N = total number of practicing quantity surveying firms July-September 2006 was 58 (Quantity Surveyors, 2006). To this number was added ten (10) Regional A.E.S.L firms in each of the ten regions. Hence, N is 68.

$n1 = S^2 / V^2$

V = the standard error of sampling distribution = 0.05

S = the maximum standard deviation of the population.

S = P (1-P) = 0.5 = 0.5 (1-0.5) = 0.25

P = the proportion of the population elements that belong to the defined class

Therefore, N = 68.

$n1 = S^2/V^2$

$= 0.25 / 0.05^2 = 25$

$$n = \frac{25}{1 + {}^{25}/_{68}}$$

= 18.28 ≈ 18.

Therefore, 18 quantity surveying firms were contacted. A minimum of two (2) persons per firm was used, thus a total of thirty-six (36), which was rounded up to forty (40) questionnaires which were administered across the five (5) regions in Ghana.

3.6 Historical Analysis of Cost Data

A detailed cost analysis on twenty-five (25) completed projects which were randomly selected out of forty (40), all of which were located within Brong Ahafo and Ashanti regions, specifically Wenchi and Agogo was done. The regions and these projects were chosen because the project information needed was readily available at the time and the researcher had personally worked on some of them in these regions. The various elemental costs were brought to their present values using the cost indices from the Building and Road Research Institute (BRRI) since the completion years deferred.

Detailed examination of evaluation reports, priced bills of quantities, and the final certificates of completed projects were analysed.

This also involved cost planning analysis of these completed projects to find out if any correlation and trend between the various elements existed. A critical study and analysis was also done on the ratio of cost to area.

3.7 Statistical Analysis

This involved the use of relevant statistical formulae such as correlation coefficients, regression analysis using SPSS 12.0 and also testing the significance of the statistical values to corroborate the survey results. The relative importance of the major factors that affect the initial cost of construction in Ghana, their interdependency and test of significance were also tested.

3.8 Model Development

The development of the model was based on the historical cost analysis that was carried out on a hundred completed passed projects. The various costs were brought to the present value because of the varying years of completion, by using BRRI construction cost indices to cater for the effects of inflation. The costs, floor areas and respective building heights of the projects were input in SPSS 12.0 and regression analysis was done base upon which the model was developed

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results of the field work done. It deals with the analysis of the various views gathered on the research questionnaires sent out to the professionals in the field, and personal interviews conducted as well. The various captions depict a summary of the questionnaires and the objectives set.

4.2 Accuracy of Initial Price Estimates

An early price estimate which is too high may discourage the client from proceeding further with the scheme and so the potential commission is lost. Alternatively, if this is too low, it may result in an abortive design, dissatisfaction on the part of the client and shoddy works as confirmed by (Ashworth, 1994**).** Decision making, initial approximation and economic feasibility studies are based on such estimates, as agreed by **(**Kouskoulas and Koehn, 1974).The survey indicated that initial price estimates are fairly accurate but not very accurate, and this leaves a lot of doubt in the client's mind, hence the error of cost estimation at the design stage which may be as high as ±20 to 40 percent of the final project cost as stated by (Marr, 1977). This agrees with Nicco-Annan (2006) report, which concluded that, for a limited survey of office buildings in Accra, Ghana, by a non-banking financial institution, cost overruns between 60 to 180% and Laryea observed that on the average cost overruns by 40%.

Table 4.1 Accuracy of Initial Price Estimates

Options	Frequency	Valid Percent	Cumulative Percent
Very Accurate	1	2.5	2.5
Fairly Accurate	32	80.0	82.5
Near Accurate	7	17.5	100.0
Total	**40**	**100.0**	

This is also due to the fact that these estimates are frequently produced within a restricted time limit ranging from several days to few hours, and because in most cases there is a shortage of relevant and historical cost data on which it can be based.

Table 4.2: Accuracy dependent on Time

Options	Frequency	Valid Percent	Cumulative Percent
Yes	30	75.0	75.0
No	4	10.0	85.0
Somehow	6	15.0	100.0
Total	**40**	**100.0**	

Most often than not, these estimates are also based on sketch designs which are sometimes complex and lack a lot of relevant information. This has a lot of influence on the initial price estimate since no cost checks are done at the detail design stage as a cost control mechanism. This was indicated by the high response rate of the influence of sketch designs, and more so when it is very complex, on initial cost estimates.

Table 4.3: Influence of Sketch Designs on Initial Price Estimates.

Options	Frequency	Valid Percent	Cumulative Percent
Very much	33	82.5	82.5
Very little	6	15.0	97.5
Not at all	1	2.5	100.0
Total	**40**	**100.0**	

4.3 Method of Catering for Inflation

A percentage adjustment to cater for inflation is common with varying magnitudes the basis of which was not stated. Very few quantity surveyors use price adjustment factors or indices from the Ghana Statistical Services and Building and Road Research Institute indices to adjust for inflation at the design stage.

As concluded by Brook (1998), inflation must be taken care of regardless the method that is being used. Others also argued that the effect of inflation is catered for by including a fluctuation clause in the final document.

As stated by Ashworth (1986), indices are used either for updating historic cost data to current pricing levels or for predicting future trends in costs and prices. 65% of the quantity surveyors admitted that they rather use the local price indices to adjust the cost of a similar old building for a new one.

