KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

FRAMEWORK FOR DEVELOPMENT OF CONSTRUCTION COST INDICES USING UNIT RATE

BY

CHARLES DELA ADOBOR

BSc. (Hons) Building Technology

A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF BUILDING TECHNOLOGY, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

OF

MASTER OF SCIENCE IN CONSTRUCTION MANAGEMENT

COLLEGE OF ARCHITECTURE AND PLANNING

JUNE, 2014

DECLARATION

I hereby declare that, this project report is the result of my own work, except for the literature whose sources have been duly stated and that, this thesis has neither in whole nor in part been prescribed by another degree elsewhere.

……………………………………….. ……………………………….

DELA ADOBOR CHARLES **DATE**

(STUDENT)

…………………………………………... …………………………………

DR. THEOPHILUS AGYEI-KUMI **DATE**

(SUPERVISOR)

…………………………………………... …………………………………

DR. GABRIEL NANI **DATE**

(SECOND SUPERVISOR)

…………………………………………... …………………………………

MR. ERNEST OSEI-TUTU **DATE**

(CO-SUPERVISOR)

…………………………………………. …………………………………

PROF. J. AYAKWA **DATE**

(HEAD OF DEPARTMENT, BUILDING TECHNOLOGY)

DEDICATION

I dedicate this work to my mum, Afua and my wife, Emefa.

ACKNOWLEDGEMENT

This work would not have been a reality without the unforgettable support of many whose input helped me to put the chapters together.

I would like to thank my supervisors, Dr. Theophilus Adjei-Kumi, Dr. Gabriel Nani and Mr. E. Osei-Tutu for supervising and offering constructive criticism to the project.
I wish to thank especially Mr. E. Osei-Tutu for putting me back on track when I lost my way. I must also acknowledge all the lecturers and staff of the Building Technology Department for their immense help in making this project work a reality.

Special thanks also go to my brother Atsu, and other staff at the GETFund secretariat, Accra for their immense assistance. I will also like to acknowledge Dr. E. Atiemo, Director CSIR-BRRI for his patience throughout the study period, which took unusually long time. Finally, to all who through one way or the other have contributed immensely to the realization of this project, I say a big thank you.

ABSTRACT

The need for the use of fluctuation price contracts to provide adequate relief for changes in prices of input resources during construction has been generally accepted in the Ghanaian construction industry. However, stakeholders are currently not satisfied with the existing methods of evaluating fluctuations for building contracts. The study was carried out to identify problems with usage and develop acceptable cost indices for the building industry.

The study identified the major problems as late release of published indices and low recovery of costs. Twenty-eight modal work items were also identified from BQ analysis. Based on these modal items, construction input resource prices were collected and using the resulting unit rates, cost indices were formulated. Statistical tests revealed that the developed indices achieved cost recovery higher than that obtained using the existing methods.

The study recommends that seminars be regularly held with stakeholders like the Association of Building and Civil Engineering Contractors (ABCECG), the construction industry professional bodies like the Ghana Institution of Surveyors (GhIS), Ghana Institution of Engineers (GhIE), Ghana Institution of Architects (GhIA), and Ghana Education Trust Fund among others, to solicit their input to enrich the developed indices.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURE

CHAPTER ONE

1.1 Background

The Ghanaian construction industry is saddled with inefficiency. Eyia, 2003 identified delayed payment as a major cause of this problem. Laryea, 2010 and Adams, 1997 also identified uncertainties in supplies and prices of materials as constraints on indigenous contractors in Ghana and Nigeria.

Studies over the past twenty years reveals a trend of rising cost of construction input resources (Osei-Tutu , 2008) and this trend is expected to continue because the factors responsible for the increased cost trend remain the same. The combined prices of labour and materials have increased by one thousand two-hundred and twenty-nine percent between the years 1997 and 2010 (Ghana Statistical Services, 2010).

The need for the use of fluctuating price contracts to provide adequate reliefs for changes in input resource prices during the construction has been generally accepted in construction contracting (Amoa-Mensa, 1996), accordingly reasonable provisions to achieve these have been made in many standard forms of contracts.

1.2 Problem statement

The CSIR-BRRI used to publish monthly construction cost indices developed using the local price adjustment formula (LPAF) using four component parameters of the unit rate. These component parameters are; foreign exchange of all inputs, local raw material input, local labour input and fuel cost. This data was developed over a twenty-year period.

The last indices published were for September 2007 leaving a gap of forty-eight months as at the time of compiling this report. At this moment, the database, theory and research reports used to develop the LPAF are not available (CSIR/BRRI/A09/42^{A}/Vol.2/8, 10, 13). Presently, the extended version representing some continuity of the cost indices as previously published by BRRI is now being published by a private organization; Construction Industry Efficiency Improvement Group-Ghana (CIEIG-GHH). Recent communications indicates that practitioners and stakeholders appear not to be comfortable with the fact that such a sensitive tool for evaluating changes in construction cost is being published by an individual private company. Consequently by a circular dated 6th September 2011 and titled 'Fluctuation Calculation-Interim Payment Certificate', the Ghana Education Trust Fund (GETFund) which is the financier of about eighty percent of educational infrastructure, instructed consultants on GETFund projects to use Prime Building Costs Index (PBCI), published by the Ghana Statistical Services for computation of fluctuations. The PBCI method has a perceived disadvantage of under-recovery. Also data released has an average time lag of four months.

There is therefore the need to develop cost indices that adequately combine construction input resources.

Literature review on the subject matter indicates that it takes in general more than ten years to gather data, test and develop the indices using the LPAF method as was previously published by CSIR-BRRI (Amoa-Mensa, 1996), for the Republic of Egypt- Department of Construction Engineering- American University in Cairo, Egypt (Hassanein & Khalil, 2006) and for the Kenyan construction industry (Gichunge & Masu, 2010)

The Researcher intends to adopt a different approach; using unit rate of works items to generate cost indices with data from market survey of prices of construction input resources that best reflect on actual recovery of cost to the contractor.

1.3 Justification of the study

There is general consensus among stakeholders (ABCECG, 2011) to improve efficiency of the construction industry. The stakeholders also claimed that current methods of evaluating fluctuations results in under-recovery and therefore wanted a method which is sensitive enough to adequately measure changes in prices.

Published monthly cost indices from a statutory research institution like CSIR-BRRI will contribute in achieving efficiency in the construction industry by making available;

- A reliable construction cost indices from CSIR-BRRI to be used in fluctuation clauses in construction contracts and for analyzing construction cost movements.

- A database of construction input cost which will be updated on monthly basis.

1.4 Research Question

The research questions which will guide the study will be as follows;

- What problems are encountered by the construction industry in application of existing construction cost indices?
- Will the indices generated using the unit rate method differ significantly from other existing methods?

1.5 Aim

The aim of the study is to develop construction cost indices using unit rate of works items.

1.6 Objectives

i) To identify existing methods of evaluating fluctuations in Ghana

ii) To determine specific shortcomings with the application of the methods identified in objective (i)

iii) To determine the components (modal work items) for inclusion in the formulation of a new construction cost index

iv) To formulate a new construction cost index overcoming the shortfalls identified in objective (ii)

1.7 Methodology

In achieving the objectives, the research adopted the following methodologies;

a) A review of literature related to the development and use of construction cost indices, types, uses and problems associated with its usage.

   This data was obtained from construction journals, construction economics and management books, technical reports, manuals and handbooks. Other supplementary information for the study was accessed via the internet and library documentation.

- Based on the literature survey, a list of potential construction cost indices types, uses and problems associated with their usage were developed into a survey questionnaire. The questionnaire was administered and together with informal interviews, information was obtained from construction professionals, built environment professional bodies, suppliers of construction resources, clients and user agencies and clients involved in infrastructural project delivery.
- The questionnaire was be analysed using Statistical Package for Social Scientists (SPSS), inferences and conclusions were

drawn from the data for incorporation into the indices development process.

b) Prices were collected from major suppliers for construction input resources in Accra. Microsoft Excel worksheet database was developed for the prices. The database is updated monthly to reflect price changes.

c) Standard output rates for construction operations in Ghana were used to build up unit rates. Microsoft Excel spreadsheet was employed. The unit rates worksheet was linked up with the input resource prices database. The rates are automatically updated when changes arising from the materials prices are updated.

d) Based on the unit rates developed, a base year and month was selected. The base date chosen is assigned the value 100 and all future increases or decreases become related to that figure (Ferry and Brandson, 1991).

Microsoft Excel spreadsheet was used for this aspect as well.

1.8 Scope of the Study

The study was limited to Accra, being the city with the largest concentration of suppliers of construction input resources, contractors, construction professionals and construction clients. This serves as a pilot for adoption in other cities for further studies. The indices were also developed for simple building projects with simple construction.

1.9 Guide the study

The study was organized in five chapters;

Chapter One is an introduction to the research. The background and justification for undertaking the research are presented in the chapter. The key questions for the research are posed, leading to the statement of the aim and the objectives. The chapter briefly describes the research process (detailed discussion follows in Chapter three). An outline of the report is also presented.

Chapter Two looks at the application of fluctuation clauses in construction contracts, methods of evaluating fluctuations, the formula methods of evaluating. It looked at methods of collecting the data required to develop cost indices from various researchers and statutory organizations.

Chapter Three describes the approach and discusses the methods used in achieving the objectives for the research. Methods and techniques used in data collection, analyses and interpretation are presented.

Chapter Four presents the analyses the responses obtained from the questionnaire and interviews. A general discussion of the results of the survey is also undertaken.

Chapter Five presents the main conclusions of the study and the achievement of the key research objectives. The recommendations made, based on the main findings are also presented in the chapter with some potential areas for future research.

Appendices comprise additional relevant information on the research that cannot be included in the main body of the study such as Questionnaires.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Research undertaken to date concerning construction cost indices have focused around development of factor cost indices and tender price index. Gichunge (2010) explored the application of factor cost indices in Kenya. Hassanein & Khalil (2006) also developed a factor cost index for Egyptian construction industry by modifying the Engineering News Records (ENR) indices model. The ENR indices model was designed to indicate basic underlying trends of construction costs and not result in substantial cost recovery when utilized. Ndihokubwayo & Haupt (2008) also developed a project-specific formula method by breaking down main components of the contract sum. This formula was developed to recover profits in a hyper-inflation economy. The computation process also consumes precious staff time and the expected recovery may not compensate for time spent.

This chapter seeks to review and discuss relevant literature that attempts to address the objectives of the study.

2.2 Price indices

The Building Cost Information Services (BCIS)-the building cost research arm of Royal Institute of Chartered Surveyors (RICS) defines price index as *"a statistic designed to measure how prices vary from one period to another (or one location to another).*" It also defined an index series as *"a set of indices at successive period"* (Yu & Ive, 2006).

Price indices are important to the construction industry, economists, governments and the general public. They are used for measuring relative price movements, cost of living and inflation as well as microeconomic and macroeconomic variables.

The idea of a price index comes when comparing prices of a good or groups of goods and services at the same point in time (Yu & Ive, 2006). The above definition for price index implies that comparison can also be done with respect to location at a particular time. For example, indices can be constructed which compares prices of goods between different cities, regions or countries at the same point in time.

As the prices of different goods and services do not all change at the same rate, a price index can only reflect their average movement.

2.3 Types of Price Indices

A price index is named according to the goods and services market where the prices are monitored. The consumer price index, producer price index, export price index are examples of these indices.

Price indices are required for determining the structure of a country, taking an economic decision, establishing the purchasing power of the members, determining costs and wages, and establishing retail prices of goods and services purchased by consumers and determining the changes of these prices in time. The basic variables required for calculating price indices are;

- Basket of goods and services (BOGS)
- Base year weights

- Base year prices
- Current prices

2.3.1 Basket of goods and services (BOGS)

Basket of goods and services is the term commonly used for the list of goods and services, together with their relative values of output and input for which a sample of prices is collected for the purposes of compiling an index.

2.3.1.1 Sampling procedures for Consumer Price Index CPI

Ideally, to construct a perfectly accurate CPI there is the need to know and record the price of every variety of every good or service available in every outlet in the country. This is not feasible in practice, so it is necessary to sample prices. There are four levels of sampling for local price collection: locations; outlets within location, items within section and product varieties. As only a sample of prices is recorded, there is inevitably some sampling error in measuring the CPI (ONS, 2010).

2.3.1.2 Selecting items in the basket

The Organisation for Economic Cooperation (OECD) reports that various countries use different methods of selecting items for inclusion in the basket (OECD, 2007) .For example, Statistics South Africa, the body responsible for compiling consumer price indices, uses two methods. The first is the estimated total expenditure on an item. All those goods and services on which expenditure exceeds a certain percentage of the total amount spent by the average household are candidates for inclusion in the basket, irrespective of the number of households that actually have purchased the item. This criterion is known in the literature as the "plutocratic criterion". The second - the "democratic criterion" - is based on the percentage of households purchasing the product. An item is a candidate for inclusion in the basket if the proportion of households purchasing it exceeds a certain percentage (Statistics SA, 2010).

2.3.2 Weight

The weight is defined as the share which the selected goods and services gain with respect to their values in the total basket and which is required for calculating an index. There are two types of weights;

Constant weight: The weights of the items of which consumption or production structure are not affected by the months or seasons

Variable weight: The weights of items of which consumption or production structure are affected by the seasons.

