The Relationship between the Performance of the Economy and the Costing of Building Projects: A Case Study of School Buildings in Egypt

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ABSTRACT

Cost estimating and cost modelling for building projects have attracted the attention of many scholars. Previous research has laid emphasis on the product physical variables and did not explicitly include the economic variables. This study aims at investigating the impact of the performance of the economy on the cost of building projects by explicitly considering the relevant economic indicators in the cost estimating process. The unique attributes of the National Project for Building Schools in Egypt that is running since 1992, provided the opportunity to focus the light on the economic variables due to the standard design applied to thousands of school buildings. The study started by reviewing the current practice in cost estimating for building projects in Egypt seeking to identify the influential cost factors and to further investigate the level of awareness of the impact of the economic changes on the cost of buildings as perceived by the experts. In addition, the study aimed at developing an explanatory cost model illustrating the relationship between the relevant economic indicators and the cost of school buildings in order to quantify the impact of the economic changes on the costing of buildings.

This research adopted a mixed methodology in a triangulation approach that was conducted in two stages. A set of 18 interviews with experts from the industry was followed by a survey covering a sample of 400 schools. The results indicated that the quantity surveyor's method is the prevailing cost estimating technique in Egypt. Practitioners in general, showed a blurred understanding of the fundamentals of economic and did not explicitly consider the economic indicators in the cost estimates for building projects. The cost modelling of the survey data adopted a multiple regression technique and factor analysis. Two sets of Cost Models including 6 economic indicators as independent variables, besides other product variables, were developed. The results indicated that the economic indicators were significant cost variables. Hence, the impact of the economic changes on the cost estimates of buildings can be quantified. The produced models indicated that the cost of school buildings, expressed in real terms, tend to increase during periods of economic recession. The produced model is useful to cost estimators working for government clients as well as contractors, given the rising application of standard design in various sectors within the construction industry in Egypt. Further work is required to gauge this impact across various sectors of the construction industry.

DEDICATION

To My Mother & Father, *with love*

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DECLARATION STATEMENT

(Research Thesis Submission Form should be placed here)

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LIST OF PUBLICATIONS BY THE CANDIDATE

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PART 1:

INTRODUCTION, LITERATURE REVIEW & RESEARCH DESIGN

CHAPTER 1

GENERAL INTRODUCTION

1.1 Context and Rationale

Construction cost estimating has attracted the attention of many researchers in the area of construction management and economics due to the role the construction industry plays in the economy at national, regional and global levels. Still it seems fragmented to the extent that there continue to be calls for further work either to address some of the existing gaps or to improve previously established techniques in search for more accurate cost estimates. So far, the method still being applied by the majority of construction firms is the standard single unit estimate method, whereby the costs of construction (labour, material, plant, subcontractors) are established then overheads and profit are added (Akintoye and Fitzgerald, 2000). In this method, the estimate is prepared in a logical manner based on historical cost data. However, the main inputs for this method of estimating have been criticized for its wide variability (Beetson, 1983; Ashworth and Skitmore, 1983) reflecting the gap between research and practice. Moreover, the current practice seems to emphasise the product physical variables with seldom any explicit mention to the economic variables that reflect the impact of performance of the economy on the cost of construction projects.

Hence, it cam be claimed in general, cost estimators have little understanding of the relationship between the performance of the economy and the project total cost. Theoretically, any change in prices of factor inputs lags the economic changes in a causal relationship that might not be fully understood or easily modelled due to its erratic and unsystematic moves especially in periods of economic turbulence. Add to this the effect of stakeholders' expectations and their subsequent behaviour that might have a multiplier effect on the market prices. However, the changes in the performance of the economy would typically have some early signs reflected in the forecasts set by experts for the key economic indicators. Understanding the relationship between the market price movements

and the changes in the key economic indicators should provide cost estimators with a time advantage due to the aforementioned lag.

Cost estimators, as per current practice, seem to focus primarily on historical data which is analogous to driving a car by only looking at the rear-view mirror. This can be one of the main factors that causes dissatisfaction with the accuracy levels of the current estimates including the majority of the developed cost models mainly based on the market prices at the time of preparing the estimates while the actual execution of the project activities would take place after some considerable time later in the future i.e. different economic conditions. Even those models that included factors such as anticipated risks fell short of explicitly investigating the relationship between the performance of the economy and the project costs.

It can be argued that the process of modelling construction costs is already crammed with factors that when translated into variables yield complex cost models and involves sophisticated analyses, thus, adding an additional set of variables such as the macroeconomic variables might not yield favourable results due to the level of sophistication and in some cases due to statistical limitations.

1.2   Problem Extent and Research Objectives

Statement of the Problem

The study is based on the case study identified as the Egyptian national project for educational buildings characterized by applying a standard design in the form of a few templates to fit the purpose for the various key stages in the Egyptian educational system. The General Authority for Educational Buildings (GAEB) was established by the presidential decree no. 448/1988 dated 21 / 11 / 1988 for the execution of this project.

An estimated total of 1500 school were to be built wary yean. The project started on 1992 and is still going up to date.

Clearly, developing a reliable cost estimate for the school building projects would be important to GAEB and all other stakeholders. If the costs were underestimated then it would most likely lead to one of the following consequences:

1. The projects in progress might not be completed due to lack of funds.

2. The scope of the schools to be constructed would be reduced since the allocated budget would not suffice to build the planned number of schools.

3. The expected implications on the quality of various work items thus leading to school buildings below the desired standards.

On the other hand, overestimating the construction cost would inflate the budget which is detrimental particularly in the case of the developing countries with scarce resources like Egypt.

The unprecedented opportunity of having a project applying a standard design to a large number of buildings and extending over a fairly long period of time was the main driver for this study. The standard design would allow for eliminating a number of the product physical variables thus reducing the noise and focusing more on the effect of the macroeconomic variables on the cost of construction. Moreover, the period covered by this study had witnessed a considerable number of economic changes and a notable economic turbulence in some years.

1.3 Aims and Objectives

In pursuit of bridging the above gap, the aim of this study is to investigate the relationship between the performance of the economy and the cost of construction projects in Egypt.

This aim can be broken down into the following objectives:

1. Review the current practice in cost estimators within the Egyptian construction industry meanwhile assessing the accuracy of the produced cost estimates.

2. Identify the influential factors that affect the cost of building projects at the detailed design stage.

3. Investigate the level of awareness among practitioners about the impact of the performance of the economy on the cost of buildings.

4.   Identify the key economic indicators that can proxy the performance of the economy and meanwhile relevant to the construction industry.

5.   Model the relationship between the key economic indicators and the cost of building projects by constructing an explanatory model that would enhance the cost estimators' understanding of the impact of the economic conditions on the project costs.

The Egyptian national project for educational buildings has been identified as the case study for this research due to its unique attributes. Despite building on this specific case study, the findings should provide cost estimators, in general, with a better understanding of how the changes in the economy affect the cost of construction.

1.4   Scope and Limitations

The study is aimed at constructing an econometric model that would explain the impact of the macroeconomic conditions on the cost of school buildings. This project has started in 1992/93 thus limiting the availability of required data to the period from 1994- 2006 i.e. 12 years which is relatively shorter than would have been desired. However, it was not the aim of this study to construct a time series as a forecasting tool but rather an explanatory model that would enhance the comprehension of the relationship between the macroeconomic variables and the cost of school buildings.

The unprecedented opportunity of having a project that applied a standard design to a large number of buildings meanwhile extending over a fairly long period of time was the main driver for this study.

The standard design would allow for eliminating a number of the product physical variables thus reducing the noise and focusing more on the effect of the macroeconomic variables on the cost of construction. Moreover, the period covered by this study had witnessed a considerable number of economic changes and even economic turbulence in some years. This would magnify the effect sought and enhance the explanatory power of the produced model.

1.5 Research Methodology

As mentioned this research was based on a case study, however, the nature of the objectives implied a mixed methods approach. For example, it was imperative to conduct a quantitative analysis in order to build a statistical model as stated in the 5th objective whereas the qualitative approach was more appropriate to review the current practice and to investigate the level of awareness amongst practitioners about the impact of the economic conditions on the cost of buildings.

Hence, it was decided to conduct the research on two stages. The first stage comprised a qualitative study through a set of 18 semi-structured interviews with experts in the construction industry in Egypt with emphasis on the national project for building schools. In the second stage, a quantitative survey of 400 school building projects was conducted in pursuit of developing a statistical model that can explain the relationship between the cost of school buildings and the significant cost variables. The study aimed at testing the hypothesis that the economic indicators were significant explanatory variables of the cost of school buildings. If the hypothesis holds true, it would be reasonable to suggest that including the relevant economic indicators explicitly in the cost modelling process would improve the accuracy of the produced cost estimates.

The combination between the qualitative interviews and quantitative survey within a single case study is known as embedded case study design. On the one hand, the quantitative statistical analysis identified the most significant cost variables and established a quantified relationship between the dependent variable and the explanatory variables. On the other hand, the findings of the qualitative study did confer meaning on the findings of the statistical analysis and also provided better insight about the other objectives that were qualitative in nature.

Whilst building the statistical model the, findings of the modelling process indicated that the economic vandalises the most influential cost variables evolved and their statistical significance was verified. This was compared and contrasted with the findings of the qualitative interviews in a triangulation approach.

The methodology in steps:

1.   Review of the cost modelling literature and the building economics literature. The former aimed at identifying the key variables that scholars had listed as significant in estimating the cost of building projects. The latter aimed at establishing the theoretical framework necessary before embarking on the statistical analysis that is the quantitative part of this study as shown in figure 1.1.

2.   A review of the research methods literature guided the design of the research and informed the decisions made about the research strategy and data collection methods as well as the analysis techniques applied in this study.

3.   The educational system in Egypt was presented. This was coupled with a brief synopsis about the key socio-economic attributes relevant to the context of this research, particularly the impact of the privatisation programme on the construction industry in Egypt. Also, the National Project for building schools was examined with emphasis on the cost estimating process at the detailed design stage given the standardised design approach applied by GAEB.

4.   The qualitative part of this study was conducted through in-depth semi-structured interviews, primarily to review current practice from the viewpoint of practitioners. Also, the qualitative research aimed at shedding light on the perceived relationships between the performance of the economy and the cost estimating process and whether the experts did consider the economic conditions when estimating the building costs, explicitly, rather than just looking at the prevailing market prices of key factor inputs. The perceived level of accuracy of the produced estimates was investigated. Overall, 18 interviews were conducted with experts. The outcome of the interviews reflected the level of understanding of the experts regarding the impact of the economic fluctuations on the cost of building and identified the key physical and economic factors that practitioners perceived as having significant impact on the cost of building projects.

5.   The quantitative part of the study aimed at modelling the relationship between the cost variables and the total cost of the project. It was decided that the ordinary least squares multiple linear regression technique would be applied in this pursuit, a decision

that was endorsed by the findings of the review of the cost modelling literature. A total sample of final invoices for 353 school projects was randomly selected from GAEB archives. The sample was selected amongst projects built over the period 1994-2006. The sample was selected from the archives of the headquarters of GAEB to ensure the equal probability of schools built across the country. The variables that were included in the modelling process were identified based on the findings of the literature review and was also guided by the findings of the interviews. In chapter 7, a detailed discussion of the identified variables is presented leading to the selection of the set of variables that constructed the variate. Before embarking on building the cost model 70 cases were randomly selected and filtered out in order to be used in the training and verification of the model. A total of 283 projects were included in the regression analysis. In chapter 9, seven models are developed as follows:

- The first model was built utilising all 283 cases meanwhile including both the physical variables and the economic variables identified in chapter 7 in order to hedge against missing variables that might turn out to be significant.

- The developed model was refined by excluding any variable that proved to be statistically insignificant. Then the modelling process was repeated on subsets of the original data set after controlling one of the product variables in each round.

- Finally the dependent variable was regressed over the economic variables only using a subset of the data that shared the same product attributes (i.e. all product variables were constant) in order to validate and confirm the findings of the previous stages.

6. The findings of the qualitative and quantitative studies were compared and contrasted in a triangulation approach. The qualitative study explained and justified the findings of the statistical analysis. The combination of the qualitative and the quantitative approaches validated and confirmed the findings. Moreover, it provided meaningful explanation for the empirical results of the regression analysis applied. Hence, it can be claimed that this approach provided the adequate depth sought. In addition, it significantly reduced the doubts typically associated with empirical results obtained by statistical analysis.

Figure 1.1 Research Design (Triangulation)

1.6 Thesis Layout

This section is aimed at presenting the thesis layout in order to provide an overview of the study. The thesis comprises, in addition to this chapter, another 8 chapters as shown in Figures 1.2 and 1.3.

The thesis is divided into three main sections. The first section introduced the research problem, aims and objectives. Also, in the first section a critical review of the relevant literature was presented and the methodology was discussed. The following section

introduced the qualitative part of this study which included two stages. The secondary data collection stage aimed at examining the Egyptian economy with emphasis on the construction industry and particularly school buildings. The primary data collection stage that followed focused on reviewing the current practice in cost estimating for building projects with emphasis on school buildings constructed by GAEB. The last section introduced the quantitative part of this study. A survey was conducted on a randomly selected sample of 400 school buildings constructed by GAEB during the period 1994-2006. The data collected was analysed applying a linear multiple regression technique whereby several cost models were produced in an attempt to test and verify the hypothesis stating that the economic variables can be included explicitly in cost models and meanwhile are significant explanatory variables contributing to the variation in the value of the school building cost. Finally the main conclusions are presented linking the findings of the qualitative and quantitative parts of the study meanwhile pinpointing the alignment of the findings of both parts with the objectives of the study.

The following section provides a brief summary of the remaining chapters.

1.6.1   Chapter Two: Construction Cost Estimating and Cost Modelling.

The literature review section of this study was conducted over three chapters; 2, 3 and 4. Chapter 2 focused on the area of cost estimating while chapter 3 covered the area of building economics. Chapter 4 wrapped up this section by reviewing the previous works published in the literature on cost estimating and econometric cost modelling in order to identify the influential factors affecting the accuracy of the produced estimates meanwhile pinpointing the various modelling techniques. Cost estimating and forecasting have been discussed by a wide range of literature. This chapter aimed at establishing the theoretical frame work that would guide the design of the research methods applied in this study. The various cost estimating techniques listed in the literature were discussed comparing the different points of view on the current practice in cost estimating for building projects and its impact on the accuracy level of the produced estimates.. The discussion also reviewed the reliability of the various sources of cost data in the context of the Egyptian construction industry.

Part One
Diagnosis
- Problem Identification
- Aims & Objectives
- Literature Review
- Research Design

- Chapters 1-5

Part Two
Qualitative Research
- Case Study
- Secondary Data Collection & Analysis
- Primary Data collection and Analysis

- Chapters 6&7

Part Three
Quantitative Research
- Survey within the case study
- Regression Analysis
- Model- Building
- Model training & Validation
- Discussion of findings

- Chapters 8&9

Conclusions
chapter 10

Figure 1.2 Thesis Structure Outline

Part I

Introduction , Literature Review & Methodology

Ch1 General Introduction

Ch2 Cost Estimating & Modelling

Ch3 Building Economics

Ch4 Influential Factors & Modelling Techniques

Ch5 Research Design

Part II

Qualitative Study

Ch6 The research Case Study

Ch7 Interviews

Part III

Quantitative Study

Ch8 Discussion of Variables

Ch9 Statistical Analysis & Cost Modelling

Ch10

Conclusions

Figure 1.3 Thesis Structure Outline within the Research Process

1.6.2   Chapter Three: Building Economics

This chapter aimed at reviewing the basic economic concepts and theories underpinning the econometric cost analysis presented in chapters 7,8 and 9. In this pursuit, a wide range of literature on building economics has been reviewed (Turin,1975; Edmond, 1979; Shutt, 1982; Karmack, 1983; Hillebrandt, 1985; Lavender, 1990; Ruegg & Marshall, 1990; Raftery, 1991; Ruddock, 1992; Seeley, 1996; Eccles *et al.,* 1999; Ive and Gruneberg, 2000 and others). The chapter compares and contrasts the neo-classical economics school of thought with the institutional views in the context of the Egyptian construction industry. On the one hand, the classical view advocates the influence of market forces mainly the demand and supply in determining prices. On the other hand, the institutional view realises the impact of the government's interventions as influential on the level of prices. This impact of the government economic policies extends beyond just regulating the market, as claimed by the classical view. The discussion aimed at establishing the underpinning theory in an attempt to identify the key economic indicators that have significant impact on price levels. Among the key indicators identified were the rate of interest and the foreign rate of exchange.

1.6.3   Chapter Four: Influential Factors and Modelling Techniques – A Review of the Literature

Following the previous two chapters, this chapter aimed at reviewing the published research on cost estimating and cost modelling including the econometric cost models. The chapter introduced a discussion on the prevailing trends in cost estimating and the accuracy of the produced estimates as perceived by scholars. The review of previous works aimed at listing the influential cost factors that scholars identified based on their impact on the accuracy of cost estimates. A list including 23 influential cost factors was presented. These factors informed the data collection stage presented in chapters 7 and 8. Furthermore, the chapter reviewed the key publications on econometric cost modelling in the context of building economics in order to establish the theoretical framework that would inform the modelling stage discussed in chapter 9.

1.6.4 Chapter Five: Research Design

The chapter introduced the methodology applied to this research as shown in figure 1.1. The methods comprised a combination of a qualitative approach through a set of semi-structured interviews with experts in addition to a quantitative analysis of the cost data set collected by conducting a survey on 400 school building projects. The chapter commenced by reviewing the research methods theory that guided the design of this study. The selected methodology was discussed in depth explaining the rationale as well as the details of the chosen methods for data collection and the techniques applied for the analysis of both qualitative and quantitative data. The discussion highlighted the alignment between the selected methods and the set objectives of this study and explained the advantages of the triangulation approach applied in this research.

1.6.5 Chapter Six: The Egyptian Economy and the Construction Industry

The chapter presented the details of the case study selected for this research. The discussion commenced by a brief introduction about the educational system in Egypt followed by shedding light on the main socio-economic facets relevant to the case study. The chapter discussed the key attributes of the national project for building schools in Egypt and presented relevant secondary data about the construction industry in Egypt in general and school buildings in particular. The secondary data were discussed in the context of the set objectives of this study with emphasis on the relationship between the performance of the economy and the cost of buildings in Egypt.

1.6.6 Chapter Seven: Review of the current Practice

The chapter described the steps followed in collecting primary data via semi-structured interviews. A total of 18 interviews were conducted with a purposively selected sample of experienced practitioners, the majority of whom had experience in school building projects. The interviews aimed at reviewing the current practice in cost estimating for building projects in Egypt in general and the school building projects in particular. Hence,

the chapter was divided in two main sections. The first section addressed the general approach to cost estimating while the second section was more focused on the particular characteristics of school buildings constructed by GAEB and its impact on the cost estimating process for this special type of buildings due to the standardised design applied to school buildings. The findings reflected the limited awareness among practitioners about the impact of the performance of the economy on the cost of school buildings. However, the findings of the interviews indicated that there was an intuitive inclination towards selecting some of the economic indicators as being of significant impact on the price levels of factor inputs, particularly building materials and hence the cost of building projects. This finding supported the need for conducting a statistical analysis in order to test and furthermore to quantify the suggested relationship.

1.6.7   Chapter Eight: Data Collection & Discussion of Variables

In this chapter the details of the survey were introduced. The discussion provided the rationale behind establishing the conceptual model and introduced the selected variables which were included in the modelling stage. The argument linked to the findings of the interviews presented in chapter 6 as well as the findings of the literature review presented in chapters 2 and 3. The chapter presented the data collected during the survey stage, and discussed the detailed treatment of the data pertaining to the selected variables, in preparation for the regression analysis discussed in chapter 8.

1.6.8   Chapter Nine: Regression Analysis and Cost Modelling

Building on the data collected during the survey and the selected variables introduced in chapter 7, this chapter aimed at introducing the modelling stage applying a multiple regression technique in pursuit of addressing the fifth objective of this study. The chapter commenced by introducing the underpinning theory informing and guiding the statistical analysis. The modelling process was conducted on several stages that started by a developing a general model which embraced all the variables and included 80% (283 projects) of the entire data set after the random selection of 20% (70 projects) of the data

in order to be used in the training stage of the produced model. The following stages were aimed at controlling some of the variables using subsets of the original dataset. The final stage included the economic variables only using a subset of the original data after controlling for all the physical variables. This was possible due to the standardised design applied to the school buildings.

The final model built was trained and validated on a subset of data that was not included in building the model as above mentioned. The results of the regression analysis were discussed and linked to the findings of the qualitative research and the set objectives of the study.

1.6.9   Chapter Ten: Conclusions

The chapter wraps up the thesis by deriving the conclusions based on the findings of both parts of the study; the qualitative research and the quantitative research. The discussion aimed at comparing and contrasting the findings of the interviews and statistical analysis in the context of the set objectives of the study. The findings of the qualitative interviews conferred meaning on the findings of the statistical analysis and justified the decision to conduct the quantitative analysis. The latter verified and furthermore quantified the impact of the influential factors which were identified by experts. Hence, the triangulation approach was justified.

 Reflecting on the main objectives of the study, the chapter concluded that the quantity surveyors approach to cost estimating was the prevailing trend within the construction industry in Egypt, particularly the public sector building projects. The performance of the economy clearly affected the cost of building projects whereby the interest rate and the exchange rate were identified as influential economic indicators that impacted the cost of buildings. The congruence of the findings of both the qualitative and quantitative parts of the study confirmed the significant impact of both indicators. In addition, the statistical analysis concluded that both indicators were significant cost variables which could be explicitly included in cost models in order to enhance the quality of the produced cost estimates for building projects. This can be claimed to have established the novelty of this

study. Finally, the developed cost models provide a useful tool that can enhance the understanding of the interrelationships between the physical cost variables and the identified economic indicators. Hence, the study can claim to have contributed to the knowledge in the context of cost estimating for building projects.

1.7 Summary

This chapter began by identifying the problem that is addressed in this research and presented the objectives of this study. The context, rationale, scope and limitations of the study were discussed. Also, the case study forming the basis of this research was identified. The methodology outline aimed at providing a road map shedding light on the direction and design of the thesis from the outset. The chapter concluded by presenting the thesis layout meanwhile providing a brief summary of the succeeding nine chapters.

CHAPTER 2

COST ESTIMATING AND MODELLING FOR CONSTRUCTION PROJECTS

2.1 Introduction

The aim of this chapter is establish the theoretical background for this study in the area of cost estimating in the context of construction projects with emphasis on the key factors that affect the accuracy of the produced cost estimates during the planning stage.

The chapter commences by general definitions that is followed by the identification of the various approaches to cost estimating methods as stated in the construction management literature. The chapter aimed at mapping out the different methods that are historically known as the most popular throughout the evolution of the cost estimating practice for construction projects. The chapter presented the various sources of cost data and discussed the reliability of the identified cost data sources. Having attracted a significant attention in the construction management literature, the accuracy of the produced estimates for buildings is discussed with particular emphasis on the Egyptian construction industry.

2.2   Definitions

2.2.1 Estimating Vs Forecasting

The definition for the term "Estimating" as stated in the concise Oxford dictionary refers to "a contractor's statement of a sum of money for which specified work will be undertaken" whereas the same source defines the term forecasting as "a foresight or conjectural estimate of something scheduled to happen in the future".

Academic studies in the field of construction management such as Ashworth (1991) and Ferry & Brandon (1994) made no distinction between the two terms. Also, the Chartered Institute of Building (CIOB and the RICS codes of practice used the term "cost estimating" when they were referring to "price forecasting".

In construction cost planning and control the following term as are commonly used: cost estimating, price forecasting and prediction. Forecasting is exclusively reserved for a future (uncertain) event whereas an estimate may also be applied to existing observable (measurable) situation. It might be argued that forecasting is an objective assessment while prediction is a subjective assessment of uncertain future events. A correctly formulated forecast should contain statements that are explicitly: a) quantitative, b) qualitative, c) related to time, d) probabilistic in acknowledging the uncertainty of the future event (Ashworth & Skitmore, 1983). It was resolved that the term cost estimating will be used in this thesis.

It is important, though, to clarify the domain from the outset. The term cost in this study refers to the cost for the client, which is the asking price by the contractor, also referred to as the tender price.

2.2.2   Cost Modelling

Reviewing the literature, it was noted that the term model had various definitions. In general a model is defined in the concise Oxford dictionary as "a representation of a proposed structure in a number of dimensions".

Academically, Ferry & Brandon (1994, p.104) defined models as "representations of real situations (or observable system) in another form, or a smaller scale, so as a realistic appraisal of performance can be made" for the purpose of "display, analysis, comparison or control".

Newton (1991, p. 98) emphasised that models could be used to "describe" how the "features" of interest in a system might "interact". Raftery (1998, p.296) stated that models

facilitated the analysis and understanding of complex phenomena that existed in the real world.

Kirkham (2007, p.165) defined cost modelling as "the symbolic representation of a system, expressing the content of that system in terms of the factors which influence its cost in a form that will allow analysis and prediction of cost".

Hence, it can be concluded that construction cost models can either be predictive models or explanatory models. This study is more concerned with the latter. Primarily the explanatory cost models would seek shedding the light on the relationship between the identified influential cost factors included in the model as explanatory variables and the dependent variable, typically, the cost of construction.

2.3 Cost Planning and Cost Estimating for Construction Projects

The cost of buildings forms an important factor that is considered by the stakeholders of any building projects both in the public and private sectors. In general, cost management which involves cost planning and cost control is a process that extends throughout the various stages of the project from inception to "demolition" (Ashworth, 1999).

The output of the cost planning cycle, that is the cost estimate, will obviously affect the cost control cycle. The more accurate the cost estimates the less the variation and consequently the limited need for remedial actions.

Kirkham, (2007) who presented the eighth edition of Ferry and Brandon's textbook on cost planning of buildings, stated that a good cost plan should " *reduce project risk*" and "*ensure that the tender figure is as close as possible to the first estimate, or that any likely difference between the two is anticipated and within an acceptable range*". The same author identified three main phases of the cost planning process; the briefing phase; the design phase and finally the "*production and operation*" phase.

2.3.1 Stages of Cost Estimating

Flanagan and Tate, (1997, p.48) identified three stages for the cost estimating process namely; feasibility; scheme design and tender action. In the former two stages first estimates are produced using approximate quantities or single rate estimating methods while in the tender action stage a full Bill of quantities is priced.

In a different approach, Ashworth, (1999, p. 273-78) phased out the cost estimating process into three phases; the preliminary estimate; the preliminary cost plan and the cost plan. The first phase provides an indication of cost before any substantial drawings are prepared and is merely perceived as a ballpark figure for guidance.

The preliminary cost plan is more correctly described as an "elemental estimate" that is based on the designer elementary design and drawings (sketch design). The cost plan can only be prepared after the detailed design has been completed. In addition, the cost data needed to formulate the cost plan include the information about the project elements, the material to be used, the contractual information and the analysis of previous projects. A sketch of the cost planning process presented by Ashworth (1999, p. 274) is shown in Figure 2.1.

Al-Turki (2000, p. 56) divided the cost estimating process into five stages; the pres-design estimate; the detailed design estimate; the bid (tender) estimate; the progress estimate and the final estimate/final account.

The client is more concerned with the final cost, which if varied significantly from the tender price, might have detrimental implications on the completion of the project especially in the case of public sector projects in the developing countries.

This was emphasised in the work of Kirkham (2007) who stressed that, so far, the clients are not satisfied with the outcome of the cost estimating process and that there is a "*major shift in emphasis*" towards the final cost rather than the tender figure. The clients are more interested in what they will actually pay for the project on completion.
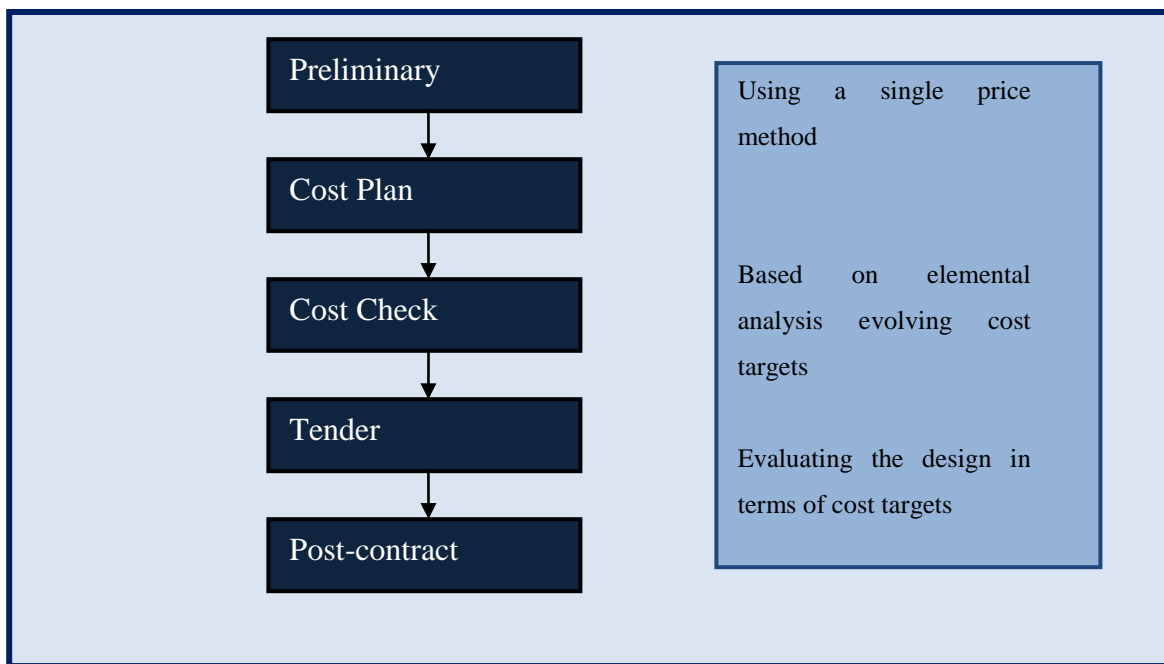
Figure 2.1   Cost planning during the design and construction phases

Source: Ashworth, 1999

2.3.2   Methods of Cost Estimates

Ashworth and Hogg (2007) divided the cost planning and control process into two stages; pre-contract and post contract. In the following discussion there will be more emphasis on the pre-contract cost estimating process. The pre-contract methods for cost estimating identified by Ashworth and Hogg (2007) are shown in Table 2.1.