Table 4.4: Method of Dealing with Inflation

Options	Frequency	Valid Percent	Cumulative Percent
BRRI Price Adjustment Factors	7	17.5	17.5
Percentage Adjustments	23	57.5	75.0
Both	10	25.0	100.0
Total	**40**	**100.0**	

4.4 Cost Planning for Initial Cost Predicting Purposes

As indicated by Ashworth (1994), cost planning ensures cost-effective and value-for-money designs and provides a greater involvement of the quantity surveyor at the design stage.

It was realized that as high as 47% of quantity surveyors agreed that they do not do cost planning often with 12% not practicing it at all. This is due to the fact that most of the times quantity surveyors are only brought in when designs are completed by the architect and are ready for tender documentation; hence cost checking at this stage becomes a problem.

Table 4.5: Doing Cost Planning for Cost Prediction Purposes

Options	Frequency	Valid Percent	Cumulative Percent
Yes	16	40.0	40.0
No	5	12.5	52.5
Sometimes	19	47.5	100.0
Total	**40**	**100.0**	

4.5 Site Visit before Preparing an Initial Estimate

It was realized that quantity surveyors base the initial estimates on the sketch designs given without any visit to the site to actually ascertain the nature and the state of the site, since even the project location has a lot of influence on the initial estimate. It was also observed that because these estimates are normally produced within a restricted time limit, quantity surveyors rather tend to use percentage adjustments to cater for the unforeseen circumstances hence the significant differences between the initial and the final costs.

Table 4.6: Visit to Site before Preparing Estimates

Options	Frequency	Valid Percent	Cumulative Percent
Not Often	24	60.0	60.0
Not at all	3	7.5	67.5
Based on Given Design	13	32.5	100.0
Total	**40**	**100.0**	

4.6 Factors Causing Variability in Initial and Final Costs

In this section, the researcher wanted to identify those factors that cause significant differences between the initial and final costs of construction and to access the extent of the effects of each factor on the initial cost. The respondents were asked to identify these factors and to rank them in order of importance. Table 4.7 shows the factors identified and arranged in descending order of effects.

Table 4.7: Factors affecting initial predicted cost and ranking

Options	Frequency	Valid Percent	Cumulative Percent	Ranking
Nature/Condition of Site	21	28.77	28.77	1st
Change in Design	19	26.03	100.00	2nd
Inflationary Trend	16	21.92	50.69	3rd
Change in Specification	10	13.70	64.39	4th
Time Overrun	7	9.59	73.98	5th
Total	**73**	**100.00**		

4.6.1 Nature/Condition of Site

This factor was ranked as number one on the list as the one with the most significant effects on the initial predicted cost representing 29% of the respondents.

The nature or condition of site has a lot of influence on the total cost of a project. This is because a sloppy site for example, will have different characteristics in terms of constructional methods, the designs and the general layout of the project as well as marshy and rocky areas for which if consideration is not given initially can have adverse effects on this predicted cost eventually.

It was realized during the survey that both architects and quantity surveyors do not often visit the sites to ascertain the nature and condition before the designs and cost predictions. Quantity surveyors also based their initial estimates on sketch designs given without having any in-depth prior knowledge about the site. This attitude of quantity surveyors and architects lead to a lot of variations and additional works which ultimately affect the initial cost.

In the construction of Dormitory Block for OLA Girls' Secondary School at Kenyase in the Brong Ahafo Region, the nature of the site led to a variation of 41% on the initial cost. This was also confirmed during the research that the location of the site itself has a greater influence on the initial cost which is in agreement with Ashworth

(1994) who stated that the cost of a project is affected by its location and that the ground conditions of the chosen site substantially influence constructional cost.

4.6.2 Change in Design

The client in collaboration with the architect can change the design based on which the initial cost prediction was done, and Ashworth (1986) agreed that these changes in the proposed plan shape will affect many of the major cost-important elements in the design.

This happens because the client may have seen a similar design somewhere which he prefers and will want certain modifications done to the original designs. Change in designs also occurs where both the architect and the quantity surveyor did not visit the site before the designs and the initial cost were done. The nature of the site might be that it is a restricted, sloppy, marshy, made up ground, etc., the effects of which could have been catered for initially if a visit was done.

There was a situation where the architect had to change the designs to include a basement, construction of girls' dormitory block at Wenchi Senior High School, in the Brong Ahafo region, because the site was sloppy. There was another situation where retaining walls had to be introduced to support the filling material because it was a sloppy site, construction of girls' dormitory block at Sacred Heart Senior High School at Nsoatre Brong Ahafo region, for the construction of Anglican Hostel at KNUST, Kumasi, the redesign had to include a whole basement floor .In all these instances initial costs were affected.

4.6.3 Inflationary Trend

Inflation means higher costs and higher selling prices. The effect of higher prices on demand is not necessarily easy to predict. We live in an economy where the effects of inflation on construction projects cannot be neglected. It was realized that quantity surveyors find it difficult to predict the effects of inflation on the initial cost.

4.6.4 Change in Specification

Specifications are written descriptions of the type and standards of the materials and workmanship. Materials constitute greater part of the total cost of the work. Quoting from Manteau's work, materials cost may constitute 60% of the total cost of the work. Hence, any change in the type and quality of initial material specified will have either a negative or positive effects on initial cost.

In the Proposed Extension of Lands Commission Regional Office Block, opposite the Regional Co-coordinating Council in Sunyani, the client ensured that, the original floor finish of terrazzo was changed to porcelain floor tiles, louver blades were all changed to aluminium sliding doors and windows, plywood ceiling was changed to plastic T&G, aluminium roofing sheets changed to coloured roofing sheets and ultimately the initial cost was increased by 25%.In the construction of 3-storey hostel block for Berekum Nurses Training College, the original floor finish of terrazzo was to be changed to porcelain floor tiles which was to be an increment of 12%, likewise the regional library still under construction. In all these instances, the initial costs were affected.