2.3.3 Base year price

Dictionary of Statistical Terms, (5th edition, 2002), defines a base as; number or magnitude used as a standard of reference. It may occur as a denominator in a ratio or percentage calculation. It may also be the magnitude of a particular time series from which a start is to be made in the calculation of a new relative series – an index number – which will show the observations as they accrue in the future in relation to that of the base period. The base year price is a price used as a standard or reference to which subsequent prices are related.

2.3.4 Current price

The current price is the existing price of the goods or services used to calculate the price index.

2.4 Consumer price index

The consumer price index (CPI) measures changes over time in average retail price of a fixed basket of goods and services taken as representing the consumption habits of households (OECD, 1996). The target set of items included in the CPI is the set of goods and services purchased for consumption purposes by households. This set therefore includes imports. There is minor revision of the basket of goods annually. CPI is Laspeyres-type index as the relative quantities of the base period provide the weighting of the respective prices. The rate of change of the CPI gauges the change in purchasing power of money and is therefore used as a measure of general inflation.

The CPI is used for various purposes. The most important ones are listed by the EUROSTAT (1995, 1996) as follows:

- Measurement of inflation in the macro-economic sense and comparison of them with other countries
- Determination of economic policies of the governments
- Adjustment of wages and costs
- Purification of any value data from inflation
- As an indicator for national accounting

- As an indicator for price analysis
- As an indicator for retail price and the increase in rent

CPI-based formulae are used for evaluating fluctuations in construction contracts. Some of these include Osborne and Haylett formula for building works, the Engineering formula for civil works and Baxter formula for civil works that are expected to last for more than 24 months.

2.5 Producer price index

Producer price index measures the average movement of prices received by producers of commodities. The target set of goods and services included in the PPI is the entire marketed output of producers in a particular country. The set includes both goods and services purchased by other producers as inputs to their operations or as capital investment, as well as goods and services purchased by consumers either directly from the service producer or indirectly from a retailer. Because the PPI target is the output of producers within a country, imports are excluded.

Various sectors of the economy also construct indices to measure the general monetary price movement of a set of goods and services produced by the particular sector. An example is the construction cost indices produced by the construction industry.

2.6 Price indices formulae

A number of different formulae have been proposed as means of calculating price indices. Yu and Ive (2006), identifies three methods of constructing price indices; the Laspeyres, Paasche and Fisher indices.

These three indices are the ratios of the weighted average of the prices in the reference period to the weighted average of the prices in the base period. The three formulae are set apart by the different ways their respective weightings are derived.

2.6.1 The Laspeyres formula

This was proposed by German economist Étienne Laspeyres (1834–1913) for measuring current prices or quantities in relation to those of a selected base period. A Laspeyres price index is computed by taking the ratio of the total cost of purchasing a specified group of commodities (basket of goods) at current prices to the cost of that same group at base-period prices and multiplying by 100. The base-period index number is thus 100, and periods with higher price levels have index numbers greater than 100.

It is also known as a base weighted or fixed weighted index because the price increases are weighted by the quantities in the base period (Yu & Ive, 2006). The following is the formula for calculating the Laspeyres price index;

$$\frac{\sum_{j} p_{tj} \times q_{oj}}{\sum_{j} p_{oj} \times q_{oj}}$$

Where

p_{tj} is the price of the jth good at time t (the reference period)

p_{oj} is the price of the jth good at time t = 0 (the base period)

q_{oj} is the quantity of the jth good at time t = 0(the base period)

As an example the price index for cement comprising ‘Diamond cement’ and ‘Ghacem’ cement will be constructed as follows; in an assumed base year, the economy produces 1,000 tons of ‘Diamond cement’ at GH₵ 10,000 per ton and 500 tons of ‘Ghacem’ cement at GH₵ 20,000 per ton. In the reference year, the economy produces 1,000 tons of ‘Diamond cement’ at GH₵30,000 per ton. It also produces 1,000 tons of ‘Ghacem’ cement at GH₵30,000 per ton. Setting the base year index as 100, the Laspeyres price index for cement in the reference year is;

$$\frac{\text{GH₵ } 30{,}000 \times 1000 + \text{GH₵ } 30{,}000 \times 500}{\text{GH₵ } 10{,}000 \times 1000 + \text{GH₵ } 20{,}000 \times 500} \times 100 = 225$$

The goods found in the base period are matched with the exact goods found in the reference period. The Laspeyres index therefore has a good control of the quality of the goods being indexed. However it does not take into account the quantities in the reference period and consumers will tend to substitute a cheaper food for a more expensive one in the event of a relative price change.

In the above example the price of 'Ghacem' cement has fallen relative to the price of 'Diamond' cement (from a rate of exchange of 1,000 tons of 'Ghacem' cement for 2,000 tons of 'Diamond' cement to a rate of 1,000 tons of 'Ghacem' cement to 1,000 tons of 'Diamond' cement), so consumers have switched towards consuming relatively more 'Ghacem' cement (from half as much 'Ghacem' as 'Diamond' to equal quantities. As a result, the Laspeyres index is often criticized as subject to substitution bias (failure to capture substitution effects) which overstates the inflation.

2.6.2 Paasche Price Index

Paasche index is often referred to as current weight index and it formula is as follows:

$$\frac{\sum_{j} p_{tj} \text{ x } q_{tj}}{\sum_{j} p_{oj} \text{ x } q_{tj}}$$

The only new notation is q_{tj} which stands for the quantity of the jth good at time t (reference period).

The Paasche index is criticized for understating the inflation as it does not reflect the choice of goods under the base period prices.

The Paasche price index for cement example above will be calculated as follows:

$$\frac{\text{GH₵ } 30{,}000 \times 1000 + \text{GH₵ } 30{,}000 \times 1000}{\text{GH₵ } 10{,}000 \times 1000 + \text{GH₵ } 20{,}000 \times 1000} \times 100 = 200$$

2.6.3 Fisher Ideal Index

As Laspeyres Index tends to overstate the inflation and Paasche Index tends to understate inflation, another index was proposed by Irving Fisher (1867-1947) in an attempt to arrive at the true measure of inflation. The Fisher Index is an average of the Laspeyres and Paasche indices and it is of the general formula below:

$$\sqrt{\frac{\sum_{j} p_{tj} \times q_{oj}}{\sum_{j} p_{oj} \times q_{oj}} \times \frac{\sum_{j} p_{tj} \times q_{tj}}{\sum_{j} p_{oj} \times q_{tj}}}$$

In theory this index should give a better measure of the true inflation. It however requires information of quantities at both base and reference periods. It is therefore not used in practice.

The Fisher Ideal Index for ‘Ghacem’ and ‘Diamond’ cement example is as follows:

$$\sqrt{\frac{3{,}000\ x1{,}000\ +3{,}000\ x500}{10{,}000\ x1{,}000\ +20{,}000\ x500}\ \mathrm{x}\ \frac{3{,}000\ x1{,}000\ +3{,}000\ x1{,}000}{10{,}000\ x1{,}000\ +20{,}000\ x1{,}000}} \quad = \quad 212$$

2.7 Construction Cost Fluctuations

Construction cost fluctuation has been defined as; changes in price levels of construction input resources driven by underlying economic conditions (Hollman and Dykert, 2007). These changes take place from one point in time to another. Hollman and Dykert explains that fluctuation reflects changes in price-drivers such as productivity and technology, as well as changes in market conditions such as high demand, labor shortages, profit margins and so on. Escalation also includes the effects of, but differs from, inflation which is a general change in prices caused by debasement of the value of a currency.

Fluctuation in construction input resource price is a construction risk which must be adequately assessed to ensure smooth implementation of construction projects.

Standard forms of construction contracts incorporate fluctuation clauses as a mechanism to evaluate changes in prices of construction resources. Though the incorporation of these clauses are not mandatory, the inclusion of the clauses as a reasonable compensation against variation in prices of inputs helps in the administration of the contract in a fair, equitable and just manner.

The purpose of a fluctuation clause in a construction contract is to provide a mechanism for reimbursing contractors or client for changes in construction input prices which occurred during the construction period (Murdoch and Hughes, 2000). Where there is increase in input price, the contractor will be reimbursed and it is expected that the client will be reimbursed in the event of a downward movement of input prices.

2.7.1 The need for construction fluctuations

In Ghana more than ninety percent of construction contracts are procured by the traditional design-bid-build method (Obeng-Ayirebi, 2002) where construction projects are performed according to a pre-confirmed contract amount and contract agreement under a lump-sum contract. There is a strong probability that the cost of construction inputs will increase during the life of the project and because it will not be in the best interest of the client to pass over the risk of price increase to the contractor, fluctuation clauses are incorporated, especially as construction projects experience time overruns more than forty-eight months in Ghana (Ameyaw, 2009, Nico-Annan, 2006).

2.7.2 Main types of construction cost indices

The Statistics Directorate of the Organization for Economic Cooperation and Development (OECD) identifies three main types of cost indices; input price indices, output price indices and seller's price indices.

2.7.2.1 Input price indices

The input price indices measures changes in the price of inputs to the construction process by monitoring separately the cost of each factor. This generally entails the compilation of a weighted index of the costs of wages and materials.

The quantity of labour hours and materials needed to construct a representative construction product, e.g., dwelling is calculated. These quantities are periodically multiplied by their corresponding prices and the outcome totaled.

Input cost indices should not be used to provide information on price movements for finished construction products because they do not reflect the whole range of factors that impact on market prices. These other factors include changes in productivity, profits, trade margins of the construction contractor and changes in actual market conditions.

2.7.2.2 Output price indices

Output price indices measures changes in the price of what is produced by entities engaged in the construction activity. Output prices cover most the items normally built-up into the price paid by clients or purchasers to the contractor. These generally include materials, labour, equipment hire, land preparation costs, overheads, profits and trade margins.

2.7.2.3 Seller's price indices

Seller's price indices measure changes in the price of the construction output paid by the purchaser or final owner of the output of the construction activity. Seller's price includes the land component as well as a range of professional services provided in the course of the transaction.

2.7.3 Methods of computing fluctuations

The various forms of construction contracts make provision for evaluating fluctuations.

The Joint Contracts Tribunal (JCT 98) used in the United Kingdom makes three different provisions

- Clause 37 simply brings into operation the fluctuations clauses. It states that fluctuations shall be dealt with according to whichever of the three alternatives as identified. The alternate clauses are clause 38, 39 and 40

- Clause 38 allows adjustment of the contract sum in respect of price changes in statutory contributions, levies and taxes. This clause applies to items which are affected by government policy directions and are thus completely beyond both the control and prediction of the contractor.

- Clause 39 allows adjustment for changes in prices of labour and materials cost as well as statutory contributions, levies and taxes as covered under clause 38.

  It appears that clauses 38 and 39 computes the fluctuations based on the traditional method.

- Clause 40 allows for the use of price adjustment formula

The Institution of Civil Engineers conditions of contract seventh edition (ICE 7) makes similar provisions like the JCT 98.

The Fédération Internationale des Ingénieurs Conseils (FIDIC) conditions of contract for construction, - for building and civil engineering works designed by the employer and or his representatives (also known as the FIDIC red book 1999) - provides in clause 13.7 for adjustment due to changes in legislation and in clause 13.8 for changes due to input cost. The modified version as issued by the Ghana Public Procurement Authority (PPA) for public works in Ghana makes provision under clause 47 for fluctuation price adjustment. This condition incorporates the formula method of adjustment but these can be amended as in the case of most construction contracts forms. The various forms of contracts also have provisions which cater for contracting parties who wish to draft their own fluctuation provisions to qualify standard clauses dealing with fluctuations.

Amoa-Mensah, 1996 identified two main methods for computing fluctuations in Ghana. These are the formula method and the traditional methods;

2.7.3.1 The traditional method

The traditional or 'factual' method is to determine actual price increases of materials and labour. In this method the contractor attaches a list of input materials and labour with their corresponding prices known as 'basic price list' prevailing twenty-eight days to opening of tender as part of the tender documents (Atkinson, 1992). A base date is thus pre-determined at tender stage.

The contractor is reimbursed for increases in the prices of the materials and labour in the course of construction on the basic price list. Cost increases are evaluated on items provided in the basic price list only. Items not provided for in the list do not attract fluctuations even if those prices changes.

Ramus and Birchal (1997) asserted that traditional method is a partial fluctuation reimbursement, because the amount of increase recovered is much less than the total amount by which costs have really increased. The following are some of the difficulties associated with the traditional method;

2.7.3.1.1 Labour

There is great difficulty in defining labour cost: there have been doubts about whether the several ancillary costs of labour, qualify for reimbursement or not. Statutory increases and other labour cost increases are generally known throughout the industry, hence they are easily agreed. However, where a contractor pays higher rates of wages than the nationally negotiated, he cannot be reimbursed for any increase, even if on a pro-rata basis. This is the common situation in Ghana where most contractors pay higher wages than those negotiated and agreed with the Association of Building and Civil Engineering Contractors (ABCECG).

2.7.3.1.2 Materials

There is the difficulty of how to determine what ‘market price’ or ‘market increase’ is; as a result of different interpretations giving rise to different applications in practice.

To be allowable for recovery under the traditional computation method, all fluctuations must:

- Relate to materials listed on the contractor's basic price list
- Be due solely to changes in market prices. Claims due to buying in small quantities, buying from a source which offers less favorable discounts and buying a different though similar material.

It is clear from the foregoing that if a material is not listed it does not qualify for price fluctuation. In the Ghanaian, where the price of every material changes rapidly (PBCI, 2011) it is impossible to list all the materials in the basic price list.