In the construction management literature there is variation in the jargon used to name the different cost estimating methods. For example, in addition to the above mentioned, there are other methods such as parametric estimating , trade unit cost, cost per enclosed area, cost per functional unit, factor estimating and range estimating methods.

However, by examining these various methods, the underlying assumptions converge so there are hardly any conceptual or technical differences when compared to the above listed methods in Table 2.1. In the following sections some of the most commonly known methods of cost estimating will be briefly discussed.

2.3.2.1 Conference Estimate

A technique that can be used to develop an early price estimate based on the collective view of a group of experts who should have experience in similar projects. This technique is used in special projects when historical data may not be appropriate. Primarily, conference estimates provide a qualitative analysis at an early stage of the cost planning process when quantitative methods might not be feasible.

2.3.2.2 Financial Methods

In building projects that apply the financial methods, cost limits are fixed based on the selling price or the rental value. For example, the amount to be spent on the construction of a building by a developer will be the selling price of the built units minus all development costs and profit. The outcome forms an integral component of the feasibility study of the project.

This method is used to mitigate the project financial risks by setting a ceiling for the final cost at the feasibility stage of the cost planning process. In addition, any variation during the execution phase beyond the set figure will erode the client's profit, for any given selling price.

2.3.2.3 The Superficial Area Method

The superficial area method is an easy method that is suitable for the early cost estimating stage of the project. It is easily understood by practitioners and clients alike. It is based on the gross internal floor area (GIFA) multiplied by a cost per square metre.

However, there are three reservations; the non-usable space should be added; the need for a variety of rates for projects that include special functions and the items that cannot be related to the floor area will be priced separately (Ashworth and Hogg, 2007, p.125).

Method	Notes
Conference	Based on a consensus viewpoint, often of the design team
Financial Methods	Used to determine cost limits or the building costs in a developer's budgets
Unit	Applicable to projects having standard units of accommodation. Used as a basis to fix cost limits for a public sector building projects
Superficial	Still widely used, and the most popular method of approximate estimating. Can be applied to virtually all types of buildings and is easily understood by clients and designers.
Superficial Perimeter	Never used in practice. Uses a combination of floor areas and building perimeter.
Cube	This used to be a popular method amongst architects, but is now in disuse.
Storey-enclosure	Is largely unused in practice.
Approximate quantities	Still a popular method on difficult contracts and time permits.
Elemental estimating	Not strictly a method of approximate estimating, but more associated with cost planning; used widely in both the public and private sectors for controlling costs.
Resource analysis	Used mainly by contractors for contract estimating and tendering purposes. Requires more detailed information on which to base costs.
Cost engineering	Mainly used for petrochemical engineering projects.
Cost models	Mathematical methods which continue to be developed.

Table 2.1   Methods of pre-tendering estimating (source: Ashworth & Hogg, 2007, p.124)

2.3.2.4 The Cube Method

Historically, the cube method was popular amongst architects at the beginning of the last century. The produced estimates were based on the volume of the building multiplied by an appropriate rate from the "cube book", a price book used as a reference that captures the prices of completed projects divided by the cubic content of the building. However, cost estimators are urged to calculate separate volumes and hence various rates for those parts of the building that vary in constructional method or quality of finishing. It is widely

agreed now that building costs correlates better with the gross floor area than the cubic capacity and hence the cube method has largely died out (Kirkham, 2007, p.66).

2.3.2.5 The Single Price Rate Method

The single price rate method refers to the different methods above mentioned that depend on a single rate applied at the pre-design stage to produce an approximate estimate given the limited information available at this early stage of the planning phase. The unit method, the superficial area method and the cube method are examples of the single price rate approach to develop pre-design cost estimates, Kirkham (2007, p.66). Hence, this method is not different from the above mentioned three methods but can be regarded as a different term that should be considered in the context of the applied rate.

2.3.2.6 Approximate Quantities

This method is based on composite items measured by grouping together bill-measured items to produce an approximate estimate. It relies on measuring the major items that determine the cost of the building. Hence, it is claimed that this method provides a more detailed and reliable approach to approximate estimating, but it involves more time and effort than any of the above mentioned methods (Ashworth, 1999, p.251).

The approximate quantities method also helps in the evaluation of the tenders by comparing the approximate estimates to the lower tender and assessing the reasons for any differences. However, this method requires more information and is subject to the experience of the quantity surveyor in selecting the most significant composite items. On the other hand, Ashworth and Hogg (2007, p.126) argued that "the use of approximate quantities for pre-contract cost control can create costing and forecasting difficulties" as more accurate information is established during the later stages of the detailed design phase.

2.3.2.7 Elemental Estimating

An element is defined as "a major component common to most buildings which usually fulfils the same function, irrespective of its design, specification or construction" (Flanagan and Tate, 1997, p.101) that is to say the subunits of the building which should be considered in the cost analysis. Examples of elements are external walls; windows; the roof, etc. An elemental cost analysis provides cost estimators and clients at large with a useful yardstick about the cost of similar projects and how the cost is distributed among the various elements. In this method, unit quantities and unit rates are identified for each element. This helps to pinpoint the source of variation among different projects, whether the variation is due to Quantity "size" or rather due to the Quality and Price level. Also, this allows a more objective comparison among buildings of "different sizes and uses". Flanagan and Tate (1997, p.102) suggested that the final accounts rather than the tender figures of the previously completed similar projects should be considered in the elemental cost analysis.

Elemental cost analysis, further, allows for appropriate remedial actions to be introduced if the bidders request higher values than those produced by the clients' cost estimators by revealing the source of variation.

2.3.3   Cost Data

Generally, the accuracy of the cost estimates will depend on the quality and level of detail of the cost information in any of the above mentioned cost estimating methods. However, it is realised that the majority of the cost estimating methods laid more emphasis on the quantities with implicit and even subtle reference to the economic conditions and its impact on the price level. This is widely noticed in the literature and manifested in the dominant emphasis on the product related variables such as size, type of project, quality of finishing, type of foundations, etc.

The Project Management Institute's (PMI) Body of Knowledge (PMBoK) presents what is arguably known as best practice in cost planning. The suggested cost estimating process commences by developing a work breakdown structure whereby the building is broken

down into simpler components known as work packages and further into tasks or activities. Unit rates are allocated to the activities (work items) which constitute the lowest level of the work breakdown structure. Multiplying the unit rates for each item by the quantity will produce the total cost for each item. The outputs of this process yield the cost breakdown structure whereby the various cost centres can be identified to be used in the cost control stage. By rolling up the total cost of the project can be calculated. In addition, the activity list forms the building block in producing the project time schedule after introducing the logical dependencies and resource constraints.

Ashworth (1999, p. 46) stated that the more detailed the cost data, the more accurate the cost estimates and argued that by identifying the major 100 items of work and pricing them, the produced cost estimate would reach an optimum level of accuracy that could hardly be improved by more detailed pricing. In a bill of quantities (BoQ), the Pareto rule which states that 80% of the total value can be attributed to 20% of the items seems to be instated. However, Ashworth argued that bills of quantities include a wide variation of rates for items of comparable nature on different projects and that small items on the bill of quantities are not priced carefully. Kirkham (2007, p. 203) stressed that at the early stages of the cost planning phase and before the design reaches the detailed stage, the cost breakdown will yield no more than 40 items which can be described as coarse data rather than refined data.

According to Ashworth and Hogg (2007, p.57) a good practice is to prepare a cost analysis including supplementary information on market conditions and specifications for every tender. This will enable the client to establish a useful data bank given the tendency to delay or lay less emphasis on the analysis of final cost records that is perceived by some practitioners as less productive. Ashworth, (1999, p. 47) stressed that in order to establish an effective and reliable cost database, the data has to be collected from a large number of similar projects. In practice, the project team usually starts preparing for the following project once they finish the project in hand. In many cases, the new project will capture the attention and efforts of the project team and will have higher priority compared to the completed projects. Kirkham (2007, p. 202) stated that the cost information needed for price forecasting would arise from the analysis of past projects, i.e. historical costs. Kirkham identified the following types of cost information for price forecasting:

- Cost per square metre for various types of building;

- Elemental unit rates

- BQ rates

- All-in unit rates applied to abbreviated quantities

2.3.4 The Sources of Cost Data

Typically, the source of data is a key determinant of the level of reliability for any data set. In general, from the client's point of view, there are two main sources of cost information; the client's own records that is based on historical data of similar projects and the published cost data as shown in Table 2.2. In addition, the specialist subcontractors can act as an important source providing the client with the needed cost information about special work items such as electro-mechanical works, landscaping, special types of finishing, etc.

2.3.5 The Reliability of Cost Data in Egypt.

In many developing counties, including Egypt, the cost estimators face a number of challenges. The cost information, in general, is scarce due to the less emphasis on establishing cost databases amongst clients and contractors. Cost estimators tend to rely more on their experience and judgment. In addition there is limited published cost information compared to the UK and other developed countries.

Furthermore, it can be argued that in many developing countries, the process of developing government published statistics which should form the most reliable source of cost data lacks the rigor and the outcome, sometimes, can be politicised. For example in Egypt, in the past, the process of measuring the private sector output in construction relied mainly on surveying the public sector contractors who in most cases would hide the real information for tax purposes. Most medium and small private sector contractors did not

keep official books and would rather accept the approximate estimates according to the guidelines set by the fiscal authorities.

Source / Publications	Cost Information
Builders Price Books e.g. Spon's Architect's and Builders' Price Book , Laxton's Price Book	Professional fees Wage rates Market prices of materials Constants of labour and material for unit rates Unit prices for measured work in accordance with the Standard Method of Measurement Elemental rates for a variety of work Building Cost index Approximate estimate rates and comparisons Cost Limits and allowances for public sector buildings European Prices and Information
Building Cost Information Services (RICS/ BCIS)	Surveys of Tender Prices (quarterly) includes updates on:ICS Tender Price Index BCIS Building Cost Index BCIS Five Year Forecast (produced each summer) includes: Building Cost Trends and Summary of Forecasts Executive summary Latest Trends Economic Background (inflation, growth and interest rates) Materials Labour Earnings, Wages and Rates Market Conditions Output Housing Output Forecasts Tender Levels Tender Price Forecast Assumptions for inflation, demand, labour and materials.
Government Literature e.g. Department of Trade and Industry (DTI) Quarterly Building Price and Cost Indices	Statistical analysis of building materials, overseas trade and overseas construction by British firms, Price and cost indices Key performance indicators of construction activity Economic analysis and advice to assist in the the assessment of the construction market and the formulation of efficient policies.

Table 2.2   Examples of published cost data. *Source: Adapted from Kirkham (2007)

2.3.6 Accuracy of Cost Estimates

For so long, cost estimating was simply the process of calculating the total cost of a project, usually performed by quantity surveyors, based on either single unit rate or a relatively more accurate method, by pricing all items of the bill of quantities. The former mostly used at the initiation phase (feasibility or sketch design) to run a feasibility study whereby an accuracy of up to 25% variation is accepted. The latter, on the other hand, is used at a later stage of the planning phase when a detailed design is achieved and an accurate estimate is required before the tendering or the bidding depending on whether the estimate is done by the client or the contractor. Hypothetically, the accuracy at this stage should fall within the range of 5-10%; still in practice, up to 15% is regarded as acceptable.

The accuracy of the cost estimates will be function of the costing strategy especially by bidders. In many cases, the bidders demonstrate a front-loading strategy when pricing items of the bill of quantities. Thus bid value will have a lower net present value compared to the total value estimated under the balanced pricing strategy (applied by most clients). In general there is a more tendency (by contractors) towards front-loading rather than back-loading. Even in volatile markets when the finishing materials and other factors inputs of the later stages work items vary significantly with time, the back-loading is usually avoided. On the one hand, the back-loading strategy will assist to hedge against risks. On the other hand, this will lead to a higher bidding value, which might deter winning the tender, especially in public sector tenders.

Public sector clients, particularly in Egypt, tend to ignore the net present value of the bid and rather focus on the total figure, the asking price to complete the project. The argument usually put forward by public sector clients is that the quantities of work items listed on the bill of quantity are subject to change. Once the work is done, the As-built drawings are produced which reflect reality and form the basis for payments. In many cases there are variations of up to ± 25% in the As-built quantities compared to those on BoQ.

This last point was pinpointed by Kirkham (2007, p.208) amongst the problems identified with the analysis of the bills of quantity. In addition, different contractors follow different pricing methods with regard to the treatment of preliminaries, overheads and profits. This is conceptually different from front-loading and back-loading; still it will affect the cost of BoQ items. It might not affect the total value, though.

Hence, it was resolved in this study that the value of the final invoice for similar school building projects would form a sensible benchmark to compare historical costs.

2.4 Summary

This chapter discussed the cost estimating theory in the context of building projects. The discussion included the various stages of the cost estimating process as well as the various estimating methods mentioned in the construction management literature. The conventional Single Price method was found to be the most popular at the feasibility stage. In the later stages of the planning phase when the detailed design is completed the Project cost is estimated by pricing of the work items on the bill of quantities. However, the accuracy of this method was debated by the majority of scholars. The chapter concluded by presenting a brief discussion on the reliability of cost data and the accuracy of cost estimates for construction projects in Egypt.

CHAPTER 3

BUILDING ECONOMICS AND THE EGYPTIAN CONSTRUCTION INDUSTRY

3.1 Introduction

The chapter aims to discuss the economic theory in the context of the Egyptian construction industry with emphasis on the factors affecting market prices that in turn affects the cost of construction projects in the public sector. The chapter commences with a general review of some of the relevant basic concepts in building economics comparing the views of the neo-classical economics versus the institutional economics school of thought. The government intervention in the economy and its impact on the market prices of the input factors is reviewed. Throughout the chapter the discussion will aim at identifying the key economic indicators that reflect the performance of the economy while having significant impact on the cost of construction projects in the public sector as established in the economic theory and the relevant literature.

3.2 Definitions

The term Economics is derived from Greek three words that are oikos, (a house), nomos, (to manage) and oikonomos (a Stewart). Thus the term economics literally means the wise and legitimate government of the household and in practice refers to the study that enables this management to be carried out by heads of family, heads of business and heads of states (Eccles et al, 1999). Economics is about the choice of the way in which scarce resources are allocated between their possible uses in pursuit of specific established ends. It is rather about the means to achieve the desired objectives and not the ends themselves (Hillebrandt, 1985).

According to Raftery (1991), "Economics is not a precise subject like mathematics. It's a subject where various opinions are voiced and where debates should be encouraged to gain full understanding of the topics covered."

Raftery (1991) argued that:

> "*Economics is a social science not a pure science. There are many untested and untestable models. There are divisions between different schools of thoughts………….. The economic journals indicate that many of the most prestigious academic economists are working on theoretical mathematical models that begin with entirely arbitrary and unrealistic assumptions and lead to precisely stated and irrelevant conclusions as far as the real world is concerned. Too often in economics, the choice is between being roughly accurate or precisely wrong.*"

On the other hand, Sloman (2006) argued that economists have a lot in common methodologically, with natural scientists. Both attempt to construct theories or models that can either explain or predict some specific relationships between a set of variables. However, Sloman emphasized that

> "*Being a social science, economics is concerned with human actions. Making accurate predictions in economics is very difficult given that economics has to deal with a constantly changing environment*"

(Sloman, 2006, p.29).

3.3 Price Theory, Price Policy and Price Determination

Microeconomics is essentially concerned with the efficiency of the firm and the relationship between the firm and the market. Historically, academics seemed to link microeconomics and price theory:

> "*Price Theory, or microeconomics, is concerned with the economic activities of individual economic units, such as consumers, resource owners and business firms.*"

(Harper, 1966)

The terms price and cost are sometimes used interchangeably. However, there is a significant difference since the price paid by the customer would normally equal the cost incurred by the producer plus other items such as profits and taxes. In this study, there shall be more emphasis on the bid value that is the asking price by the contractor which on the other hand equals the cost incurred by the client.

Reviewing the literature on pricing, there are two main categories: literature for price makers and literature about price makers. The former aims at helping people charged with setting and managing pricing policies make better decisions. While the latter discusses the theoretical aspects of pricing and the decision making processes of price makers, analyzing their policies in the context of economic efficiency and social welfare. Price policy and procedure attempt to bridge the gap between the aforementioned two approaches meanwhile retaining the management strategic objectives. In this pursuit, there is usually an interaction between several theories. In general, the economic theories receive the most attention followed by the quantitative and marketing theories, and in addition to the behavioural sciences. (Harper, 1966)

In the following section, price determination by the firms operating in the market will be discussed in the light of the neo-classical view and the perfect competition assumptions. The counter argument set by the institutional economics view and the impact of the government intervention in the economy as reflected on the prices of different products and services will be discussed in later sections of this chapter.

3.4 The Market and the Construction Firm

3.4.1 The Market

A market is said to exist where buyers and sellers are brought together, so that goods can be exchanged for money. In the construction sector, the market can be defined by (Hillebrandt 1985):

- Product
- Type of client

- Location, and the analysis of the market would typically discuss the following:

- Client

- Type of work

- Competition

- Change in consumer demand

- Relevant external influences such as:

- Government actions

- Technology

3.4.2 The Firm

Typically, firms would seek to maximize their profits. In this pursuit, the traditional classical school of thought introduces the concepts of marginal utility and the law of diminishing utility. Firms should continue to produce any product or service as long as the cost of the additional unit produced; Marginal Cost (MC) contributes to the profit of the firm. Hence, production should continue as long as the change in total revenue that results from the sale of an additional unit; Marginal Revenue (MR) exceeds the marginal cost. If the additional unit of production does not add to the profit of the firm i.e. MR= MC, then according to the neo-classical school of thought, there is no benefit realised and the firm should refrain from producing more units if seeking profit maximisation. Also, different commodities tend to portray different price elasticities, i.e. the responsiveness of the quantity sold to price changes. That is the ratio of the percentage change in the quantity sold to the percentage change in price. Hence, the price elasticity of demand for steel and cement, for example, would normally be much less compared to other less dominant factor inputs such as luxurious finishing materials. The steel and cement price movements in the Egyptian market over the past 20 years and its impact on the cost of construction for school buildings will be discussed in further depth in chapter 6.

The neo-classical economics argues that market forces adjust the prices of goods and services and eventually an equilibrium price will be reached. The equilibrium price is the price of any goods or services when the demand equals the supply, in other words, it is the

point of intersection of the demand and supply curves for any commodity (Where MC = MR). If the price of any commodity rises thus accruing above normal profits to the firm, more producers will be attracted to the market which will cause an increase in the supply and eventually bringing the price back to the normal profits level. If on the other hand the price of any commodity falls below the normal profits level, firms will not be enticed to stay in this market and some firms will switch to more profitable ventures. The reduction in the supplied quantities will result in an escalation in the price given that the demand stays unchanged. Eventually the price will return to the normal profit level.

There are several economic factors that affect the construction firm and the market such as (Hillebrandt, 1985):

- Market prices of inputs [material– labour– machinery– money]

- Conditions of competition.

- Size of firm

- economics of scale

- Bulk purchases of material

- Quantity of work at any point in time

- Division of labour.

- Plant and machinery.

- Capital structure.

- Experience in similar project.

- Organizational structure.

- Efficiency (productivity).

- Location of project.

3.4.3 Limitations of Perfect Competition

This neo-classical school of thought has set some rather unrealistic simplifications manifested mainly in the assumptions of the perfect competition:

- There is a large number of buyers and sellers and no single individual or firm has any influence on price.

- There is complete freedom to enter and exit the industry, i.e. no structural entry or exit barriers.

- Homogeneous products and services, i.e. no product differentiation.

- Both sellers and buyers have full knowledge about the terms and conditions of sale.

- All factors of production in the economy are fully employed.

The above mentioned underlying assumptions have been criticized due to the following (Harper, 1966):

1. Many industries have a limited number of buyers or sellers some of whom are quite large in size, such as the case with GAEB and other public sector clients in the Egyptian construction market.

2. The construction industry requires a notable capital investment particularly for contractors opting to acquiring qualification for medium and large size public sector projects. Consequently both entry and exit barriers exit.

3. In the construction industry, even within standardised design projects there are some factors such as location, type soil and type of foundation that render any two projects quite heterogeneous.

4. Full knowledge is generally lacking especially on the buyers' side.

5. It might be reasonable to argue that the construction industry very often does not operate at full capacity.

Moreover, the neo-classical school has been criticized for laying more emphasis on the balance between the supply and demand forces. In doing so, the neo-classical school has been accused of diminishing the crucial effect of different institutions on the performance of the firms and the markets.

3.5   Competition, Monopoly and the Public Interest

Most markets in the real world are imperfect. Firms tend to enjoy various degrees of market power in search for supernormal profits, an issue that has been addressed by governments in framing regulatory legislations. Governments tend to combat anti-competitive practices of monopolists and oligopolists such as price fixing and charging a higher price in pursuit of a larger profit (Sloman, 2006, p.348).

3.5.1   The Impact of Privatization on Market Prices

From the early 1980s, the British government has started an extensive programme of privatization that returned many of the state owned industries to the private sector. Many other countries including Egypt followed similar privatization programmes in what has become a worldwide phenomenon. Namaki, (2008, p.85) argued that governments would opt for the privatisation strategy when they have a strong external orientation but a weak competitive performance.

On the one hand, it might be argued that privatization will lead to better efficiency, faster growth and greater responsiveness to the consumer because the industries will act upon the market forces. On the other hand, in search for price maximization, governments might sell industries in such manna that encourages and facilitates the evolution of monopolies or oligopolies which would probably be against the interest of the consumer. It might be reasonable to argue that the market forces are most likely to break down if a public monopoly is simply replaced by a private monopoly given that the private monopoly, unlike the public monopoly, would be seeking profit maximization (Sloman, 2006, p.356).

However, the current economic crisis forced many governments to take various economic measures that involved the purchase of some of the leading private sector financial institutions and strategic industries. Thus it is reasonable to argue that the claims about efficiency and competitiveness might not be substantiated.

Figure (3.1) shows the privatization of different sectors within the Egyptian economy. The statistics indicates that the cement and building material public industries formed 39% of the total privatization programme (Namaki, 2008, p.87). This had significant impact on the market prices of the end product. For example, the cement price in Egypt has increased almost three fold following the privatization of the cement industry over a relatively short period of time. There was no evidence of any significant changes in the prices of the factors of production that could justify this increase. More importantly, there was no concrete evidence that this price movement was due to a shift in the demand for cement in the local market. On the contrary, the market witnessed an increase in the supply as a result of the expansion strategy pursuit by the oligopolistic cartel that controlled the cement industry. A detailed analysis of the impact of the increase in the price of cement on the cost of school buildings in Egypt will be presented in the following chapter.
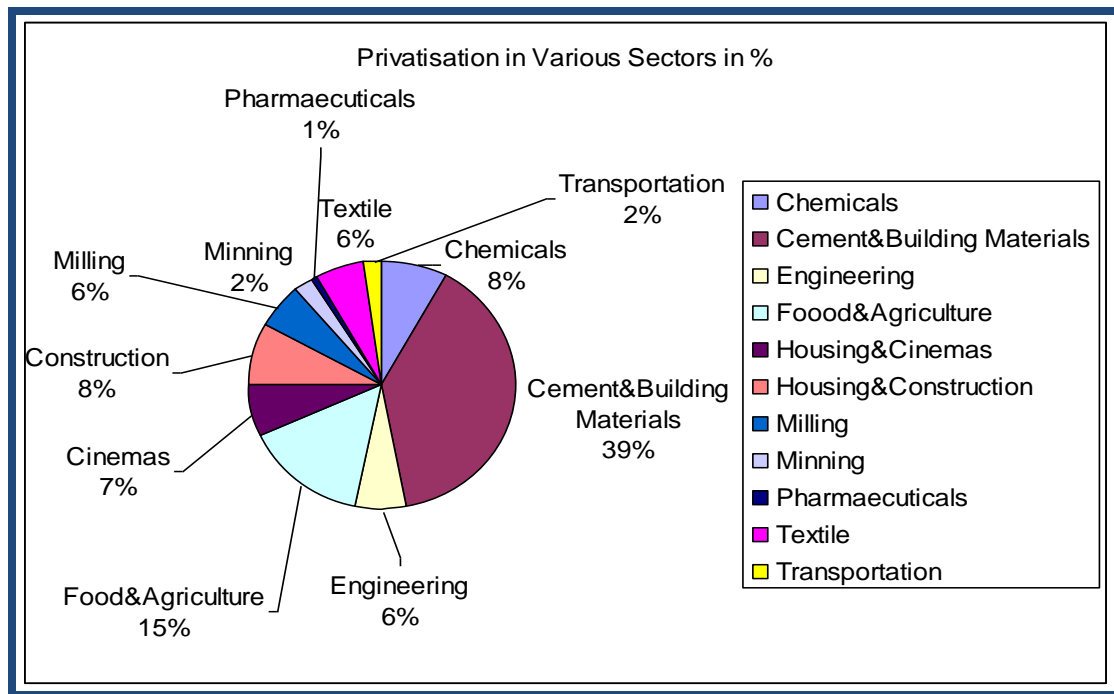
Figure 3.1   Privatisation of Egypt's public enterprises in different sectors, 2000
Source: Namaki, (2008, p.87)

3.6 Macroeconomics

Macro economics is concerned with studying the whole system let it be the economy or the industry (Hillebrandt, 1985).

In an attempt to provide a more detailed definition of the term macroeconomics, Lipsey and Cherystal (2006) stated that:

> *"A modern economy makes available millions of goods and services for people to choose from………………Yet nobody sat down and planned how all this will work. It has evolved as a response to economic forces interacting with individuals and institutions ………… today, as in the time of (Adam) Smith, economists seek to understand the self-organising forces of market economies, how well they function and how governments may intervene to improve (but not to replace)specific aspects of their workings."*

<div align="right">(Lipsey and Cherystal, 2006)</div>

Sloman (2006) argues that macro-economics is concerned with the balance between aggregate demand and aggregate supply. For example, if aggregate demand is relatively high compared to aggregate supply then this is most likely to cause inflation and trade deficits.

3.6.1 The Gross Domestic Product (GDP) and Price Levels

The macroeconomic theory attempts to explain the GDP gap that is the deviation of the actual from the potential GDP as policy makers try to achieve a minimum level of unemployment meanwhile keeping inflation under control (Lipsey & Chrysal, 2007, p. 406).

The four components of GDP are:

1. Consumption: Non-durable goods + Durable goods + Services.

2. Investment: Business fixed investment + residential fixed investment + inventory investment.

3. Government purchases.

4. Net exports (exports – imports).

Ive and Gruenberg (2000, p. 234), in their discussion about the 9-stage business cycle method, questioned whether the construction output will fluctuate in time with GDP, or in a leading or lagging relationship. They mentioned that expectations of future direct costs as well as the opportunity costs of management resources influence tender prices. They referred to the post-Keynesian view that "*because future prices are uncertain, firms can neither bargain nor calculate in real terms'*.

The real GDP is the nominal GDP corrected for the effects of inflation. The ratio of nominal GDP to real GDP is known as the GDP deflator. The latter gives information about the overall level of prices in the economy. However, it is more common to use the consumer price index (CPI) as a measure of the Price level. The main differences are (Mankiw, 2009 p. 32):

- The GDP deflator measures the prices of all goods and serviced produced whereas the CPI measures the prices of the goods and services bought by consumers only. Any increase in prices of goods and services bought by the firms or governments will affect the GDP deflator but not the CPI.

- The GDP deflator includes the domestically produced goods only. Imported goods are not part of the GDP hence will not affect the GDP deflator, but will affect the CPI.

- The CPI assigns fixed weights to the prices of different goods included in a fixed basket of goods (*Laspreyres index*). The GDP deflator assigns changing weights and allows the basket of goods to change over time according to the composition of the GDP.

There are two types of CPI; *Laspreyres index* and *Paasche index*. The *Paasche index* is based on a changing basket of goods. Economists tend to argue that neither is clearly superior. On the one hand, *Laspreyres index* tends to overstate the increase in the cost of living by overlooking the consumer's tendency to go for cheaper substitutes. On the other

hand, the *Paasche index* tends to understate the increase in the cost of living as it does not reflect the decrease in the consumer's welfare by having to shift to cheaper substitutes (Mankiw, 2009 p. 32).

Ive and Gruenberg (2000, p. 258) compared and contrasted the price indices of construction materials and the tender price index (TPI) for all public sector non-house building contracts in the UK over the period 1987 – 97. The results indicated that over the period of 1987- 90 the tender price index for all public sector non-house building contracts was falling while the price indices for the construction materials were rising.

In absence of a reliable tender price index for the construction sector in Egypt, the above findings would rule out replacing the TPI with any of the material price indices, even for those that have a considerable influence on the project cost like cement and steel. The same stands for the use of the material price index to deflate the current tender prices. This will be discussed further in the last section of this chapter when comparing and contrasting the various econometric modelling techniques relevant to this study.

3.6.2   The Balance of Payment and Exchange Rates

3.6.2.1 The Balance of Payment

The balance of payment expresses the country's transactions with the rest of the world. Payments to or deposits from other countries are recorded as debits whereas receipts or deposits from other countries are recorded as credits. The balance of payment includes the balance of payments on current account, capital and financial accounts (Sloman, 2006, p. 416). A balance of payments surplus or deficit usually refers to the current account balance alone (Lipsey & Chrysal, 2007, p. 539).

A current account deficit is likely to be an indication of a healthy growing economy (capital inflows) as of an unhealthy economy in the short run. It is rather the persistence of deficits that would indicate the condition of the economy. A healthy economy will not remain in deficit indefinitely.

3.6.2.2 The Determination of Exchange Rates

Lipsey & Chrysal (2007, p. 528) defines the exchange rate as

> *"the value of one currency in terms of another, when one currency appreciates, the other must depreciate."*

In most cases, international trade between any two nations necessitates the exchange of one nation's currency for that of the other. Despite being *just a price* that can be explained from the perspective of demand and supply, Lipsey & Chrysal (2007, p. 528) stressed that it is

> *"potentially influenced by (and influences) all payments into and out of the national economy from abroad."*

The demand for any currency arises from all international transactions resulting in a receipt of foreign exchange whereas the supply will arise from all international transactions that involve payments in other currencies, i.e. purchasing foreign exchange.