4.6.5 Time Overrun

The concept of project duration is important in accessing the success viability of a project and is also seen as one of the benchmarks in assessing the importance of a project.

Construction time has always been seen as one of the benchmarks in assessing the performance and efficiency of the project organization. Timely completion of a construction project is one goal of the client and the contractor because each party tends to incur additional costs and lose potential revenues when completion is delayed, as confirmed by (Thomas et al., 1995).

Referring to Chan and Kumaraswany (1999), a project is usually regarded as successful if it is completed on time, within budget and to the level of quality standards specified by the client at the beginning of the project, and this was confirmed by Ashworth (1994) that one method of measuring the success of a project is whether it is available for commissioning by the date promised in the contract document. As concluded by Skitmore and Ng (2003), this completion time may be affected by the client, project and contractual characteristics.

The problem of project time overrun is of international concern. In Australia, it was found out that seven-eighths of building contracts surveyed in the 1960s were completed after the scheduled completion time, while in Hong Kong, 70% of building projects were delayed.

In Saudi Arabia, Al-Khalil and Al-Ghafly (1999), confirmed in a study carried out in 1995, that contractors agreed that 37% of all their projects were delayed while consultants admitted that delayed projects accounted for 84% of projects under supervision, and that 70% of public projects in the same country experienced time overrun.

In Ghana, public projects experienced time overrun on unduly, and this often leaves contractors in a state of uncertainty about their cash-flows. A limited survey of construction of few office buildings in Accra, Ghana, which were commissioned by a well-known non-bank financial institution indicated that the time overrun between 12 to 24 months.

The constructions of various socio-economic developmental projects at Wenchi, Agogo and Oda by the Social Investment Fund (SIF), in collaboration with the various Assemblies were to take a maximum period of eight (8) months. This period has doubled, yet the projects are ongoing, the construction of Dormitory Block for OLA Girls' Secondary School at Kenyase which was to be completed in one year, took five years to complete with fluctuation component of 28% and a general cost increment of 87% on the initial cost which is a major deviation from the initial figure.

One of the main causes of time overrun in Ghana is the client's inability to honour payments in time as stipulated in the contract documents. It takes an average of one or more years to honour a twenty-eight days payment certificate. For the construction of proposed Assembly Block for Sunyani Secondary School (GetFund), an interim payment certificate that was submitted in November, 2008 has not yet been honoured through to March, 2010 the results of which is that the contractor has abandoned the site and the project is hanging. The consequences of time overrun on the initial project cost are re-evaluation of the rest of the works, calculation of fluctuations, and if none of these happens, it can lead to abandonment of the project by the contractor.

4.7 Existing Methods in use for Initial Cost Estimation in Ghana

The researcher wanted to identify the existing methods in use for initial cost predictions in Ghana. There are various methods of initial cost prediction in use, the choice of which depends on one's familiarity and ease of use. Respondents were asked to state the level of familiarity and ease of use with these existing methods, using a scale 1 to 3, where 1=Very familiar, 2=Familiar and 3=Not Familiar.

Table 4.8: Ranking of Initial Cost Predicting Methods in Use

No.	Initial Cost Predicting Methods	Very Familiar %	Familiar %	Not Familiar %	Ranking
C	Superficial Floor Area Method	95	2.5	2.5	1st
F	Unit Method	60	25	15	2nd
H	Element Cost Method	50	45	5	3rd
I	Analytical Method	40	32.5	27.5	4th
D	Superficial Perimeter Method	32.5	42.5	25	5th
E	Cube Method	32.5	42.5	25	5th
J	Cost Models	20	30	50	5th
B	Financial Method	23	40	38	6th
G	Storey Enclosure Method	20	42.5	37.5	7th
A	Conference Estimate	5	27.5	67.5	8th

The research indicated that the most widely used methods in Ghana are the cost per meter square of floor area, followed by the Unit cost and the elemental cost methods respectively, although the later provides better cost advice during the design process and gives the client better value for money.

The first three most commonly used methods were critically analysed as to ascertain their advantages and disadvantages and to compare their areas of applications.

4.7.1 Superficial Floor Area Method

This method is the most popular form of initial cost estimating. The total floor area of a building measured between the internal faces of external enclosing walls is multiplied by a calculated unit rate per square metre to obtain the probable cost. It is simple and easy method to remember, and a rapid method of calculating initial costs. The advantages of this method are that an architect may be able to the system as a guide to cost during preparation of sketch designs. Costs expressed in per (m^2) are more readily understood by clients and their accountants and also most published cost data are expressed in (m^2).

The method however does not directly take account of change in plan shape, overall or storey height and construction methods of the buildings and this in agreement with, Jaggar et al, (2002), who stated that the shortcoming of the cost per floor area method is that cost is influenced by factors other than floor area alone. It is further confirmed by Heng Li et al (2005), that total floor area and total building height account for over 96 per cent of the accuracy in construction cost estimation and this was also agreed by Ashworth (1994) that buildings with high storey heights will cost more per square metre of floor area than comparable accommodation with lower storey heights, which buttress the earlier assertion by Jaggar et al, (2002).