2.7.3.1.3 Plant

Fluctuations in plant hire rates are not covered by the traditional method of computation. However the cost of plant in construction projects can be very high especially road construction projects where plant cost make up approximately fifty-five percent of the total cost.

The traditional method places the burden of proof on the contractor. This computation method also takes a great deal of staff time to prepare. This method is therefore inadequate to reimburse the contractor.

2.8 The formula method

The formula method was introduced in the United Kingdom in the 1970s as an alternative to the traditional method to fully reimburse the contractor for losses incurred due to price fluctuation. The method uses a set of formula rules which define a technical financial calculation, based on a wide variety of categories and published indices (usually monthly) by which each sum should be multiplied. The purpose of the formula method therefore is to reduce the amount of time spent by the project team in evaluating fluctuations and to overcome some of the disadvantages of the traditional methods.

Presently, three institutions produce construction indices for use in the England; these are the Department of Trade and Industry which produces the most extensive public sector tender price index (TPI), the Building Cost Information Services (BCIS), which are the building cost research arm of the Royal Institution of Chartered Surveyors (RICS) compiles building TPI and Davis Langdon (DL) - a quantity surveying practice which produces their own TPI.

The Bureau of Labour Statistics (BLS) compiles consumer price indices (CPI) for use by the construction industry. Engineering News Record (ENR) a weekly magazine that provides news, analysis data and opinion on the construction industry also publishes two monthly indices in the United States of America; the construction cost index and the building cost index with the difference between the two indices being the composition of their labour components. The labour component of the construction cost index is unskilled labour while that of the building cost index is skilled labour.

Three types of formula methods used in Ghana for adjusting construction contract price;

- the Local Price Adjustment Factor (LPAF) previously published by the CSIR-BRRI and currently by the Construction Industry Efficiency Improvement Group of Ghana (CIECG-G),
- the Construction Price Adjustment Formula published by Ministry of Roads and Transport for use in road contracts.

- the Prime Building Cost Index (PBCI) published by the Ghana Statistical Service used basically for building works

2.8.1 Local price adjustment formula (LPAF)

This method was developed by Amoa-Mensah formerly of CSIR-BRRI as a response to the need for a local price adjustment formula that can use readily available local data.

A comprehensive analysis of resources of input component of bills of quantities items was undertaken. In the process, an evaluation of the cost constituents of each bill item showed that its unit rate is essentially made of some or all of the following;

i. foreign exchange component (F)
ii. local raw material component (M)
iii. local labour component (L)
iv. fuel component (P)

Amoa-Mensah, 1996, developed a relationship between a works-item-unit- rate and the four component cost parameters (FMLP) as follows:

$$\boldsymbol{U = F + M + L + P}$$

Where *U* represents bill item unit rate

F represents foreign exchange components of all inputs

M represents local raw material inputs

L represents local labour inputs

P represents fuel input

From the above equation it was deduced that a price change in the bill item will result from price changes in the units of each component and can be represented as:

$$Ut = F\left(\frac{Ft - Fo}{Fo}\right) + M\left(\frac{Mt - Mo}{Mo}\right) + L\left(\frac{Lt - Lo}{Lo}\right) + P(\frac{Pt - Po}{Po})$$

Where U_a represents price adjustment for the unit rate at time *t* (reference period)

F_t represents foreign exchange rate at time *t*,

F_o represents foreign exchange rate at the base period, etc.

Clearly this is a Laspeyres type formula as the increases are weighted by the base units.

Next, a unit of each input component was determined such that it allows for general application on operating factors that influence local construction cost. The units determined have readily accessible trend cost data and future trends costs can also be readily generated. The resulting units are shown in Table 2.1 below.

Table 2.1: Component cost parameter and selected unit.

Item	Component cost	Selected unit	Base reference
A	Foreign exchange (F)	1US$-Gh₵ The Gh₵ equivalent of 1US$	The US$: Gh₵ exchange rate
B	Local raw material (M)	Price of 1 trip of $5m^3$ sand ex-pit i.e no transportation, no added value	
C	Local labour (L)	Carpenter input	All-in-daily rate for a carpenter
D	Fuel (P)	Fuel consumption	Cost of 1 gallon of petrol

Sample bill item unit rates were analyzed to determine the percentage contribution of each of the component cost (FLMP). The bill items were then grouped into construction works categories for meaningful application.

Cost trend data was assembled using component unit cost contribution to the bill item unit rate as shown in table 2.3. Base reference index was constructed such that changes in each component's unit price can be expressed as a factor, *R* of the basic unit price at the time of bidding.

The factor R is then multiplied by the pre-determined percentage contribution *r* as set out in table 2.2 for the component in the work category to obtain its contribution factor to works-category-price change relative to its bid unit rate. The sum of all component units constitutes the net price change factor.

Table 2.2 component unit trend cost for the period 1987-1995

Year	Component unit cost			
	Foreign exchange 1US$-Gh₵ (F)	1 trip of Sand $5m^3$ ex-pit (M)	All-in daily rate for carpenter (L)	Fuel cost 1 gallon of petrol ex-pump (P)
1	2	3	4	5
1995	1187	3000	4000	2400
1994	1000	1800	3500	1900
1993	790	1400	2800	1600
1992	450	800	1800	1000
1991	370	500	1400	900
1990	330	400	1200	750
1989	270	350	900	600
1988	200	300	600	
1987	160	200	400	

Source: Amoa-Mensah, 1996

2.8.2 Price adjustment formula using schedule of rates

This method entails the selection of a representative sample of construction projects either taking place, or completed, in a given geographical area. The cost of each works item (derived from drawings, specifications, etc) is priced as at the base reference date.

By aggregating the prices of all components, a theoretical average price of the entire construction is obtained as though it had been undertaken at the base reference date. The general weighting is obtained from statistics on the current construction. A price index is then obtained by calculating the ratio of the current actual price of the sampled construction to the recalculated price at the base period. (Sources and Methods Construction Price Indices, 1996, p.19). This method is widely used in the United Kingdom for producing the tender price indices.

For example the Department of Trade and Industry (DTI) compiles their public non-housing Tender Price Index (TPI) using information from priced bills of quantities (BQ) produced in a quarter. The bills of quantities provide a rich collection of information about prices and the quantities of various elements of the measured works of building projects at the reference period.

To construct a price index, the prices at the base period as well as the reference are used period if required. The DTI uses the former Property Services Agency (PSA) schedule of rates for building works as the main source of the base prices. The bills of quantities is re-priced using the rates in the PSA schedule of rates, supplemented by some BQ rates collected at the base year.

From each work section of the project, items are re-priced in a descending order of value until the re-priced items are more than 25% of the value of the work section and all items with values greater than 1% of the measured work total are re-priced.

The following trades are usually re-priced

- excavation and earthworks

- in situ concrete and sundries
- membranes
- reinforcement
- formwork
- precast concrete
- brickwork/blockwork
- asphalt
- slate and tile roofing
- sheet metal roofing and flashings
- decking
- corrugated and troughed roofing
- felt roofing
- woodwork carcassing
- woodwork 1st and 2nd and composite items
- insulation
- structural steelwork
- metal windows

- metalwork and other windows
- plumbing
- wet finishes
- dry finishes
- glazing
- painting and decorating
- drainage
- roads and pavings

The sum of all items re-priced at the schedule of rates is divided by the sum of the corresponding values at the bill rates, with the adjustments on measured work in the BQ amortised to obtain a Schedule Factor.

Schedule Factor = *sum of the selected items being re-priced at the schedule of rates*

Sum of the selected items at the bill rate + amortised adjustments on measured works

The adjustments on measured works are the adjustments made on the main summary of the BQs such as head office overheads, correction of arithmetic errors, and commercial discounts. These adjustment are amortised to the selected items pro rata to their values/

With the Schedule Factor, the project index is computed by the formula:

<u>Contract sum less dayworks and contingencies</u>

Contract sum less preliminaries, dayworks and contingencies x schedule factor

The reason for deducting the preliminaries from the contract sum in the denominator is that rates in the schedule factor include amortised preliminaries. Since location and function of the building are believed to be the main cost driver, and the DTI wish to reflect the general building price over time independent of the changes in these factors, each project index number is adjusted for these factors. The published indices is the median value of these project index numbers in a quarter and is smoothed by three quarter moving averages. (Yu & Ive, 2006)

2.8.3 Prime Building Costs Index (PBCI)

The Prime Building Costs Index (PBCI) is published by the Ghana Statistical Service and is a weighted average of selected construction materials and labour. Materials included are cement, sand, roof material, steel material, stone, timber and miscellaneous materials. Skilled and unskilled labour is also included. This method however does not cater for labour productivity, the manner in which the various materials are combined and hence does not adequately capture the real movement of construction costs.

The price adjustment factor is evaluated using the following formula;

$$\mathbf{P_c = A_c + B_c\,(I_{mc}/I_{oc})}$$

$\mathbf{P_c}$ is the adjustment factor, $\mathbf{A_c}$ and $\mathbf{B_c}$ are coefficients specified in the contract data section of the contract documents representing the adjustable and non-adjustable portions respectively of the contract price in specific currency 'c'. $\mathbf{I_{mc}}$ is the index prevailing at the end of the month being invoiced and $\mathbf{I_{oc}}$ **is** the index prevailing 28 days before tender opening for the inputs payable in the specific currency ‘c’.

If the value of the index is changed after it has been used in a calculation, the calculation shall be corrected and an adjustment made in the next payment certificate. The index value shall be deemed to take account of all changes in cost due to fluctuations in costs (PPA, 2003).

2.9 Construction Input Resource Price Collection

The procedures implemented in this phase of the indices compilation have a major impact on the accuracy of the indices produced (OECD, 1996). However a balance have to be obtained between producing an indices which will adequately measure changes in prices at minimum administrative cost and one which will measure the indices more accurately at prohibitive administration expense.

In principle, it would be desirable to select both outlets (suppliers of products) and the input resources using random sampling with known probabilities of selection. This ensures that the sample of items selected is not distorted by subjective factors and enables sampling errors to be calculated. The researcher employed purposive selection for selection of suppliers for the input resources identified and products, because random sampling may be too difficult and too costly. Purposive selection is believed to be more cost-effective, especially when the sampling frames available are not comprehensive and not well suited to CPI purposes [www.ilo.org/public/English/bureau/stat/download/cpi/chapter1.pdf].

It may also be cost-effective to collect a "cluster" of prices on different input resources from the same outlet, instead of distributing the price collection more thinly over a larger number of outlets.

2.10 Estimating

Estimating is the process of pricing work based on the information/specification and or drawings available in the preparation of submitting an offer for carrying out work for a specified sum of money. This specified sum is known as the Tender Sum (Buchanan et al, 2003).

In the traditional three-stage tendering process, tender documents are usually prepared by the client's representative or project management firm. This document contains the Bills of quantities which are prepared in accordance with a standard set of measurement rules. The Ghana Institution of Surveyors (GhIS) currently requires all members to prepare BQ in accordance with the 7th Edition of Standard Method of Measurement (SMM 7).

2.10.1 Information required for preparation of an estimate

The CIOB's Code of Estimation Practice (COEP) 6th Edition provides a list of information necessary for preparation of an estimate. These are;

- Drawings
- Specifications (including performance specifications if required)
- Schedules
- Technical reports

- Program work period for major nominated sub-contractors
- Bills of quantities

2.10.2 Analytical estimating

Analytical estimating is the process of determining unit rates by examining individual input resources and the amounts needed for each input of work (Brock, 2004). The COEP further provides four stages for producing analytical estimates;

i) Establish all-n rates for individual resources in terms of rate per hour for labour, rate per hour for plant and cost per unit for materials delivered and unloaded at the site.
ii) Select methods and outputs to calculate net unit rates to set against items in the bills of quantities (BQ)
iii) Add to the net cost project overheads, contingencies, inflation and risk
iv) Summarize resources and prepare reports for management.

2.11 The Unit Rate

The unit rate is an important element because it forms the basis of arriving at the total tender figure. A construction company's long term survival is based on the firm's ability to provide competitive rates. The unit rate is also the basis of evaluating variations during construction. Usually the unit rates cannot be changed once the tender is accepted but there are some instances where changes can be made. Sometimes the tendering conditions may require that the best evaluated tenderer be subjected to final negotiations to determine contract price. In this case the initial unit rate as submitted by the firm will be subject to some changes based on the outcome of the negotiation.

2.11.1 Composition of the unit rate

Brock, 2004 reports that the unit rate is usually composed of rates for materials, labour, and sub-contractors if applicable. Only direct cost is included because management will develop a better understanding of the pricing levels if on-costs are dealt with separately.

Buchanan et al, 2003 describes the components as;

2.11.2 Labour

The time taken for an operative or gang to complete an item of work is obtained from labour constants generated by the firm or from published sources. This is normally expressed as an output of work per hour or per day in some cases. By totaling these and multiplying by cost of labour per hour the labour costs associated with an item of work is obtained.

2.11.3 Plant

Generally plant is priced on the same basis as labour as if the plant is used for a specific task. For example an excavator digging a trench will be priced on the basis of the amount of work it can do in an hour. Static plant, such as scaffolding, site hutting or tower crane, which cannot be associated with one item of work is priced on the basis of the time that it is required on site.

2.11.4 Materials

The price of material is based on its purchase price, and includes allowance for delivery to site, off-loading, storage and placing in position. In addition, allowances may have to be made for the handling and breakages, site and storage losses.