Ideally, the foreign exchange market, like other competitive markets should follow the forces of demand and supply whereby an equilibrium price is reached when demand equals supply. However, governments tend to intervene to control or adjust the exchange rate (Lipsey & Chrysal, 2007, p. 530-31). The determination of exchange rates falls in three main categories:

Flexible or floating exchange rate regime: when there is no official intervention by the monetary authorities. The exchange rate is determined merely by the forces of demand and supply.

Fixed or pegged exchange rate regime: The monetary authorities intervene to control the exchange rate at a specific (or close to) rate. This was the case with the Egyptian currency during the 60's and 70's. This is also the case with the Gulf countries (except Kuwait) where the currencies are pegged to the US dollar.

Adjustable peg and the managed float: These are among the various possible intermediate cases between the above mentioned two pure regimes. Adjustable peg is when governments attempt to maintain par values for the exchange rate; still the par value can

change in reaction to the changes in the economic conditions. On the contrary, governments in the managed float regime, attempt to have some stabilizing influence on the exchange rate but do not set or announce a par value.

Historically, after World War II and under the Bretton Woods exchange system, countries pegged their currencies to the US dollar and to gold. Even after the demise of the Bretton Woods system in 1971, most "*small*" countries still peg their currencies to the US dollar (Samuelson and Nordhaus, 1999, p.732).

Recently, the world has moved to a hybrid exchange-rate system whereby

> *"almost all countries tend to intervene either when markets become disorderly or when the exchange rates seem far out of line with the fundamentals that is, with exchange rates that are appropriate for existing price levels and trade flows."*

(Samuelson and Nordhaus, 1999, p.720).

In order to intervene in the foreign exchange markets, governments tend to hold stocks of ***foreign-currency-dominated*** assets known as "***the official foreign exchange reserves***." In a fixed exchange regime with an overvalued currency, the government will suffer a loss of reserves which will cause balance of payments crises. To deal with such imbalance, governments will face difficult but imperative choices; to devalue their currency; to introduce trade restrictions such as quotas and tariffs or by raising interest rates to stimulate short-term capital inflows (Lipsey & Chrysal, 2007, p. 532).

Sloman, (2006, p. 424) argued that in order to prevent the exchange rate from falling, the central bank intervenes by purchasing the domestic currency in the foreign exchange market. In this pursuit, the central bank would either use the foreign exchange reserves or seek foreign loans.

The Egyptian central bank maintains a carefully monitored foreign exchange reserves in US dollars in order to intervene in the foreign exchange market and control the foreign exchange rate. However, the Egyptian government devalued the currency twice during the period 1998-2003.

The nominal foreign exchange rate US dollar: L.E. fell from 3.39 in 1998 to reach 6.126 in 2003 as shown in Table 3.1.

Yr	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Rate	3.35	3.39	3.39	3.38	3.38	3.38	3.40	3.69	4.49	4.5	6.12

Table 3.1   Nominal Exchange Rate US$:L.E

3.6.2.3 Exchange Rates and Price Levels

On the one hand, the rise in the foreign exchange rate will result in lower prices of the imported factors of production. In the construction industry in Egypt some of the main input factors such as steel and finishing materials are function of the prices of the imported raw materials. Hence, it might be a reasonable hypothesis that a stronger domestic currency is inversely proportional to the total project cost (to the client) in the construction industry in Egypt.

On the other hand, the foreign exchange rates can affect relative prices and net exports. A fall in a nation's foreign exchange rate will increase the net exports and output (Samuelson and Nordhaus ,1999, p.732). Governments, therefore, face a dilemma having to balance between economic growth and an excessive current account balance of payment deficits while controlling inflation and maintaining a minimum level of unemployment.
The exchange rate and the price levels are both indicators of the currency value. While the price level reflects the value of the currency based on a specific basket of goods, the exchange rate expresses the value of the currency in terms of another currency.

3.6.3   Money Supply, Price levels and Interest Rates

Samuelson and Nordhaus (1999, p.466) defined money as

> *"anything that serves as a commonly accepted medium of exchange or means of payment."*

Sloman (2006 p.480) in his definition of money supply distinguishes between narrow money and broad money. Narrow money includes cash, i.e. items of money that can be spent directly. The broad definition of money includes over and above the items included in the narrow definition, any other items that can be readily converted into cash.

Lipsey and Chrystal (2006, p.500) stated that the monetary equilibrium occurs when the demand for money equals the supply of money. They mentioned that in most countries the monetary authorities set the level of interest rates and the money supply adjusts to become equal to the demand at the policy determined interest rate. The nominal interest rate is the reported rate of interest paid by investors to borrow money. The real interest rate is the nominal interest rate minus inflation. It is widely accepted that the interest rates are inversely related to investment, aggregate demand and hence the real GDP (Mankiw, 2007).

Sloman (2006 p.439- 49) further discussed the various economic views on the relationship between the supply of money, price levels and the interest rates. The classical view, based on the quantity theory of money, stated that *the level of prices is directly related to the quantity of money in the economy*. On the other hand, Keynes rejected the quantity theory of money suggesting that an expansion of the money supply will lead to an increase in output rather than prices, if there is slack in the economy.

Most economists agreed though, that excessive growth in money supply causes inflation and that the interest rates can be a more effective tool than controlling money supply for governments to achieve inflation targets. In other words, the rate of interest has a more significant effect on the price levels in the short term. Monetary Policy tools include changing interest rates or money supply whereby high interest rates are a sign of a tight monetary policy aiming at reducing the demand in the economy. The costly borrowing will lead to shrinkage in investment and business expansion. By the same token, low interest rates will stimulate demand. (Lipsey & Chrysal, 2007, p. 370).

3.7 Different Economic Systems

The economic thought has developed over the years in various parts of the world under different environmental and cultural conditions which might explain the variation among different economic systems. Raftery (1991) argues that

> *"Through out the development of economic thought, the questions examined by various schools are usually those, which are of contemporary relevance at a particular point in time in a given set of circumstances. Therefore, the comprehension of underlying*

circumstances and prevailing trends at the time of evolution of different economic theories as integral parts of the developed theories should always be considered prior to application."

In the following sections, the three main types of economic systems; the planned economy, the free market economy and the mixed economy will be reviewed briefly.

3.7.1 Planned Economy or Command Economy

The degree of government control of the economy determines the type of economic system in place. At the one extreme lies the completely planned economy where all decisions are made by the government and at the other extreme lies the completely free economy where all decisions are taken by individuals and firms without any government intervention (Sloman, 2006). The Egyptian economy was run as a planned economy since the 1952 revolution up till the mid seventies. Over the past three decades the Egyptian government has announced the shift towards the market economy, gradually. In the construction sector, this move was manifested in the privatisation of the majority of cement factories; the major steel manufacturing company and some of the major public sector contracting companies. Also, the government started implementing an open door policy allowing the private sector to enter the construction materials markets as manufacturers and importers. The government has lowered the entry barriers by providing various incentives to manufacturers and reducing the customs and tariffs on exports.

3.7.2 Free Market Economy

In the free economy, all parties have the freedom of choice. The owners of the factors of production are free to decide upon prices and quantities they will supply. On the other hand, the entrepreneur is free to choose what type and the quantity of factors needed to supply goods at a certain price. In addition, consumers decide upon the type and quantity of goods they want at the price they can afford. The price determination mechanism in a free economy fails to act as a balanced tool weighing up the needs of consumers against

the requirements of production in relation to sales and the marginal utility of the various goods. The effect of other factors such as elasticity of demand and the elasticity of supply should be considered.

3.7.3 Mixed Economy

The real free economy does not seem to exist even in developed countries that mostly apply a mixed economy where the price mechanism tends to work much slower than in theory. While many individuals may need a product, the economic demand for the product will be restricted to those who can pay the price. In a free market, there are no restraints on the operation of the supply and demand model. However, governments realised that some sectors within the society could not afford to satisfy essential needs such as education and healthcare. This has led to a dispute about the standard of service which any individual has the right to expect, given that resources are not being allocated according to the pricing model. The costs to the state comprise a significant percentage of the annual budget especially in developing countries.

3.8   The Government and the Economy

3.8.1 Economic Growth

In general, governments pursue economic policies aiming to achieve economic growth. According to Samuelson and Nordhaus (1999, p.518) "Economic growth represents the expansion of a country's potential GDP or national output" and the four wheels of economic growth are:

1. Human resources (labour supply, education, discipline, motivation).

2. Natural resources(land, minerals, fuels, environmental quality).

3. capital formation(machines, factories roads).

4. technology (science, engineering, management, entrepreneurship).

Samuelson and Nordhaus (1999, p.522) discussed the classical view of Adam Smith and Malthus when land was freely available and people could easily spread out to occupy more land when population increases thus the output expands with population and the real wage per worker is constant. On the other hand, as the population growth continues, eventually all the land will be occupied and the balanced growth of land labour and output cannot be sustained. The increasing land-labour ratio leads to a declining marginal product of labour and to a declining real wage rates. However, in the twentieth century the technological innovation and capital investment did overcome the law of diminishing returns as witnessed during the Industrial Revolution. The neoclassical growth model summarises the effect of capital deepening on output and wages and interest rates as follows:

"Capital deepening occurs when the stock of capital grows more rapidly than labour force (population). In the absence of technological change, capital deepening will produce a growth of output per worker; of the marginal product of labour and of wages it will also lead to diminishing returns on capital and a consequent decline in the rate of return on capital (interest rates)…" Samuelson and Nordhaus (1999, p.526).

Added to this, the effect of the change in technology has led to an upward shift in the production function due to enhanced productivity generated by the application of new processes and products. Hence, both capital deepening and technology result in rising output per worker; increase in wages and better living standards. Samuelson and Nordhaus (1999, p.555) stated that among the key ingredients for economic development are "macroeconomic stability, high investment rates, a sound financial system and an outward orientation in trade and technology policies."

Many developing countries, like Egypt, sometimes called less developed countries (LDC), are caught in the population trap where the increase in population erodes the growth in output, thus keeping incomes and standard of living at significantly low levels. However, it is argued that less developed countries can turn the relatively high population to an advantage by exploiting the abundant human resources factor. Improving education is imperative to enhance productivity and increase the output. The scarce resources would add to the challenges facing LDC's in this pursuit thus rendering any incremental improvements to the accuracy of the cost estimating process in for school building projects of vital importance.

3.8.2 The Government's Role in the Transition towards Market Economy

Typically, the government plays the role of the regulator in any economic system which is an essential role to protect the general population from the profit maximisation tendencies of the market forces and to act in favour of the society at large, in an attempt to achieve a fair distribution of wealth among the different social classes.

In this pursuit, the government would use a number of tools manifested in both fiscal and monetary policies. In Egypt, the government still subsidises a number of essential commodities such as bread. In addition, the education system in Egypt including higher education is free for all Egyptian citizens. The Government has to finance the school buildings out of the budget. The same applies to the housing sector where the government subsidises the building of thousands of flats every year for those who cannot afford the market prices, given the widening gap between the income and the market prices in various sectors.

At the industry level, governments use a number of tools to regulate the construction markets and adjust prices such as subsidies, price ceilings, quotas and tariffs. For so long, the Egyptian government has been the key producer of the main factors of production such as steel and cement in addition to being the main supplier of sand and gravel. The government used to set the prices of these inputs and issue annual price list, for the different categories of steel and cement. The political decision to privatise the steel and cement industries caused serious turbulence in the markets of both commodities and affected the Egyptian construction industry at large. Typically, government intervention leads to market imperfection manifested in the deviation of the price levels from the neo-classical equilibrium price.

Samuelson and Nordhaus (1999, p. 553) argued that in the transition from the planned (command) economy towards a free market economy, governments should:

- set up a legal framework for the market
- establish a modern banking system
- break up the pervasive monopolies
- tighten the monetary and fiscal policies in order to control inflation
- open up the economy to international competition.

In Egypt, the institutional actions that associated the shift towards a market economy has given rise to monopolistic and oligopolistic practices in the steel and cement industries respectively. In chapter 6, a review of the steel and cement prices over the past twenty years will be discussed in further details.

3.9   The Egyptian Government and the Construction Market

3.9.1   The Government Controls Prices in Public Sector Projects

The Egyptian government acted as a key player in the construction market being the biggest client during the period when the Egyptian economy was managed as a command economy. The government continued to play the same role even after the shift towards the market economy. During the 80's the Egyptian government introduced the notion of "low cost" residential buildings known as "economic housing", the equivalent of council houses in the UK. In this pursuit, the government succeeded for the first time in the modern history of the Egyptian construction industry to drag down the cost residential buildings to reach as low as 99L.E. / sq.m. in order to meet the set targets with regard to the needed housing, given the limited resources and the slim budget for a country that was still suffering the consequences of many years of war. These prices were at least 30% less than the prevailing asking prices by contractors at that time. In other words, the government acted a price maker in the construction market. Such move caused notable changes in the construction industry. New entrants alongside the existing construction firms who agreed to deliver at the offered prices had to undertake several adjustments to cope with the significantly low prices. Coupled with migration of many skilled labourers to the neighbouring rich Oil countries, the contractors opted for cheap labour, and cost dominated the equation. Due to the subsequent low wages offered by contracting firms, the Egyptian construction market started to suffer a clear shortage in skilled labour, something that was strange to occur in a highly populated country like Egypt meanwhile suffering from a significantly high rate of unemployment.

In addition the sub-markets had to react to this change and the demand for many low quality factor inputs started to exceed the demand for the more expensive and better

quality products. As a result of the government intervention with the benevolent objective to provide accommodation for the low income citizens, the construction industry took a down turn. In a few years, some of those low cost units started to show symptoms of poor quality such as cracks, settlements and other facets of failure both in the structural elements and the finishing thus blowing the whistle about some of the poor practices that accompanied the new trend. This gave rise to a debate about the feasibility of the "low cost" trend in construction initiated and nurtured by the government even in the short run.

3.9.2   The Shift towards Market Prices in Public Sector Projects

After the 1992 earthquake, the government, once more, played a significant role in the construction market by introducing another trend that is the no-fringe buildings.
Learning the lesson from the previous experiment in the housing projects and also affected by the consequences of the earthquake, the Egyptian government opted for robust buildings with emphasis on the skeleton meanwhile providing very basic finishing specifications. This new trend was applied to the national project for building schools, the case under investigation in this study. The set prices that were released to the contractors in the form of price lists reflected, in essence, more realistic estimates based on the market prices of the factor inputs. This practice has become the prevailing practice within the majority of the public sector construction projects.

Despite this paradigm and strategic shift in the government's role, the quality of the produced estimates has been questioned. In reaction to the released price lists, bidders asked for a mark up that varied from 10% up to 50%. Given the relatively large number of bidders whereby none of them enjoys any relative power, the competition condition tends towards perfect competition rather than oligopoly. Hence, it is reasonable to assume that the bidders used the mark-up as an adjustment tool to narrow the perceived gap between the released prices and the market prices. It is also reasonable to assume that the asking price (tender value) is set to achieve normal profits since the bidders cannot be categorised as price makers.

3.10 Summary

In this chapter the economic theory was reviewed with emphasis on the macroeconomic concepts that affect the market prices of the factor inputs and consequently the total project cost, in the context of the construction industry. On the one hand, the classical view advocates the influence of market forces mainly the demand and supply in determining prices. On the other hand, the institutional view realises the impact of the government's interventions as influential on the level of prices. This impact of the government economic policies extends beyond just regulating the market, as claimed by the classical view.

In the past, the Egyptian government controlled the prices for the construction public sector projects. Recently, the privatisation of the cement in Egypt, for example, illustrated the impact of the economic policies on the market prices of cement. The discussion aimed at establishing the underpinning theory in an attempt to identify the key economic indicators that have significant impact on price levels. Among the key indicators identified were the rate of interest and the foreign rate of exchange.

CHAPTER 4

INFLUENTIAL FACTORS AND MODELLING TECHNIQUES – A REVIEW OF THE LITERATURE

4.1 Introduction

The theoretical framework underpinning and informing the academic research in the areas of construction cost modelling and building economics was presented in the previous two chapters in the context of this study. This chapter aims at extending the discussion to review the previous published research on cost estimating and cost modelling with emphasis on the influential factors and the applied modelling techniques. The chapter commences by discussing the different views on cost estimating followed by a critique of the prevailing trends in cost estimating and modelling. The review of previous works examines the different views on the accuracy of cost estimates primarily aiming at identifying the influential factors that impact the accuracy of the estimated cost of building projects. The review also examines the various modelling techniques applied in published research. The chapter concludes by a review of the published research on building economics with emphasis on econometric cost models.

4.2 Different Views on Cost Estimating

Cost estimating had developed progressively but had been related to quantity surveyors for a considerable period. The evolution of research addressing the accuracy of this approach drew the attention to the need for further research to improve the accuracy of the produced estimates. Researchers then embarked on investigating all the factors and variables affecting the cost of building projects in more detail, introducing new techniques and in

some cases getting too much concerned with details that albeit enrich the research and add to the knowledge, its applicability to the real world of practitioners is to be questioned. Despite the rigorous research over the past forty years addressing the area of cost estimating from different angles and view points, still in many parts of the world the simple technique used by the quantity surveyors seems to be the most applied.

A shift from a traditional trend to a new trend is a change that needs a solid foundation of change management system and management is the scarcest of all resources (Turin, 1975). Turin was addressing the construction case in the UK so comparatively management is indeed a crucial problem in developing counties like Egypt. The fallacy of rationality in the construction world or as Turin (1973) called it a world of "as if", as if all stakeholders know what is best for them amid the dynamic and sometimes turbulent business environment.

The current structure of the industry is characterised by a majority of the contractors as small or medium size companies that lack resources and expertise with regard to IT and skilled staff to adopt and implement the above mentioned change. For the majority of small companies, the PC is only used for word processing. Simple packages like MS Project are, sometimes, beyond the capabilities of their staff.

The dynamic environment and the economic turbulence Egypt has experienced for over two decades, so far, caused a remarkable shrink in investments by all stakeholders in the construction industry. A general trend of short term planning superimposed any prosperous long term plans. The public sector had a quota to achieve meanwhile being uncertain about the finance where as the contractors had a main goal that is to survive, thus their only option was milking a sick cow to the last drop.

Researchers addressed the need for some research direction or a paradigm shift (Kuhn, 1970 and Brandon, 1982). Bowen and Edwards (1985) called for a change in thinking rather than just improving the current practice. A shift through mathematically based technique such as regression (termed inferential-relational methods) towards a concept of stochastic simulation to incorporate explicit consideration for uncertainty and variability in

cost estimating. The paradigm shift should be seen as a description of a vital area of study. The existing paradigm might be considered as a predominantly historical-deterministic approach. It is easy to understand and follow but does not explain the strengths of relationships between building prices and the independent factors that affect price.

"As a profession, we have failed to appreciate the statistics of description, let alone the statistics of inference, and have relied on deterministic techniques which a scientific approach to quantity surveying finds increasingly unacceptable." Bowen and Edwards (1985).

Bowen and Edwards (1985) argued that the precision of estimates depends on both the method and the type of work and recommended the use of a probabilistic approach to cost estimating.

So far, the main method used by companies is still the standard estimating procedure (Akintoye and Fitzgerald,2000; Beeston, 1983; Ashworth and Skitmore, 1983) which is also known as the quantity surveyors method, where the cost of construction (labour, material, plant, subcontractors) are established then an allowance for overhead and profit is added. The estimate is prepared in a logical manner based on historical costs and anticipated production outputs during construction on site. However, as above mentioned, the input forming the basis for this method of estimating was criticized for its wide variability.

In many developing countries like Egypt, this approach is claimed to the most popular despite all the research done on construction cost modelling up to date.

4.3 Debating the Prevailing Trends in Cost Estimating

The accuracy of the quantity surveyors price forecasting process was criticised for mainly four reasons; a) forecasting is not an exact science, it is heavily dependent upon the availability of historical price data, professional expertise and judgment, b) historical data may be defective, c) at the design stage, ambiguity in the design and ambiguity in the price forecast go hand in hand, d) the variability in unit price rates contained in the bill of quantities (Flanagan and Norman, 1983).

Morrison (1984) examined the accuracy of cost estimates prepared by quantity surveyors during the design stage and concluded that those estimates are not sufficiently accurate to meet all the objectives of cost planning. Morrison suggested developing other methods using large cost databases with emphasis on the importance of sample size or the availability of data but did not mention what methods and techniques should be applied as most appropriate to enhance the accuracy of estimates.

Raftery (1991) set general rules for cost estimating as a guide to good practice suggesting that estimating should only show the level of detail that is relevant to decisions as well as including all items. Documentation must be in a form that is easily understood, checked, verified and corrected.

Since the late 1950's modelling has been applied in search for more accurate cost estimates in the construction management research. Cost models can be classified into three generations (Raftery, 1991)

1. The first generation which began in the late 1950s and continued up to the late 1960s was characterised by a procedural (elemental costing) approach.

2. The second generation, which began around the mid 1970s, was characterised by intensive use of regression analysis.

3. The third generation began in the early 1980s and was characterised by considering uncertainty through probabilistic estimates frequently based on Monte Carlo techniques.

In the late 1990's another generation developed including fuzzylogic; artificial neural network (ANN) (Boussabaine and Kaka, 1998) and neurofuzzy (Boussabaine, 1999 and Wanous *et al*. 2004).

Also, cost models were classified into the following categories in terms of descriptive primitives (Newton, 1991):

- Relevance: whether it relates to a specific design proposal

- Units: the units of measurement.

- Cost/price: how the model is intended to be used.

- Approach: the level at which modelling is applied.

- Time point: when during the design process it is applied.

- Model: a general classification of the technique.

- Technique: the specific classification.

Cost estimating and price forecasting is still a contentious issue. Simple models have been characterised by being non-specific with implicit assumptions and deterministic outcomes. Other models applying different techniques such as regression analysis, Monte Carlo simulation, neural network, artificial neural network, fuzzy logic, and subjective probability are often beyond the comprehension of practitioners besides the need of adequate recourses to integrate them in the estimating process. Also, cost modelling research has been disadvantaged by having no formal means of describing one cost model relative to another (Skitmore, 1988).

There is a consensus among researchers towards the need to communicate the new models and techniques relevant to the industry through training programmes commanded by institutional bodies.

The introduction of appropriate techniques as an integral part of new versions of the widely applied software packages may enhance the awareness and reduce the ambiguity in a practical context especially for small and medium size companies. A wide majority of research either focus on the methodology, technique or the product variables and attributes and the consequent relationship with the cost estimates.

4.4 The Factors Affecting the Accuracy of Cost Models

Typically, the components of cost estimates as can be grouped into direct and indirect costs or variable and fixed costs. Runeson (1988) investigated the significance of cost items based on their contribution to the total cost. Horner and Zakieh (1996) addressed the effect of 'cost-significant' items applying the famous Pareto 80-20 rule. That is to say, that 80% of the value of any contract is contained within only 20% of the items in the bill of quantities. By focusing on these significant items and further more aggregating them into quantity-significant work packages, simpler estimating and more effective control procedures can be achieved. Horner and Zakieh (1996) albeit presenting a simple and user friendly approach, the five conditions they described as necessary before the technique can be applied with confidence call for further study for every project on case by case basis.

Shash and El Khaldi (1992) identified the factors affecting the accuracy of cost estimating. The main factors responsible for the accuracy of cost estimates irrespective of the size of contractors were set in the following order:

- financial issues,

- bidding situations,

- project characteristics

- the estimating process itself.

- the previous experience of the contractor on the type of project.

- anticipated or frequent delays in periodic payments,

- type and size of contract and

- project location.

Al-Harbi *et al.* (1994) mentioned that the major problems facing cost estimators in preparing cost estimates in order of importance were:

- tough competition,

- contract period,

- incomplete drawings and specifications,

- incomplete project scope definition,

- unforeseeable changes in material prices,

- changes in owner requirements,

- current work load,

- errors in judgment,

- inadequate production time data,

- lack of historical data for similar jobs,

- lack of experience,

With the exception of the material prices factor, all the other factors can be claimed to be of minor impact when estimating the cost of school buildings in Egypt due to the application of a standard design. This will be discussed in further depth in the forthcoming chapters.

Al Momani (1996) developed a model relating the total cost at completion for school buildings in Jordan as the dependant variable to three main independent variables; project cost at awarding the contract, variation orders and the project final area in square metres. The model is a multiple linear regression model illustrating the importance of

- accomplishing complete drawings,

- bidding documents,

- consistent specifications,

- the implementation of a project cost system,

It might be a reasonable assumption that in periods of economic turbulence studying the effect of anticipated economic changes on the different components of the independent variable named as the project cost at awarding the contract is imperative. This variable if accurately estimated will improve the accuracy of the suggested model and vice versa. Al Momani whilst developing the model did not address this crucial issue. Hence, the

presented model might be regarded as a useful tool for planners and decision makers explaining the relationship between the three selected independent variables and the dependant variable but fell short of providing an explanatory tool for the effect of the economic conditions on the project total cost. This was the main gap identified lay this study which aims of attempting to cost this gap.

Wanous *et al.* (2004) introduced a neuro-fuzzy decision support model for mark-up estimation. The variables identified as the most influential factors affecting the mark up were:

- anticipated risk,

- confidence in cost estimates,

- competence of expected competitors,

- way of construction,

- rigidity of specifications,

- site accessibility,

To conclude this section a list was produced that collated the various factors identified in the literature as shown in Table 4.1. The produced list illustrates the absence of economic factors as explicit variables included in the models. It might be argued that some factors such as tough competition, anticipated risk and material prices reflected the economic conditions. However, this was implicitly considered. It is not clear, so far, how cost estimators understand the relationship between the performance of the economy and the total cost of the project whilst producing cost estimates at the planning phase of the project. This will be discussed in further detail in chapters 7, 8 and 9.

4.5 Modelling Techniques

Newton (1991) classified techniques or modelling tools for cost estimating into four groups:

1. experienced based (algorithms, heuristics, expert system programming).

2. simulation (heuristics, expert models, decision rules).

3. parametric (regression, Bayesian, statistical models, decision rules).

4. discrete state (linear programming, classical optimisation, network, PERT, CPM).

Raftery (1991) classified the techniques of business forecasting into three categories;

1. qualitative, (e.g. Delphi technique),

2. time series that predict future values of a variable from observations of its historical behaviour using mathematical exploration and taking into account, trend, seasonality and cyclicality,

3. causal methods (e.g. regression and/or correlation analysis),

Other techniques developed in the late 1990's including fuzzylogic; artificial neural network (ANN) (Boussabaine and Kaka, 1998) and neuro-fuzzy (Boussabaine, 1996 and Wanous *et al*., 2004).

A number of researchers mentioned that regression models have emerged as the most popular techniques in the work of Chan & Park (2005); Neale & McCaffer (1974); McCaffer (1975); Flanagan & Norman (1978); Bowen (1982 , 1984), Al-Turki (2000); Bee-Hua (1999); Ng *et al.* (2004); Raftery (1991); Reynolds, 1993) and others. Bowen and Edwards (1985) pinpointed the superiority of the regression models and wondered why these models were not widely applied in practice or adopted by the industry.

Moreover, regression analysis has been applied by many researchers; Ashworth et al. (1980); Fellows, (1991); Akintoye and Skitmore (1994); Songer and Molenaar (1997); Konchar and Sanvido (1998); Smith (1999); Ameen et al (2003); Ranasinghe (2000); Salama *et al.* (2005); Salama *et al.* (2006) and others.

Therefore, it was resolved that the Multiple Regression technique was appropriate for building the explanatory cost model which is explained in detail in chapter 9.

Influential Factors	Sources from the Cost Estimating and Modelling Literature
1. Tough competition,	Al-Harbi *et al.* (1994) - Wanous et al. (2004)
2. Type and size of contract	Al-Harbi *et al.* (1994) - Wanous et al. (2004)- Shash and El Khaldi (1992) - Bowen and Edwards (1985)
3. Incomplete drawings and specifications,	Al-Harbi *et al.* (1994)
4. incomplete project scope definition,	Al-Harbi *et al.* (1994) - Flanagan and Norman (1983)
5. Unforeseeable changes in material prices,	Al-Harbi *et al.* (1994)- Raftery (1991)- Ashworth (1999)
6. Changes in owner requirements,	Al-Harbi *et al.* (1994)- Al Momani (1996)
7. Current work load	Al-Harbi *et al.* (1994) - Wanous et al. (2004)
8. Errors in judgment by estimators,	Al-Harbi *et al.* (1994) - Runeson (1988)
9. Inadequate production time data,	Al-Harbi *et al.* (1994)- Raftery (1991)- Ashworth (1999)
10. historical data for similar jobs	Al-Harbi *et al.* (1994) -Flanagan and Norman (1983) - Morrison (1984)
11. Experience of estimators	Al-Harbi *et al.* (1994) - Wanous et al. (2004)- Runeson (1988)
12. Project cost at awarding the contract,	Al Momani (1996)
13. Variation orders	Al Momani (1996) - Al-Harbi et al. (1994)
14. Project final area in square metres.	Al Momani (1996)- Raftery (1991)- Ashworth (1999)
15. Complete drawings and bidding documents,	Al Momani (1996)- Raftery (1991)- Ashworth (1999)
16. Consistent specifications	Al Momani (1996)- Wanous et al. (2004)
17. Implementation of a project cost system.	Al Momani (1996) - Horner and Zakieh (1996)
18. Size of contractors	Wanous *et al.* (2004)- Raftery (1991)- Ashworth (1999)
19. Previous experience of the contractor on the same type of project.	Shash and El Khaldi (1992)- Raftery (1991)- Ashworth (1999)
20. Anticipated delays in periodic payments,	Shash and El Khaldi (1992)
21. Type and size of project	Wanous *et al.* (2004)- Shash and El Khaldi (1992) – Bowen and Edwards (1985)
22. Project location.	Wanous *et al.* (2004) - Shash and El Khaldi (1992)- Salama *et al.* (2005)
23. anticipated risks	Wanous *et al.* (2004)- Turin (1973) – Raftery (1991)

Table 4.1   Factors affecting cost estimates for building projects

4.6 Econometric Cost Modelling

At the start of this section it is worth noting that this review of the literature aimed at identifying the best-fit methods and techniques that would guide the analysis of the data set pertaining to the school building in Egypt and was not limited to the identification and discussion of the relationships which were deduced in the specific context of a certain country or region.