4.7.2 Unit Cost Method

This is a method that lends itself to certain types of buildings where the building's functions can be expressed in unit terms. It is used early in the design stage where a client may only be able to express his requirements in simple terms, in schools (per place), theatres (per seat), and hospitals (per bed).The method provides a convenient form of stating a cost limit. It is a simple method of comparing different schemes has the speed of application.

However, this method suffers from lack of precision as there is no sufficient information so as to make a realistic estimate. It is unsuitable for estimating the cost of individual buildings within a project, and also difficult to accurately adjust unit cost to take account of variations of sites (geographical and topographical), changes in specifications, and variations in labour rates and cost of materials.

4.7.3 Elemental Cost Method

This method compares costs of buildings using information from the previous bills of quantities of similar projects. The contract figure is sub-divided into costs of the various building elements as set out in the rules prescribed by the Royal Institute of British Architects (RICS). It is a rapid and accurate method of preparing realistic estimates and provides better cost advice during the design process and gives the client better value for money. It also allows adjustments to be made to individual elements, thus the means to increase or decrease levels of specification. The method gives an excellent base system for making comparisons with the costs of other buildings and also indicates possible cost distribution for the individual elements.

However, a high degree of skill is needed to interpret the differences between elements and calculating their cost effects and also requires more time to prepare than the first two methods.

4.8 Cost Models

As stated by (Ashworth,1994), cost modelling is a more modern method that can be used for forecasting the cost of construction project and it helps in the provision of cost advice in more reliable and informed manner by considering variable factors

In Hong Kong, (Kouskoulas and Koehn, 1974) developed a cost model for predicting initial cost of office buildings. In Ghana, the interest in developing cost models is limited. This is evident by the low response of 20% very familiar and 50% not familiar with cost models by the respondents. Amoah-Mensah (1995) used mathematical models to predict bill rates for the various bill items, the principle of which can be used to develop a cost model for predicting initial construction cost.

4.9 Computed-Aided Estimating

The use of computers by estimators has grown steadily during the 1980s and 1990s but it is disappointing to observe that there are still many estimators who have failed to recognize the benefits of information technology or go beyond simple word-processing in their day to day work as confirmed by (Ashworth, 1994).It is often difficult to measure the improvements computers bring to estimating performance. This is probably because the benefits come from additional facilities which manual systems cannot provide.

It was realised during the survey that the extent of application of computers in the initial cost predictions in Ghana is limited. The researcher wanted to find out whether there were Computer-Aided Estimating softwares in use, 78% of the respondents agreed that there were no such softwares in the country. However, the rest added that they have been able to use the spreadsheets, word-processors and database to develop an improvised program for estimating purposes in their respective offices.

CHAPTER FIVE

DEVELOPMENT OF COST MODEL

5.1 Introduction

This chapter deals with the principles of regression analysis and its application in the development of a mathematical model for predicting construction cost in Ghana.

5.2 Regression Analysis

Regression analysis is the statistical method concerned with the study of the dependence of a variable of primary interest, Y, on a set of influencing variables $X_{1,}$ X_2 ……, X_k with the view to:

(a) formulating a mathematical model to represent the statistical relation;

(b) estimating the model parameters and;

(c) using the model to

- Make inferences about the primary variable, that is, to predict or control the behaviour of the primary variable,
- Describe the behaviour of the primary variable, (Y), based on the influencing variable, (X_i).

The primary variable, (Y), measures the effect or response resulting from a certain combination of factors under specified conditions. It establishes the relationship between variables and the effect of a change in one variable on the other.

5.3 Simple Regression Model

This model has only one predictor variable and is the simplest regression relation in which the regression function is a linear function of the predictor variable. The simple linear regression model is given by the equation;

$Y_i = \beta_o + \beta_1 X_i + \mathcal{E}_i$

Where,

Y_i - is the value of the response variable in the ith observation.

X_i - is the known value of the predictor variable in the ith observation.

$\mathcal{E}_i$- is the random error term or the "stochastic disturbance" which caters for the errors due to chance and neglected factors which are assumed not important.

β_1 - gives the intercept on y-axis, and are the regression parameters.

β_o - measures the slope of the linear model.

5.4 Multiple Regression Model

Multiple linear regressions are a regression that involves more than one independent variable. It is a straightforward extension of simple linear regression and is one of the most widely used techniques. The general linear model is denoted as;

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_1 X_{i2} + \cdots + \beta_k X_{ik} + \mathcal{E}i$$

Where,

Y_i - is the value of the response variable in the ith observation.

X_{ij} - are the values of ith observation of the jth independent variable;

$\beta_1 \ldots \beta_k$- are the population regression coefficients which indicate the effect of a given X on Y

β_0 - is the intercept which indicates the expected value of Y when all of the X's are zero;

$\mathcal{E}i$ - is the ith observation of the disturbance or stochastic (error) term i =1, 2 ...n, j =1, 2,…, k.

5.4.1 Application of Multiple Regression Analysis in Cost Model Development

Ashworth (1988), stated that the most popular, useful and applicable technique in cost model development is that of multiple regression analysis, and this was agreed by Norusis (2004), that this is a statistical technique that will find a formula or mathematical model that best describes the data available. The technique is used in those situations where the relationship between the variables is not unique, in the sense that a particular value of one variable always corresponds to the same value of the other variables.

Heng Li et al (2005), stated that multiple regression analysis has the greatest application to cost modelling, since cost is unlikely to be able to be described by a single variable. Examples of cost models developed by using multiple regression analysis are: a regression cost model for public school buildings, Al-Momani (1996), regression models for forecasting actual construction time and cost when client sector, contractor selection method, contractual arrangement and project type are known while contract period and contract sum are estimated, Skitmore and Ng (2003), regression cost model for office buildings in Hong Kong, Heng Li, et al (2005), a regression cost models for predicting various bills rates Amoah-Mensah (1993).