2.11.5 Overheads and profit

Once the estimator completes the estimates and the BQ is priced, a report is submitted to management. The estimator's report must detail the full breakdown of costs for management. Sometimes the estimator may suggest allowances for inclusion for overheads and profits but usually management decides the final percentages to be included. Management will arrive at allowances for overhead and profit by considering among other factors, the following;

- General/specific conditions of contract
- Project location
- The type of client and payment conditions
- The level of competition
- The prevailing economic conditions
- Tender validity period
- Competitors pricing trends

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the various research methods employed in finding answers to the research question. The methods selected in this study were designed based on the nature of research questions being answered by each objective. Various methods of data collection were adopted that included the use of questionnaire, BQ content analysis and collection of prices of construction input resources.

The research was carried out using BQ from the Ghana Education Trust Fund (GETFund) secretariat. This is because GETFund, being the major financier of public sector educational infrastructure in Ghana employs contractors (indirectly through tertiary, secondary and basic educational institutions as well as the metropolitan, municipal and district assemblies) from all financial classes of contractors in Ghana. It also indirectly employs the services of consultants, mainly quantity surveying firms for design and supervision of its infrastructural projects. It also has a collection of contract documents for the various projects. Consultants included both private and public companies.

3.2 Identifying problems with usage of existing indices

The population of interest to the research was;

i. All D1K1 building contractors. However because an updated list of construction firms by the Ministry of Water Resources Works and Housing was not available at the time of the study, the researcher used a list of paid-up members of Association of Building and Civil Engineering Contractors of Ghana (ABCECG). The ABCECG is umbrella body for both building and road construction firms in Ghana and is responsible for their day-to-day activities. The list consisted of 57 registered and operational D1K1 contractors out of which 41 were randomly selected from the Ashanti and Greater Accra Regions. The researcher focused on these two regions because the ABCCG list indicated that about 55% of the building contractors are located in the Ashanti and Greater Regions. Time and financial constraints also limited the researcher from taking data from contractors in the other regions. 27 of the questionnaires were returned. These two regions also have the two largest cities of Ghana and hence have the most active contractor base.

ii. Registered quantity surveying firms as obtained from the Ghana Institution of Surveyors (GhIS) secretariat. The list consisted of 44 registered firms out of which 39, representing 88% were based in the Greater Regions. The researcher therefore selected the 39 Greater Accra based firms for the study, and conducted a census on them. 26 of the questionnaires were returned

Separate questionnaires were designed for the consultants and contractors. The questionnaire was designed into two main parts. The first part dealt with the demographics of the respondents with respect to their background and working experience in the construction industry. The second part of the questionnaire provided respondents with the opportunity to indicate their perception of the problems with the usage of construction cost indices. The majority of the questionnaires were self-administered. Some were also sent via email.

Table 3.1 Questionnaire Response Rate

Type of Respondent	No. of questionnaire sent	No. returned	No. responsive	Percentage responsive (%)
Consultants	39	26	26	67
Contractors	41	27	25	61
Total	**80**	**53**	**51**	**64**

SOURCE: Field data, 2012

3.2.1 Data Analysis tools

The data gathered was analyzed using SPSS statistical package and Microsoft Excel software. Frequency analysis was used to represent results of the data collected. Relative importance index (RII) was also used for some of the questions. These methods have been previously used by Jimoh (2012) and Asare (2011) in similar research works.

The ratings of identified factors made by respondents against the five-point scale were combined and converted to deduce the Relative importance indices RA_x (Tam et al, 2000) of the various factors as follows:

$$RA_x = \frac{\Sigma r}{A \times N}$$

Where Σr = summation of the weightings given to each factor.

A = highest rating and N= Total number of respondents for that factor.

Example for the problem 'late release of data';

Weight = 1(1) + 2(2) + 3(4) + 4(3) + 5(16) = 109

$$\text{Relative Importance index} = \frac{109}{5(1 + 2 + 4 + 3 + 16)} = 0.838$$

The factor with the highest relative importance index was then ranked as 1, and then followed by two as the next higher rank and so on. See Table 4.2 for details

3.3 Identification of works items for inclusion

3.3.1 Modal items

In an attempt to develop a basket of goods (BOG) for inclusion in the indices development, modal work items were identified. The modal item as used in this research is defined as those works items occurring in more than 50% of the bills of quantities analyzed.

BQs were available at the GETFund secretariat. These are copies of contract documents for various educational infrastructure deposited at the secretariat by 16 different consultants. The BQs covered contracts for educational works awarded between year 2007 and 2012. The BQs had tender values ranging between GH¢100,000 and GH¢ 7m. The BQs analyzed were for new building works only. This is because the new buildings bills include a wide range of works items.

3.3.2 Process of determining modal work items

The two methods identified from the literature survey for selecting items for inclusion are: the ‘plutocratic’ and the ‘democratic’ methods. The researcher used the ‘democratic’ method (An item is a candidate for inclusion in the basket if the proportion of households purchasing it exceeds a certain percentage). This method was chosen because the structure of BQ enabled all items to be enumerated and those occurring frequently could be easily identified.

Preliminary analysis of the 114 BQs available the secretariat revealed that 82 out of the 114 BQs were for a special GETFund project; Schools under Trees (SUT). This implied that only 32 are different BQs. One SUT BQ was therefore added to the 32 other bills making a total of 33 BQs for analysis. As SUT BQ is a repetitive BQ for 6-Unit Classroom Block, using all of for analysis will not give a true picture of construction activities undertaken.

Table 3.3 shows the details of contract documents whose BQ content was analyzed. The table reveals that BQ analyzed were for projects executed in all regions in Ghana. GETFund did not permit the researcher to include the contract sums in the report as they are confidential documents and some of the projects were still on-going.

The 33 selected were analyzed, a score of zero (0) and one (1) was given if a work item is absent and present in the BQ respectively. The frequency of occurrence of the work items were tallied and a percentage calculated by dividing frequency by the total number of BQs =33.

Table 3.2 shows extract of the details of an Excel Spreadsheet created for the analysis.

ITEM	Table 3.2. raw scores for 33 BQ content analysis		WORK ITEM SCORE (1=PRESENT, 0=ABSENT)																																	
	BQ WORK ITEM DESCRIPTION		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	total	percentage
1.0	**Site preparation**																																				
a	removal of trees		1	1	0	0	1	1	1	1	0	1	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	20	61%
b	clearing site vegetation		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	33	100 %
2.0	**Excavation & earthworks**																																				
a	topsoil preservation		0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6%
b	pit		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	33	100 %
c	trench		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	33	100 %
d	reduced level		1	1	0	0	1	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	21%
e	removal of surplus		1	1	1	0	1	1	1	1	1	0	1	0	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	21	64%
f	breaking existing hard material		0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	12	36%
g	filling to excavations (backfill)		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	33	100 %
h	filling to make up levels (hardcore)		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	33	100 %
j	termite treatment(aldex 40)		0	0	0	0	0	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25	76%
3.0	**In situ concrete**																																				
3.1	concrete		1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	32	97%
a		1:1.5:3	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6%
b		1:2:4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	33	100 %
c		1:3:6	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	21	64%
d		1:4:8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	33	100 %
3.2	formwork		1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	32	97%
a		sides and soffit	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	33	100 %
b		edges	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	33	100 %
3.3	reinforcement																																				
a		6mm	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3%
b		8mm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%
c		10mm	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	23	70%
d		12mm	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	32	97%
e		16mm	1	1	1	0	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	30	91%
f		20mm	0	1	1	0	0	0	1	0	1	0	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25	76%
g		25mm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0%

LEGEND: 1= PRESENT, 0 = ABSENT SOURCE: Researchers field data,

3.4 Formulation of indices

Standard output rates for building construction works was used to build-up unit rates for the identified works items. These material and plant utilization capacities and average labor output rates were obtained from the outcome of construction data collection and analysis conducted at the CSIR-BRRI and AESL. Average mark-ups for profits and overheads were solicited from questionnaires to the contractors.

3.4.1 Construction input resource price collection

The procedures implemented in this phase of the indices compilation have a major impact on the accuracy of the indices produced (OECD, 1996). However a balance has to be obtained between producing an index which will adequately measure changes in prices at minimum administrative cost and one which will measure the indices more accurately at an uneconomical cost which cannot be sustained over time.

In principle, it would be desirable to select both outlets (suppliers of products) and the input resources using random sampling with known probabilities of selection. This ensures that the sample of items selected is not distorted by subjective factors and enables sampling errors to be calculated. The researcher nevertheless used purposive selection of suppliers for the input resources identified and products, because random sampling may be too difficult and too costly. The difficulty with random sampling method is that sampling frames available are not comprehensive enough and also a more than proportionate large number of outlets have to be sampled which comes at a cost.

Purposive selection is believed to be more cost-effective, especially when the sampling frames available are not comprehensive and not well suited to Consumer Price Indices (CPI) purposes (ILO, 2003). It may also be cost-effective to collect a "cluster" of prices on different input resources from major distributors of the resources, instead of distributing the price collection more thinly over a larger number of outlets. Again it is difficult to empirically identify major distributors of construction input resources.

3.4.1.1 Construction Input Resources

The researcher relied on a list of suppliers of construction input resources based in Accra which is published in the Ghana Institution of Surveyors (GhIS) Quantity Survey Division quarterly magazine. The data needed for computation of the indices are collected every month from 35 identified outlets in the Greater Accra Region. See Table 3.3 for details. Prices for labour were obtained from Ghana Trade Unions Congress (TUC) Collective Bargaining Agreement. A database of input resources was thus developed using Microsoft Excel. This is attached as Appendix 2.

3.4.1.2 Mark-ups

Average mark-ups used by contractors were solicited and incorporated into the unit rate build-up. These were solicited through the questionnaire survey from D1K1 contractors. Although only about 60% of respondents supplied the information, it served as a general guide to the levels of mark-ups used in the industry.

3.4.2 Unit rate build-up

Data obtained above was used to generate unit rates for the selected works items identified above. The unit rate build-up was done using Microsoft Excel and linked to the resource prices database. This enabled the unit rates to be automatically updated when resource prices are changed. New sets of unit rates are generated each time the resource price database is updated.

Details of a typical unit rate build-up for concreteworks is attached as Appendix 3

3.4.3 Generating the indices

The month of December 2011 was selected as the base month. This choice was made for convenience because the researcher commenced collection of prices in October 2011 and full prices were collected in December 2011. Subsequent indices will be related to the indices for the base month. This month was assigned the value 1. Unit rates for subsequent months are thus divided by the corresponding unit rate for the base month to obtain the reference month indices.

3.5 Analyzing the resulting indices

The indices developed from this research which is called New CSIR Indices (NCI) was compared with existing indices: the Prime Building Cost Indices (PBCI) published by the Ghana Statistical Service and widely used for government funded projects, especially GETFund, and that published by the Construction Industry Efficiency Improvement Group-Ghana (CIEIG-GH). There was however insufficient data for PBCI did not allow a meaningful comparison at the time of writing this report.

The two-sample t-test was also carried out to compare monthly mean indices for NCI and CIEIG-GH indices.

The monthly mean indices for the New CSIR Indices (NCI) were obtained by averaging the monthly indices of all the works items.

Cost recovery using NCI, CIEIG-GH and the traditional methods of evaluating fluctuations was also performed. In order to facilitate the traditional method of evaluating fluctuations, material schedule for a typical GETFund designed 6-Unit Classroom Block was extracted. Typical basic price list submitted to GETFund by contractors was used for the purpose of evaluating fluctuations by the traditional method.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF RESULTS

4.1 Introduction

The aim of this study is to develop construction cost indices using unit rates. In order to achieve the purpose of study, a methodology consisting of a review of literature and a survey difficulties faced by practitioners in using existing construction cost indices and the development of the cost indices for the Ghanaian construction industry. This chapter therefore presents the questionnaire survey results, modal and cost significant work items identified, analyses of the results and findings of the study.

4.2 Response Rate and Characteristics of Respondents

Questionnaires were sent to 80 respondents, consisting of consultants and contractors out of which 51 responses were received resulting in a response rate of 64%. The responses were further analysed to determine the profile of respondents, problems associated with the application of construction cost indices from the perspective of the contractors and consultants.

4.2.1 Characteristics of Respondents

An overwhelming majority (80%) of the respondents had more than 5 years of experience in the construction industry. It was necessary to find out the working experience of the respondents so as to be able to obtain practical and convincing answers to the questions asked (Refer to Fig. 4.1). All respondents have completed at least one project subject to price fluctuation within the last 5 years. In summary, the demographic variables show that the respondents were experienced in the construction industry and therefore are familiar with construction work and issues relating to use of construction cost indices.