The economic journals indicate that many of the most prestigious academic economists are working on theoretical mathematical models that begin with entirely arbitrary and unrealistic assumptions and lead to precisely stated and irrelevant conclusions as far as the real world is concerned. Too often in economics, the choice is between being roughly accurate or precisely wrong (Raftery, 1991).

Throughout the development of economic thought, the questions examined by various schools are usually those, which are of contemporary relevance at a particular point in time in a given set of circumstances (Raftery, 1991). Therefore, the comprehension of the underlying circumstances and the prevailing trends at the time of evolution of different economic theories as integral parts of the developed theories should always be considered prior to application. In some cases, the mix between two approaches may prove to be the best fit for the status quo. Many countries now apply a mixed economy approach. Hence, the analysis of the economy and economic related issues is a form of value judgment.

In a chronological approach, Ofori (1984) investigated the construction industries in Ghana and Tanzania, compared and contrasted the economic environment affecting the construction industry in both countries. Ofori suggested, in order to rescue the declining industry, that the experts themselves should take some measures and not to expect the government to shield the industry from unfavourable economic conditions. Ofori's paper did not really add new knowledge regarding the suggested remedial actions, yet when mentioned in the context of Ghana and Tanzania case coupled with a clear analysis of the two countries' construction industry, it served its aim. Then Ofori (1988) investigated the relationship between the construction industry and the economic growth in Singapore.

Raftery (1997) studied the price stability and the business cycle in the UK construction bidding pattern over the period 1970-91 and used two measures of tender patterns; a coefficient of variation to compare data from different populations and a coefficient of skewedness as a measure of systematic deviation from the mean. Raftery in stating the limitations of this study referred to the data as the main source of sample error and bias. The data was spread over a long time scale and with dominance of public sector projects.

Tse and Ganesan (1997) investigated the relationship between GDP and construction flows in Hong Kong using unit roots tests (DF, ADF) and Granger causality tests. Their findings showed that for the Hong Kong case the GDP tended to lead the construction flow not vice versa. Despite not directly addressing the cost of construction the findings of the study indicated the impact of the performance of the economy on the flow of the construction activities which amongst other factors would affect the cost of construction projects. Seeley (1996) commented on the variety of building cost indices and tender price indices (TPI) used in the construction industry as reflection of the need for different series of indices covering different time periods.

Tysoe (1991) recommended that the following four factors should be considered when constructing an index:

- the purpose of the index.

- the selection items weighted as necessary.

- the choice of weighting reflecting the relative importance of the items.

- the choice of the base year, preferably a recent year when there were no unusual occurrence.

Akintoye *et al*. (1998) investigated the macro-economic leading indicators of construction contract prices in the UK. Typically, the quantity surveyors depend on macro construction price forecasts available in the form of the tender price index which are inevitably inaccurate (Fitzgerald and Akintoye, 1995). If construction prices have a close relationship to the trade cycle (Akintoye, 1992) then it seems reasonable to claim that construction price movements have their own leading indicators. Akintoye *et al*. (1998) used the quarterly tender price index prepared and published by the Building Cost Information

Service (BCIS 1983). They stated that the construction tender price index (TPI) is used in estimating, updating of cost data, deflation of economic time series data into real terms, escalation management and in the calculation of the replacing costs of buildings.

The economic indicators can be classified into three main types; leading indicators, coincident indicators and lagging indicators, all of which are distinguished by their cyclical timing. Leading indicators are time series, which lead the general business cycle and thus enable the cyclical movements to be predicted. An indicator with less than a quarter time lead will help immediate forecasting, while a lead-time of up to three quarters may be useful for short term forecasting. Medium and long term forecasting will need longer lead-time. The most promising traditional approach to the forecasting of cycles and their turning points is by leading indicators (Akintoye *et al.*, 1998).

Akintoye *et al.* (1998) defined some basic characteristics of economic indicators:

- should represent an important economic process and accurately measure it.

- should not be subject to occasional major revisions in terms of constituents, composition and measurement.

- should bear a consistent relationship over time with movement and turns in the economic variable of interest.

- should not to be dominated by irregular and non-cyclical movements.

- should be promptly available and shortly reported.

They stated that it might be very difficult for a time series variable to satisfy these conditions over a long-run period due to random economic shocks that might create fluctuation over periods of short duration. They selected 23 variables (potential indicators of construction price movements) and applied correlation and regression techniques to determine what type of indicator each variable represents (leading, coincident or lagging) and hence establish the relationships between the leading indicators and construction price. Their findings being based on the UK data may not be of relevance to our case. However, their findings provided important guidelines which informed this research towards building an explanatory cost model using a cross-sectional data set and meanwhile endorsed the decision to apply the regression analysis technique in the data analysis stage

of this study. Furthermore, the findings of the above mentioned study emphasized the superiority of the leading economic indicators as explanatory variables of the dependent variable; the construction price.

Using a different approach; 'a multivariate discriminant analysis' MDA, Ng *et al.* (2000) developed a model to predict the TPI trends in Hong Kong based on eight economic indicators relevant to the construction industry and economic environment in the country. It was noted that they only referred to the work of Akintoye *et al.* (1998), aforementioned, superficially. This is quite understandable due to the difference in economic environment. Wang and Mei (1998) developed a model for forecasting construction cost indices in Taiwan using time series and autocorrelation analysis mainly based on an existing construction cost index that they regard as inaccurate. So far, there is no officially published construction cost index in Egypt.

Dawood (2000) developed a methodology encapsulated in the form of a computer programme to forecast the cost indices in the Greek construction industry. Dawood in his methodology combined the subjective approach based on the judgment of experts with the objective approach applying scientific process to analyse previous data. He used a statistical approach to create 'a fit' to the historic data then applied a model to predict the future occurrences.

Dawood (2000) called his approach 'Joint Approach Methodology' and reviewing the literature, he listed the subjective forecasting techniques as; sales force estimates, the survey method, the average judgment method, the Delphi method, identification methods and graph and table method. He also listed the objective forecasting techniques as; moving average models, smoothing models, decomposition models, ARIMA models/Box Jenkins, causal models and learning models (Neural Networks). Dawood (2000) concluded a model whereby: Forecast = Trend* Seasonality * Cyclicality and discussed how to estimate each variable based on both historical data and expert judgment. The developed model despite being semi-complex remains subject to the accuracy of inputs from involved experts, merely based on their judgments.

Lopez and Ribeiro (2000) presented a review of the macro-economic and construction data from Portugal post 1970, analysing the impact of the Economic and Monetary Union on

the construction sector. The main aim of referring to this paper is to further illustrate the prevailing trend of many researchers to investigate the economics of the construction industry as applies to a specific country or region. The uniqueness of each case is the impetus for this trend and is an inherent characteristic of building economics.

Several researchers addressed the relationship between time and cost based on Bromilow's time cost model (Bromilow *et al* 1980, Kaka and Price 1991, Chan 1999 and others). Ng *et al*. (2000) investigated the relationship between the BTC model and commonly used economic indicators in Australia using correlation analysis. They stated that their findings agrees with CIDA 1993 that one major factor on cost time performance (CTP) is the prevailing economic climate. One interesting finding was that the more favourable the economic climate the longer it takes contractors to finish their work. They reasoned this as due to an excessive amount of work in hand.

This in fact contradicts the case in Egypt and hence pinpoints the importance of identifying the capacity of the industry and utilisation rates as may widely vary amongst different countries.

Tse and Raftery (2000), investigated the effect of money supply on construction flows in Hong Kong. Tse and Raftery presented an informative paper addressing, as they claimed, an area where there has been a little or no research done. The study investigated the econometric relationship between financial and construction sectors. They examined the extent to which fluctuation in the money supply M3 caused fluctuation in real construction activity using Granger causal test. Tse and Raftery concluded that; a) the construction activity does not relate to credit availability, b) the broadly defined money supply is causally prior to construction flow. The main critique of paper is the tendency to generalise the findings albeit based on Hong Kong data. It suggested that this study may need to be run on different data sets from other parts of the world under various economic conditions in order to verify the generalisabilty of the findings beyond the specific context of Hong Kong.

Goh (1999) suggested that there was a predominant use of the multiple regression in construction demand modelling and forecasting. Goh investigated the accuracy of the approach by comparing the forecasting performance of different forms of regression

techniques through a case study modelling Singapore's residential, industrial and commercial construction demand. The techniques used included:

- multiple linear regression (MLR),

- multiple log-linear regression (MLGR), and

- autoregressive nonlinear regression (ANLR).

Goh (1999) used a quarterly time-series data set over the period 1975-1994. The objective was to evaluate the reliability of these techniques in modelling sectoral demand based on ex-post forecasting accuracy. It was found that the (MLGR) outperformed the other two methods in two of the three sectors examined by achieving the lowest mean absolute percentage error. The study concluded that the nonlinear techniques were more accurate in representing the complex relationship between the demand for construction and its various associated indicators.

The findings of Goh (1999) further supported the decision taken in this study to apply multiple regression analysis to the Egyptian data set as above mentioned in section 4.5. The discussion presented in chapter 9 examined the most appropriate type of multiple regression analysis to be applied to the Egyptian data set in light of the selected variables.

4.7 **Main Conclusions of the Literature Review**

The main conclusions of the aforementioned review of the building economics and the cost modelling literature can be summarised as follows:

1. Building economics topics are mostly investigated on regional or even country basis due to the considerable differences between different territories that invalidates the relationships deduced.

2. Investigating the cause and effect relationships between different economic variables and analysing the performance of the economy in relation to the

construction industry can be a stand-alone research even if no model was concluded.

3. The conventional QS Unit Rate Estimate method is still up to date the most commonly used amongst construction firms in different parts of the world, yet the accuracy of this method is regarded by most researchers as unsatisfactory.

4. Cost estimating / price forecasting is still a contentious issue. Simple models have been characterised by being non-specific with implicit assumptions and deterministic outcomes. Other models applying different techniques; regression analysis, Monte Carlo simulation, neural network, artificial neural network, fuzzy logic, subjective probability ….etc. are often beyond the comprehension of practitioners. In addition there seems to be a lack in the recourses needed to integrate such techniques in the estimating process.

5. Risk management and mainly risk analysis' application is remarkably limited in practice in spite of the awareness of its importance by practitioners who still treat risk intuitively based on their experience and judgment. The main factors that contributed to such attitude do not differ much than those above mentioned related to the application of cost models.

6. There is a consensus among researchers towards the need to communicate the new models and techniques relevant to the industry through training programmes commanded by institutional bodies. The introduction of appropriate techniques as an integral part of new versions of the widely applied software packages may enhance the awareness and reduce the ambiguity in a practical context especially for small and medium size companies.

7. A wide majority of research either focus on the methodology/ technique or the product variables and attributes and the consequent relationship with the cost estimates.

8. Economic variables are integral part of cost estimating, yet the economic variables were addressed in most cases through implicit assumptions. This is the gap that

formed the main driver for conducting this research. This study argues that this is one of the main factors that contribute to the inaccuracy of cost estimates. The claim that such assumptions simplify the produced model is a contentious issue.

9. The majority of researchers recommended the use of regression analysis as one of the reliable techniques in formulating the relationship between different variables in cost estimating.

4.8 Summary

Following the review of the cost estimating and building economics theory presented in the previous two chapters, this chapters aimed at reviewing the published research on cost estimating and cost modelling including the econometric cost models. The chapter introduced a discussion on the prevailing trends in cost estimating and the accuracy of the produced estimates as perceived by scholars. The review of previous works aimed at listing the influential cost factors that scholars identified based on their impact on the accuracy of cost estimates. A list including 23 influential cost factors was presented. In addition, the review of the published academic research identified the various modelling techniques, primarily, aimed at selecting the most appropriate data analysis technique to be applied to the Egyptian data set. The chapter, also, discussed the different views of the construction management researchers on the development of the cost modelling over the past five decades. The various trends and modelling techniques have been presented. The regression technique emerged as one of the most popular modelling technique applied by many scholars. It was, therefore, resolved to apply the multiple regression technique to the Egyptian data set examined in this study. Furthermore, a gap was identified since the variables informing about the performance of the economy were included in most cases through implicit assumptions. Finally, the review of the building economics published research indicated that in most cases the research findings were relevant to the specific context of the country or region where the research was conducted due to the variation in the economic conditions.

CHAPTER 5

RESEARCH DESIGN

5.1 Introduction

In this chapter the research design process will be discussed. The chapter commences with some definitions of the most commonly used terms to shed some light on the specific meaning sought within this study, given the variation witnessed in the research literature such as Creswell (2007 & 2009); Bryman (2004); Easterby-Smith *et al.* (2008); Cortty, (1998); Bryman and Bell, (2007); Tashakkori and Teddlie (1998); Fellows & Lui,(2008); Remenyi *et al.* (2009); Denzin and Lincoln (1994, 1998 & 2008); Flick, (2007) and others Like Thorpe ctat (2008) see p.73 . The chapter then discusses the main elements of the research process namely, ontology, epistemology, methodology and methods in the context of this study. The selected methodology is described and explained whereby a detailed design of the research process is presented and discussed with emphasis on the applied methods for data collection. The chapter concludes by elucidating the alignment of the methodology with the research objectives.

5.2 Definitions

In the research design literature the terminology, sometimes, causes a bit of confusion especially when the terms used may suggest different meanings; "the terminology is far from being consistent in research literature and social science texts. One frequently finds the same term used in a number of different, sometimes even contradictory, ways" Crotty (1998). Therefore, this section aims to introduce some definitions before embarking on the discussion in the following sections.

Research: The term research is defined as "a careful search or investigation"; "systematic investigation towards increasing the sum of knowledge" (The Chamber Dictionary, 2001). The terms careful, systematic and investigation indicate that research is a process that

should be well designed and should have a clear plan with specific aims and objectives. (Fellows and Lui 2008). According to Denzin & Lincoln (2008):

> *"Three interconnected, generic activities define the qualitative research process. They go by a variety of different labels, including theory, analysis, ontology, epistemology and methodology...........The gendered multiculturally situated researcher approaches the world with a set of ideas, a framework (theory, ontology) that specifies a set of questions (epistemology) that he or she then examines in specific ways (methodology, analysis)"*

Ontology: This is the most fundamental branch of metaphysics. Ontology is the study of being and its basic categories and relationships. It is about determining what can be said to "exist". Ontology is an attempt to answer the question "what is the form and nature of reality" (Denzin & Lincoln, 1998)

Epistemology: Derived from the Greek *επιστήμη - episteme*, "knowledge" + *λόγος*, "logos" or theory of knowledge and is a branch of philosophy concerned with the nature and scope of Knowledge. In other words it seeks to provide an answer to the question *"what is the nature of the relationship between the knower and what can be known"* Denzin & Lincoln (1998) or "how we got to know what we know?". Thorpe *et al.* (2008) define it as general set of assumptions about the best way of inquiring into the nature of the world. The term was introduced into English by the Scottish philosopher James Frederick Ferrier (1808-1864). Hence, epistemology can be defined as the theory of knowledge embedded in the theoretical perspective which in turn provides the context for the research process.

Theoretical Perspective: "the philosophical stance informing the methodology and providing context for the process and grounding its logic and criteria" as defined by Crotty (1998) who followed his definition by stating that examples of theoretical perspectives are positivism, interpretivism and constructivism. Thorpe *et al.* (2008) criticized Crotty preferring to use the term "ontology" for what Crotty called "theoretical perspective". Denzin and Lincoln (1998), agreed with Thorpe et al. that constructionsim, (term used by Crotty) is an example of epistemology meanwhile used the term paradigm when discussing the philosophical stances informing the methodology as reflected in the definition below, in the following section an example of the variation in the use of terminology within the research literature which suggests that the discrepancy is well beyond just the terminology.

In this study it was resolved that the term Ontology will be used to describe the realism stance and that the term epistemology will be used for the positivism philosophical stance both guided the design of the methodology and the methods selected for this study.

Paradigm: A conceptual or methodological model underlying the theories and practices of a science or discipline at a particular time; hence, a generally accepted world view (Oxford online Dictionary)**.**

Denzin & Lincoln (2005) defined paradigm as "the net that contains the researcher's ontological, epistemological and methodological premises" or as "the basic set of beliefs that guide actions" (Guba & Lincoln, 1989). Kuhn (1970) used the term paradigm to describe the evolution and progress of scientific discoveries in practice rather than within academic investigations.

Paradigm Shift: a conceptual or methodological change in the theory or practice of a particular science or discipline; (in extended sense) a major change in technology, outlook,(Oxford online Dictionary). Therefore, it is essential to note when discussing a paradigm shift whether the shift concerns the concept and the theory (epistemological) or just the methodology which does not necessarily call for a different epistemological stance. Take case study as a research methodology, for example, compared to a quantitative survey research, both can be conducted in a positivist setting that is adopting an objectivist epistemology based on a realism ontological stance. However, and it is not meant to complicate things further, it is worth noting that a conceptual paradigm shift may still fall within the same epistemological stance.

Methodology: can be defined as *"the principles and procedures or logical thought processes which could be applied to a scientific investigation"* Fellow and Liu (2008). Crotty (1998) defines methodology as the research strategy or design that shapes the researcher's choices and use of particular research methods linking the objectives of the study to the outcomes in a justifiable manner, also providing the rationale for the choice of the methods and the particular forms in which the chosen methods are applied. Hence, the methodology is the plan of action that details the tasks and actions needed to reach the set objectives of the study.

Research Method: The research method refers to the detailed description of the techniques of data collection and analysis undertaken, well justified and planned for within

the overall research plan (the methodology). So for example, if the researcher chooses to undertake a survey- as applied in this study - it would not be enough to mention that it was done through interviews. It will be essential to look at the type of interviews; the interviewing techniques; the sampling techniques; the context and content of the questions asked; the degree of participation, etc… (see chapter 7)

5.3 The Main Elements of Research Design

Typically, when embarking on research, the researcher often expresses bewilderment at the array of methodologies and methods available. At the heart of the research design process is the choice of a suitable methodology and methods. However, there might be several routes leading to the same destination. It is, therefore, the researcher's decision on which route to follow. Having said so, it is important to note that there are, in most cases, some agreed upon guidelines and procedures to be followed in order to yield a rigorous piece of research. In the following section, the five main elements of research will be introduced and discussed briefly.

As stated above in section 5.2 under the definition of the term "research, the following discussion presents one of the valid views that should neither be regarded as exclusive nor exhaustive but rather the proposition by the author as one of the valid views on the research design process.

As a starting point, the researcher would be seeking an answer for the following questions:

- What are the methods proposed?

- What methodology dictates the choice and application of the methods?

- What is the theoretical framework behind the suggested methodology?

- What epistemology informs this theoretical framework?

- What ontology informs the selected epistemology?

The answer to these five questions provides the main elements of the research design process as shown in Figure 5.1, namely: a) the method which is the data collection and analysis techniques; b) the methodology that is the action plan justifying the choice of the methods and linking the objectives to the outcomes; c) the theoretical framework that is the theory or set of theories informing the methodology; d) the epistemology which is the philosophical stance embedded in the theory and thereby in the methodology and finally e) the ontology is the philosophical stance that informs the epistemology.

In the following sections the five elements will be discussed in further detail in the context of this study. The discussion will start in a reverse order though, compared to the above stated since the ontology and epistemology are thought to be the foundation and the base on which the whole structure rests. Hence, it might be reasonable to start by the ontological and epistemological stances followed by the theoretical perspective then the methodology and finally the methods.
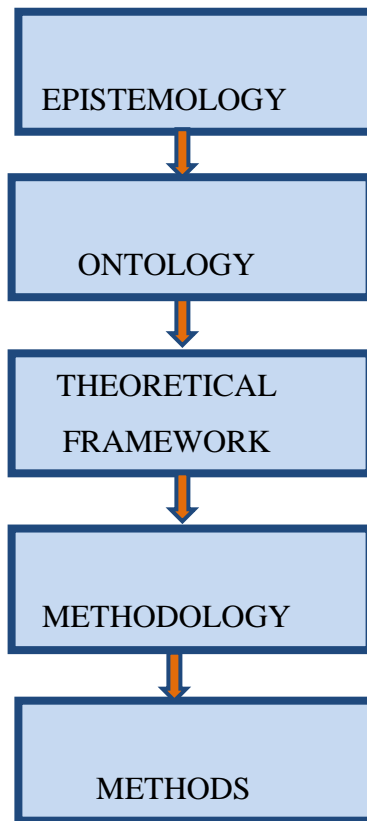
Figure 5.1   The Five Elements of the Research Design Process

5.3.1 Ontology and Epistemology

As previously defined, ontology is an attempt to answer the question "what is the form and nature of reality" whereas epistemology is the theory of knowledge; an attempt to answer the question "how do we to know the world" or as Creswell (2009) puts it, the assumptions on the relationship of the researcher to that being researched.

Under ontology, there are a number of philosophical stances such as realism, critical realism, historical realism and relativism. Also, under epistemology there are a number of stances such as objectivism and subjectivism. However, this brief list is neither inclusive nor exhaustive. In presenting his suggested approach to design the research process, Crotty (1998) intentionally skipped ontology and theoretical framework and focussed on the other elements, adding the term theoretical perspective

> *"...it would seem that we can deal with the ontological issues as they emerge without expanding our schema to include ontology. This is borne out when we look at literature that suggests the understated importance of the ontological dimension in research. In many instances, the authors are not talking about ontology at all."*
>
> (Crotty 1998)

Denzin & Lincoln (1998) and Crotty (1998) seem to have agreed that there are substantial linkages between positivism and objectivism (epistemology) However, Denzin and Lincoln (1998) took a further step backwards to the ontological stance linking positivism to naïve realism and post-positivism to critical realism.

On the other hand, Denzin and Lincoln (1998) have tried to link the different theoretical perspectives to the relevant ontology, epistemology and methodology as discussed in section 5.2. In the following sub-section, positivism will be discussed being the paradigm or theoretical stance adopted by this study.

5.3.1.1 Positivism

Positivism which has origins dating back to August Comte, 19th century French philosopher, bases knowledge solely on observable facts (Tashakkori &Teddlie, 1998).

Positivism assumes the objective existence of meaningful reality, put in other words, that the meaning did always exist, awaiting researchers to discover it without any influence of the researcher. If only researchers go in the right way, they can find (discover) this meaningful reality with certitude. Conventional positivist social science applies four criteria:

Internal validity: the degree to which findings correctly map the phenomenon in question. The venal les selected to build her resdel are justified & supported by theory the prove to lea statistically significant.

External validity: the degree to which findings can be generalised to other settings similar to the one in which the study occurred. The sample size & the pend covenend should confirm that E.V. is verified.

Reliability: the extent to which findings can be replicated, or reproduced by another enquirer. The random sampling – The sample size – The period all should unify the reliability.

Objectivity: the extent to which findings are free from bias (Denzin and Lincoln, 1998). Fandom sampling – Sample size.

Post-positivists have criticised the conventional positivists' stance and partially deviated from it. Post-positivists like Feyerabend (1987), Popper (1963) and Kuhn (1970) questioned both the absolute objectivity and certitude.

However, despite the differences with conventional positivists, post-positivists' stance is fundamentally different from other paradigms or theoretical stances like constructivism or interpretivism that adopt a relativist (relativism) ontology and a transactional epistemology (Denzin and Lincoln, 1998).

Crotty (1998) suggests that researchers should be presenting their studies in positivist terms or non-positivist terms rather than quantitative vs. qualitative. Following this line of thought, it is claimed that qualitative research as well as quantitative research can be understood positivistically or positioned in an overall positivist setting.

Crotty (1998) suggests that when exploring meaning through qualitative methods such as interviews, for example, then confirming and validating the results by a quantitative method, the study is said to be conducted in a positivist manner. It is not the use of quantitative methods that reflects a positivistic posture on the study but rather the attribution of objectivity, validity and generalisability to quantitative findings.

Therefore, it might be reasonable to claim that this study follows the positivist paradigm or philosophical stance since it starts by identifying the key factors (including the macro-economic factors) that affect cost estimates within construction projects from the literature and through the qualitative semi-structured interviews then aims at verifying and validating the findings through an alternative approach that is the proposed quantitative analysis in what is known as triangulation (Tashakkori and Teddlie, 1998).

5.3.1.2 Constructivism

Constructivists tend to differ from positivists in their ontological stance by following relativism ontology contrasting the positivist ontological realism or critical realism.

In presenting an overview about the constructivist (also known as interpretivist) thinking, Denzin and Linclon (1998) reflect on interpretivists' refutation of the naturalistic interpretation of the social sciences stating that:

> *"the mental sciences (Geisteswissenschaften) or cultural sciences (Kulturwissenschaften) were different in kind than natural sciences (Naturwissenschaften): The goal of the latter is scientific explanation (Erklären), whereas the goal of the former is the grasping or understanding (Vershtehen) of the "meaning" of social phenomena"*

The same idea was mentioned by Bryman (2004) asserting that this philosophy reflected Weber's idea of "vershtehen" that is understanding through seeking to obtain "a *view of events, actions, norms and values from the perspective of the people involved in the process"*

This suggests that constructivists or interpretivists adopt a subjectivism epistemological stance based on an ontological relativism view. Denzin and Linclon (1998) discussed the debate amongst interpretivists by stating that:

> *"they celebrate the permanence and priority of the real world of first-person, subjective experience. Yet in true Cartesian fashion, they seek to disengage from that experience and objectify it. They struggle with drawing a line between the object of investigation and the investigator. The paradox of how to develop an objective interpretive science of subjective human experience thus arises"*

However, this view of research has often been accused of being unscientific and biased, hence, incapable of producing generalisable results (Fortune, 1999).

In Table 5.1, a series of contrasts between the positivist and constructivist paradigms is presented. Tashakkori and Teddlie (1998) added a sixth distinction where positivists follow deductive logic that is contrasted by the inductive logic of constructivists. In other words, positivists tend to lay emphasis on arguing from the general to the particular i.e. on a priori hypotheses (or theory) whereas constructivists lay emphasis on arguing from particular to general such as the case with grounded theory.

Distinction Areas	Positivists	Constructivists
Ontology	There is a single reality	Multiple constructed realities
Epistemology	The knower and the known are independent	The knower and the known are inseparable
Axiology (role of values in the enquiry)	The inquiry is value-free	The enquiry is value-bound
Generalisations	Time and context-free generalizations are possible	Time and context-free generalistions are not possible
Causal Linkages	There are real causes that are temporarily precedent or simultaneous with effects	it is impossible to distinguish the causes from the effects

Table 5.1   Main contrasts between Positivists and constructivists

* Adapted from Tashakkori and Teddlie (1998) axioms of positivists and naturalists

5.3.2 Research Methodology & Methods

The research methodology is a common term used in the majority of the research literature compared to the less common terms; ontology, epistemology and paradigms. It might be that scholars are more interested in the practicality of the research process design rather than the implicit philosophy that informs the discussed methodologies. In this study, however, it is believed that the suggested systematic approach to the research design process encompasses all the essential elements of the research process presented in a simplified manner; easy to comprehend and steering away from the philosophical debates and the jargon jungle.

The research methodology, therefore, could be regarded as the plan that encompassed all the activities undertaken in search for an answer for the research question or in other words to achieve the set objectives of the study. The research methods on the other hand, are the specific techniques used to collect and analyze data. Examples of different methodologies and methods are presented in Figure 5.2.

Examples of Research Methodologies and Methods
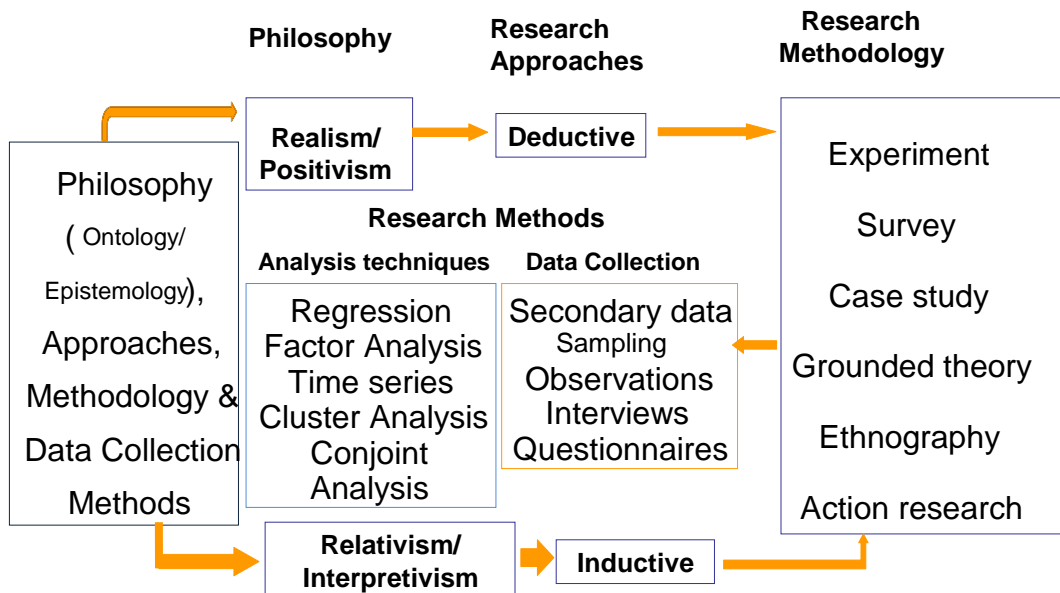
.Figure5.2   Example of Research Methodologies and Methods

Adapted from: Saunders, M.N.K, Lewis, P. & Thomhill, A.(2000)

5.3.2.1 Deductive and Inductive approaches

In the "*deductive approach*" to research design, the activities include the review of the relevant literature to establish the theoretical framework that informs the data collection and analysis stages. The researcher would then choose the appropriate data collection method leading to the selection of the suitable data analysis technique. The findings would either accept or reject the hypothesis and finally the theory would be revised. In the "*inductive approach*", on the other hand, the research would start by observations and analysis leading to a hypothesis that if accepted could lead to the development of theory. In cases where inductive studies generate interesting findings but cannot establish clear theoretical significance, it can still provide insightful empirical generalisations (Bryman & Bell, 2007).
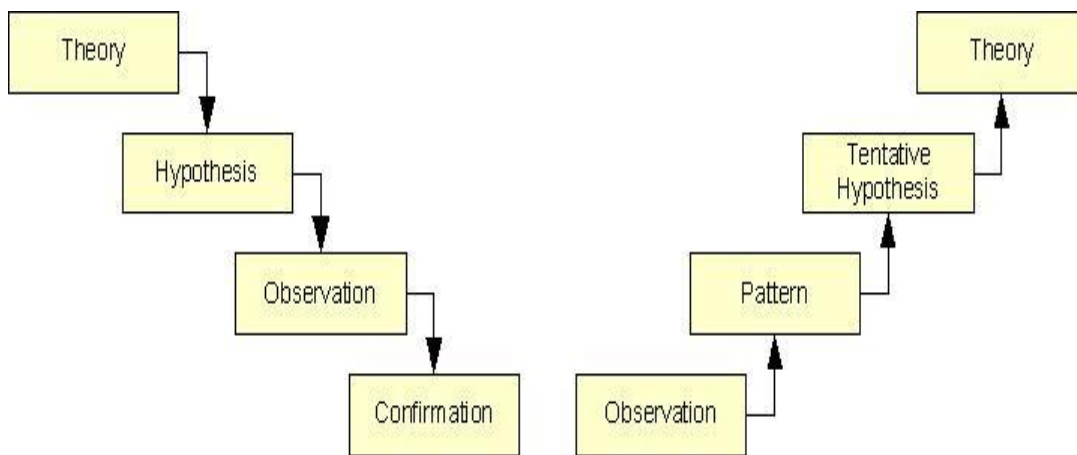
Figure 5.3 Deductive vs. Inductive approach Adapted from & Bryman & Bell (2007)

5.3.2.2 Qualitative and Quantitative Research

Creswell (2009) categorised the research design into three main types; quantitative; qualitative and mixed design but emphasised that these should not be viewed as "*polar opposites or dichotomies; instead they represent different ends on a continuum*"

Typically, a qualitative research design would be more appropriate for an inductive study as in the case of the grounded theory research methodology whereas a quantitative design would fit more the deductive approach to test objective hypotheses by examining the

relationship between variables using statistical analyses. In many cases, the type of data would determine the appropriateness of the research design selected including the data collection method and analysis technique.