5.5 Development of Cost Model

In applying multiple regressions, it is assumed that the relationship between the estimated construction cost and the independent variables can be approximated by a linear model which provides best fit estimates of the model parameters by minimizing the error of the model. The cost model has the following form:

$$Y = \beta_0 + \beta_1 X_1 + \beta_1 X_2 + \cdots + \beta_k X_k + \mathcal{E}i$$

Where,

Y - is the dependent variable, which is the initial construction cost of the building

X_1, $X_{2,}$..., X_k- are known variables which are the given floor areas and building heights,

β_0, β_1, $\beta_2 \ldots \beta_k$- are the partial regression coefficients computed by SPSS12.0

$\mathcal{E}i$ -is the observation of the disturbance or stochastic (error) term.

Application of regression analysis assumes that the variables have a linear relationship with each other hence no further transformation is needed for the independent variables, (Heng Li et al, 2005).

5.5.1 Data Source for Model Development

The development of the model was based on the historical cost data of twenty-five (25) completed buildings, with screed as floor finish, obtained directly from A.E.S.L, IKA Consult, and Public Works Department (PWD), all building consultancy firms based in Sunyani. The data included detailed information on the final construction cost, total floor areas and total building heights. The various final construction costs were brought to the present value because of the varying years of completion, by using the Building and Road Research Institute (BRRI) construction cost indices published in May, 2009, to cater for the effects of inflation so as to have a common base for the analysis.

5.5.2 Data Processing and Analysis

The adjusted final costs of the twenty-five completed projects which were classified as the "dependent variable", the total floor areas and the building heights which were also classified as the "independent variables", with the building height measured from the ground level to the roofing level, were all inputted the SPSS 12.0 package and then analysed. The data was made up of seven school buildings, ten residential buildings and eight other public buildings.

5.5.3 Analysis of the Developed Model

The model was interpreted based on the following statistical parameters to investigate the relationship between the independent variables and the construction cost:

- Coefficient of determination-square.
- Correlation coefficient, R.
- Test of Significance
- Standard Error

5.5.4 General Model of Data Collected

The general model for the data collected refers to the combine model for schools, residential and other public buildings which is as follows:

Total Cost= -203,688 + 99.15 (Floor Area) + 43,919.71(Building Height).

Table 5.1 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.604	.364	.306	29216.44511

a. Predictors: (Constant), Building Height, Floor Area

Table 5.2 Coefficients of Model

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-203687.909	116730.567		-1.745	.095
	Floor Area	99.152	44.226	.399	2.242	.035
	Building Height	43919.711	22372.321	.349	1.963	.062

b. Dependent Variable: Tc

5.6 Interpretation of the Model

This aspect attempt to explain the statistical parameters that is used to further explain the model better and gives it a better understanding.

5.6.1 Coefficient of Determination, R-square (R^2)

Maddala (1992), stated that this is the proportion of total variation in the dependent variable explain by the full set of independent variables included in the model. That, it is a measure of the reduction in the variability of Y obtained by including the independent variables $X_1, X_2, \ldots, X_k$ in the model.

He further explained that a large value of R^2 that is close to 1 indicates a good fit of positive relation, which implies that most of the variability in Y is explained by the regression model. A low value of R^2 indicates a poor fit.

Referring to Table 5.1, the value of R^2 of the model is 0.364.This means that 36.4% of the variability in the pre-design estimates is explained by the variability in floor area and the building height. That is to say floor area and total building height contribute only 36.4% of the pre-design estimates. This means the remaining 63.6% of the cost is influenced by other independent variables.

5.6.2 Correlation Coefficient, R

This measures the degree of relationship between the variables. A degree of correlation (±0.6 to ±0.99) indicates a higher degree of correlation. From Table 5.1, the correlation coefficient of 0.604 indicates a strong correlation between the variables.

5.6.3 Test of Significance

From Table 5.2 all the t-values of 2.242 and 1.963 for floor area and building height respectively are all more than 1, hence the two variables are significant in determining the pre-design estimates. The standard error of estimate of 29,216.45 from Table 5.1, is a measure of the anticipated difference between the actual values and what the regression analysis predicts and is also the standard deviation of the pre-design estimate given the floor area and the total building height. A lower standard error of estimate denotes that the regression line is a better fit of Y values than relationship with a higher standard error of estimate (Maddala, 1992)

5.7 Conclusion

From the interpretation of the various statistical parameters, it is concluded that from the data collected, the floor area and building height contribute only 36.4% of the total cost of the pre-design estimates, and that there are other independent variables that add up the remaining 63.6% of total pre-design estimated cost of the building.

Though the correlation coefficient and the t-values indicate a strong correlation and significance of the variables respectively, it is not in agreement with Hen Li et al (2005), who concluded that over 96% of the accuracy of construction cost estimation can be explained by the floor area and total building height in Hong Kong. The disagreement could be due to the different environments, economies, sites conditions, building types and constructional methods which could have serious effects on the cost. The disagreement rather confirms Jaggar et al (2002), who stated that, the shortcoming of the cost per floor area method is that cost is influenced by factors other than floor area alone.

It is clear that the model cannot be used to predict pre-design estimates successfully since the effect of other unidentified variables is so great and has to be considered.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter deals with the conclusions arrived at based on the results and findings from the fieldwork and the specific objectives that were set. Recommendations for improving initial cost prediction were also looked at and areas for further research identified.