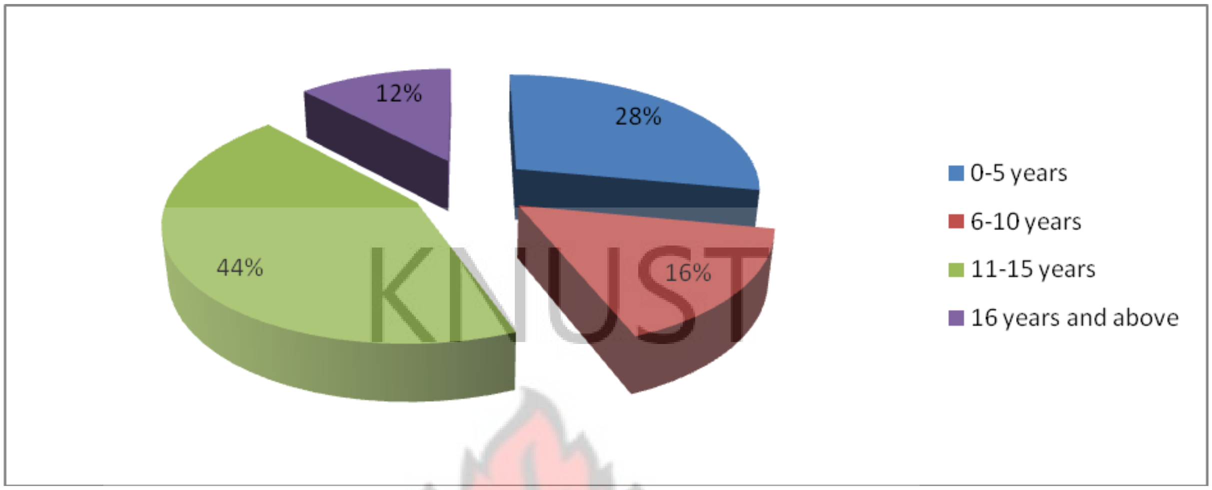

Fig. 4.1 Respondents years of experience in the construction industry

4.3. Computation method used for evaluating fluctuation

Consultants were asked to state which method they used in evaluating fluctuation on their most recently completed project. The Prime Building Cost Index (PBCI) as published by the Ghana Statistical Service (GSS), Local Price Adjustment Formula (LPAF) as previously published by the CSIR-BRRI and now by Construction Industry Efficiency Improvement Group-Ghana (CIEIG-GH), and the Traditional methods were selected by the respondents. The two former methods listed above are formula methods hence it can be deduced that 96% of respondents uses the formula method of evaluating fluctuations. However majority of the respondents, 73% used PBCI. Refer to Table 4.1 and figure 4.2 for details.

Table 4.1. Method of evaluating fluctuation (consultants)

COMPUTATION METHOD	FREQUENCY	PERCENTAGE (%)
PBCI	19	73.07
CIEIG-GH/BRRI	6	23.07
Traditional	1	3.86
Others	0	0
Total	26	100

Source: Field data, 2012

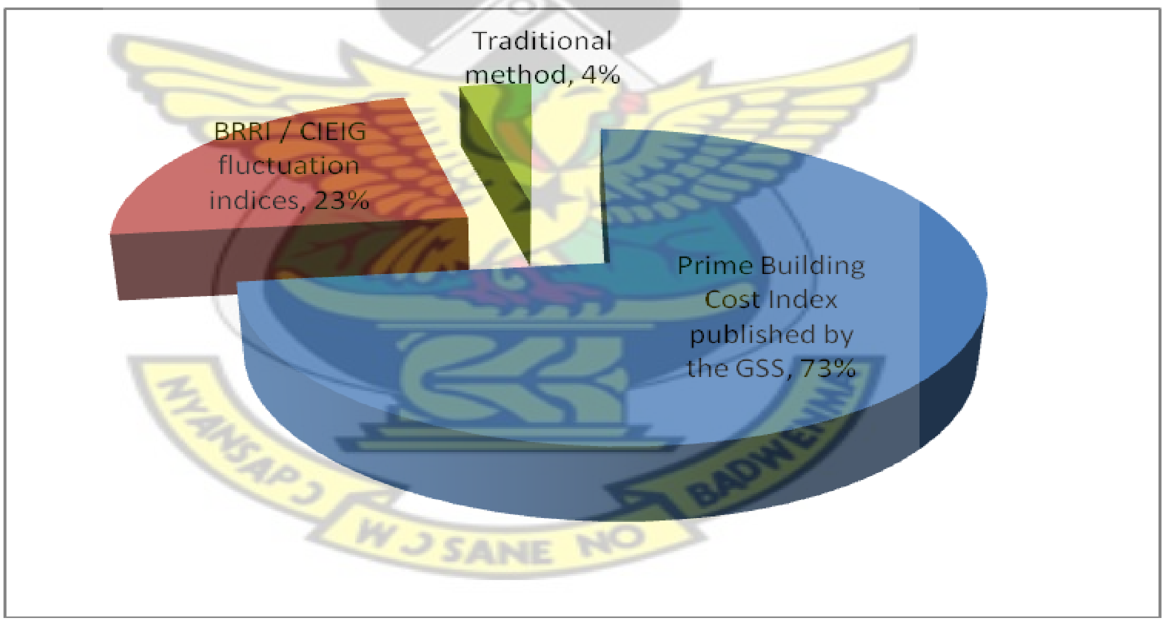

Figure 4.2 Choice of method for evaluating fluctuations

4.4 Factors influencing the choice of method for evaluating fluctuations

Consultants were asked to give reasons for choosing a particular evaluation method. 19% indicated they made the choice because it is available and easily accessible. 4% of respondents said they believe the chosen method gives better recovery of costs. The respondents were given the option of stating their reasons and 77% gave other reason like 'the client instructed them to choose a particular method'. All respondents who used the PBCI method indicated they were instructed by the client to do so. It is significant to note that only 4% of respondents used their preferred choice because they believe it gives better recovery. The GETFund by a circular to Consultants had instructed that PBCI method should be used for all its projects. No reasons were officially assigned for the choice of this method. Figure 4.3 shows the factors for the choice of methods chosen

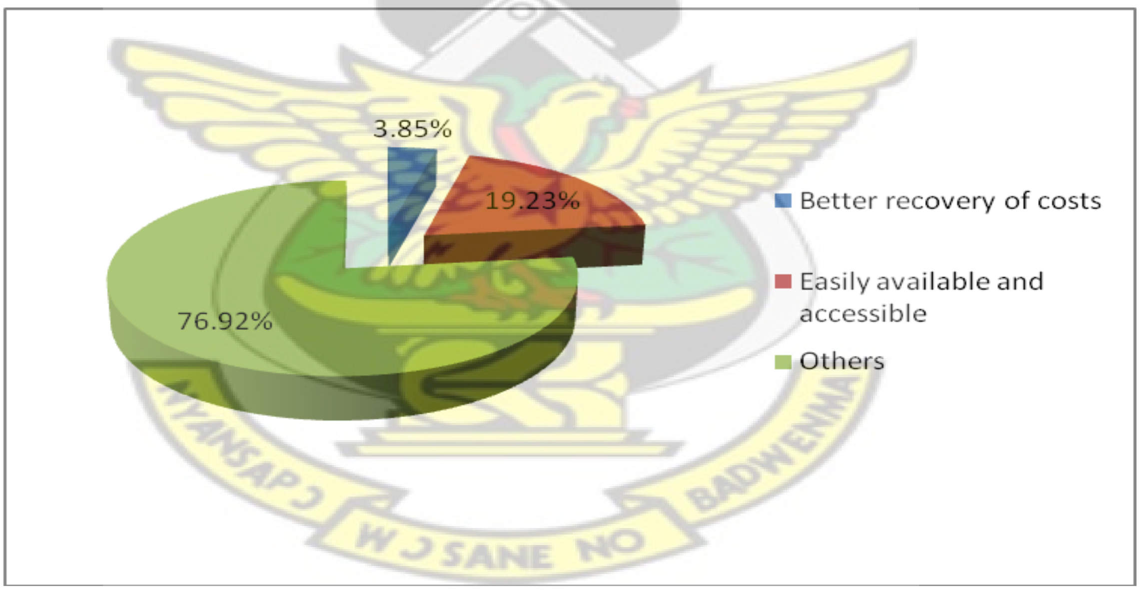

Fig. 4.3: Reason for choice of method Source : researcher's field data, 2012

4.5 Method of evaluating fluctuations (Contractors)

Figure 4.4 shows contractors response to the method used for evaluating fluctuations. The contractors surveyed were asked what method was used to evaluate fluctuation on their most recent payment certificate. 63% reported the use of PBCI, 25% indicated CIEIG-GH and 13% reported that the traditional method was used. This further confirms the prevalence of the use of the PBCI method (63%). Those respondents who used the CIEIG-GH method did not state wether it was for GETFund projects. It is also significant that 13% of respondents still used the traditonal method considering all the disadvantages associated with it.

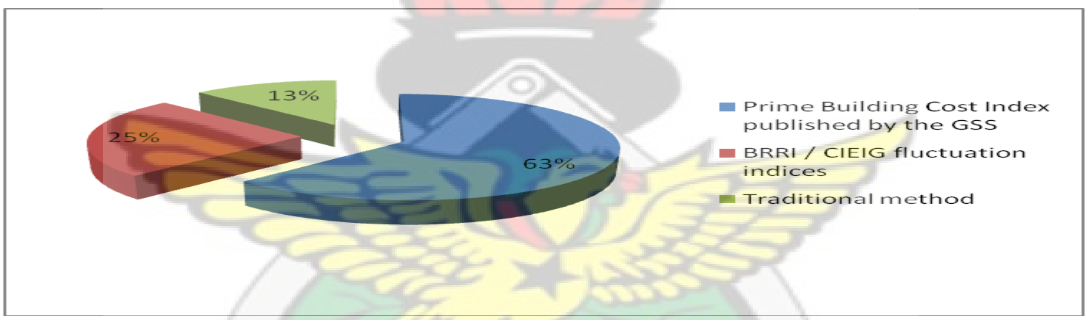

Figure 4.4. Method of evaluating fluctuations (contractors)

4.6 Problems associated with usage of existing construction cost indices (CCI)

Respondents were asked to rank problems associated with usage of existing indices on a scale of 1-5, a rank of 5 denoting an extremely frequent problem and 1 being not frequent. The survey revealed that the most frequent problem encountered in using PBCI method is late release of published data, followed by inadequate recovery of costs. This confirms the perception that use of PBCI leads to under-recovery. Refer to

Table 4.2 for details of rankings. The inadequate cost recovery is compounded by the late release of data. At the time of compiling this report (October 2012), the PBCI indices available were for March 2012. Practitioners preparing payment certificates for say, September 2012 therefore have to rely on outdated March 2012 indices, further resulting in low cost recovery.

Table 4.2 Problems encountered in application of existing indices

Item	Problems associated with usage of existing CCI	Rating					Weight	RA_x	Rank
		5	4	3	2	1			
A	Late release of data	16	3	4	2	1	109	0.838	1
B	Inadequate recovery of costs	4	10	9	2	1	92	0.708	2
C	Particular work item of interest not included in published indices	2	3	12	1	8	68	0.523	3
D	Components of a weighted sample	5	1	3	0	17	55	0.423	4
E	Non-familiarity with computation method	0	0	1	3	22	31	0.238	5
F	High subscription fees	0	0	1	1	24	29	0.223	6
G	Human error	0	0	1	1	24	29	0.223	6
H	Indices based on historical data	0	0	0	1	25	27	0.208	7
J	Obsolete methods and components	0	0	0	1	25	27	0.208	7

Source: Researcher's field survey, 2012

4.7 Contractors' satisfaction with level of cost recovery

Contractors were asked if they are satisfied with the level of costs recovered using the existing construction cost indices. 85% indicated they were not satisfied with the level of costs recovered and 15% reported they were satisfied (see Figure 4.5). This is not surprising because the construction cost indices (CCI) is a measure of average movement of construction prices irrespective of actual costs incurred. What worsens the amount of cost recovered is the late release of published data identified as the number one deficiency of the PBCI method. This forces practitioners to apply provisional indices with an average time lag of 6 months. The level of cost recovery could be increased if published data is released at about the time valuation is being done.

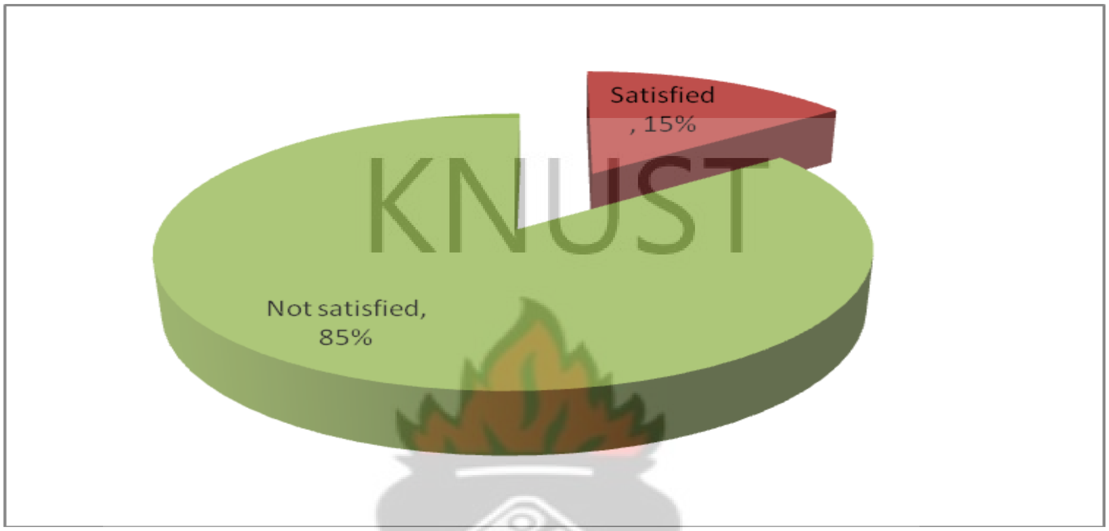

Fig.4.5 Contractors' satisfaction with level of cost recovered using existing indices

4.8 Identification of works for inclusion

This section presents results of analysis of BQ content. This was done to identify works items to be included in formulating the new indices. Tables 4.3 provide details of work items identified in the BQ content analysis for Groundwork and In situ concrete work sections respectively. This analysis was carried out for all the work sections. Analysis for other work sections is presented as appendix 4.