In this study, on the one hand, the qualitative categorical data about the key factors that would affect the cost of school buildings in Egypt as well as the details and level of accuracy of the cost estimating process currently implemented as perceived by experts led to the selection of the in-depth semi-structured interviews as an appropriate data collection method. A purposive sampling approach was applied comprising experienced practitioners (minimum 15 years) involved in the cost estimating process to ensure the reliability of data collected and to provide meaningful insight about the sought objectives. Tashakkori &Teddlie (1998) stated that the interview is a "*powerful method of data collection*" and recommended semi- structured interviews for mixed design research. Bryman and Bell (2005) stated that semi-structured interviews technique had the advantage of identifying hidden activities, encountering the unexpected meanwhile providing a greater breadth of coverage due to its flexibility and recommended applying it when the researcher had a specific focus.

On the other hand, and still in the context of this study, it was imperative to collect quantitative data about the various cost items and the key economic indicators from the final invoices of the projects and the official economic reports in order to construct a data set. A statistical analysis, applying a multiple linear regression technique, was undertaken to build an explanatory model primarily to provide better insight about the relationships between the selected variables, meanwhile establishing the statistical significance sought in order to validate the findings. The application of regression analysis for cost modelling was recommended by a number of researchers such as Neale & McCaffer (1974); Flanagan & Norman (1978); Bowen (1982 , 1984), Al-Turki (2000), Ameen *et al.* (2003), Bee-Hua, (1999); Ng *et al.* (2004); Raftery (1991); (Reynolds, 1993) and others.

In the mixed design, both qualitative and quantitative data might be collected and analysed either in a sequential manner or in concurrent triangulation (Creswell, 2009). In this study, it was resolved to apply a mixed design in a concurrent triangulation approach. This will be discussed in further depth in the following section.

5.4 The Selected Methodology - A Case Study Design

Case study research methodology is defined as an empirical inquiry that investigates a contemporary phenomenon within its real-life context (Yin, 2003), in which a single organization, location, person or event is studied through intensive and detailed examination. (Bryman and Bell, 2007P:62).

Yin (2003) stated that: "*The case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result, relies on **multiple** sources of evidence, with data needing to converge in a **triangulation** fashion, and as another result, benefits from the prior development of theoretical propositions to guide data collection and analysis*"

To establish the quality of any empirical social research, four tests have been commonly recommended, namely; construct validity; internal validity; external validity and reliability. Typically, the case study research logic is linked to analytical generalisation whereby the investigator is striving to generalise a particular set of results to some broader theory in order to satisfy the external validity criteria. This is profoundly different from the statistical generalisation that can be achieved through the statistical analysis of a representative sample followed by an inference about the population accordingly (Yin, 2003).

However, as shown in figure 5.4, the case study design may take various forms. In this study, the embedded single case study design was chosen. The Egyptian National Project for Building Schools was selected as the research case study. Within this case study multiple units of analysis have been used including, first, the qualitative data was collected via conducting 18 in-depth interviews with experts and practitioners. Second, a sample of 400 schools from which the cost data have been extracted from the final invoices in addition to other relevant data pertaining to variables such as the location, the date of construction and the number of classrooms. Third, the economic data set needed was extracted from the official economic reports and other reliable sources such as manufacturers' and agents' price lists for steel and cement and also from some of the contractors' archives.

As the national project for building schools in Egypt was unique in applying a standardised design to all school buildings, i.e. eliminating many of the product physical variables, "*the single-case study design was eminently justifiable*" (Yin 2003).

5.4.1 Sampling and Data Collection Methods

The sampling techniques applied for this study varied according to the nature of the data and the purpose sought. The random sampling technique was applied to the survey of the schools while the purposive sampling technique was deemed suitable for the interviews with the industry experts. In the following sections both techniques will be discussed.

5.4.1.1 Survey within the case study

A total of 400 schools were randomly selected for the survey of the cost data. All schools were built by GAEB during the period 1994-2006. The sample included schools built across the country (in various Governorates). This ensured that the various locations were represented in the sample. For example, the sample included schools from urban, rural and remote areas. Also, the schools in the sample were in ratio and proportion to the population distribution. A detailed review of the population distribution will be discussed in the following chapter under the introduction and background of the research case study.

Cost Data for the Selected Sample of schools

The variables included in this study were selected based on the factors identified from the review of the construction cost estimating and cost modelling literature as well as the building economics literature presented in chapters 2,3 and 4 respectively.

In addition, the literature review justified the decision to use regression in the analysis of the quantitative cost data. The scale of measurement was then resolved and guided the data collection method as follows:

- A metric continuous scale was applied to the numerical data for the product physical variables extracted from the final invoices of the sample of schools included in the study. The figures collected were used to construct a new set of data, hence can be claimed to be regarded as a primary data set.

- A metric continuous scale was applied to the economic data extracted from the economic reports issued by the government and released on the websites of relevant departments.

- A nominal scale was applied to the categorical product physical variables such as location; type of foundation and type of school which were extracted from the archives of GAEB. These variables needed prior treatment in order to be included in the regression analysis as discussed in chapter 8.

Furthermore,, the secondary data pertaining to the socio-economic conditions in Egypt were collected from reliable sources such as government reports on CAPMAS (Central Agency for Public Mobilisation and Statistics) website, the economic reports published by MoF (Ministry of Finance), manufacturers and agents price lists and contractors archives

	Single-case designs	Multiple-case designs
Holistic (single unit of analysis	TYPE 1	TYPE 3
Embedded (multiple units of analysis)	TYPE 2	TYPE 4
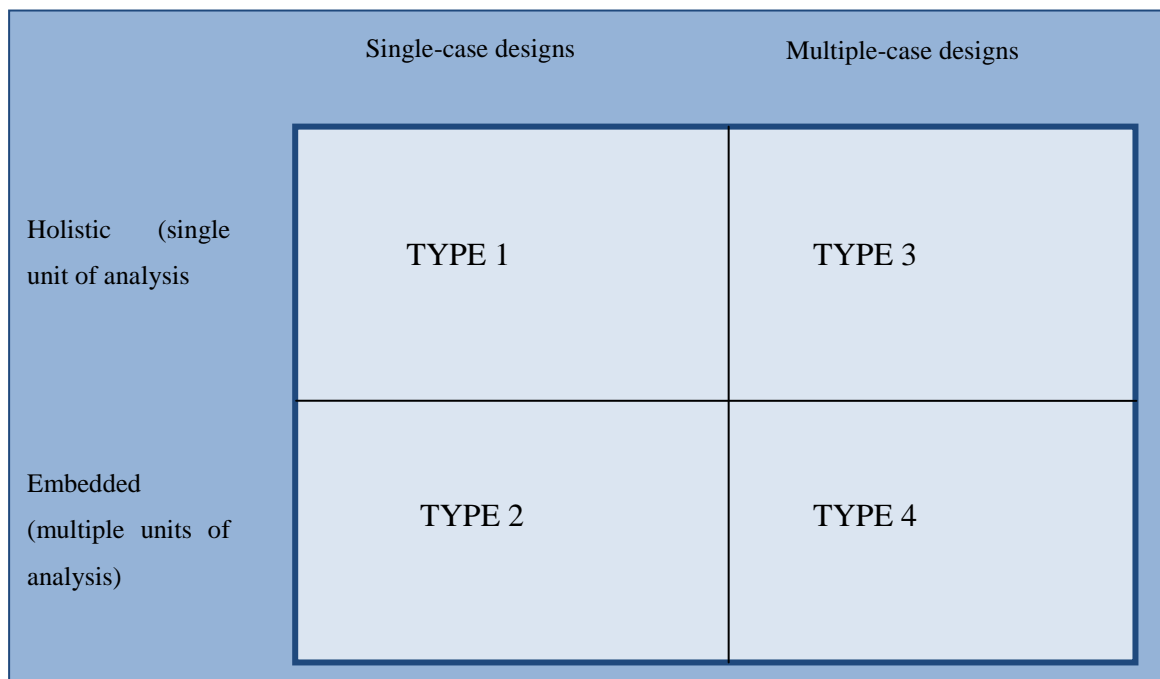
Figure 5.4 Main Types of Case Study Design - Adapted from (Yin, 2003).

5.4.1.2 Interviews within the case study

A purposive sampling technique has been applied to select experts with relevant experience in the construction industry and particularly the management of building projects. Also some participants were purposively selected based on their experience in the national project for building schools in particular. The first objective of this study aimed at reviewing the current practice in cost estimating for building projects at the detailed design stage in the wider context of the Egyptian construction industry. Hence the sample was not limited to those with experience in school buildings. The criteria set for selecting experts could be summarized as follows:

- Minimum 10 – 15 years of practical experience in managing building projects in the wider context of the construction industry in Egypt and not limited to the national project for building schools.

- Diversity of role, i.e. main contractor, subcontractor and client representative. In the context of the case study, some participants worked for GAEB, while others worked for main contractors who built schools for GAEB or worked for subcontractors involved in building schools.

- Diversity of project type. The sample was selected to include practitioners with experience in public sector projects as well as private projects. Also, the type of projects included residential projects, commercial projects and special structures such as stadiums, theatres and hospitals.

- Direct involvement in the cost estimating process since some experts might have the majority of their practical experience in the site management activities (execution phase) with minimum interface with the planning phase.

- A significant percentage of the sample would have experience in the national project for building schools.

5.4.1.3 Type of Interviews

The semi-structured interviews approach was selected due to the nature of the study. The semi-structured interviews have the advantage of providing better insight about the problem investigated as it allows the participants to elaborate in further depth meanwhile maintaining the research context.

5.4.1.4 Interviews Technique

The **18** interviews were conducted in Arabic. The semi structured interviews comprised 6 open ended questions (see chapter 7) that followed filling in a form about the data illustrating the personal profile of the respondent which included the number of years of experience and the various roles undertaken by each participant.

Furthermore, the researcher prepared a set of interview probes that could be used as appropriate. The interviews were recorded using a voice recorder meanwhile the researcher was taking brief notes about the body language and other factors that might not be captured or realized when listening to the voice recorder. The tapes were then transformed into a written script in Arabic.

The content was then translated to English by the researcher. The content was reviewed to ensure that the translation has accurately expressed the respondents' answers. Also, at this stage the comments of the interviewer were added. For example when asked about the economic indicators, one of the respondents smiled indicating that he was not sure what the answer might be. Another respondent moved in his seat reflecting the sense of unease when asked the same questions. The same observation applied to number of respondents who portrayed a different attitude reflected mainly through their body language rather than the tone of voice or the words they spoke. Hence, the note taking was thought to be instrumental in the analysis of the interviews outcome as discussed in chapter seven.

5.4.1.5 Content and context of the Interviews Script

The questions were designed in such a way so that they funnelled down from the general to the specific in order to gradually establish a clear and comprehensive picture about the following:

- The process applied by practitioners when estimating the project cost both at the item level and at the total project cost level.

- The most significant factors that affect the cost of building projects as perceived by the experts interviewed.

- The level of awareness of the experts in the construction industry about the performance of the economy in general and the economic indicators in particular. Also, the level of understanding that practitioners acquired regarding the interaction between these indicators and the cost of building projects.

- Identifying the key economic indicators that were perceived to have significant impact on the cost of buildings. In addition, the interviewer sought to investigate whether practitioners included any of those indicators either implicitly or explicitly when estimating the cost of a building project.

- Finally, the practitioners' view on the accuracy of the cost estimates produced and the reasons behind the perceived accuracy level.

5.4.1.6 Degree of Participation of the Researcher

The researcher avoided leading the participants by phrasing the questions in neutral words and in broad terms to allow the practitioners to elaborate freely on the topic. In the few cases when the respondent seemed to be going off to tangents or sounded as if the question asked was not clearly understood, the interviewer introduced a probe in order to clarify the question and guide the respondent back on track. This was expected to take place more when answering the questions related to the performance of the economy and the economic indicators.

Overall, the participation of the researcher could be claimed to have been restricted to the clarification of the questions asked and the confirmation of the answers provided when the respondents' statements were not clear.

5.4.1.7 Content Analysis Applied to the Interviews data

The data collect via interviews were analysed using content analysis. The interviews yielded a significant amount of information. This had to be coded prior to the analysis in order to organise and make sense of the inter-related textual data collected.

Typically, coding is the process of converting the textual, non-numerical and unstructured data into meaningful information to support the analysis. The data coding process should not be limited to the cases of data reduction, condensation, grouping or classification; rather it is a process that allows researchers to connect data in order to facilitate the comprehension of emerging phenomena (Basit, 2003). The main objective of analysing qualitative data was to identify the themes, categories and factors, relationships and assumptions which inform the participants' view of the research topic. Hence, the codes reflected on a set of themes and categories and factors. This is discussed in further details in chapter 7 under section 7.2.6 (see p. 142).

The two sets of codes used were priori codes and inductive codes. A priori codes occurred before conducting the interviews, i.e. while preparing the interview script whereas inductive codes were applied to the data collected and typically occurred after the interviews took place. The priori codes reflected on the objectives of the interviews and informed the purposive sampling technique applied in the selection of the interviewed practitioners. This included the categorisation of the practitioners based on their role and experience in different types of project. The inductive codes, on the other hand, reflected on the data collected during the interview

5.4.1.8 Detailed Outlines of the Research Methodology

The research was conducted in the following steps:

- An exploratory literature review leading to the development of the research proposal.

- A pilot study that encompassed further review of the literature, data collection and an exploratory analysis for direction verification.

- The research objectives, question and hypotheses were then reviewed for fine tuning based on the results of the pilot study.

- A further stage of literature review was conducted with more specific focus.

- The primary data pertaining to the quantitative part of this study were collected from a large sample of 400 schools built over the period 1994-2006 in the form of the priced bill of quantities and final invoices for each school. Data were collected from both the archives of GAEB and some contractors particularly for the schools built during the period 1994-1996 since it was difficult to get this information from the archeries of GAEB.

- In addition, the primary data pertaining to the qualitative part of this study were collected via conducting in-depth interviews with **18** senior project managers.

- The secondary data included all the economic indicators required for the research and available through governmental published documents and websites. The secondary data also included socio-economic data about Egypt such as the latest census, distribution of population, demographic attributes of the population, etc.

- Data analysis was conducted in a mixed approach, quantitatively and qualitatively. The qualitative analysis of the data collected via interviews addressed the details of the cost estimating process and the influential factors considered when deciding upon the various cost items and hence the total cost of building projects in general and school buildings in particular by both the client and the contractor. Also, the content analysis sought to investigate the perceived level of accuracy of the produced cost estimates and the

awareness of the impact of the economic conditions on the cost of buildings. The quantitative analysis applied a multiple linear regression technique as recommended by the literature in order to model the relationship between the total cost and the macroeconomic variables. Figure 5.4 illustrates the research design process.

Figure 5.5 Research Design (Triangulation)

- Developing a model that represents the relationship between the cost of school buildings and significant cost variables with emphasis on the relevant macroeconomic variables.

- The model was then tested and validated through a muti-stage modelling process whereby subsets of the original data set were used while controlling the various product physical variables to emphasise the significance of the economic variables.

5.5   Alignment of Chosen Methods with the Set Objectives

Hakim (1987) commented that a good research design *"dealt"* with the aims and purposes within the existing practical constraints. In chapter one, the main objectives of this study have been stated.

- **The first objective** aiming at reviewing the current practice by cost estimators and the perceived level of accuracy of the produced cost estimates was qualitative in nature. Hence, a qualitative approach would provide better insight about the details of the cost estimating techniques applied by various categories of practitioners; clients, contractors and subcontractors both in the public and private sectors.

- **The third objective** which aimed at exploring the level of awareness of the impact of the economic conditions on the cost of building projects was also qualitative in nature, hence, rendering the qualitative approach imperative.

- **The second and fourth objectives** sought to indentify the main influential cost factors that impacted the cost of building projects. Whereas the second objective addressed the wider context of cost variables, the fourth objective was more concerned with the specific context of the significant economic indicators that were perceived to impact the cost of building projects. In order to achieve both objectives, it was resolved to conduct the qualitative interviews and the quantitative analysis in a triangulation approach. The findings of the interviews conferred meaning upon the findings of the statistical analysis whereas the latter established the statistical significance of the findings of the interviews.

- **The fifth objective** aimed at modelling the relationship between the key economic indicators and the cost of construction projects by constructing an explanatory model that would enhance the cost estimators' understanding of the impact of the economic

conditions on the project costs. The quantitative data analysis applied a multiple regression technique to construct the cost model in order to verify and validate the relationships sought between the macroeconomic variables, an indicator of the performance of the economy, and the cost of school buildings in a quantifiable manner that would be useful to the cost estimators. It might be argued that qualitative findings would not be of adequate practical benefit to the cost estimators who are typically interested in quantified relationships that they can factor into their cost calculations rather than conceptual or qualitative causal relationships. Therefore, the quantitative analysis was deemed important and sought establishing a cost model to cater for the particular needs of cost estimators, meanwhile providing a better understanding of the causal relationships between the macroeconomic indicators and the cost of building projects. Also, the statistical analysis aimed at confirming and validating the findings of the qualitative part of the study.

5.5.1   Concurrent Triangulation within the Selected Methods

In this study, the first four objectives were achieved through a set of qualitative semi-structured interviews with experts inquiring about the current practice. On the other hand, the fifth objective that is modelling the relationship between the macroeconomic indicators and the total cost of school projects had to apply a quantitative statistical analysis. In triangulation, the results of the qualitative research are confirmed by the findings of the quantitative research (Creswell, 2009). In this study, the findings of the semi-structured interviews with experts reflected the lack of awareness about how to quantify the impact of the economic variables when estimating the total cost for school project thus illustrating the need for and justifying the undertaking of quantitative stages of the study. In addition to the quantification sought, the findings of the quantitative analysis identified the key factors that were statistically significant determinants of the cost of school projects. Those factors were also identified through the content analysis of the qualitative interviews in what is known as triangulation since the same findings have been achieved through two different approaches namely qualitative and quantitative and also using two different data sets. Triangulation has the advantage of providing well-validated and substantiated findings (Creswell, 2009).

5.6 Summary

In this chapter, the chosen research methodology was presented. The chapter started by introducing some conceptual definitions and a brief discussion of the philosophical stances driving academic research which informed and justified the decisions pertaining to the design of this study. This study followed a critical realism ontology that informed an objective, positivist epistemology. The embedded single-case study design was chosen as the research strategy embracing a triangulation approach within the data collection methods and the data analysis techniques. A variety of data collection methods were applied including; semi-structured interviews; archival data, direct observations and secondary economic data via reliable sources. The details of the qualitative interviews were presented. Also, the quantitative analysis seeking to develop a statistical cost model applying a multiple linear regression technique was discussed. The chapter concluded by illustrating the alignment between the research design and the overall objectives of the study meanwhile portraying the advantages of the triangulation approach applied to this study.

PART II:

THE QUALITATIVE RESEARCH

CHAPTAR 6

THE NATIONAL PROJECT FOR BUILDING SCHOOLS IN EGYPT

6.1 Introduction

This chapter introduces the case study selected for this research. The chapter starts with a brief introduction about the national project for building schools in Egypt. Despite the emphasis on the cost estimation of the school buildings, being the focus of this study, it was resolved that there are essential areas that needed a brief review to elucidate the factors affecting the cost of construction. Three main topics have been briefly introduced in this chapter, namely, the education system in Egypt; the development of the local and rural areas and the Egyptian construction market. To help the reader to understand some of the case study specific characteristics, especially those that relate to the type of schools, a brief introduction to the educational system is presented. This was followed by a brief background about the development across local (urban) and rural areas in Egypt in order to expound the importance of the location and other social variables which will be discussed in the following chapters. Then the chapter reviews the Egyptian construction market with emphasis on the economics of the cement and Steel industries being key factor inputs with significant impact on the cost of construction projects. In general, the chapter aims at providing an essential introduction and background about the case study before embarking on the data collection, analysis and discussion of findings in the following chapters.

Figure 6.1   The Map of Egypt

6.2 The National Project for Building Schools. A Case Study.

Egypt is an emerging country where a third of the population is under the age of 14. Only some 57% of its 75 million inhabitants can read and write. With thousands of years of civilisation, Egyptians want to equip the next generation with the skills to enrich the economy and create wealth.

The General Authority for Educational Buildings (GAEB) was established by the presidential decree no. 448/1988 dated 21/11/1988 for the execution of the national project of developing the educational buildings to cope with the increasing numbers of pupils in all age stages. This project aims at building new schools embracing an improved design to allow for the implementation of the contemporary methods, tools and techniques in education. The Egyptian government was committed to improve the educational buildings as illustrated by the resources allocated to GAEB over three 5year plans as shown in Figure 6.2. GAEB besides building new schools manages the task of replacement and a renewal of the old schools. The management of this project is conducted by full time qualified members staff based in the headquarters of the organization in Cairo and the branches spread in every governorate across the country.

During the period from 1992-2003 GAEB built a total of 13350 schools (see Figure 6.3) contributing to more than a third of the total number of schools of Egypt ; 36332 schools with about 15 million students (of which 48% are girls) equating to about 21% of the population.

GAEB applied standard designs for different key-stages. Each Key stage had a few standard designs to fit different locations. This meant that the same design was applied to many schools in different locations. The concept of standard design has been a trend the government introduced to other sectors like health services buildings and state housing.

Moreover, the Egyptian government intends to carry on with the same project due to the prevailing demand triggered by what seems to be everlasting uncontrolled growth in population.

The project has several objectives that can be briefly summarised as follows:

1. Reduce the current density in classrooms from 60 pupils/class to a maximum of 40 pupils /class and gradually shift all schools to work a full day and cancel the prevailing trend of two or three shifts per day.

2. To contribute to the main strategic line of the current policy aiming to reduce the numbers of illiterates.

3. To cope with the rapidly growing population.(a new baby born every 26 second)

4. Narrow the gap due to uneven distribution of schools' buildings among urban and rural areas that led to inequalities of opportunity. Rural areas needed more attention especially that they contribute to about 45 % of the population.

5. Introduce a new concept about educational building design to match the new trends in the educational process (computer labs – e-library- video conference halls - well equipped theatres ...etc.) as well as to maintain safety requirements.

The earthquake that hit Egypt in 1992 implied a different approach to the design of foundation for Schools and major attention to safety issues which was not considered in previous designs.

This project was chosen as the case study for this research due to the uniqueness of its attributes manifested in the standardized design implemented whereby few templates that build on the same module and use the same material were applied to all schools across the country. The basic and simple standard design is thought to help in the modelling process by eliminating a number of the product physical variables thus reducing the noise.

In addition, this case study provides an adequate sample size extending over the period from 1994- 2006, the period that had witnessed some dynamic changes within the Egyptian economy leading to the unprecedented devaluation of the currency twice in years 2001 and 2003 respectively to depreciate by more than 40% of its values in less than three years as shown in Table (6.1).
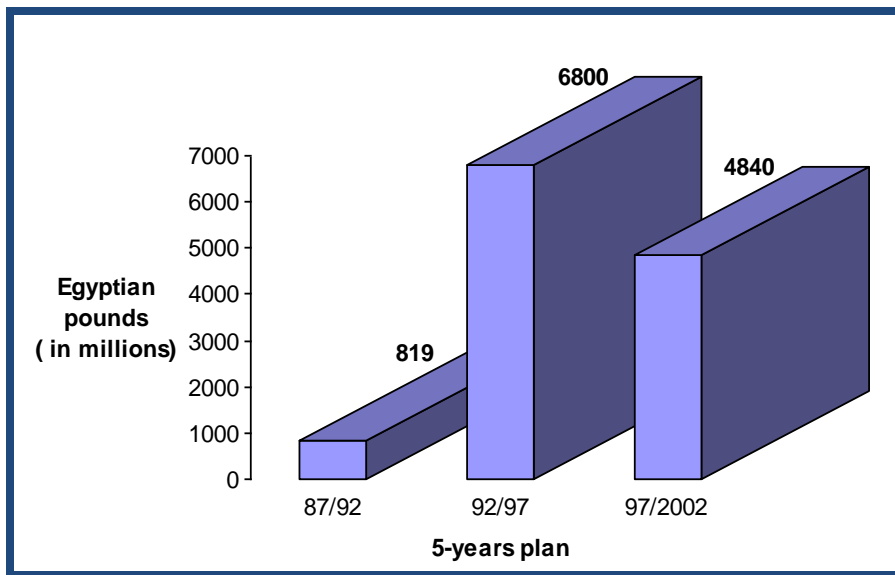
Figure 6.2   Investment in education buildings over three 5-year plans
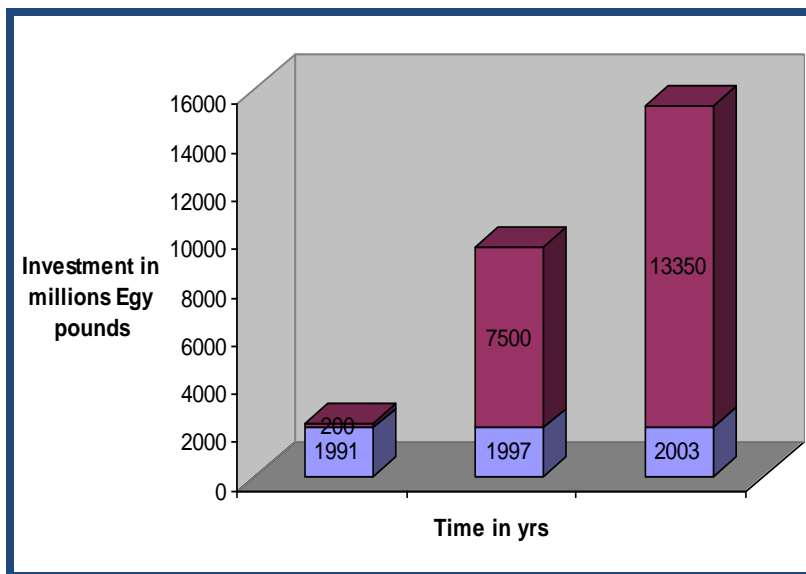
Figure 6.3   Cumulative investment in educational buildings

Yr	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Rate	3.353	3.392	3.393	3.388	3.388	3.388	3.405	3.69	4.49	4.5	6.126

Table 6.1   Egyptian currency Exchange Rate (L.E per US $)

6.3 Egypt - A Socio-Economic Synopsis

6.3.1 The Education System in Egypt

Among the challenges identified by the Egyptian Ministry of Education (MOE) in its national report for the period 1990- 2000 (National Center for Educational Research and Development (NCERD), 2000) are:

- Environmental problems.

- Population explosion.

- Economic development and competition.

- Globalization.

- Violence, addiction, extremism, and terrorism.

- Technology control over cultures and civilizations.

As a result of these challenges as well as other challenges, the political leadership in Egypt considered education as a national security issue. Hence, the Egyptian education policy is based on broad lines that exemplify this concept. Among the key factors considered are:

- Equity of educational opportunities for all Egyptian citizens without any kind of discrimination or exceptions.

- The continuous development of education curricula, improving school textbooks, and supporting educational activities.

- Introducing advanced technology into schools and developing students' life and communication skills.

- Diversifying resources of education finance and offering sufficient opportunities for the private sector and non-governmental organizations to participate in financing education.

- Providing education for all and education for mastery and excellence.

These factors have deep roots in the Egypt political system as the Egyptian constitution established the following fundamental framework of the education system in Egypt:

Education is a basic right for all Egyptian citizens (article No. 18).

The Egyptian state is responsible for education and supervises it to guarantee equity (article No. 18).

- Basic education (primary and preparatory education) is compulsory (article No.18 for primary education). Compulsory preparatory education extended to encompass preparatory education in law No. 139 in 1981.

- Education in all education institutions in Egypt is free at all stages (article No. 20).