6.2 Conclusions

The conclusions were as stated below and were based on the captions of the findings from the survey conducted.

6.2.1 Accuracy of Initial Price Estimates

The initial estimate is what the client always remembered and steps must therefore be taken to ensure its accuracy. If this initial estimate is too high it will discourage and scare clients from proceeding further with the scheme and therefore lose the potential commission since this estimate is part of the economic feasibility studies.

Most often these estimates are frequently produced within a restricted time limit based on uncompleted sketch designs and scanty or no relevant historical cost data. As a result of the restricted time limit, quantity surveyors and for that matter architects, most often do not get the opportunity to visit the proposed site before preparing the initial estimates.

Estimates that are too low, may deceive the client to undertake the project, but will not get the value for his money because it will lead to abortive designs and shoddy works, and ultimately abandonment. This initial estimate most often carries the burden of being the cost limit of the proposed project and set the budget limit for the client, hence the need for more rational initial estimates to ensure value for money for the clients.

6.2.2 Effects of Inflation

We live in the part of the world where the effects of inflation on initial estimates can not be overlooked. Unfortunately, quantity surveyors find it difficult to cater for the effects of inflation at the initial cost prediction stage. As a result, uncalculated percentages are used to adjust for inflation.

Very few quantity surveyors use price adjustment factors or indices from the Ghana Statistical Services and Building and Road Research Institute indices to adjust for inflation at the design stage. Unfortunately these indices do not project into the future and cannot predict the effect of inflation on the initial estimate in the near future, hence making it difficult to access its actual effects and this has the tendency of throwing the initial estimates or the client's budget out of gear.

6.2.3 Cost Planning

Cost planning a major tool for cost distribution, monitoring and control during the project design stage is lacking in the initial cost estimating practices by quantity surveyors. This practice which ensures cost-effective and value- for- money designs and provides a greater involvement of the quantity surveyor at the design stage has rather not been given attention.

Most often than not quantity surveyors are only brought in when designs are completed by the architects and are ready for tender documentation and this inhibits any effective cost planning and cost checking and design evaluation. As a result tender figures either far exceed or go below the consultant estimated cost by an undesirable margin of error.

6.2.4 Variability in Initial and Final Construction Costs

All things being equal one would have thought that the initial estimated cost would be equal to the final cost. Unfortunately this is not so because the effects of certain factors cannot be overlooked.

- **Nature/Condition of Site**

This has a lot of influence on the total cost of a project and it affects the constructional methods, the designs and the general layout of the site and the project. Unfortunately, architects and quantity surveyors do not often visit the sites before the designs and cost predictions are made resulting in lot of variations and additional works which ultimately affect the initial cost.

- **Change in Design**

Changes in the original plan shape will affect many of the major cost elements in the design and this ultimately affects the overall cost of the project.

Change in designs often occurs where both the architect and the quantity surveyor did not visit the site to acquaint themselves with the nature and conditions of the site before the designs and the initial cost.

- **Inflationary Trend**.

Inflation means higher costs and higher selling prices. We live in an economy where the effects of inflation on construction projects cannot be neglected and needs consideration at the initial cost prediction stage.

- **Change in Specification**

Specifications are written descriptions of the type and standards of the materials and workmanship. Materials cost constitutes greater part of the total cost of the work. Any change in the type and quality of initial material specified will have either a negative or positive effects on initial cost.

- **Time Overrun.**

Construction time has always been seen as one of the benchmarks in assessing the performance and efficiency of the project organization. A successful project is the one that has been completed within the time specified in the contract document and within budget.

Most of the project time overrun in Ghana is as a result of the client's inability to honour payments in time as stipulated in the contract documents, because no contractor would want to pay Liquidated and Ascertained Damages by intentionally delaying the execution of a project. The consequences of time overrun on the initial project cost are re-evaluation of the rest of the works, calculation of fluctuations, and abandonment of the project by the contractor.

6.2.5 Methods in use for Initial Cost Prediction in Ghana

A number of methods exist for initial cost prediction purposes the application of which depends on the ease of use and familiarity with the method.

The commonest method in use for that purpose by quantity surveyors is the superficial floor area or cost per square meter of floor area. Probably it is because it is simple and easy to remember, and a rapid method of calculating the costs and this might have overshadowed the fact that the method does not directly take account of change in plan shape, overall or storey height and construction methods. Jaggar et al

(2002), in his quest to access this method argued that, cost is influenced by factors other than floor area alone.

The unit and elemental cost methods are the least use even though the latter provides better cost advice during the design process and gives the client better value for money.

In Ghana, the interest in developing cost models is limited. Most quantity surveyors are not familiar with cost models and for that matter are not interested in using them. Amoah-Mensah (1995) was able to develop a mathematical model using regression analysis to predict bill rates for the various bill items, the principle of which can also be used to develop cost models for predicting initial construction cost.

The proposed cost model developed needs to be upgraded by identifying the other variables with the 63.6% effects and inculcating them in the model to make it more useful.

6.2.6 Computer- Aided Estimating

The extent of application of computers in the initial cost predictions in Ghana is limited. Only few quantity surveyors have been able to improvise a program for estimating purposes using spreadsheets, word-processors and database in their respective offices.

6.3 Recommendations

Based on the field work done, views gathered from the various construction professionals the in the construction industry, the following measures were recommended:

6.3.1 Methods of initial Cost Estimates

The various methods of initial cost estimation which are in common use in Ghana by quantity surveyors must be critically examined by Ghana Institution of Surveyors, other allied bodies and both researchers and prospective researchers and the necessary amendments made.