Table 4.3: Frequency of occurrence of identified work items in Bills of Quantities: (Groundwork & In situ concrete)

	Identified work items	Freq (n)	Percentage (%) = [n x 100%]/ 33
D: Groundwork	Removal of trees	20	61
	Clearing site vegetation	33	100
	Topsoil preservation	2	6
	Pit excavation	33	100
	Trench excavation	33	100
	Reduce level excavation	7	21
	Removal of surplus excavated materials	21	64
	Breaking existing hard material	12	36
	Filling to excavations (backfill)	33	100
	Filling to make-up levels	33	100
	Termite treatment	14	42
E: In situ concrete Large precast concrete	Reinforced in situ concrete, 1:1.5:3	2	6
	Reinforced ditto 1:2:4	33	100
	Plain in situ ditto, 1:3:6	21	64
	Ditto, 1:4:8	33	100
	formwork to sides and soffits,	33	100
	Ditto, to edges	33	100
	20mm diameter mild steel reinforcement bars	25	76
	16mm ditto	30	91
	12mm ditto	32	97
	10mm ditto	23	70
	6mm ditto	1	3

Source: Researcher's Field data 2012

Analysis for electricals and plumbing was carried out for 9 out of the 33 BQ because 24 BQ had provisional sums for the electricals and plumbing sections. This confirmed an earlier study by Nani, 2007 that items for electrical and plumbing are usually not fully measured by quantity surveyors in Ghana. Data collected for these two sections were therefore not considered as representative. The researcher however included these items as a general indicator of their respective measurements.

4.8.1 Selection of modal items

The modal work item is defined as those work items which occur in more than 50% of BQ analysed (see Table 3.2). 132 work items were enumerated out of which 64 occurred in more than 50% of BQ and were thus selected as the modal work items. (See appendix 5 for details of all work items enumerated. The 64 modal work items were grouped into their respective work sections as follows:

D: Groundwork

1. Removal of trees
2. Clearing site vegetation
3. Pit excavation
4. Trench excavation
5. Removal of surplus excavation
6. Filling to excavations
7. Filling to make up levels

E: In situ concrete

8. Reinforced in situ concrete 1:2:4
9. Plain in situ ditto 1:3:6
10. Ditto, 1:4:8
11. Sawn hardwood formwork to sides and soffits, etc
12. Ditto, to edges of slabs, etc
13. 20mm diameter mild steel reinforcement rods
14. 16mm ditto
15. 12mm ditto
16. 10mm ditto

F: Masonry

17. 150mm solid sandcrete blockwork

G: Structural/carcassing metal/timber

18. Sawn hardwood, 50 x 150mm
19. Ditto, 50 x 100mm
20. Ditto, 50 x 50mm
21. Wrought hardwood fascia board, 25 x 300mm

H: Cladding/covering

22. Aluminium roofing sheets

K: Lining/sheathing/dry partitions

23. Plywood ceiling

L: Windows/doors/stairs

24. Insect-proof netting

25. Door and window battens

26. Window frame

27. Louvre frames

28. Louvre carriers

29. Welded metal bars

30. Door frame 50 x 150mm

31. Solid panel hardwood doors

M: Surface finishes

32. Screed

33. Render

34. Tiling

35. Emulsion paint

36. Oil paint

N: Furniture and equipment

37. Kitchen sink

38. Water closet

39. Wash hand basin

P: Building fabric sundries

40. Mortice lock

41. Hinges, 75mm long

R/U/V/W/Y: Mechanical and electrical services, etc

42. 13mm diameter conduit pipes

43. 6mm2 diameter cables

44. 2.5mm2 ditto

45. 1.5mm2 ditto

46. 13A switch socket outlet

47. Ceiling rose

48. Lamp-holder

49. Consumer unit

50. 75mm diameter circular pvc

51. 75 x 75mm galvanized square

52. 75 x 150mm ditto

53. 1 gang 1 way switch

54. 2 gang 1 way ditto

55. 3 gang 1 way

56. Ceiling fan

57. Energy saver bulbs

58. 13mm diameter pvc pipe

59. 19mm diameter ditto

60. 50mm diameter ditto

61. 100mm diameter ‘class O’

62. Pipes, valves, stop cocks

63. Towel holder

64. Toilet roll holder

Further analysis of the 64 items revealed similarities in some of the measured items, for example pit excavation and trench excavation, in situ concrete 1:2:4, 1:3:6, 1:4:8. In this case, most frequently occurring work item was chosen as the representative work item.

The number of work items was thus further reduced using the above criteria and the final modal work items list is as presented below;

D: Groundwork

1. Clearing site vegetation
2. Trench excavation
3. Filling to excavations

4. Filling to make up levels

E: In situ concrete

5. Reinforced in situ concrete 1:2:4
6. Sawn hardwood formwork to sides and soffits, etc
7. 12mm mild steel reinforcement bars

F: Masonry

8. 150mm solid sandcrete blockwork

G: Structural/carcassing metal/timber

9. Sawn hardwood, 50 x 150mm

H: Cladding/covering

10. Aluminium roofing sheets

K: Lining/sheathing/dry partitions

11. Plywood ceiling

L: Windows/doors/stairs

12. Louvre carriers
13. Welded metal bars
14. Door frame 50 x 150mm
15. Solid panel hardwood doors

M: Surface finishes

16. Render

17. Tiling

18. Emulsion paint

19. Oil paint

N: Furniture and equipment

20. Kitchen sink

21. Water closet

P: Building fabric sundries

22. Mortice lock

R/U/V/W/Y: Mechanical and electrical services, etc

23. 1.5mm^2 cable

24. 13A switch socket outlet

25. Consumer unit

26. Ceiling fan

27. 13mm diameter pvc pipe

28. Pipes, valves, stop cocks

4.8.2 Preliminaries and general conditions

Only 19 out of the 33 BQ analysed had the preliminaries and general conditions sections fully measured. The following items were identified from the preliminaries sections as having occurred in more than 50% of the BQs analysed and were thus selected as the modal items for the preliminaries section

- Provision of sign/name board
- Setting out works
- Water for the works
- Insurance (Contractor-All-Risk)
- Watching and protecting
- Foreman/supervisor

4.9 Unit rate build-up and formulation of indices

Unit rates were built-up for the representative work items using Microsoft excel software and linked up with the construction input resource prices. This enabled data to be updated when prices are collected. See Appendix **3** for details.

Tables 4.4 and 4.5 show summaries of rate build-up for $10m^3$ of reinforced in situ concrete: 1:2:4 (June 2012 and December 2011). The unit rate for December 2011 is the base unit rate for indexing in situ concrete. To obtain index for June 2012, its unit rate will be divided by that of December 2011.

$$\text{Index for June 2012 denoted by } I_c = \frac{\text{Unit rate for June 2012}}{\text{Unit rate for December 2011}}$$

$$\frac{366.48}{276.26} = 1.327$$

Table 4.4: June 2012 unit rate build-up for reinforced in situ concrete 1:2:4 ($10m^3$)

Description	Quantity	Unit	Price(GH₵)	Amount (GH₵)
materials				
cement	62.08	bags	20	1,241.61
sand	4.22	m3	45	189.81
chippings	8.44	m3	82.05	692.18
materials subtotal				**2,123.61**
plant				
300/200 concrete mixer	1.39	days	60	83.33
diesel	1.39	gallon	7.67	10.65
poker vibrator	1	days	20	20.00
plant sub-total				**113.99**
labour				
Total labour cost				**646.92**
Total prime cost				2,884.51
Add: over heads	10%			288.45
				3,172.96
Add: Profit	10%			317.30
				3,490.26
Add: Tax	5%			174.51
TOTAL COST FOR $10m^3$				3,664.77
COST PER m^3				**366.48**

Source: Field data, 2012

Table 4.5: December 2011 unit rate build-up for reinforced in situ concrete 1:2:4

Description	Quantity	Unit	Price (GH₵)	Amount (GH₵)
cement	62.08	bags	14	869.13
sand	4.22	m3	37.5	158.18
chippings	8.44	m3	65.19	549.95
materials subtotal				**1,577.26**
plant				
300/200 concrete mixer	1.39	days	60	83.33
diesel	1.39	gallon	6.13	8.51
poker vibrator	1	days	20	20.00
plant sub-total				**111.85**
labour				
concrete gang				**485.34**
Total prime cost				**2,174.44**
Add: over heads	10%			217.44
				2,391.88
Add: Profit	10%			239.19
				2,631.07
Add: Tax	5%			131.55
TOTAL COST FOR 10m^3				2,762.62
COST PER m^3				**276.26**

Source: Field data, 2012

Table 4.6: Extract from the construction cost indices developed.

Construction Work Category	Dec	Jan	Feb	Mar	Apr	May	June
Preliminaries	1.000	1.040	1.078	1.094	1.094	1.184	1.211
Site Clearance							
Manual	1.000	1.237	1.237	1.237	1.237	1.237	1.237
Machine	1.000	1.058	1.058	1.058	1.058	1.083	1.083
Earthworks							
Manual excavation	1.000	1.237	1.237	1.237	1.237	1.237	1.237
Machine	1.000	1.058	1.058	1.058	1.058	1.083	1.083
Filling and Compacting							
Manual	1.000	1.051	1.051	1.051	1.051	0.000	1.073
Machine	1.000	1.058	1.058	1.058	1.058	1.086	1.086
Concrete Work							
Using crushed agg.	1.000	1.146	1.204	1.211	1.211	1.382	1.327
Reinforcement	1.000	1.050	1.050	1.050	1.050	1.050	1.050
Formwork	1.000	1.121	1.121	1.121	1.121	1.121	1.121
Brickwork/Blockwork							
Brickwork	1.000	1.034	1.044	1.044	1.044	1.273	1.259
Blockwork	1.000	1.139	1.184	1.184	1.184	1.321	1.252
Woodwork							
Carcassing-roof str. etc.	1.000	1.140	1.289	1.289	1.289	1.289	1.306
Joinery-frame	1.000	1.149	1.283	1.283	1.283	1.283	1.283
Doors & fittings	1.000	1.293	1.293	1.293	1.293	1.293	1.293
Ironmongery	1.000	1.027	1.027	1.027	1.027	1.027	1.027
Metalwork							
Louvre Carriers	1.000	1.016	1.016	1.016	1.016	1.016	1.016
Collapsible burglar proofing	1.000	1.040	1.040	1.040	1.040	1.040	1.040
Plumbing Works							
PVC pipes	1.000	1.180	1.180	1.180	1.180	1.180	1.279
Sanitary Fittings, etc							
Water closets wash hand basin, etc	1.000	1.015	1.015	1.015	1.015	1.015	1.391

Source: Field data, 2012

The table above show extract from the resulting construction cost indices. Full details are presented as appendix 6.

The average monthly index is obtained by taking the mean of all the work items of that particular month.

4.10 Comparison of mean indices

The researcher compared the mean index for the indices developed denoted by New CSIR Indices (NCI) with the combined labour and materials indices of the Prime Building Cost Indices (PBCI) published by the Ghana Statistical Services. Table 4.7 shows the mean indices. PBCI had a base reference date of 1997 whereas NCI has a reference date of December 2011. PBCI was therefore converted to December 2011 base to enable meaningful comparison.

Table 4.7: mean monthly indices for NCI, CIEIG-GH and PBCI

MONTHLY MEAN INDICES							
	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12
NEW CSIR-BRRI	1.000	1.103	1.137	1.142	1.143	1.171	1.203
PBCI	1.000	1.119	1.119	1.120	1.120	1.120	1.124

Source: Field data, Ghana Statistical Services website

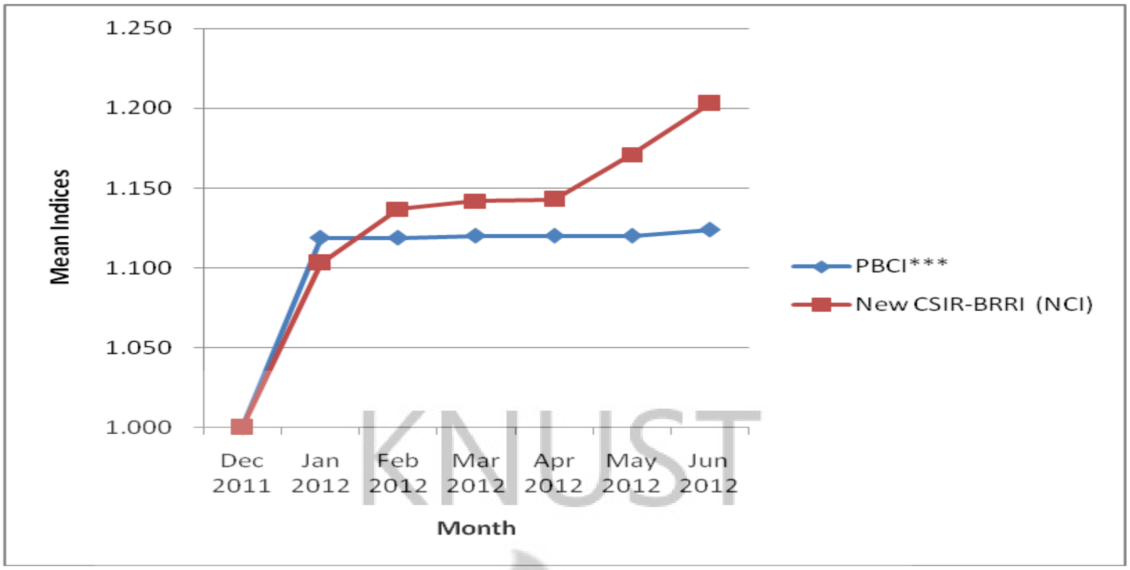

Fig.4.6: comparison of mean monthly indices

The graph in Fig. 4.6 for the both PBCI and NCI shows general upward movements indicating rise in construction input resources costs with respect to the base reference month. The graph for the NCI indices is above both the PBCI, thus implying that it will result in better cost recovery when used to compute cost fluctuations.