- Illiteracy eradication is a national duty (article No. 21)

6.3.1.1 General Education

In virtue of law No. 23 in 1999, which modified some of the items and articles of law 139 in 1981, the duration of pre-university education is 12 years starting from the age of six till the age of 18 years old. This pre-university education includes:

- Nine years are dedicated for compulsory education, which consists of two stages (the primary stage taking six years and preparatory stage taking three years).

- Three years of secondary education (whether general or vocational).

- Five years for advanced technical secondary education.

- This education sequence is preceded by the kindergarten stage, which is an independent education stage of two years starting from the age of four till the age of six. The kindergarten stage aims at achieving a comprehensive development for.

- Pre-school children and preparing them to join basic education stage.

6.3.1.2 Basic Education

All Egyptian children aged six have the right to get Basic education. The state is committed to providing those children with basic education and parents are committed, by law, to send their children to schools to receive their basic education when children become six years old. This basic education takes the duration of nine years. Governors in each Egyptian governorate are responsible for assuming the necessary decrees to regulate and implement compulsory education and distribute children aged six among basic education schools within the governorate. It is allowed to give aged five years old and half the chance to join primary schools in case of having enough vacant places in schools provided that the class density agreed upon should not be violated.

To achieve equity in educational opportunities during the period from 1990 till 2000, several measures were taken (National Center for Educational Research and Development (NCERD), 2000). Table 6.2 shows the increase in the pupils' numbers over this period. Among the measures taken are:

- Offering enough opportunities for financially unable pupils and fatherless orphans to join educational tutoring groups to improve their educational levels in virtue of ministerial decree No. 48 in 1994 and its modifications according to ministerial decree No. 244 in 2000.

- Working hard to enable students with financially hardships to pay for their education tuition to join educational institutions at various education levels.

- Establishing one-classroom schools for girls who were not included in primary education and who are still in the compulsory education admission age (from 6 to 8 years old) and those who dropped out of primary schools especially in remote and deprived areas.

- Establishing community schools for children above (8 years old) and below 14 years old to endorse the notion of education for all.

- Enabling pupils who finish successfully their studies at one-classroom schools and community schools to continue their basic education studies and join preparatory schools. This measure was achieved by raising the maximum limit for admission to 18 years old in grade one of preparatory school for pupils who graduated from those two types of schools, i.e., one-classroom and community schools). Hence, the maximum limit for admission age in preparatory grade one for graduates of those two types of schools was raised to become 18 years old.

- Establishing 10700 schools over the period 1990-2000. These schools cover the different educational stages and aim at reducing classroom density and putting an end to the multiple educational periods.

This last point needs further clarification. It was a common practice that a second cohort of pupils would be attending in the evening in addition to the morning cohort due to the lack of school buildings. In some cases the same school building would host three cohorts throughout the day. Each of the two or three educational periods is administered by a different team of teachers and administrators and in some cases the school name is different as well. In other words the same premise would be hosting two or three schools. Needless to mention the repercussions this practice had on the reduced contact hours and the odd timing which might be argued as one of the factors that affected the quality of school education in Egypt. Hence, reflecting the strategic significance of the national project of educational building aiming at building 1500 new schools every year.

Stage	1991/92	1999/2000	Increase	Increase Ratio
Kindergarten	223051	354435	131384	58,90%
Primary	6541725	7224989	689264	10,44%
Preparatory	3593365	4345356	751991	20,92%
General Secondary	572026	1039958	467930	81,80%
Technical Secondary	1110184	1913022	802838	72,32%
Special Education	14428	29396	14968	103,7%
One-Classroom Schools	3165	51461	48296	1525,9%

Table 6.2   Increase in Pupils number in different stages 1991- 2000

Number of Individuals (From 6 to 19 years	Sex		
Governorates	Female	Male	Grand Total
Cairo	675,281	706,191	1,381,472
Sharkia	643,910	685,069	1,328,979
Dakahlia	563,791	593,583	1,157,374
Menia	548,585	599,928	1,148,513
Behera	543,441	577,714	1,121,155
Suhag	500,270	550,056	1,050,326
Kalyoubia	480,904	508,889	989,793
Asyout	457,235	500,285	957,520
Gharbia	440,027	463,805	903,832
Alexandria	406,668	434,816	841,484
Qena	394,546	425,925	820,471
Menoufia	370,026	392,341	762,367
Giza	333,999	352,430	686,429
Fayoum	327,475	354,760	682,235
Beni Suef	309,796	333,674	643,470
06-Oct	308,725	335,730	644,455
Kafr ElSheikh	305,319	322,158	627,477
Helwan	197,497	209,965	407,462
Aswan	141,290	148,271	289,561
Damietta	122,147	129,519	251,666
Ismailia	112,030	119,124	231,154
Suez	59,698	61,882	121,580
Port Said	58,315	62,714	121,029
Supreme Council Luxur city	55,315	57,651	112,966
North Sinai	44,591	49,594	94,185
Matrouh	44,002	48,489	92,491
Red Sea	24,035	26,441	50,476
El Wadi El Gidid	22,344	23,649	45,993
South Sinai	9,122	10,044	19,166
Grand Total	8,500,384	9,084,697	17,585,081

Table 6.3   Number of Male/ Female Individuals from age 6 to 19 in each Governorate CAPMAS

Governorate	Male	Female
South Sinai	10,044	9,122
El Wadi El Gidid	23,649	22,344
Red Sea	26,441	24,035
Matrouh	48,489	44,002
North Sinai	49,594	44,591
Supreme Council Luxur city	57,651	55,315
Port Said	62,714	58,315
Suez	61,882	59,698
Ismailia	119,124	112,030
Damietta	129,519	122,147
Aswan	148,271	141,290
Helwan	209,965	197,497
Kafr ElSheikh	322,158	305,319
06-Oct	335,730	308,725
Beni Suef	333,674	309,796
Fayoum	354,760	327,475
Giza	352,430	333,999
Menoufia	392,341	370,026
Qena	425,925	394,546
Alexandria	434,816	406,668
Gharbia	463,805	440,027
Asyout	500,285	457,235
Kalyoubia	508,889	480,904
Suhag	550,056	500,270
Behera	577,714	543,441
Menia	599,928	548,585
Dakahlia	593,583	563,791
Sharkia	685,069	643,910
Cairo	706,191	675,281

Figure 6.4   Number of Male/ Female Individuals from age 6 to 19 in each Governorate CAPMAS

Sum of Number enrolled and dropped out	Sex		
Governorates	Female	Male	Grand Total
Behera	14,192	18,438	32,630
Kalyoubia	13,467	16,407	29,874
Sharkia	11,588	18,557	30,145
Alexandria	11,223	12,741	23,964
Asyout	10,407	15,511	25,918
Cairo	10,095	12,534	22,629
06-Oct	9,759	9,931	19,690
Gharbia	9,545	14,304	23,849
Suhag	9,299	11,689	20,988
Menia	8,776	13,992	22,768
Beni Suef	8,730	13,783	22,513
Dakahlia	8,130	17,176	25,306
Menoufia	7,728	10,569	18,297
Helwan	5,914	6,332	12,246
Giza	5,617	6,776	12,393
Fayoum	5,208	9,618	14,826
Qena	5,172	4,886	10,058
Kafr ElSheikh	4,536	8,256	12,792
Ismailia	3,792	4,872	8,664
Matrouh	2,694	2,073	4,767
Damietta	2,496	7,801	10,297
Suez	1,198	1,605	2,803
North Sinai	946	665	1,611
Supreme Council Luxur city	804	716	1,520
Aswan	734	1,432	2,166
Port Said	570	79	1,349
South Sinai	397	456	53
Red Sea	264	408	72
El Wadi El Gidid	147	88	435
Grand Total	173,428	242,595	416,023

Table 6.4   Number of Male/ Female age 6 to 19 who enrolled and dropped out CAPMAS

	Male	Female
El Wadi El Gidid	288	147
Red Sea	408	264
South Sinai	456	397
Port Said	779	570
Aswan	1,432	734
Supreme Council Luxur city	716	804
North Sinai	665	946
Suez	1,605	1,198
Damietta	7,801	2,496
Matrouh	2,073	2,694
Ismailia	4,872	3,792
Kafr ElSheikh	8,256	4,536
Qena	4,886	5,172
Fayoum	9,618	5,208
Giza	6,776	5,617
Helwan	6,332	5,914
Menoufia	10,569	7,728
Dakahlia	17,176	8,130
Beni Suef	13,783	8,730
Menia	13,992	8,776
Suhag	11,689	9,299
Gharbia	14,304	9,545
06-Oct	9,931	9,759
Cairo	12,534	10,095
Asyout	15,511	10,407
Alexandria	12,741	11,223
Sharkia	18,557	11,588
Kalyoubia	16,407	13,467
Behera	18,438	14,192

Figure 6.5   Number of Male/ Female age 6 to 19 who enrolled and dropped out

Number enrolled and did not drop out	Sex		
Governorates	Female	Male	Grand Total
Cairo	636,628	663,388	1,300,016
Sharkia	599,117	631,796	1,230,913
Dakahlia	543,100	557,558	1,100,658
Behera	487,029	528,569	1,015,598
Menia	457,312	545,459	1,002,771
Kalyoubia	444,649	471,110	915,759
Suhag	437,485	510,457	947,942
Gharbia	419,945	437,461	857,406
Asyout	383,705	447,362	831,067
Alexandria	378,451	406,690	785,141
Qena	358,963	407,270	766,233
Menoufia	350,393	371,478	721,871
Giza	316,145	332,767	648,912
Kafr ElSheikh	287,724	301,524	589,248
Fayoum	280,231	319,074	599,305
06-Oct	271,954	305,390	577,344
Beni Suef	254,843	295,385	550,228
Helwan	177,693	193,438	371,131
Aswan	135,924	143,169	279,093
Damietta	117,960	118,138	236,098
Ismailia	104,169	110,763	214,932
Suez	57,319	58,814	116,133
Port Said	56,746	60,740	117,486
Supreme Council Luxur city	52,487	55,177	107,664
North Sinai	40,472	47,071	87,543
Matrouh	33,466	43,069	76,535
Red Sea	22,653	24,732	47,385
El Wadi El Gidid	21,704	23,001	44,705
South Sinai	7,858	8,891	16,749
Grand Total	7,736,125	8,419,741	16,155,866

Table 6.5   Number of Male/ Female age 6 to 19 who enrolled and did not drop out CAPMAS

Region	Male	Female
South Sinai	8,891	7,858
El Wadi El Gidid	23,001	21,704
Red Sea	24,732	22,653
Matrouh	43,069	33,466
North Sinai	47,071	40,472
	55,177	52,487
Port Said	60,740	56,746
Suez	58,814	57,319
Ismailia	110,763	104,169
Damietta	118,138	117,960
Aswan	143,169	135,924
Helwan	193,438	177,693
Beni Suef	295,385	254,843
06-Oct	305,390	271,954
Fayoum	319,074	280,231
Kafr ElSheikh	301,524	287,724
Giza	332,767	316,145
Menoufia	371,478	350,393
Qena	407,270	358,963
Alexandria	406,690	378,451
Asyout	447,362	383,705
Gharbia	437,461	419,945
Suhag	510,457	437,485
Kalyoubia	471,110	444,649
Menia	545,459	457,312
Behera	528,569	487,029
Dakahlia	557,558	543,100
Sharkia	631,796	599,117
Cairo	663,388	636,628

Figure 6.6   Number of Male/Female age 6 to 19 who enrolled and did not drop out

Sex	Governorates	Number of Individuals (age 6 to 19)	Number enrolled & did not drop out	Number enrolled & dropped out	Number Never Enrolled
Female	Egypt	8,500,384.00	7,736,125.00	173,428.00	590,831.00
Male	Egypt	9,084,691.00	8,419,741.00	242,595.00	422,361.00

Table 6.6   Totals Number of individual from age 6 to 19 that enrolled and did not drop out, enrolled and dropped out and those that never enrolled

Figure 6.7   Totals Number of individual from age 6 to 19 that enrolled and did not drop out, enrolled and dropped out and those that never enrolled

6.3.2 Demographic and Social Characteristics

Examining the demographics of the Egyptian population would emphasise the importance and attention given to the education system in the country. Egypt enjoys a noticeably young population. The distribution of the number of students enrolled across the various governorates is shown in Tables 6.3 - 6.6 and is graphically plotted in Figures 6.4 - 6.7. A significant majority of the population are under the age of 25years. The fact that the numbers within this age group is steadily growing adds further pressures on the capacity of the education system and particularly the need to build new schools, continually. The increase in population over the past 60 years as well as the projection of the expected increase in population over the next 40 years as shown in Table 6.7 and Figure 6.8.
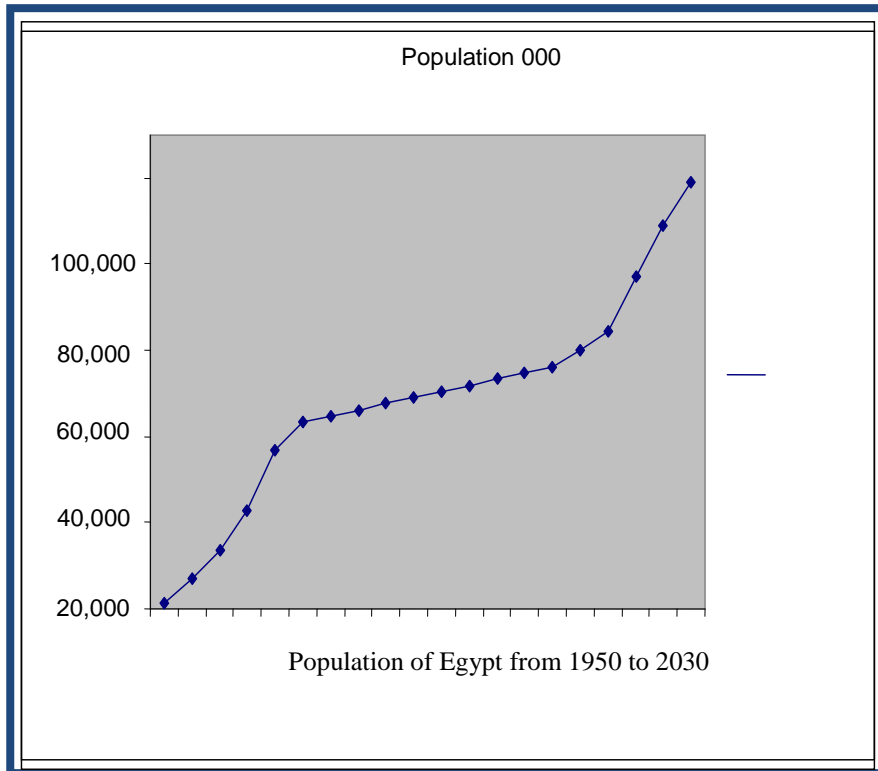
Figure 6.8   Population of Egypt from 1950 to 2030 in 000 (CAPMAS)

Year	Population
1950	21,198
1960	26,847
1970	33,574
1980	42,634
1990	56,694
1995	63,322
1996	64,705
1997	66,135
1998	67,602
1999	69,067
2000	70,492
2001	71,902
2002	73,313
2003	74,719
2004	76,117
2006	80,000
2010	84,348
2020	97,295
2030	109,044
2040	119,010
2050	126,921

Table 6.7   Distribution of the population across the various governorates of Egypt based on age and gender.

According to Srinvasan (2005) "The unemployment rate rose from 9.0% in 2002 to 10% in 2003, and it was expected to rise further to 11% in 2004. There are no long time series data on poverty based on household surveys. According to one source of data, poverty, as measured by the proportion of individuals living below the national poverty line, showed only a small decrease of 2%, from 25% in 1990-91 to 23% in 1995-96. In fact, urban poverty increased by about 2% in the same period. Another source (El-Laithy et al. 2003) suggested that poverty fell by 2% from an average of 19% in 1991-95 to 17% in 1996-2000 and rose to 20% in 2001-02".

However, in 2008-09 a number of experts have been re-iterating that poverty has risen to 42%. This figure has been endorsed by a number of unofficial reports. On the one hand,

the blurry benchmark and the vagueness of the grounds upon which this figure is based left the researcher quite uncertain about the accuracy of this estimate. On the other hand, both the government and ruling party did not deny or even challenge the accuracy of this figure. On the contrary the government did acknowledge the urgent need for further attention through enhancing the development of the disadvantaged regions and those in destitute, particularly the villages in Upper Egypt. Typically, building new schools comes as the first and foremost item on the government priority list in order to develop the impoverished areas.

6.3.3 Development of Local and Rural Areas

To complement the understanding of the Egyptian variables that should be included in the study of the national project of building schools, the review of the main social aspects of Egypt is imperative. It was resolved that the development of the local and rural areas can assist in understanding the main characteristics and hence, the differences across the Egyptian territory. Local and rural development is the basis of comprehensive national development in Egypt. It aims to strike a balance of development rates between governorates on the one hand and between rural and urban areas on the other. Moreover, it is instrumental in activating investments by local administration units and increasing their contributions in promising provinces.

6.3.4 Governmental Investments in Regions and Governorates:-

Total government investments distributed among regions and governorates under the 4th five-year plan (1997-2002) showed about LE 137.3 billion, while investments allocated for the 5th five-year plan (2002-07) showed about LE 445.0 billion. Comparing the relative structure of investment distribution in both Plans, the Following can be noticed:-

- Relative importance of investments allocated for the greater Cairo region decreased to 21.6 percent in the fifth five-year plan (2002-07) down from 26 percent in the 4th five-year plan (1997-2002).

- Relative importance of investments allocated for the Upper Egypt region increased to 21.6 percent in the fifth five-year plan (2002-07) up from 13.6 percent in the fourth five-year plan (97-2002), as it reflects the state orientation to activating decentralization in local administration as well as paying due attention to Upper Egypt governorates.

6.3.5 Regions and Governorates Investments in the Plan (2005-06):-

Total investments distributed among regions and governorates in (2005-06) showed about LE 110 billion, distributed as follows:

- About LE 20.1, accounting for 18.3 percent of the total investments for the greater Cairo region.

- About LE 18.2 billion accounting for 16.5 percent of the total investments for the west Delta region.

- About LE 20.6 billion, accounting for 18.8 percent of the total investments for the central and East Delta region.

- About LE 17.3 billion, accounting for 15.7 percent of the total investments for Suez Canal and Sinai region.

- About LE 8.3 billion, accounting for 7.5 of the total investments for the north Upper Egypt region.

- About LE 25.5 billion, accounting for 23.2 percent of the total investments for the south Upper Egypt region.

6.3.6 Local and Rural Development Investments:-

Implemented investments in the local and rural development program in (2002-2004) showed about LE 6.9 billion, of which about 96.7 percent were implemented by the

government and economic authorities. Total investments implemented in local and rural development program during 2005-2006 showed about LE 3.9 billion, accounting for 15 percent of the public investments, distributed among different authorities. These aim to give a greater boost to developing basic services in villages and districts (electricity, potable water, sanitary drainage, transportation, paving roads and bridges) as well as universalizing handicrafts.

Government investments represent 16.7 percent of the total investments. These investments included the following:

- About LE 240 million allocated to rural development projects.

- About LE 192559000 allocated to developing and upgrading Squat areas.

- About LE 783.9000 allocated to completing infrastructure in industrial zones.

In addition, other investments were allocated to other projects.

6.3.6.1 Local Development

Local development is the basis of Egypt's integrated development. Salient Local Development Achievements in (2005-2006) included the following:-

- **The standardized plan**

The standardized plan was implemented in 2005-2006 to apply the principle of local development, financial and administrative decentralization, as the local development three branches were distributed as follows (governorates headquarters, express plan, village Development and construction system), gathering them in the light of priorities and necessities, starting from village and ending with governorates level.

- **Local Development Information Centers:-**

Upgrading Local development information structure is a vital project that aims to provide the data and information needed to achieve the development objectives and implement its different programes through integrated information. In this frame work, the comprehensive national development information base was modernized in a way that allows an integrated

information map for all villages, cities and centres of the various governorates, with an annual total finance of about LE 60 million provided by Ministry of Finance.

Those youth work on continuous modernization of all sectors of local development data bases by the end of 2004. A total number of 2.5 million families were covered and the electronic version of the data was saved for future planning.

- **The National Project for Developing Villages that Surround Deserts:**

Expansions were directed towards East and West Nile at an area of about several kilometres, due to over population and the continuous erosion of the agricultural land, to establish about 400 new villages on urban and cultural foundations that can cope with the planned expansion on both sides of the valley. It was considered a national project, to be implemented over the coming twenty years to absorb about 4 to 5 Million individual.

A number of 21 villages were chosen in 2005/2006, as a first phase in the desert that surrounds villages in 7 governorates. The preparation of the project second phase started, aiming to develop deserts surrounding villages in all governorates. A total of around 280 villages were considered in various locations.

- **Developing Industrial Zones:**

The developing and flourishing of the industrial zones is one of the most important aims of the local development process. The year 2005/2006 witness the development of industrial zones supervised by governorates and the completion of the infrastructure for 64 industrial zones, of which 17 were included in the unified plan over and above the rest of industrial zones supervised by other authorities (26 industrial zones).

- **Productive Cooperative Societies:-**

The year 2005/2006 witnessed effectuating the productive cooperative society's activities, supervised by the localities and expanding its bases to support small-size enterprises, through providing production and marketing requirements. The number of productive cooperation societies reached 475 societies in all governorates and 15 general societies. The total amount of cooperative society's activities reached about LE 1.3 billion.

- **Popular Lending Project**

The project started by a total Loan LE 107 million in 107 village and district; and the state afforded the difference of rate interest about LE 10 million, included in local development.

- **Lending From Local Development Fund:**

The fund provided loans in 2004, with an amount of LE 162.2 million for 51.4000 small-size enterprises for youth and woman in all the governorates, villages that allowed about 86.5000 job opportunities.

- **Youth Employment Systems:**

Youth employment systems contributed in 2005/2006 to providing about 42000 job opportunities in different governorates and about 9400 job opportunities in the projects of local development fund.

6.3.6.2 Rural Development

Developing and rebuilding the Egyptian Village have become a top priority to which the state pays due attention, due to the great economic and population weight of rural society. The national program for integrated rural development (Shoroq) has functioned as an effective means for developing the Egyptian village as it is based on the concept of local popular participation in integrated development in the Egyptian Countryside, the project started in 1994.

Total investments implemented over the period 1995 - 2004 reached about LE 2 billion. In addition to about LE 240 million investments allocated for rural development in 2005/2006. These projects contributed to implementing more than 100000 projects in governorates, villages. It included different fields as domains potable water, sanitary drainage, roads, electricity, health, youth, culture, woman and child, as well as education, as the number of students in the Egyptian countryside account for more than 53 percent of the total number of students enrolled in pre-university education.

The Program of Replanning 4500 Egyptian Village and Laying Down a New Urban Area:
The program seeks to prepare an integrated plan to develop the Egyptian village by the year 2020, aiming to realize the following:

- Urban upgrading of the countryside and its services,

- reducing over crowdedness and improving life standard,

- providing job opportunities,

- developing local economy,

- upgrading the village and providing it with services and utilities.

Squat Areas:

The state adopts a long-term plan aims to curb the expansion of Squat areas by upgrading 1221 Squat area spread over 24 governorates, in addition to Luxor. Total investments implemented in upgrading and developing Squat areas showed about LE 192559 thousand distributed among the activities of electricity, paving roads, bridges, providing potable water, and sanitary drainage services. In addition to Universalizing production bases in Squat areas, and laying down an integrated system to the processes of planning, organizing, managing solid and liquid wastes, as well as paying due attention to general cleaning and upgrading environment by increasing the green areas.

The National Program of Eliminating Squatters 2020:

A new strategy was allowed to upgrade squat areas, in the light of the international views of dealing with Squat areas, entitled the National program of eliminating squatters 2020, aiming to drawing up a unified view and an integrated program to which all the state systems and granting authorities must adhere, to guarantee realizing integrated development in such area and laying down the necessary mechanisms to avoid the appearance of more Squat areas.

The Program of Urban Upgrading of Rural areas and Cities:

The program aims at dealing with Squatters in a way that depends on urban planning; through preparing an urban planning based on the present needs and vision, as well as the future perspective. Time plan is being prepared to avoid the appearance of any new Squatters, to improve and upgrade services, modernize the infrastructure and utilities, as well as taking into consideration the traffic state. This program contributes to keeping the agricultural area and controlling Squatters through appropriate legislative procedures to forbid such Squatters, in the light of the new standardized construction draft code.

6.3.7 The Consumer Price Index in Egypt

The CPI is a measure of the average change over time in the prices of consumption items - goods and services - that people buy for day-to-day living. CAPMAS has published the 8th series of consumer price index (CPI) starting from September 2007. The basket included (826) commodities and services. The CPI covered both urban and rural areas. CAPMAS produced indices for eight geographic areas. These include: Cairo - Alexandria -Urban Lower Egypt - Urban Upper Egypt - Canal cities - Frontier governorates - Rural Lower Egypt - Rural Upper Egypt. In addition, CAPMAS Produces All Urban, All Rural, and All Egypt indices. Prices are collected on monthly basis for Urban regions whereby the number of price outlets is (3324), For Rural regions, prices are collected twice every month for (3825) price outlets during the period from 15th – 17th. Starting July 2008 prices were collected on monthly basis for both Urban and Rural. Prices of January 2007 are used as base period for starting the new series of CPI.

The CPI is published according to The International classification (COICOP–2003). COICOP is the internationally accepted and recommended classification System for the CPI. The use of COICOP is recommended in the System of National Accounts (SNA, 1993) and by the International Monetary Fund (IMF), and International Labour Organization (ILO). COICOP is also used in the International Comparison Program (ICP).

The weights were derived from the Income, Expenditure and Consumption Survey (2004/2005). The weight of the commodity item is the ratio of the commodity expenditure to the total of all Consumption expenditure. To reflect international standards and best practices, the 2004/2005 weights were updated to reflect the relative change in price between the weight reference (2004/2005) and the price reference (Jan.2007).

The formula used can be expressed as follows:

Where:
$$e_{a,i}^{0} = e_{a,i}^{04/05} \left[\frac{I_{a,i}^{Jan.07}}{AVG.I_{a,i}^{04/05}} \right]$$

$e^{0}_{a,i}$ = The updated weight for category items (i) in area (a) for base period (Jan. 2007)

$e^{04/05}_{a,i}$: The updated weight for category items (i) in area (a) from Income, Expenditure and Consumption Survey 2004/2005.

$I^{Jan.07}_{a,i}$: Index an unweighted for category items (i) in area (a) for Jan. 2007 base period 1999/2000.

$AVG.I^{04/05}_{a,i}$: An unweighted geometric mean for indexes for category items (i) in area(a) in 2004/2005 with base period 1999/2000.

The CPI compiled on two steps:

a- Basic index for the (171) category items use the Jevons index formula: an unweighted geometric mean is as follows:

$$I^{t}_{a,i} = I^{t-1}_{a,i} \left(\prod_{k=1}^{k_{a,i}} \frac{p^{t}_{k}}{p^{t-1}_{k}} \right)^{\frac{1}{k_{a,i}}}$$

$I^{t-1}_{a,i}$: The current index for category items (i) in area (a).

$k_{a,i}$: The number of commodities in category items (i) in area (a).

a=1,2,…,8 ; i=1,2, … , 171

p^{t}_{κ} : Price of available commodity or service in category item (i) in the current month (t).

b- The formula for the calculation of the CPI is short- term basis, thus each current month's price is compared to the previous month's price. The formula is as follows:

$$I_{Egypt}^{t} = I_{Egypt}^{t-1} \times \sum_{a=1}^{8} \sum_{i=1}^{171} S_{a,i}^{t-1} \left(\frac{I_{a,i}^{t}}{I_{a,i}^{t\,1}} \right)$$

Where

$$S_{a,i}^{t-1} = \frac{e_{a,i}^{t-1}}{\sum_{a=1}^{8} \sum_{i=1}^{171} (e_{a,i}^{t-1})}$$

$S_{a,i}^{t\,1}$:   The relative weights for category items (i) in area(a) for the previous month(t-1).

$e_{a,i}^{t-1}$:   The updated weight for category items (i) in area (a) for the previous month (t-1).

$$e_{a,i}^{t\,1} = e_{a,i}^{0} \times \frac{I_{a,i}^{1}}{I_{a,i}^{0}} \times \frac{I_{a,i}^{2}}{I_{a,i}^{1}} \times \frac{I_{a,i}^{3}}{I_{a,i}^{2}} \times \ldots \times \frac{I_{a,i}^{t\,1}}{I_{a,i}^{t\,2}} = e_{a,i}^{0} \left(\frac{I_{a,i}^{t\,1}}{I_{a,i}^{0}} \right)$$

Where

$$I_{a,i}^{o} = 100$$

6.3.8   The Egyptian Public Sector Construction Market

This section aims at reviewing the public sector construction market in Egypt during the period 1980 - 2008 with emphasis on the role of government which had seriously affected the cost of building projects in general and the cost of building projects constructed by the public sector in particular.

The Egyptian government acted as a key player in the construction market being the biggest client during the 60's and 70's when the Egyptian economy was managed as a command economy. The government continued to play the same role even after it announced the shift towards the market economy in the late 70's and early 80's.

During the 80's the Egyptian government introduced the notion of "low cost" residential buildings known as "economic housing", the equivalent of council houses in the UK. In this pursuit, the government succeeded for the first time in the modern history of the Egyptian construction industry to drag down the cost residential buildings to reach as low as 99L.E. per square metre in order to meet the set targets with regard to the needed housing given the limited resources and the slim budget for a country that was still suffering the consequences of many years of war. These prices were at least 30% less than the prevailing asking prices by contractors at that time. In other words, the government acted as a price maker in the construction market. Such move caused notable changes in the construction industry.

New entrants alongside the existing construction firms who agreed to deliver at the offered prices had to undertake several adjustments to cope with the significantly low prices. Coupled with migration of many skilled labourers to the neighbouring rich Oil countries, the contractors opted for cheap labour and cost dominated the equation. Due to the subsequent low wages offered by contracting firms, the Egyptian construction market started to suffer a clear shortage in skilled labour, something that was considered unlikely to occur in a highly populated country like Egypt meanwhile suffering from a significantly high rate of unemployment.