- **Superficial Floor Area Method**

The method does not take account of change in plan shape, overall building height and constructional methods of the new building in question. It is therefore recommended that further more research be done to establish a formular that can effectively include these variables in the method or to identify certain adjustment factors that can be used to adjust for these variables in the method so as to improve upon its usefulness and effectiveness. This should be done by researchers and prospective researchers in the building industry. Lecturers in the Departments of Building Technology at Kwame Nkrumah University of Science and Technology, Kumasi, together with their counterparts in the various Polytechnics should team up with students to do a thorough research in the area.

- **Elemental Cost Method**

The adoption of this method by quantity surveyors is very paramount because it is an accurate method of preparing realistic estimates than the superficial floor area method. It allows for necessary cost checking at the design stage of individual elements and serves as an excellent base system for making useful comparisons with the costs of other buildings.

6.3.2 Cost Planning

Cost planning, a method of cost distribution, monitoring and control during the design stage is more appropriate for cost estimating purposes than the other methods. It allows for cost checking at the design stage against the cost target and provides cost information on the proposed total project expenditure which assists the design team members in design decision making.

It is therefore recommended that quantity surveyors in their various respective offices should have elemental cost analysis and cost plans for all the various past projects including residential, commercial, offices, schools, etc. with all types of finishes for easy comparisons with proposed projects.

By so doing it will assist the designer in the choice of the correct economic framework provide cost information and check the designer's design solutions against the predetermined project budget.

6.3.3 Design Evaluation

As stated by Kwakye (1997), the design of the building influences its eventual overall building cost. The design team must therefore examine all viable design options at the various stages in the design sequence and maintain cost control by undertaking a series of cost checks.

The cost checks should be a series of on-going exercises which should be carried out during and must be in conjunction with the design process so that the cost effects of design decisions can be reported and examined and corrective measures taken when necessary to be within the project cost.

6.3.4 Cost Model

The interest in cost models development is lacking in the country and this may be because of the varying independent variables and the unpredictable economic situations that pertain in the country. Nevertheless it has been done in other countries amidst similar conditions and situations, so the same principles and ideas can be used to develop cost models that suit the conditions in our country.

It is therefore recommended that researchers and prospective researchers should take up the challenge of developing an appropriate cost model for predicting construction cost.

The researcher has been able to develop a cost model using regression analysis for initial estimating purposes using the floor area and building height but unfortunately these variables constitute only 36.4% of the accuracy of the estimates. Further research work is needed to establish the other "independent" variables whose effects contribute to 63.6% of the accuracy of the cost model.

6.3.5 Computer-Aided Estimating

All the estimating methods identified so far can be made easy by the use of the computer. It is highly recommended that quantity surveyors should explore the use of the computer in their fields of estimating and probably develop appropriate estimating software that can be linked to an AutoCAD program so that reliable estimates can be obtained direct from the design at any point in time.

6.3.6 Cost Data Publication

Publications of project cost data either quarterly or yearly by the appropriate professional body such as Ghana Institution of Surveyors (Gh.I.S), just as it is done for construction materials, in their quarterly magazine will go a long way to facilitate the process of estimating the cost of proposed projects. The basis of this cost data should be the actual cost of completed projects in the different regions with their locations, design features, building type, specifications and date of completion. This can be used as basis for cost estimations for proposed projects.

6.3.7 Site Visit

Architects, and for that matter quantity surveyors and other allied construction professionals should always endeavour to visit proposed sites to ascertain the conditions and nature before designs and estimating so as to avoid the issue of redesigning which could lead to a lot of variations and additional works.

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APPENDIX A
A COST DATA FOR MODEL DEVELOPMENT AS AT MAY, 2009

Project Title	Year of completion	Floor Area (m^2)	Building height (m)	Original Contract sum (Gh¢)	Adjusted as at May, 2009 (Gh¢)
6-Unit classroom Block at Buoku, Wenchi	2003	524	5.50	23,614.30	33,441.23
Construction of Maternity Block at Kwameasua, Dormaa	2004	238	5.40	25,690.24	30,453.31
Ditto at Berekum	2004	216	5.35	18,946.13	24,845.95
Construction of 3-Unit pre-school classroom block at Odumase	2003	260	5.08	19,296.72	27,810.43
Construction of 10-Unit Teachers Quarters at Yawsae, Sunyani	2003	305	5.55	26,872.15	39,687.48
Ditto at Kwatire	2003	305	5.55	26,935.18	39,780.57
Construction of 3-Unit Classroom Block at Nkyiraa, Wenchi	2004	283	4.75	16,612.42	19,692.37
Construction of Dental Clinic at Agogo Presbyterian Hospital	2008	138	4.85	36,415.35	43,024.74
Construction of 6-Unit Teachers at Collins School at Agogo	2008	348	5.58	75,162.60	88,804.61
Construction of 3-Unit Classroom at Antwikrom, Sunyani	2006	270	5.48	36,050.63	64,209.78
Ditto 6-Unit classroom at Baakoniaba,Sunyani.	2006	487	5.20	52,717.53	93,895.19
Construction of Slaughter house at Asuokwaa,Sunyani.	2006	369	5.72	61,911.65	110,270.83
District Fire service station, Drobo	2006	304	5.5	54,689.08	90,226.04
6-Unit Nurses Quarters at Agogo Presbyterian Hospital	2008	348	5.58	95,262.85	112,553.06
6-Unit Teachers Quarters at Tewbaabi, Berekum	2004	288	5.58	25,183.50	33,025.64
Ditto at D/A ‘3’ JHS at Agogo	2008	348	5.58	96,043.75	113,475.69
Construction of Rural Clinic at Bongase,	2004	113	4.70	12,368.98	16,220.68