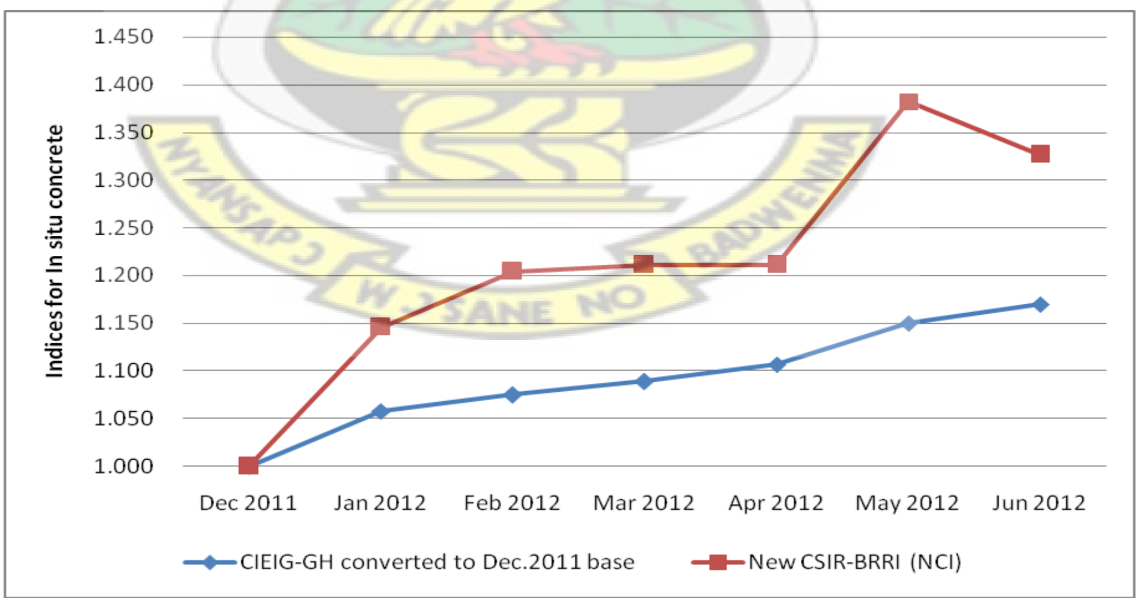

Fig.4.7: Comparison of Indices for In Situ Concrete

Fig. 4.7 was obtained by plotting the indices for 'in situ concrete (using crushed aggregates)' using NCI and CIEIG-GHH indices. Presently the component cost of cement is about 33% to the total cost of reinforced in situ concrete 1:2:4. This implies that a small change in the cost of cement will result in change in the unit rate and hence the indices. The index for concrete work and others works with cement content increased and decreased with the rise and fall of cement price between the months of April May and June 2012 for the new CSIR Indices (NCI). This was not the case with CIEIG-GH indices. This was the period when the open market price for cement increased from GH¢17 to GH¢25 and then decreased to GH¢20 for the months of April, May and June 2012. This implies that the NCI is more sensitive to changes in construction costs.

The new indices were also compared with the prevailing rate of inflation in Ghana (as measured by the CPI) and the Ghana Cedi versus United States Dollar exchange rate. This is because the price of construction input resources are affected by both the exchange rate and the inflation rate. Tables 4.8 and 4.9 shows the New CSIR indices with the CPI and Cedi: US dollar exchange rates respectively.

Table 4.8: Mean Indices and CPI

NEW CSIR-BRRI VERSUS CPI (INFLATION RATE)							
	DEC' 11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12
NEW CSIR-BRRI	1.000	1.103	1.137	1.142	1.143	1.171	1.203
CPI	1.000	1.012	1.000	1.023	1.058	1.080	1.094

Table 4.9: Mean Indices and Cedi: US$ exchange rate

NEW CSIR-BRRI VS CEDI:US$ RATE							
	DEC' 11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12
NEW CSIR-BRRI	1.000	1.103	1.137	1.142	1.143	1.171	1.203
US$	1.000	1.030	1.030	1.065	1.124	1.170	1.176

Source: Field data , Bank of Ghana and Ghana Statistical Services websites

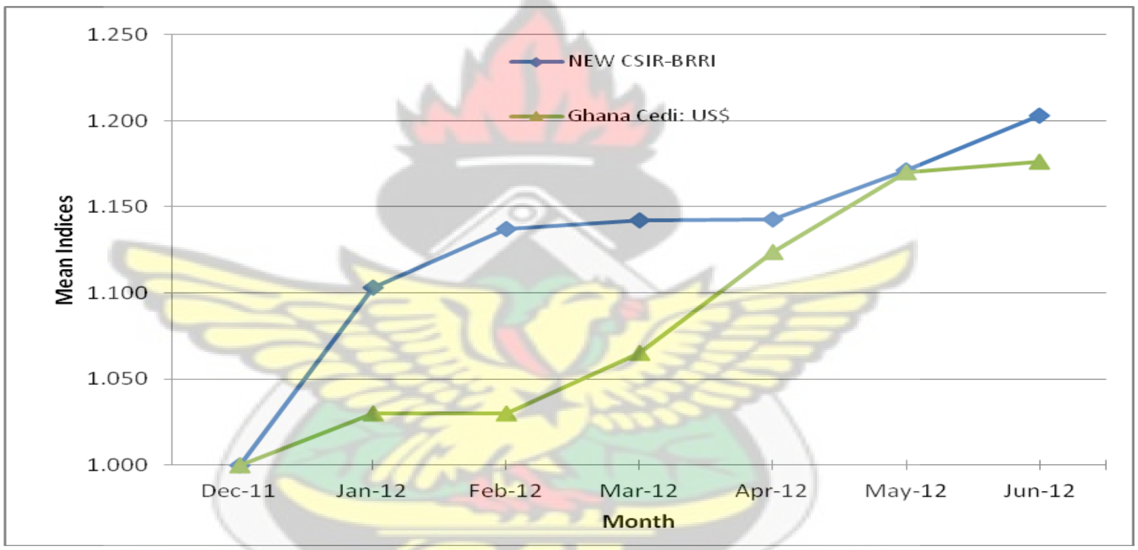

Fig.4.8: New CSIR indices against Cedi: Dollar Exchange rate

The graph in Fig.4.7 shows that the new indices (NCI) increased with an increase in the Cedi: Dollar exchange rate and the rate of inflation measured by the CPI. This is consistent with the generally observed trend that prices of goods and services increase with increase in the United States dollar exchange rate.

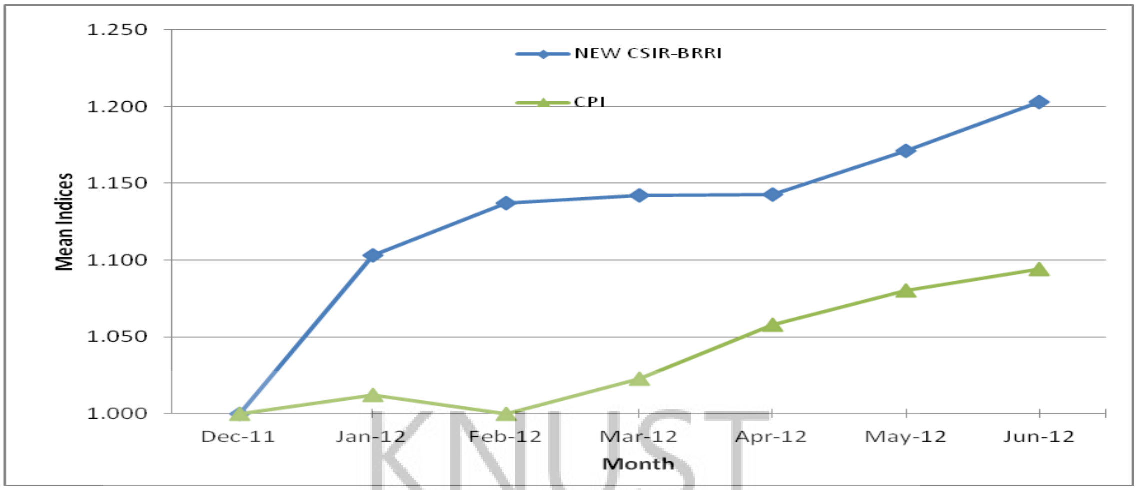

Fig.4.9: Graph of mean indices against CPI

4.11 Comparison with traditional method

The traditional method of computing fluctuations was compared with the New CSIR-BRRI and PBCI methods. Table 4.10 indicates how the fluctuation factors were computed for New CSIR-BRRI and PBCI. The applicable factor for the month under consideration was calculated using the formula;

$$P_c = \frac{I_t - I_o}{I_o}$$

P_c = change in cost index

I_t = index at the time t, applicable month

I_o = base month index, in the example below, I_o is the base month of December 2011 and it was assigned the value 1.000

Table 4.10: NCI and PBCI (combined labor and material) for Jan.-June 2012

Indices Type	2011	2012					
	Dec	Jan	Feb	Mar	Apr	May	Jun
Raw PBCI	1,589.50	1,777.90	1,779.10	1,780.10	1,780.10	1,780.60	1,785.90
PBCI converted to Dec 2011 base	1.000	1.119	1.119	1.120	1.120	1.120	1.124
New CSIR-BRRI	1.000	1.103	1.137	1.142	1.143	1.171	1.203

Source: Field data, Ghana Statistical Services website

Table 4.11: Computation of applicable factors

	INDICES TYPE	MONTH					
		JAN	FEB	MAR	APR	MAY	JUN
MEAN INDEX (I_t)	CSIR-BRRI)	1.103	1.137	1.142	1.143	1.171	1.203
	PBCI	1.119	1.119	1.120	1.120	1.120	1.124
APPLICABLE FACTOR [$Pc = (I_t-I_o)/I_o$]	CSIR-BRRI	0.103	0.137	0.142	0.143	0.171	0.203
$Pc = [0.1+0.9It/Io]-1$	PBCI	0.107	0.107	0.108	0.108	0.108	0.112

Source: Field data

Table 4.12: Comparison of fluctuation computation methods

COMPARISON OF COSTS RECOVERED USING NCI, PBCI and TRADITIONAL METHODS (JANUARY –JUNE 2012)							
CONTRACT START DATE:		1ST JANUARY 2012					
BASE DATE		DECEMBER 2011					
CONTRACT SUM (Less Prov. Sums +Contingencies)			123,878.00				
COMPLETION DATE	30TH JUNE 2012						
	A	**B**	**APPLICABLE INDEX ('C)**		**AMOUNT OF FLUCTUATION (GH¢)**		
	CUMM. VALUE OF WORKS	**NET VALUE OF WORKS DONE**	**CSIR-BRRI ('C)**	**PBCI (D)**	**CSIR-BRRI**	**PBCI**	**TRAD.**
Valuation No.1 (31/01/12)	24,775.60	24,775.60	0.103	0.107	2,551.89	2,650.99	1,166.99
Valuation No.2 (28/02/12)	49,551.20	24,775.60	0.137	0.107	3,394.26	2,650.99	1,484.42
Valuation No.3 (31/03/12)	68,132.90	18,581.70	0.142	0.108	2,638.60	2,006.82	406.40
Valuation No.4 (30/04/12)	92,908.50	24,775.60	0.143	0.108	3,542.91	2,675.76	1,497.00
Valuation No.5 (31/05/12)	105,296.30	12,387.80	0.171	0.108	2,118.31	1,337.88	1,162.07
Valuation No.6 (30/06/12)	123,878.00	18,581.70	0.203	0.112	3,772.09	2,081.15	494.08
TOTAL		**123,878.00**			**18,018.06**	**13,403.60**	**6,210.96**

Source: Field data,

The following assumptions were made

- Advance mobilisation was not paid
- Contractor adhered strictly to the original scheduled program
- Payment was done promptly
- Retention was not withheld
- Full payment was done at the end of the 6th month
- Percentages of works done were; 20%, 40%, 55%, 75%,85% and 100% at the end of first, second, third, fourth, fifth and sixth months respectively. These percentages were applied to the total contract sum to arrive at the work done for the respective months. This enabled computation to be done for the formula methods of computing fluctuations.

4.11.1 Computation for traditional method

In computing the fluctuation for the traditional method, material and labour schedules were extracted for an assumed works done for each month. The respective quantities of the input resource were multiplied by the difference in prices between the applicable and the base months to obtain value of fluctuations. Table 4.12 shows details for the computation of fluctuations using the traditional method for the month of March 2012. The amount GH¢ 406.40 was obtained by summing the fluctuation amounts for the various resources. This was carried to Table 4.11 as the traditional fluctuation amount for March 2012 as shown above.