Also, the sub-markets had to react to this change and the demand for many low quality factor inputs started to exceed the demand for more expensive better quality products and services. As a result of the government intervention with the benevolent objective to provide accommodation for the low income citizens, the construction industry took a down turn. In a few years some of those low cost units started to show symptoms of poor quality thus blowing the whistle about some of the poor practices that accompanied the new trend. This gave rise to a debate about the feasibility of the "low cost" trend in construction even in the short run.

Following the 1992 earthquake, the government, once more, played a significant role in the construction market by introducing another trend that is the no-fringe buildings. Learning the lesson from the previous experiment in the housing projects and also affected by the consequences of the earthquake, the Egyptian government opted for robust buildings with emphasis on the skeleton work packages meanwhile providing very basic finishing specifications. The set prices that were released to the contractors in the form of price lists reflected, in essence, more realistic estimates based on the market prices of the factor inputs. Despite this paradigm and strategic shift in the government's role, yet the produced estimates had been perceived by contractors as lower than the acceptable range. This was reflected in the mark-up that contractors did ask for over and above the released priced Bill of quantities (BoQ) which formed the main document among the tendering documents for public sector projects.

6.3.8.1 A Tale of Two Industries

Egypt has been gradually dismantling tariff and non-tariff barriers following its accession to the WTO in January 1995. Trade liberalization, on the one hand, led to the substitution of domestic manufactures by imports in some sectors. On the other hand this period witnessed a sporadic reversion to protectionist measures inconsistent with the WTO such as the imposition of prohibitive import duties on apparel in mid 2001 due to the sharp drop in margins for domestic producers.

Typically the cement and steel industries formed the backbone for the construction industry in Egypt over the past decades particularly in the case of the public sector large scale projects such as housing projects and the national project for building schools. The main reason was the basic finishing specifications that rendered the cost of the structural elements accounting to more than 50% of the total project cost. Any fluctuation in the production levels of both industries inflicted on the market prices of the key building materials; cement and steel. Consequently this had a significant impact on the total cost of building projects which affected the contractors, particularly those working on public sector projects.

For example, when the prices of cement increased to 360 LE up from 120 LE per ton meanwhile associated by the increase in steel prices to reach 3400LE up from 1200LE per ton, a considerable number of contractors defaulted. The contractors particularly those working on public sector rigid contracts that do not allow for compensations in the case of market price movements could not embrace the subsequent repercussions. Even those who have been in the market for 20 years or more and seemed to be financially robust were announced bankrupt.

The government tried to intervene by promising compensations in the range of 10-15% which was not adequate. In addition, the bureaucracy delayed the implementation of the promised pay rise something that did not help contractors who are bound to tight time schedules. In other words if contractors were to wait until they received the promised compensations then they would risk facing hefty penalties that would normally exceed the pay rise. In the following section a brief review of both the steel and cement industries will be presented.

6.3.8.2 A Brief Review of the Cement Industry in Egypt

Traditionally the cement industry in Egypt was owned and controlled by the government. Even though the government tried to control the cement prices, usually during summer period, the price of cement would rise significantly due to the increase in demand derived by the relative increase in the building activities. This was mainly attributed to the private

market whereby individuals working abroad, particularly in the rich Gulf countries would return for their summer vacation and embark on building houses or renovating their existing accommodation. Add to this the impact of the drop in supply due to the maintenance of the majority of cement production lines across the country typically taking place in summer.

Over the years, cement agents and retailers anxiously waited for the summer period in anticipation of the above normal profits due to the above mentioned factors which would compensate for the humble profit margin they accrued during the rest of the year when the production level was normal meanwhile the demand was relaxed especially in winter and during the festive seasons. This was the case that practitioners were quite familiar with until 1993 when the market started taking a sharp bend derived by the introduction of the privatisation programme. Table 6.9 shows the cement Prices over the period 1980 – 2005

Privatisation of Cement Industry

The once has been known to be a state-owned industry appealed to foreign investors who found in Egypt a safe haven as an alternative to Europe and other developing countries due to the rising awareness of the environmental factors and the concerns about the cement industry due to the significant levels of the associated pollution.
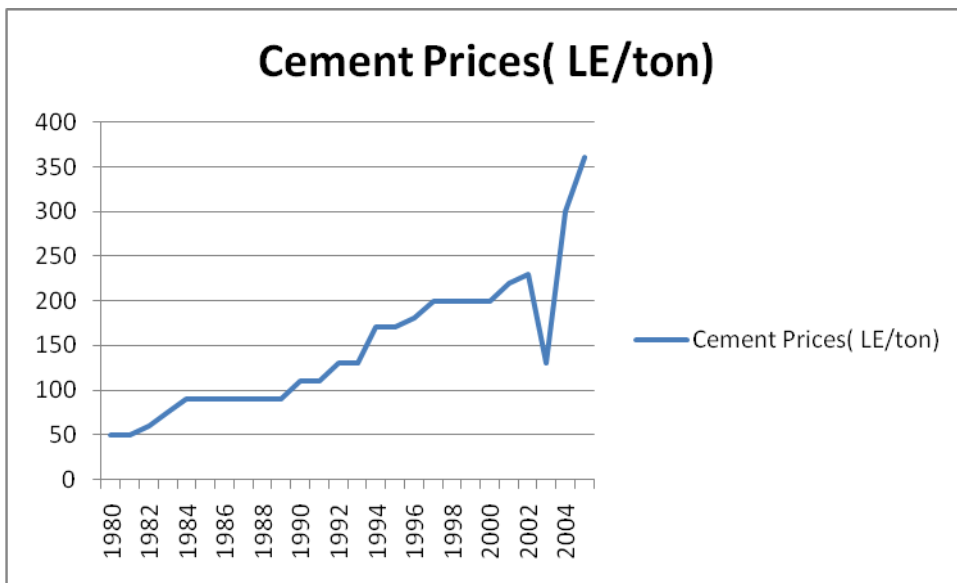
Figure 6.9   Cement market prices over the period 1980 – 2004

Also, due to the intensifying global and local competition coupled with the peculiarities of the Egyptian market which continued to include extensive governmental regulations and immature distribution channels, the privatization of the cement sector seemed to be imperative. Furthermore, the combination of inexpensive labour, plentiful supplies of high quality raw materials and cheap energy prices, suggested that the cement industry in Egypt had the potential to enjoy a strong comparative advantages.

The multinational giants played the acquisition game professionally and applied the most effective tactics in pursuit of a well defined strategy. During the acquisition stage, once the multinational and other local private sector investors started having a grip on some of the previously state-owned cement factories, the new players dumped the prices to a record low. This was an effective step as part of the strategy that aimed at driving the remaining state-owned manufacturers towards losses or at the least towards very low profit margins. Consequently, the government became less interested in retaining its stake in such endangered businesses and opted for further privatisation. The government apparently did not seem to realise the strategic repercussions of this decision. On the other hand the poor performance of the remaining state-owned cement manufacturing companies meant a cheaper acquisition by the financially robust multinational incumbents.

As soon as the majority of the stake in the cement industry was owned and controlled by the private investments let it the multinational investors or the local private sector investors, the cement prices started to rise significantly.

It was imperative that the new owners' aspirations extend well beyond the territory of Egypt, mainly targeting enhancing exports to cater for the needs of their global market and international clients. The result of upgrades and new capacities following the privatisation of the major cement producers, in addition to the downturn of local consumption due to the general economic slump and the slowdown in construction activities, led to the emergence of a large surplus that turned Egypt from a net importer to a net exporter to cement.

This was one of the key factors that led to the escalation of the prices of cement in the domestic market given the devaluation of the Egyptian currency whereby the exchange rate against the US Dollar increased by more than 30% in 2003 (see section 5.2). There was no evidence that the prices of factor inputs increased in the same proportion to justify

the increase in prices. Hence it was more logical to attribute this increase to the opportunity cost, typically, considered by the multinational incumbents with well established distribution channels in the global market.

The events escalated dramatically until it reached the peak in January 2009 when the government filed a court case against the cement cartel accusing them of monopoly act. However, the 10m LE fine ruled by court was pretty much ineffective compared to the multibillion profits accrued by the monopolists. It seems as if the government the genie out of the bottle and was then desperately trying to control it. It was apparent through the cement market prices that the government has failed to control the dynamics of the cement industry so far. Even when the parliament discussed amending the Law to increase the fine for monopoly practice to 300m LE up from 10m LE, the cement producers lobbied against the suggested change in regulations and the parliament failed to gather to the required majority to approve the new fine.

The economic reporters in almost all the major news paper in Egypt linked the failure to approve the hefty fine to the monopoly in the steel industry dominated by some key politicians very powerful and could then manipulate the voting in the parliament in their best private interest.

Hence the imperfection in the competition within the cement market was mainly driven by the political decision to privatise the cement industry without careful consideration of the strategic consequences. Advocates of the open market economy suggested that the government should have introduced adequate regulations to hedge against the anticipated monopoly prior to embarking on the implementation of the privatisation programme of strategic products such as cement and steel.

The repercussions extended beyond the direct impact of the lost control over one of the key strategic industries. On the one hand and in financial terms, the government continues to pay a hefty price due to the significant increase in the cost of buildings given the government is still considered the dominant client in the construction market in Egypt. On the other hand, the cement producers are believed to accrue above normal profits typically associated with the monopoly/oligopoly enjoyed by the incumbents.

Cement Consumption Outlook in the Arab Countries						
According to the GDP growth (2003 – 2004), population growth rate (1995 – 2004), Consumption growth rate (2002 – 2004) and share of construction Industry (2002 – 2004)						
Country	2005	2006	2007	2008	2009	2010
Algeria	12726	14380	16250	17387	18605	21023
Bahrain	1354	1449	1551	1659	1775	1899
Egypt	28256	30179	32292	34552	36971	39559
Jordan	3675	3895	4129	4377	4640	4918
Kuwait	3815	4081	4367	4673	5000	5350
Lebanon	2875	3032	3184	3343	3510	3685
Libya	3433	3673	3930	4205	4499	4814
Mauritania	618	636	656	675	696	716
Morocco	10290	10205	11345	11912	12508	13133
Oman	2294	2523	2776	3053	3359	3695
Qatar	2400	2688	3011	3372	3776	4230
Saudi Arabia	24700	26429	28280	30258	32377	34643
Sudan	1492	1567	1645	1727	1814	1904
Syria	5170	5422	5700	5925	6284	6598
Tunisia	5930	6345	6789	7264	7773	8317
UAE	11526	13024	14718	16631	18793	21236
Yemen	3080	3296	3526	3773	4037	4320

Table 6.8   Cement Consumption Outlook in the Arab Countries

International Companies' stakes distribution in Egypt (2002-04)		
Domestic Company	International Company	Share
Assiut Cement Company (Cemex Egypt)	Cemex	95%
Egyptian Cement Company S.A.E.	Holcim	42.59%
Alexandria Portland Cement CO.	Lafarge	73.60%
Beni Suef Cement Company	Lafarge	47.50%
	Titan	47.50%
Amreyah Cement Company	Cimpor	97%
Suez Cement Company	Italcementi	54%
Sinai Cement Company SAE	Cementir	5%
	Vicat	10%
Sinai White Portland Cement Company S.A.E.	Cementir	49%
	Paries	10%
ASEC Cement Co. SAE	Asec	100%

Table 6.9   International Companies' stakes distribution in Egypt (2002-04)

6.3.8.3 A Brief Review of the Steel Industry

The steel industry does not seem much different from the case of the cement industry. The key difference is mainly that the dominant incumbents are private sector Egyptian business giants contrasted with the domination of the multinational producers in the case of the cement industry as shown in Table 6.11.

The Egyptian steel sector today is dominated by Ezz Steel Rebars (ESR) who acquired a 28 percent share of government controlled Alexandria National Iron and Steel Company in Dikhela (ANSDK). The two companies consolidated their marketing operations under the name Ezz-Dekhela Steel (EZDK), of which Ahmed Ezz was appointed chairman in March 2000. The marketing alliance of ESR and EZDK also goes by the name Ezz-Dekhela (EZDK). EZDK has maintained a dominant position, and the company now controls around 54 percent of the total market potential capacity and 61 percent of the market share. EZDK's objective is to maintain its dominance over the Egyptian steel market share by holding on to its increasing market share (Selim, 2006).

There are other private producers such as Kouta Steel Group, Suez Steel, Beshai Steel, Aswan for Iron, and the Arab Steel Factory, which account for around 26 percent of the market. Public sector companies such as Helwan Steel make up about 7 percent of the market. Thus, it is obvious that the steel sector is dominated by private business with weak competition from the public sector.
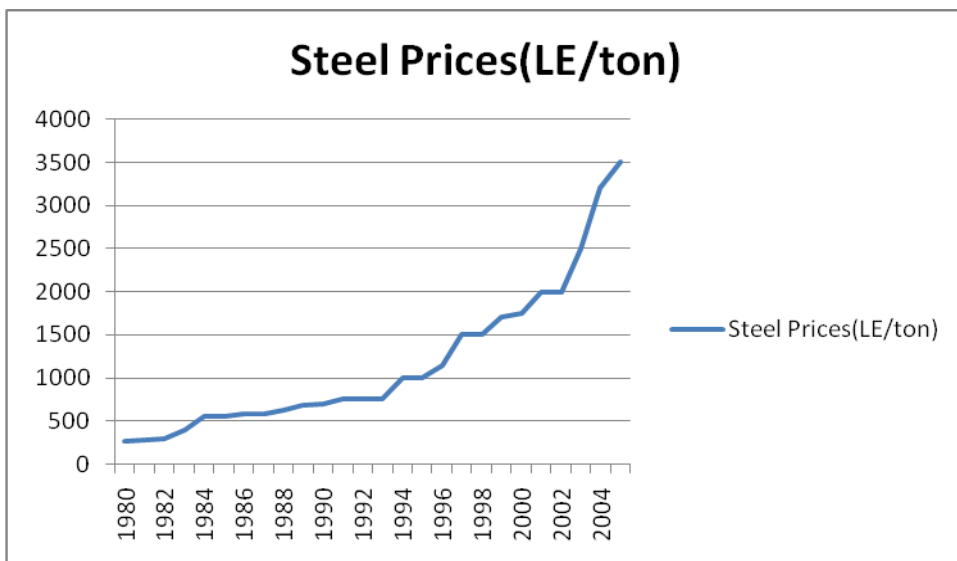
Figure 6.10   The steel prices over the period 1980 - 2005

The political-economical dimension seemed more clearly portrayed in the case of the steel industry due to the significant political power enjoyed by the main monopolist who controls the steel industry whereby there is a single producer who controls around 61% of the total steel market in Egypt. Hence the severity of the impact of this sheer monopoly was reflected in the level of increase in steel prices that moved up from 1200LE to 3500LE per ton as shown in Figure 6.10 i.e. nearly 300% (quite similar to the increase in the cement prices).

Supplier	Production (million tons)	Market Share
Ezz Steel	1147	27.50%
Alexandria National Iron and Steel	1375	33.20%
Ezz-Dekhela	2522	60.70%
Kouta Group	360	8.60%
Int'l St. R.M.-Beshai	275	6.60%
Delta Steel	91.8	2.20%
Suez Co. Al-Koumy	82	2.00%
Egyptian Metal Hatem	80	1.90%
Egyptian Iron& Steel	56.2	1.30%
Al-Said Steel	50	1.20%
Menouefya Steel	46	1.10%
Ayyad Rolling	36	0.90%
Egyptian Copper Wk	34.2	0.80%
Al-Arabi Planet Sharkawi	33	0.80%
Misr Iron & Steel	24	0.60%
Al-Temsah Steel	24	0.60%
National Metal Ind.	16.9	0.40%
Sarhan Steel	< 3.7	<0.1%
Total	3731	89.70%
Imports	440	10.30%

Table 6.10 Market Share of Local Steel Rebar Producers, 2000 - Source: (Selim 2006)

In contrast to the cement industry where the government failed to take effective measures to dump this increase in market prices, the government recently in 2009, introduced some measures that significantly reduced the market prices of steel.

The government uplifted the protectionist measures that were once implemented in favour of the local manufacturers. By lowering the imports barriers, the local manufacturers had to reduce their prices in order that they can compete with the exported steel. The market prices for steel bars surged to 3000LE down from 6800LE in just a few months time.

A review of the cost of the steel manufacturers indicated the high profit margins they enjoyed by setting the market price levels in their favour in the absence of any significant competition. This indicated the absence of effective regulations to protect the end consumers against such monopoly practices.

In general, the cement and steel industries seemed in desperate need for appropriate regulation. This is typically the role of governments in open market economies as indicated by the economic theory which suggests that the Egyptian government has moved towards the market economy in an unplanned manner.

It is imperative that in pursuit of the economic reforms sought by the Egyptian government, the regulation of the strategic industries and the subsequent market prices is of prime importance. This should not be misinterpreted as a call for the recourse towards controlled economy. On the contrary, it is rather a call for striking the right balance through undertaking the appropriate measures as part of the government's regulatory role meanwhile seeking the best interest of the society at large.

6.4   Summary

This chapter aimed at providing a brief introduction about the case study investigated in this research which is the national project for building schools in Egypt. At the start the General Authority for Educational Buildings (GAEB) was introduced. The chapter then presented a synoptic review of the socio-economic factors that were thought to be relevant to the national projects for building schools in Egypt. The details of the demographic

factors as well as the population distribution typically have impact on the number and size of school buildings. The variation of the economic conditions across the various geographic zones in Egypt indicated the importance of the location as a cost variable when estimating the cost of the school buildings. Finally the construction industry in Egypt was briefly reviewed with emphasis on the public sector building projects. In the same context the review included the cement and steel industries being the most influential cost factors in the case of the building projects in Egypt.

CHAPTER 7

REVIEW OF THE CURRENT PRACTICE

7.1 Introduction

In this chapter the semi-structured interviews conducted with practitioners were discussed. At the start, the first part of the chapter presented the rationale and context of the interviews. The details of the semi-structured interview design described how the data were collected. Then the objectives of the interviews and how they linked to the overall objectives of the study were illustrated. The second part in this chapter critically examined the data collected in an attempt to extract the sought meaning pertaining to the research objectives out of the provided responses. This was conducted over two stages. In stage one; the content analysis considered the wider context of the building projects in Egypt whilst stage two focused on the research case study, the national project for building schools. Finally, the chapter wrapped up with a summary of the findings as well as reflection on this qualitative part of the study.

7.2 The Rationale & Context of the Interviews

Primarily, the interviews aimed at reviewing the current practice in cost estimating for building projects in Egypt. This was conducted on two main axes; the review of the cost estimating practice for buildings in the wider context of the Egyptian construction market and a more focused review of the prevailing practice in the specific context of the research case study; the national project for building schools. The rationale behind this dual approach was to identify a comprehensive list of variables and factors from the review of the wider range of buildings then to compare and contrast these variables to the specific attributes of the research case study. Hence, the effect of the unique attributes of the research cases study (including and not limited to the standardised design applied by GAEB) on the inputs to the cost estimating process could be established.

7.2.1 Type of Work within Building Projects

Typically building projects in Egypt can be classified according to the type of works as well as the end use. Residential buildings, for example, would need different experience compared to special projects such as water tanks, swimming pools and petrol stations. Similarly the construction of a hospital building or a manufacturing plant would need different expertise compared to other special structures such as stadiums, airports, theatres, etc...

It might reasonably be argued that the variation in type of works would imply the need for more than just the relevant technical skills. Practitioners in general and cost estimators in particular should acquire adequate knowledge about the basic tools and techniques of cost estimating in order to produce accurate results.

However, on the other hand, it might be argued that unlike the significant variation in the technical skills needed to execute different types of project, cost estimating can be regarded as a process with comparatively less variation and a fairly standard set of procedures. Still, the variation in the type and the complexity of the works included in any project might have relative impact on the inputs to the cost estimating process rather than the skills needed to manage the process.

This study supports the viewpoint that recognizes the cost estimating function as a process that has inputs, tools and techniques and outputs. Hence, once the cost estimators have mastered the relevant tools and techniques, there should be less concerns about the type of work or the complexity of the project. Following this line of thought, it might be reasonable to suggest that more emphasis should be laid on the clear understanding of the process including the identification of variables to be included and more importantly, the inter-relationships between the significant cost variables.

As shown in chapter two in the review of the cost estimating and cost modelling literature, a number of tools, techniques and models are out in the public domain and available for the use of practitioners. Still the conclusion from the review of the literature was that the level of accuracy has not yet reached a satisfactory level, at least from the point of view of the scholars who conducted research on the this topic.

The interviews sought to investigate the current practice in the context of the construction industry, particularly buildings in Egypt with emphasis on the tools and techniques applied as well as the level of accuracy as perceived by the practitioners interviewed. The interviewed sample covered a relatively wide spectrum of experience with regard to the type of work as well as the other key projects variables.

7.2.2. The Main Categories within Industry Experts

Building Projects in Egypt fall into two principal categories: public sector and private sector projects. Yet, the national statistics indicated that a significant percentage of the number as well as the value of the executed projects was delivered by subcontractors (CAPMAS). Hence, the sample in addition to considering the public – private dimension, also considered that participants would include a fair portion of experts with substantive experience as subcontractors in the various types of building projects.

Needless to say, the client let it be the owner or the consultant representing the owner are instrumental in the decision making process when estimating the project costs. In the preparation for the interviews, the selection of the interviewed sample ensured the participation of experts with experience in various roles, i.e. clients; project management firms; main contractors; subcontractors and furthermore, specialized subcontractors.

Typically, practitioners with a minimum of 10 years of practical experience in building projects were deemed suitable candidates for the interviews. Finally, to fit the purpose of this study, the sampling aimed at including as many practitioners as possible with experience in the national project for building schools in order to reflect on the unique attributes of the case study under investigation. Table 7.1 shows the distribution of the sample based on the experience of participants in tradition & special works.

7.2.3. Rationale in the Selection of Participants

The purposive sampling technique was resolved as suitable to fit the context of the interviews aiming to cover the relatively wide spectrum of various types of works in

building projects. The sample included practitioners with a minimum of 10 years of working experience across the various strata (client – project managers - contractor – subcontractor – specialized subcontractors). The aim was to cover the relevant participants within the supply chain in order to investigate the aspects of the procurement system in general. In Egypt the cost still dominates most of the decisions related to building projects which agrees with Greenwood (2001).

In addition to the aggregate figures mentioned in Table 7.1, Table 7.2 provided the breakdown of the type of projects on individual bases and also indicated the work experience of each case expressed in the total number of years as shown in the last column. For example, the first column in Table 7.1 indicated that 9 members in the sample had experience working as the client's representative for public sector clients while participating in traditional projects whereas 4 members represented public sector clients in non-traditional projects. In Table 7.3, participants were listed and identified by their initials.

The key at the bottom of the table 3 explains the roles of each individual throughout the years of working experience both in traditional and non-traditional projects. Out of the interviewed sample, a total of 12 participants (67%) had experience with GAEB and participated in the national project for building schools.

Hence, the views expressed during the interviews can be reasonably assumed to be representative and less biased with regard to the type of project; type of works; size of project, complexity of the project and the role of practitioner interviewed. Table 7.3 presented the total no of years of experience of the sample in various types of projects. The key used in Table 7.3 applies to in Tables 7.1 & 7.2.

Project (by category)	Traditional Work	Special Work
Participants (*by Role)*		
Public Sector Client (PbC)	9*	4
Private Sector Client (PrC)	7	4
Main Contractor (MC)	15	16
Subcontractor (SC)	10	6
Specialized Subcontractor (SSC)	-	5

Table 7.1   Distribution of sample based on the type of work experience

*Some practitioners had experience in several roles due to their extended experience

Type of Project	Public Sector				Private Sector			
	Client	MC	SC	SSC	Client	MC	S C	SSC
Residential Buildings	√	√	√	√	√	√	√	√
Hospitals	√	√	√	√	√	√	√	√
Schools	√	√	√	√	X	X	X	√
Commercial Buildings	√	√	√	√	√	√	√	√
Special Structures	√	√	√	√	X	√	√	√

Table 7.2 Experience of participants in various types of Public & Private sector Projects

Experience / Participants (*by initials*)	Traditional Works	Special Works	Years of Experience
1. H.M.	PbC – PrC-MC**	PbC – PrC-MC	28
2. A.M.	PbC –PrC- MC	PbC –PrC-MC	32
3. A.G.*	PbC–PrC- MC	PbC –PrC-MC	23
4. M.S.*	MC – SC	MC-SSC	27
5. H.F.*	PrC- MC- SC	PrC- SSC	28
6. A.W.*	N/A	MC-SSC	26
7. H. W.*	PrC- MC- SC	MC-SSC	27
8. M. Z*	PbC – MC	MC	30
9. A. W. A*	PrC- MC-SC	MC	15
10. A. M.*	PbC--MC –SC	PbC-MC	38
11. A. A.W*	PbC- MC- SC	MC-SC	23
12. T. G.*	MC –SC	MC -SC	10
13. H. A.	PrC-PbC-MC	PrC- SC	28
14. S.E.	PbC-PrC-MC	MC–SSC	42
15. K. R.*	PbC –MC	PbC-MC	23
16. M. K.*	MC –SC	MC –SC-	23
17. S. M.	PbC –MC	N/A	10
18. M. Q	MC –SC	MC - SC	28

**Public Sector Client = PbC   Private Sector Client = PrC   Main Contractor = MC

Subcontractor = SC   Specialized Subcontractor = SSC

Table 7.3 Type of work experience and total number of years in the industry

* Participants with experience in school building projects with GAEB. Total number = 12 out of the 18

7.2.4 Context of the Interviews

The interviews applied a semi-structured approach with open ended questions that were mostly broad in terms of the phrasing and simple in vocabulary to facilitate the understanding and allow the respondents to elaborate freely.

The questions were divided into four main categories:

- Surveying the views of experts on the different tools and techniques used in estimating building project costs.

- Examining the key variables (main factors) that experts consider as most significant when embarking on estimating building costs.

- Exploring the level of awareness amongst practitioners about the key attributes of the performance of the economy in the context of estimating the cost of building projects.

- Discussing the experts' views on the level of accuracy of the estimated costs for building projects.

7.2.5 Interviews Script

The interview script comprised 6 main questions as follow:

Question 1: Based on your experience how can you describe the cost estimating process for building projects in Egypt?

Question 2: Based on your experience how do you identify the factors to be considered in the cost estimating process for building projects?

Question 3: In your opinion, how can you identify the factors that have the most significant impact on the cost of buildings in Egypt?

Question 4: How can you explain the relationship between the performance of the economy and the cost of buildings in Egypt? What does the term economic indicator mean to you? Can you give any examples?

Question 5: How can you identify the relevant economic indicators that have significant impact on the cost of buildings in Egypt?

Question 6: In your opinion, how can you assess the current level of accuracy in the produced cost estimates for building projects in Egypt?

7.2.6   Data coding

Coding is the process of converting the textual, non-numerical and unstructured data into meaningful information to support the analysis. The data coding process should not be limited to the cases of data reduction, condensation, grouping or classification; rather it is a process that allows researchers to connect data in order to facilitate the comprehension of emerging phenomena (Basit, 2003). The codes, typically, reflect on a set of themes and categories. Figure 7.1 shows the main themes and categories applied in this part of the study.