Wenchi					
6-Unit Teachers Quarters at SDA/Frema cluster, Wenchi	2008	348	5.58	91,903.16	108,583.58
6-Unit Classroom block at Ntoase Methodist 'C' Wenchi	2008	689	5.30	66,000.0	77,979.00
Ditto at Hwidiem Methodist Primary school at Agogo	2008	689	5.30	81,722.95	96,555.67
Ditto 5-Unit classroom block at Chiraa	2007	415	5.58	51,615.05	77,835.50
6-Unit Teacher Quarters at Kwaku Manu R/C Primary school Wenchi	2008	348	5.58	68,075.50	80,431.20
Maize storage facility at New Market, Wenchi	2008	421	5.78	84,603.95	99,959.57
6-Unit Nurses quarters at Wenchi Methodist Hospital	2008	348	5.58	93,469.70	110,434.45
4-Unit Nurses quarters at Botokrom, Berekum	2004	175	5.35	17,900.00	23,474.06

APPENDIX B

QUESTIONARIES TO PRACTISING CONSULTANTS

Please tick appropriate the one that best suit the question

1. How accurate are initial price estimates in Ghana
   Very ☐ Fairly ☐ Near ☐

2. Does the accuracy of the initial price estimates depend on the time within which it is needed?
   Yes ☐ No ☐ Somehow ☐

3. Do you base your initial price estimate on historical cost data or past projects of similar nature?
   Yes ☐ No ☐ Sometimes ☐

4. Do sketch designs have influence on the initial price estimate?
   Very much ☐ Very little ☐ Not at all ☐

5. Which of the following methods do you normally used in your initial price estimating?
   Floor area method ☐ Analytical method ☐ Elemental cost method ☐
   All ☐

6. In using any of the above methods, how do you cater for the effect of inflation?
   Using BRRI price adjustment factors ☐ Using percentage adjustments ☐
   Both ☐

7. Do you do any cost planning for initial price prediction purposes?
   Yes ☐ No ☐ Sometimes ☐

8. Apart from the methods mentioned in question 5, what other methods do you use.
   Unit method ☐ Storey enclosure method ☐
   Cube method ☐ superficial perimeter method. ☐

9. Has proposed construction time an influence on the initial cost?
   Very significant ☐ Not at all ☐ Very little ☐

10. Does the estimator's experience matter in the initial cost prediction?
    Very much ☐ Very little ☐ Not at all ☐

11. Does the complexity of design affect the initial cost prediction?
    Very much ☐ Very little ☐ Not at all ☐

12. How significant is the difference between the initial estimated cost and the final cost of the Project.
    Very significant ☐ Not significant ☐ No difference ☐

13. How do you cater for risk in terms of unforeseen ground conditions at the initial cost prediction stage?
By making percentage allowance ☐
Always assume a level ground ☐
…………………………………..

14. Do you get the time to visit the site before preparing the initial estimates?
Not often ☐ Not at all ☐ Based on the design given ☐

15. How do you take care of external works during your initial estimates?
As part of the main work ☐
As a separate cost item, analyse different ☐
…………………………………… ☐

16. How is the cost of an old project adjusted, for costing a similar new project?
Using Present Value Factors ☐ By doing cost planning ☐
Using Local price indices ☐ Others………………………… ☐

17. Has the project location an effect on its initial cost
Very much ☐ Very little ☐ Not at all ☐

18. The following is a list of methods use for initial cost prediction; please rank them in order of your familiarity with these methods using a scale of 1 to 3.
1 = Very familiar 2 = Familiar 3 = Not familiar

NO	**INITIAL COST PREDICTION METHODS**	**RANK**		
		1	**2**	**3**
A	Conference Estimate			
B	Financial Methods			
C	Superficial Floor Area Method			
D	Superficial Perimeter Method			
E	Cube Method			
F	Unit Method			
G	Storey Enclosure Method			
H	Elemental Cost Method			
I	Analytical Method			
J	Cost Models			
K	Others			

19. Is there reliable historical cost data that you have access to? Yes ☐
No ☐

20. Do the project size, nature and location have an effect on the initial project cost?
Very much ☐ Not really ☐ Not at all ☐

21. How are contingencies catered for in your cost predictions?
From your experience on previous similar works ☐
By making a reasonable percentage allowance ☐

Both ☐

22. Does your initial estimate cover both contractor's overhead and profit?
Yes ☐ No ☐

23. If yes, how is it done?
By a percentage adjustment ☐
From experience ☐
Both ☐

24. Are there reliable cost data publications in Ghana for cost estimating purposes?
Yes ☐ No ☐

25. Do you have a computer – Aided cost estimating software.
Yes ☐ No ☐

26. If yes, what is the name of that software……………………………………….

27. Do you consider the method of construction of the project in your cost estimating?
Yes ☐ No ☐

28 The following is a list of factors that can affect the initial predicted cost, please rank them in order of their importance using 1 to 5, where 1=very important, 2=important, 3=moderately important, etc.

ITEM	FACTOR	RANK
A	Nature/Condition of site	
B	Inflationary trend	
C	Change in Specification	
D	Time Overrun	
E	Change in Design	