Table 4.13: Computation using traditional method for March 2012

TRADITIONAL (FACTUAL METHOD) FOR MARCH 2012							
Item	**Description**	**Qty**	**Unit**	**Base Price**	**Current Price**	**Diff.**	**Fluct. Amount (GH₵)**
A	Reinforced in situ concrete, (1:2:4-20mm aggregate) in ring beam	6.0	m^3				
1	cement	36.0	bags	14.00	15.81	1.81	65.16
2	sand	0.5	trips	187.50	225.00	37.50	20.25
3	chippings	5.7	m^3	65.19	72.70	7.51	42.81
4	skilled labour	4.5	days	21.76	21.76	-	-
5	unskilled labour	4.5	days	16.17	16.17	-	-
C	12mm diameter mild steel reinforcement bars in ring beams	289.0	kg				-
1	12mm diameter rod	36.0	nr	13.41	14.07	0.66	23.76
2	skilled labour	2.6	days	12.00	21.76	9.76	25.47
3	unskilled labour	2.6	days	-	16.17	16.17	42.20
	125mm blocks	500.0	nr	1.45	1.63	0.18	90.00
1	cement	10.0	bags	14.00	17.00	3.00	30.00
2	sand	0.5	trip	187.50	225.00	37.50	18.75
3	skilled labour	6.0	days	18.00	22.00	4.00	24.00
4	unskilled labour	6.0	days	18.00	22.00	4.00	24.00
	TOTAL FLUCTUATION AMOUNT FOR FEBRUARY 2012						**406.40**

Fig.4.10: Comparison cost recoveries achieved using NCI, PBCI and Traditional methods.

Figure 4.9 indicate that about GH¢18,000, GH¢13,000 and GH¢6,000 was recovered using NCI, PBCI and the traditional methods. It can be inferred that NCI produces higher cost recovery than the other methods. This also confirms the generally held belief that the traditional method does result in lower recovery of costs. The assumptions were made in order to obtain valuation figures to enable meaningful comparison. In practice delays in payment and execution of projects occur frequently in Ghana and valuations certificates usually takes months before payment is done.

4.12 T-test for difference in mean indices between NCI and PBCI indices

Let the hypothesis:

"There is no significant difference in mean indices between NCI and PBCI" be the Null hypothesis and denoted by H_0.

Let the alternative hypothesis:

"There is significant difference in mean indices between NCI and PBCI" be the Alternative hypothesis and denoted by H_1.

The null hypothesis H_0 will be sustained if p-value >0.05 at 95% confidence interval.

The two-sample-t-test was used because the two indices had unequal sample size and unequal variance.

Table 4.14: average monthly means

MONTHLY MEAN INDICES							
		Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12
NCI		1.103	1.137	1.142	1.143	1.171	1.203
PBCI		1.119	1.119	1.120	1.120	1.120	1.124

Table 4.15: Two Sample t-test

T-TEST FOR EQUALITY OF MEANS			
Two Sample t-test for equality of means at 95% C.I. of differences			
significance	t-value	d.f	p-value
0.05	2.1293	10	0.0591

Since P=0.0591 < 0.05, the null hypothesis that: 'there is no significant difference in means between NCI and PBCI indices' is accepted and it is concluded that there is no statistically significant difference in mean indices for NCI and PBCI.

4.13 T-test for differences in cost recovery between NCI and PBCI indices

Let the hypothesis:

"There is no significant difference in cost recovery between NCI and PBCI" be the Null hypothesis and denoted by H_0.

Let the alternative hypothesis:

"There is significant difference in cost recovery between NCI and PBCI" be the Alternative hypothesis and denoted by H_1.

The null hypothesis H_0 will be sustained if p-value >0.05 at 95% confidence interval.

The two-sample-t-test was used because the two indices had unequal sample size and unequal variance

Table 4.15: Costs Recovered

Costs Recovered						
	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12
NCI	2,551.89	3,394.26	2,638.60	3,542.91	2,118.31	3,772.01
PBCI	2,650.99	2,650.99	2,006.82	2,675.76	1,337.88	2,081.15

Table 4.16: Two Sample t-test

T-TEST FOR EQUALITY OF MEANS			
Two Sample t-test for equality of means at 95% C.I. of differences			
significance	t-value	d.f	p-value
0.05	2.3323	10	0.0419

Since P=0.0419 < 0.05, the null hypothesis that: 'there is no significant difference in cost recovery between NCI and PBCI indices' is rejected and the alternative hypothesis that: "There is significant difference in cost recovery between NCI and PBCI" is accepted. From Fig 10, cost recovered suing NCI is higher than that of PBCI.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This concluding chapter provides insight into the major findings of the study. It further provides key recommendations to stakeholders and also outlines recommendations for further research.

5.2 Summary of findings

The following are key findings made in the research;

a) Currently the predominant method of evaluating fluctuations is the PBCI method. It has been established that this method has a disadvantage of late release of data.

b) Majority of contractors reported that they were not satisfied with costs recovered using the PBCI method.

c) The major problem associated with the use of existing indices is the late release of data.

d) 32 modal works items were identified as constituting a basket of good for building cost indices.

e) Cost recovered is higher cost recovery is achieved when the new CSIR indices is used as compared with PBCI method.

f) The traditional method of computing fluctuations resulted in the lowest cost recovery.

5.3 Conclusions

Given the importance of construction cost indices to the industry, there is need for stakeholders to have confidence in the methods available for computing fluctuations. The study revealed that practitioners have issues with existing methods of computing cost fluctuations especially the PBCI method; late release of data and low recovery of costs being the major problems. The study also identified 32 modal works items which will serve as a base or skeleton for which further items shall be added in future to capture comprehensively the wide range of construction work items. The cost indices developed in this study using unit rate method results in better cost recovery as compared with the two other main methods; CIEIG-GH and PBCI

5.4 Recommendations

- The study recommends that workshops and seminars be regularly held with stakeholders, e.g., Association of Building and Civil Engineering Contractors (ABCECG), construction industry professional bodies like Ghana Institution of Surveyors (GhIS), Ghana Institution of Engineers (GhIE), Ghana Institute of Architects (GhIA), etc., and GETFund to expose the process and method of developing the new indices and to solicit their input to enrich the developed indices.

- Further studies should be made on the BQ analysis to obtain a comprehensive list of work items for inclusion in the cost indices

- Comparison of NCI with the PBCI was done with data for 6 months January – June 2012 because of the limited time available for the study. Trends costs should be monitored for extended periods to observe movement of NCI with respect to the other methods.

- The base year of December 2011, selected for the study was used because comprehensive market survey was done in December 2011. Cost trend studies should be carried out with the objective of identifying a period of relatively stable prices. A base month should then be selected based on the cost trend studies.

- The major problem identified from the questionnaire survey in applying construction cost indices is the late release of published data. In order for the new indices to be effective, it is recommended that publication should be released not later than 2 weeks after the end of the month.

- It is recommended that the formula below should be used for computing fluctuations using the new indices;

$$P_c = \frac{I_t - I_o}{I_o}$$

Where; P_c = change in cost index, I_t = index at the time t, applicable month and I_o = base month index, be used for computing fluctuations using the developed indices

It is also recommended that base reference date (usually 28-days before tender opening date) be expressly stated in the tender data sheet for contracts subject to fluctuations.

References

Amoa-Mensah, K. (1996), *Building Estimating Manual for West African Construction Practice.* Parcom: Kumasi

Ashworth, A. (2004). *Cost Studies of Buildings.* Pearson Education Limited: London.

Brock, M. (2004). *Estimating and Tendering for Construction Work, 3 ed.*Elsevier: Oxford.

Buchanan, R. D., Fleming, E. F., & Grant, F. E. (2003), *Estimating for Bulders and Surveyors, 2 ed.* Elsevier: Oxford. pp 2-3,

Dagostino, F. R., & Peterson, S. J. (2011). *Estimating in Building Construction, 7 ed.* Prentice Hall: New Jersey .

Eyia, A. a. (2003). Financing Small and Medium-scale Contractors in Developing Countries: A Ghana case study. *Construction Management and Economics*, pp 357-367.

Ferry, D., & Brandson, P. (1991). *Cost Planning of Buildings, 7 ed.* Oxford: Basil Blackwell.

Ghana Statistical Services. (2012). *Prime Building Cost Indices.* Accra.

Gichunge, H., & Masu, S. (2010), Factor Cost Indices Practices in Building Industry for Nairobi, Kenya. *Journal of Financial Management of Property Construction, Vol.15(1)*, pp 61-70.

Hassanein, A., & Khalil, N. L. (2006). Building Egypt 1; A General Indicator Cost Index for Egyptian Construction Industry. *Engineering, Construction and Architectural Management Vol. 13,Issue 5*, pp 463-480.

International Labour Organisation. (2012, June 3). Retrieved from www.ilo.org/resolutions/consumerpriceindex

International Labour Organisation. (2012, May 25). *ILO.* Retrieved from ILO website: www.ilo.org/public/english/bureau/stat/download/cpi/ch1.pdf

Jimoh, R. (2012). Improving Site Management Practices in the Nigerian Construction Industr: The Builders' Perspective. *Ethiopian Journal of Environmental Studies and Management, Vol.5, No.4*.

Laryea, S., & Mensah, S. (2010). The Evaluation of Indigenous Contractors in Ghana. *West Africa Built Environment Researchers Conference.* Accra.

Murdoch, J., & Hughes, W. (2000). *Construction Contracts: Law and Management.* London: Taylor and Francis.

Nani, G., & Adjei-Kumi, T. (2008, June). Adoption of SMM7 in Ghana: A Practical Guide to Matching SMM6 and SMM7. *The Quantity Surveyor*.

Osei-Tutu, E., & Adjei-Kumi, T. (2008). An Evaluation of Housing Cost Trends in Ghana for the Period 1991-2008. (pp. 166-182). Kumasi: CSIR-BRRI.

The Royal Institution of Chartered Surveyors, (1998). *Standard Method of Measurement of Construction Works, 7 ed.*

APPENDIX 1:

SURVEY QUESTIONNAIRE FOR CONSULTANTS

This questionnaire forms part of a study on the **Development of Construction Cost Indices using Unit Rate being undertaken by** DELA ADOBOR, an MSc. Student in Construction Management at KNUST.

Your participation by filling the questionnaire will help to achieve the aim and objectives of the study. Your input therefore will be appreciated for the successful completion of this exercise.

Thank you.

SECTION ONE

Please answer the following questions by ticking / filling the spaces provided

1. Which of the following consultancy firm do you belong

    i. Private

    ii. Public

    iii. Other(s)   (specify)………………………………………..

2. How long has your company been in the construction industry?

i. 0-5 years

ii. 6-10 years

iii. 11-15 years

iv. 16 years and above

3. What is the average number of projects you have completed in the last 5 years?

i. 1-5/ year

ii. 5-10 / year

iii. 10-15 / year

iv. 15 or more / year

4. Is allowance made for cost fluctuations in the initial estimates

i. Yes

ii. No

5. If no explain……………………………………………………………………

6. If yes to Q.5, how was it calculated

i. By making a reasonable percentage allowance based on experience from previous similar project

ii. Using cost escalation prediction models

iii. Other(s) (specify)………………………………………..

7. How significant was the difference between the initial estimated fluctuation and the final actual fluctuation on completed projects.

    i. Very significant

    ii. Not significant

    iii. Other(s) (specify)……………………………………..

8. What standard form of contract was used

    i. Ghana Public Procurement Authority standard forms (modified FIDIC)

    ii. FIDIC

    iii. SFC pink form 5th Edition,1988

    iv. Other(s) (specify)……………………………………..

9. Do you incorporate cost fluctuation clauses in the contract documents?

    i. Yes

    ii. No

10. If no to Q.7, what was the reason for not using a fluctuation clause?

    i. Short term contract

    ii. Long-term but fixed price

    iii. Restricted by a funding agency

    iv. Lack of knowledge in the existing fluctuation computation methods

v. Other(s)

(specify)…………………………………………………………..

11. If yes to Q.7, which computation method was used?

i. Local Price Adjustment Factor (LPAF) published by CSIR-BRRI / CIEIG-GH

ii. Prime Building Cost Indices (PBCI) published by the Ghana Statistical Service

iii. Traditional method

iv. Other (s)

(specify)…………………………………………………………..

12. What informed the choice of computation method

i. Better recovery of costs

ii. Easily available and accessible

iii. Other(s)

(specify)……………………………………………………………

13. The following is a list of deficiencies associated with the use of construction cost indices. Rank them in order of frequent occurrence a scale of 1 to 5.

1= not frequent 2 =slightly frequent 3 =frequent 4= very frequent
5= extremely frequent

NO	PROBLEMS ASSOCIATED WITH USAGE OF COST INDICES	RANK				
		1	2	3	4	5
A	Late release of published data					
B	Inadequate recovery of costs					
C	Particular work item of interest is not included in the published indices					
D	Non familiarity with computation					
E	Based on historical data					
F	Components of a weighted sample					
H	Obsolete methods and components					
K	Human error					
L	High subscription fees					

14. How do you fix the base month for evaluating fluctuations

    i. End of tender validity period

    ii. 28 days to tender submission date

    iii. Other(s) specify ……………………………………………………………

15. Does the location of a project have influence on the level of cost recovery for fluctuations?

i. Yes

ii. No