The two sets of codes used were priori codes and inductive codes. A priori codes occurred before conducting the interviews, i.e. while preparing the interview script whereas inductive codes were applied to the data collected and typically occurred after the interviews took place. The priori codes, as shown in Figure 7.2, reflected on the objectives of the interviews and informed the purposive sampling technique applied in the selection of the interviewed practitioners. This included the categorisation of the practitioners based on their role and experience in different types of project. The inductive codes, shown in Figure 7.3, on the other hand reflected on the data collected during the interviews
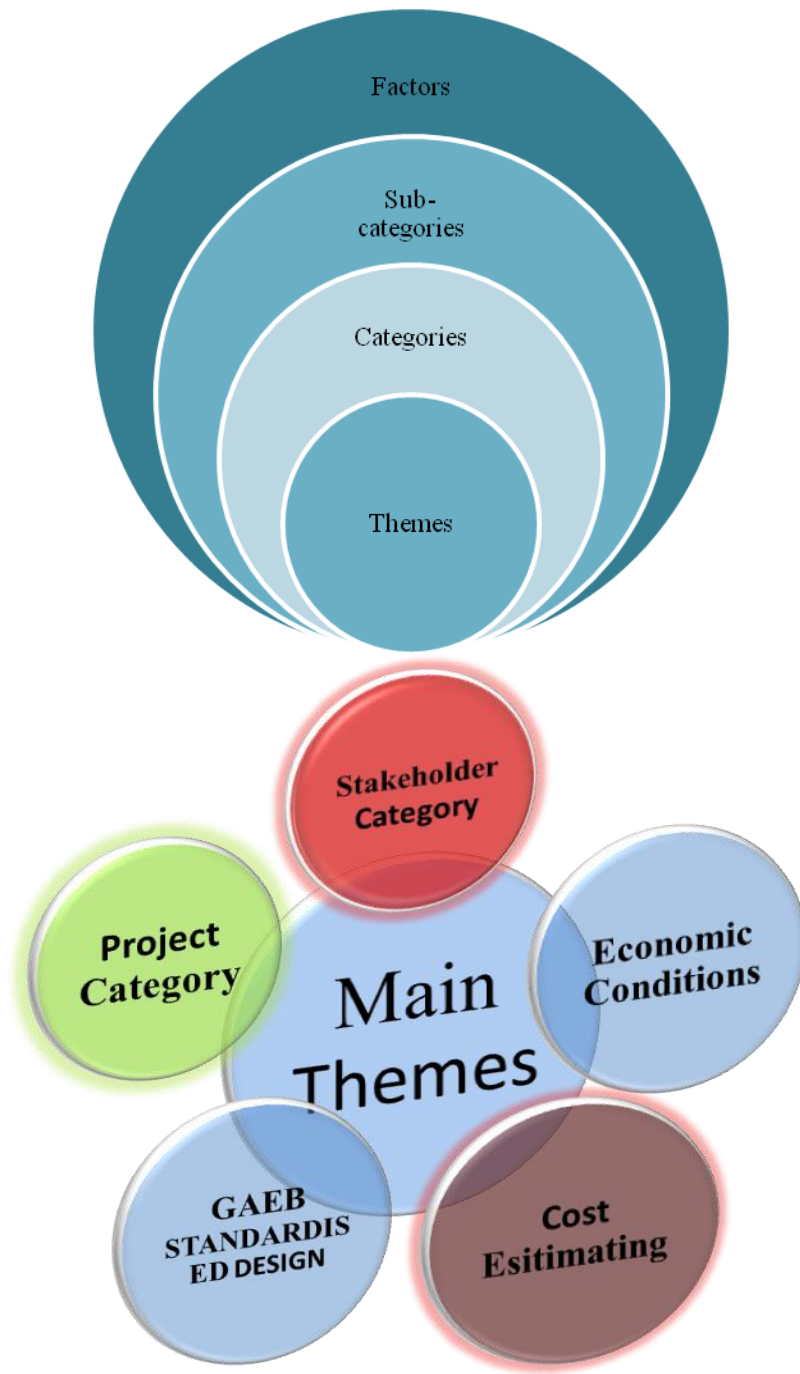
Figure 7.1   The Main Themes and Categories
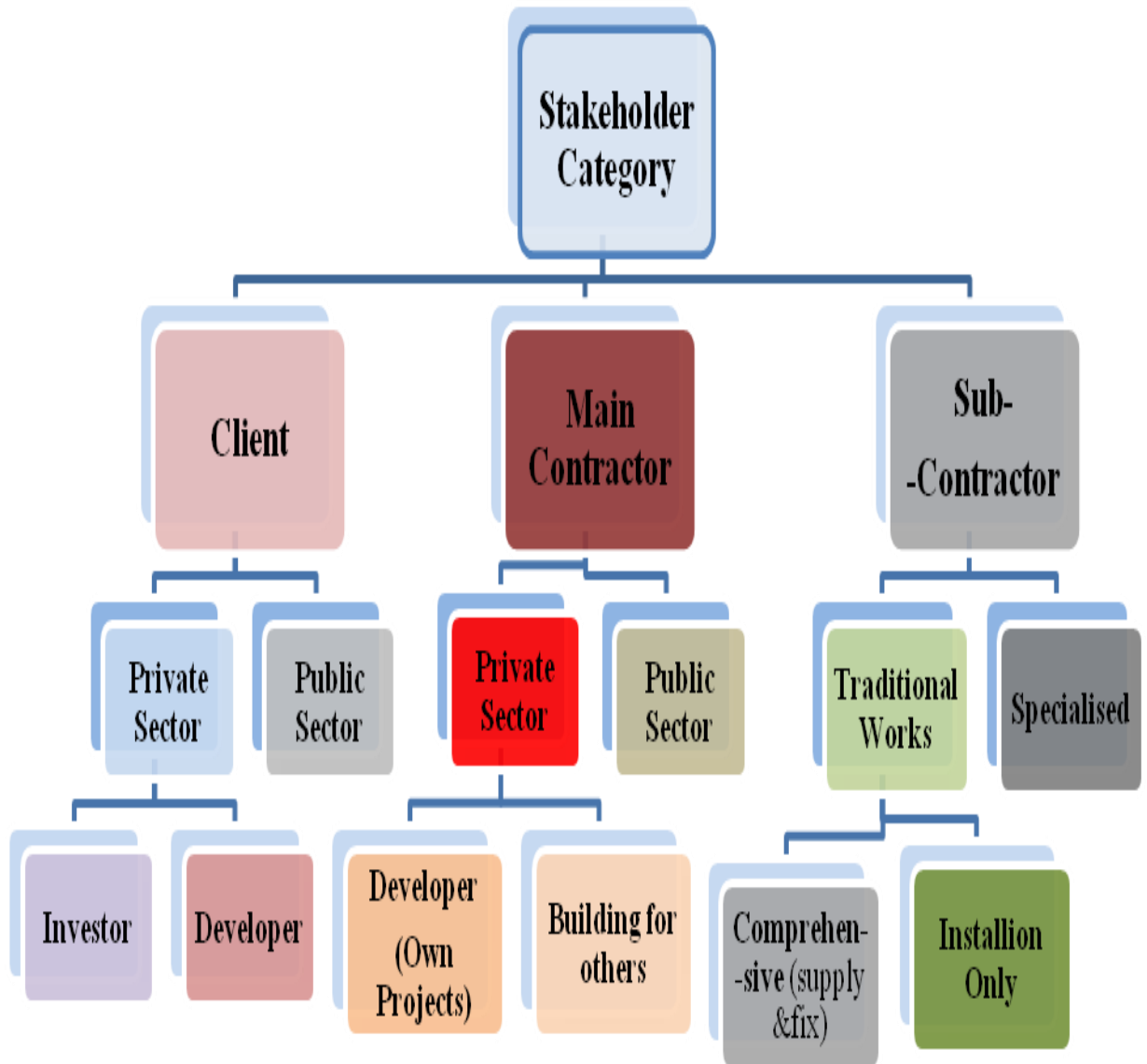
Figure 7.2   A Priori Coding system used in the sampling method for the interviews
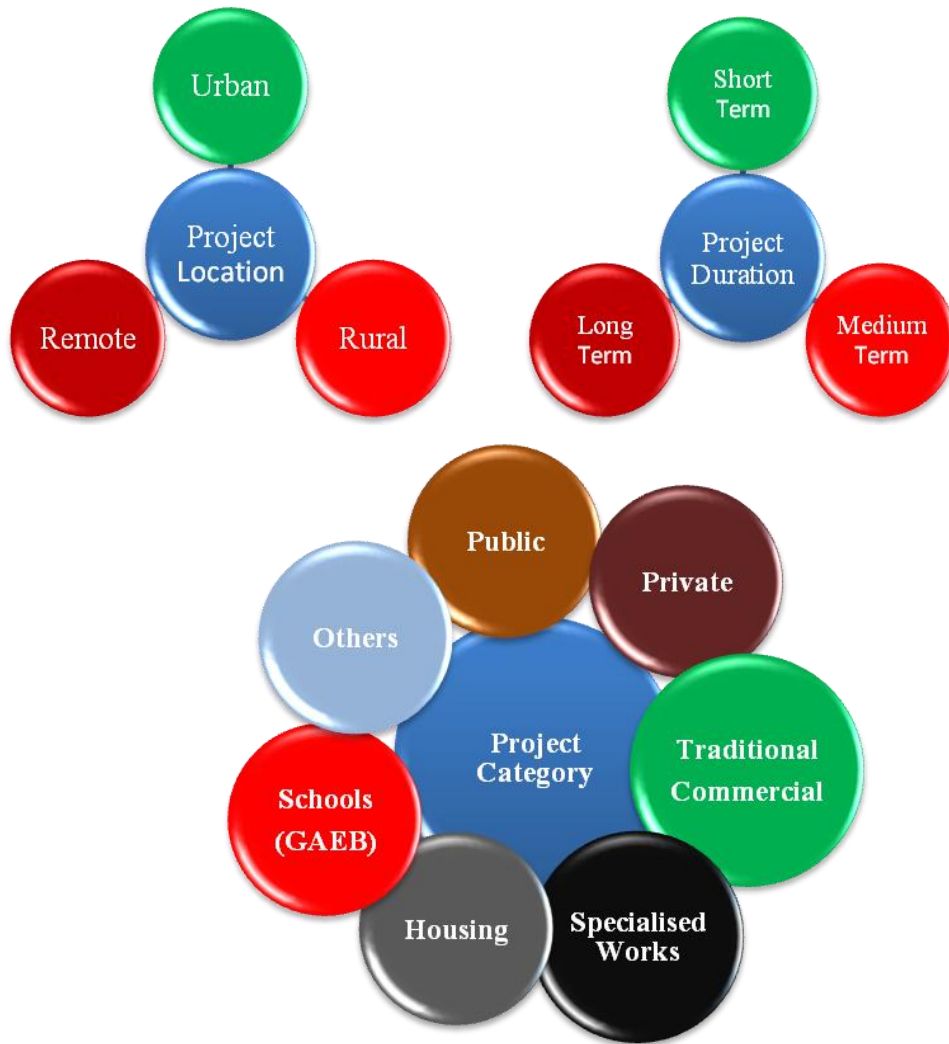
Figure 7.3   Inductive Coding System for project category

Figure 7.4   Inductive Coding System for Cost Estimating Practice

7.3 Alignment within the Objectives

7.3.1 Objectives of the Interviews

The main objectives of the interviews can be summarized as:

1. Identifying the key attributes of the current practice in cost estimating for building projects in Egypt. The question was broadly phrased in order to allow the participants to elaborate on their views and reflect on their experience in various types of projects. The question deliberately did not set any boundaries such as type of building; type of client; size of project; location of project, etc….so the question addressed the cost estimating process in the wider context of the construction industry with emphasis on building projects.

2. Identifying the key factors that experts thought were important when embarking on the task of estimating building costs. In addition, the interview question was aimed at identifying the most significant factors that would affect the produced estimates from the experts' point of view. This objective was broken down into two questions; the second and third questions on the interview script respectively. The second question did not specify any particular domain thus allowing the participant to elaborate freely while eliminating the bias and the doubts about leading the respondents. Then the third question portrayed a funnelling down approach moving from the wider context to the specific domain of key factor inputs. The study started with a hypothesis that some variables, particularly the economic variables were not explicitly included in the cost estimating process. This needed to be verified in the context of the Egyptian construction market meanwhile avoiding setting leading questions. Hence, maintaining the neutral stance of the interviewer and eliminating the consequent bias.

3. Assessing the level of awareness of the interviewed sample (as a representative of the population, i.e. the construction management practitioner) about the impact of the economic fluctuation on building project costs. Then identifying the most significant economic indicators that would have impact on building project costs as

perceived by the interviewed experts. Also, investigating whether practitioners included any of these indicators in the cost estimating process and how they were included (if at all). This objective was broken down into two questions; the fourth and fifth questions in the interview. The fourth question directly asked the participant about the sought cause and effect relationship, allowing the respondents to elaborate expressing their views on the subject matter. This question was phrased in broad terms in order to explore the sample's awareness of the basic concepts of economics in general and the key attributes of the performance of the economy in particular within the context of construction costs.

4. Assessing the understanding of the term economic indicators in the context of construction cost estimating by the interviewed sample. The fifth question together with the forth question were set to cascade from general to specific. The end goal as explicitly spelled out was to identify the economic indicators that would affect the construction costs from the interviewee's perspective. Clearly, the fifth question was aimed at identifying the most significant indicators that were perceived to have impact on the costs of building projects. In addition, this question was aimed at examining whether practitioners did include the identified significant economic indicators (if any) when estimating the costs of buildings. It is worth noting that the study started with a hypothesis that, overall, cost estimators acquired a fairly limited knowledge about economics in general and the impact of the economic fluctuation on the building costs in particular.

5. Assessing the level of accuracy of the produced cost estimates as perceived by practitioners. The review of the construction cost estimating literature and the construction cost modelling literature revealed that the accuracy of cost estimates is a contentious issue. Therefore, the sixth question sought to examine the views of the experts in the construction management discipline in Egypt about the accuracy of the produced cost estimates meanwhile comparing and contrasting these views with the findings of the literature review. Also, this objective aimed at pinpointing the main attributes as well as the challenges pertaining to the Egyptian construction industry in the context of cost estimating for building projects, particularly those that shaped the experts' perception.

7.3.2 Alignment with the Research objectives

The objectives of the interviews were set in alignment with the research objectives. A detailed manifestation of the alignment among both sets of objectives can be summarized in the following points:

1. The first objective of the study as mentioned in chapter one was to investigate the current practice in the context of cost estimating as well as to assess the accuracy of the produced cost estimates. Questions one and six in the interviews clearly addressed the two parts of this objective respectively.

2. The second objective of the study was to identify the key factors that affect the cost of construction projects. The second question of the interview clearly reflected this objective and comprised two parts. The first part of this question sought to identify the important factors that practitioners perceived as relevant and influential when estimating project costs. Then in its second part, the most significant factors pertaining to the Egyptian construction industry were identified.

3. The Secord objective of the study aimed at identifying the most significant factor inputs that have impact on the estimated building costs. The third question in the interview reflected this objective, clearly. The question used the terms material – labour – equipment to clarify what was meant by factor inputs since there were doubts that practitioners were familiar with the latter. Also, to eliminate the confusion with the second question that was more general. The flow from general to specific assisted in narrowing down the focus and helped in achieving the level of depth that was sought by the researcher in order to meet the set objectives of the study.

4. The third objective of the study aimed at examining the relationship between the performance of the economy and cost of building projects. Indeed, the main aim was to investigate whether this relationship could be modelled through some variables that would proxy the economic conditions against the cost of building project.

The study started with the hypothesis that practitioners in general had limited knowledge about the economic concepts and particularly how to include the impact of the economic fluctuation when estimating the costs of buildings. The fourth and fifth questions addressed this objective through testing the aforementioned hypothesis. The fifth question in particular aimed at testing the hypothesis that the key economic indicators were not explicitly included in the cost estimating process of building projects. In addition the forth objective of the study was explicitly addressed address in question five.

5. The fifth objective of the study was to model the relationship between the key economic variables and the cost of buildings. Typically a statistical analysis would be more appropriate to achieve this objective. However, it was planned in the research design that the triangulation approach would validate and further confirm the findings. The interviews, therefore, were aimed at identifying the independent variables that would explain the variation in the dependent variable, the cost of buildings in general and school buildings in particular. Despite the emphasis on the economic variables, it was decided that the project variables and particularly the physical variables were still deemed important in building the cost model which is discussed in details in the chapters 8 and 9. The selected statistical quantitative analysis would test the significance of the identified factors as mentioned in the previous point in a triangulation approach.

In other words, the congruency between the findings of the interviews and the statistical analysis would confer meaning over the findings of the statistical analysis. In addition, the identified variables would be confirmed and validated via two different routes within this research; the quantitative statistical analysis and the qualitative interviews.

The argument that either approaches could have sufficed may need further elaboration. Despite the results of the interviews that clearly pinpointed the main physical factors as well as two main economic variables, it was resolved though that the statistical analysis would provide better explanation and would more rigorously establish the relationship among the selected variables a facet usually attributed to the quantitative methods within data analysis techniques.

Furthermore, the obvious lack of awareness among practitioners regarding the basic economic concepts called for further analysis through a relatively large sample of numerical data set and suggested the use of the alternative statistical analysis to confirm and validate the findings of the interviews.

7.4 Discussion of the Interviews' Responses

The interviews yielded a significant amount of information. This had to be coded prior to the analysis in order to organise and make sense of the inter-related textual data collected. The main objective of analysing qualitative data was to identify the categories, factors, relationships and assumptions which inform about the participants' view of the research topic (McCracken, 1988).

The participants' responses indicated that the current practice varied according to the role of the cost estimator and whether the latter was representing the client; the main contractor; subcontractor or the specialized subcontractor. In the following sections each category will be discussed in detail. Also the first category, the client, will be divided into two categories: the public sector client and the private sector client. The interviews indicated the importance of some of the project specific variables. It was, therefore, decided to divide this section into three sub-sections. The first part will review the current practice based on the various categories of stakeholders. The following section will discuss the project specific variables and the last section will examine the participants' views on the relationship between the economic conditions and the cost of building projects.

7.4.1 Review of the Current Practice

In this section the review of current practice in cost estimating will be discussed in order to highlight the prevailing techniques with emphasis on the variations amongst the different categories of stakeholders.

7.4.1.1 The Public Sector Client

In general the clients in Egypt can be classified into two main categories; public sector and private sector clients. In the majority of the cases as indicated by the interviewed sample, the public sector clients seemed to have a relatively standardized process whereby a unit rate was applied to the different work items on the Bill of Quantities (BoQ). Each work item was broken down into its main components then each component was assigned a unit rate. The estimated rates mainly depended on the current prices of the material based on the manufacturer's price list at the time of estimating the item cost. The labour and equipment were aggregated in a unit rate that was most likely based on the experience of the cost estimator rather than any formal quotation from the relevant contractors or subcontractors.

The cost estimator was inclined, in most cases, to keep updated about the labour and equipment market prices through the informal communications with the contractor representative that takes place on daily basis whilst the latter was following up the paper work in progress. It was quite uncertain though how accurate this information might be.

The responses of the interviewed sample indicated that the safeguard lay mainly in the reoccurrence of this search for information through asking a number of representatives working on various projects. For example one of the respondents mentioned that "it was known" that the labour and equipment unit rate for reinforced concrete works asked by the subcontractor was around 100L.E. on average. Then the unit rate for material was added to the unit rate for the labour and equipment and finally a mark up was added to account for the contractor's fixed costs, overheads and profit margin. It was worth noting that this mark up would also include all the deductibles such as the value added tax, the National insurance, etc...

Most participants agreed that the mark up would range from 25%-35% (in traditional projects) over and above the total unit rates of material, labour and equipment. The cost estimating process for special work items did undergo a different process. Example of special works include central air conditioning; the delivery and installation of fire fighting systems; the delivery and installation of high masts in stadiums; the delivery and

installation of water proofing system for swimming pools and reinforced concrete water tanks; etc…

In such types of work, usually the cost estimator would refer to the key specialized subcontractors for quotations. In most cases, the specialized subcontractor would ask for a down payment and rarely would the public sector clients agree to provide down payments nor do they opt for dividing the project if it included special works. Instead, most public sector clients would award the project to a single main contractor. The main contractor would be responsible for dealing with the specialized subcontractor. In most cases the main contractor would not have the expertise to do this type of work and would rather rely on the specialized subcontractor in the delivery and installation of the work items.

It was worth noting that the concept of nominated subcontractor was hardly known in Egypt and even practitioners who heard of it in some post graduate applied studies, mentioned that it did not exist in practice. However, the specifications in most cases would clearly indicate a particular brand. In some cases the brand would be explicitly mentioned still the BoQ would state "such as brand X or the equivalent". In this case the main contractor would refer to the agent/dealer of this brand and would try to negotiate the best prices and terms of payment. In most cases, the main contractor would bear, alone, the burden of providing the specialized subcontractor the down payment that the latter would typically ask for.

As for the mark-up, the client would typically treat the special work items in pretty much the same manner as the traditional items. The significant difference was that the mark-up was based in this case on the quotation received from the actual implementer let it be the specialized subcontractor or the agent/dealer.

7.4.1.2 The Private Sector Client

The client in the private sector handles the cost estimating process in a less standardized approach. The cost estimating undergoes considerable variation depending on the type of project as well as the role the client plays. For example, the client who was classified as a

developer building residential buildings may have a different approach compared to the client who as an investor was building resorts or other types of commercial buildings.

According to the interviewed sample, in the Egyptian construction market, the developers would divide the residential building projects into work packages and award each work package to the relevant sub-contractor. Usually the client would purchase the material and the subcontractor would provide the skilled labour and equipments. The client would have a small project team lead by the site manager based in each site and in most cases a central technical office for planning and managing the client's projects in a home-grown approach.

The client would typically apply the unit rate method in estimating the cost of various work items. The unit rates for the material are based on the market prices rather than the manufacturer price lists used in the case of the public sector clients. The unit rates of the skilled labour and equipment would typically depend on the quotations from the subcontractors.

The time factor was a key difference in the cost estimating process performed by both types of client. The private sector clients seemed to enjoy the advantage of the less bureaucratic process compared to the public sector. The latter had to produce their budget for the new financial year some 6-8 months in advance since these estimates would go through various stages that would start in the technical office within the concerned department until it was finally approved by the parliament among so many other projects as part of the overall budget presented by the prime minister.

For example GAEB would present its budget to the MoE (Ministry of Education) which in turn included it into its whole budget that would be presented to the Cabinet whereby the overall budget was developed and then presented to the parliament for approval. In order that GAEB would do so meanwhile delivering the set target in terms of number of schools to be built within a particular financial year, the cost estimates had to be completed much earlier than the actual tendering of the projects. If the aggregate sums were approved through the various stages, then the funds would be transferred to GAEB by the beginning of the following financial year that is July. The tendering would normally start in

July/August and the actual execution would start normally around 4 weeks after the two stages of tendering; the technical envelop followed by the financial envelop.

In the private sector the time lag between the produced estimates and the actual execution was much less significant compared to the public sector projects. Also, in many private sector projects money tended to exchange hands in a quasi-formal manner. In many cases no formal contracts were scribed between the client and the suppliers or subcontractors. Parties would only rely upon receipts documenting the cash amounts or the value of the cheques exchanged. As the interviewed sample reflected, the relationship tended to rely on the word of mouth and the reputation of both parties in the market based on previous projects. Also there seemed to be a mutual benefit since this approach enabled both parties to adjust their books for tax purposes as mentioned by some of the respondents. However, this approach was more commonly applied to traditional work packages rather than special work items.

In the case of special works, the private sector client would negotiate the best prices and best terms of payment with the relevant subcontractor directly. In most cases, the latter would request a formal contract and a down payment.

In some projects such as industrial buildings, the client would select a main contractor to deliver the entire project from start to finish. The main characteristic that differentiated this type of client from the previously mentioned was that the construction activity tended to be secondary and less frequent within the client's business portfolio. For example the client who builds a factory or manufacturing plant does not tend to repeat the same as frequently as the developer whose business was mainly focused on residential buildings. In industrial and commercial buildings the client (investor) would usually opt for hiring a consultant/project management firm to undertake the planning and project management activities on the client's behalf.

The consultant (as widely known in Egypt) would be responsible for producing cost estimates for the project; typically, using the unit rate method (priced BoQ) based on quotations from the relevant contractors and suppliers, i.e. market prices. The time lag between the planning and the execution phases would be greater in these type of projects compared to the traditional residential projects managed directly by the client. As the

client dealt directly with the suppliers and contractors a considerable amount of time was saved. When the consultant managed these tasks, the consultant would negotiate with the contractor and the supplier in order to reach the best possible deal. The outcome was then presented to the client for approval. If the client was not satisfied that this was the best deal the entire process was repeated by the consultant in the light of the new parameters that the client would set. In some cases the client would not have adequate experience to decide upon these criteria from the outset so it was not unusual as the interviewed sample had mentioned to undergo an iterative procedure of cost estimating and even tendering (in some cases) for this type of project.

In many cases, the consultant would filter the offers received by bidders to create a short list that would be presented to the client for the selection of the best offer. It was quite rare that the client would leave such critical decisions to the consultant. Obviously this process was usually prolonged and would take, over all, a longer time period compared to the case when client was are planning and managing the project through their own technical team.

The client intervention affected not only the total duration of the project and speed of the decision making process but more significantly the quality of cost estimates according to the viewpoint of the respondents. Typically, when a client was conducting direct negotiation with a supplier or a contractor who was expecting to start the delivery within a few days, the outcome was different from the case when the consultant was asking for a quotation. In the former, the contractor and/or supplier appreciated that they are dealing directly with the decision maker and particularly the budget holder who had the capacity to approve the deal.

In general, the breakdown of the project into work packages to be tendered in a sequential manner following what could be labelled as JIT approach seemed to be preferred by the private sector developers who had their own technical teams and their business portfolio was primarily focused on the construction market. On the other hand, investors would opt for experts to plan and manage their projects as the establishment of their own technical team was perceived as cost ineffective due to the scarcity of the projects or the relatively long periods of time between the different projects.

7.4.1.3 The Main Contractor

The type of client and the type of works within the project were listed amongst the most important variables that main contractors consider when classifying a project, particularly for cost estimating purposes.

In the case of public sector projects, the main contractor would feel more secure about the payments being guaranteed by the credible government despite the possibility of considerable delays in payment. In most cases there was no down-payment in public sector projects so the main contractor had to consider the cost of finance especially at the early stages of the project, particularly the mobilization and foundation works. Some contractors would opt for front-loading strategy when pricing the various work items in the public sector projects. In addition, the main contractors in public sector projects would consider the deductibles and the retentions over and above their fixed costs, overheads and profit margin.

In the case of the private sector projects, the main contractor would typically ask for a down-payment in the range of 20-30% of the total project value. Also the time lag, being an important factor as mentioned earlier, was much less in the private sector compared to the sophisticated bureaucracy in the majority of the public sector projects. Some respondents noted that in public sector projects, in some cases, the main contractor had to wait for 8 months after bidding before having access to the building site to start the mobilization phase. During that period the market prices were most likely to change and the main contractor would bear the consequences alone due to the strict and rigid contract imposed by the public sector clients.

Hence the main contractors were more likely to include risk provisions and contingencies in the case of public sector projects to hedge against the fluctuation of market prices. However, it was not clear from the interviews whether the main contractors followed any structured process or a clear methodology in estimating such provisions. It was noted by the interviewed sample that the above mentioned provisions would be reflected in a higher profit margins. This was contrasted by another point of view of some experts within the sample. The counter argument hinted that in general the quality of works in public sector

projects was less than the similar private sector projects. Hence, this might explain how some contractors indigenously managed the risk due the volatility of market prices without explicitly asking for higher profit margins. On the contrary in some cases the prices asked by main contractors bidding for public sector projects were lower compared to the same contractor's bid for similar works within the stringent quality assurance and control systems applied in the majority of private sector projects. Some of the respondents reflected upon this using expressions such as "*quality assurance measures are not so tight and generally less strict*" when referring to public sector projects. However, it seemed that this *"flexibility"* varied according to the type of work with more likelihood of occurrence in the finishing work items rather than the structural elements.

It had been noted by the majority of respondents that in private sector large projects, the main contractor usually takes into consideration the cost of health and safety procedures on the building site which was almost neglected in most public sector projects. It was mentioned in the interviews that main contractors would typically depend on historical data when estimating the cost of health and safety which was then pooled across the various work items in ratio and proportion.

In some cases the extra cost resulting from the implementation of health and safety procedures was directly allocated to the relevant work package. For example, when using special scaffolding that meets the health and safety requirements, the main contractor will include the extra cost directly in the unit rate of the external plastering work items. This would add a significant increment to the unit rate of the work item compared to the traditional timber scaffoldings used in the majority of building projects in Egypt.

In the case of special works, the main contractor would depend mainly on the quotation from the supplier or the subcontractor such as the delivery and installation of pumps for water stations, fire-fighting systems; CCTV systems; etc…

The main contractor would then add the overheads and profit margin in the case of private sector projects. In the case of public sector projects, the mark-up asked by the main contractor would include over and above the aforementioned a provision for the deductibles.

7.4.1.4 The Subcontractor

The subcontractors tend to differ from the main contractors when estimating project costs. Before discussing the details of the cost estimating process from the subcontractor perception, it was worth noting that subcontractors for traditional projects would fall into two main categories; those who tended to bid for the comprehensive delivery of the work package, i.e. supply and installation versus the subcontractors who would only provide the skilled labour and equipment while the main contractor would supply the material.

Typically the latter will be less concerned with the market prices of the building material. This category of subcontractors seemed more concerned with the price movement within the labour market in general and the construction skilled labour in particular. The wages seemed to vary significantly with the type of work as well as the location of the project.

For example, when the labour migration to the lucrative construction market in the Gulf region was booming in the late 70's and through to the new millennium, the wages of the skilled labour in the Egyptian construction market increased significantly. Not only that the wages level increased but this migration was also associated by a notable decline in the quality or in other words the competence of the skilled labour after the best qualified and experienced individuals had left for the better pay offered by the rich Gulf states eager to develop rapidly. Needless to say, the Arabic speaking skilled labour were preferred especially at the early start of this era in the late 60's and early 70's.

The impact of this migration and shortage in skills was clearly manifested in the gap in the wage level among the skilled labour depending on the class of work. Work packages widely known as 5 stars or super deluxe finishing work packages witnessed a relatively higher increment compared to the basic finishing work packages. Subcontractors serving these up-market projects with supreme finishing standards had to consider the soaring costs in order to secure the adequate skills amid the shortage in supply.

The variation in skills also affected the fundamental work items such as brick works. For example the brick layer who used to work on the prestigious Cairo underground project for a local subcontractor with the French main contractor would be paid almost 50% higher than the brick layer working with another local subcontractor who was working for a main

contractor on one of the public sector housing projects. The higher pay was due to the higher quality needed in the former project that necessitated a higher level of competence. Add to this that the productivity of the meticulous brick layer, for example, on the underground project was less than his counterpart on the housing project. Hence the cost in terms of unit rate for the subcontractor was significantly higher in projects with prime quality.

This last point is worth further clarification. The subcontractors were typically more concerned with the productivity and efficiency of the skilled labour more than the main contractor or the client. The unit rate method when applied by both the client and the main contractor relied on the figures provided by the subcontractor for the labour and equipment, in most cases. So both parties did not feel the urge to undergo a detailed analysis for this component in pursuit of a comprehensive unit rate. On the other hand the subcontractor tended to breakdown the cost items into its simplest form whereby the unit rate of the work performed would be the result of the total cost incurred to finish the work item under study divided by the quantity of work performed. The total cost incurred by the subcontractor would include several subsections. First the direct costs equal the wages of the skilled labourer plus the share of overheads divided by the quantity of work produced at the end of the day. Add to this other cost variables such as the handling of the material and the cleaning of the work place once the work was completed. Then the fixed costs and overheads were added to the aforementioned total. For example, the accommodation and transportation costs for labour; maintenance and spare parts for equipments, utility bills for the office and the salaries of the support staff in the office.

In most projects the subcontractor would be responsible for providing accommodation and transportation for the work force. In remote projects as the respondents had emphasized, the subcontractor had to provide an incentive up to 100% of the typical wage in order to entice the skilled labour. Also, this incentive was perceived as compensation since labourers had to stay away from home for longer periods that may extend up to 45 days in some remote projects. In real sites the work force would stay on the construction site during the six working days of the week that was Saturday to Thursday in Egypt. In some urban projects the workforce might have the option to leave at the end of the working day since the transportation and facilities are usually available. Still if any individual had to

travel a long distance to reach home, the option to stay on site was usually available and was part of the subcontractor's responsibility.

Over and above the aforementioned factors, the subcontractors who bid for comprehensive works would consider the cost of material. This was typically estimated based on market prices. In most cases, especially in private sector projects and many public sector projects the time lag between the cost estimating and the actual implementation was considerably short that it might not have significant impact except for the work packages that might extend for longer period i.e. more than 6 months. Most subcontractors are called to the job at relatively short notice, usually a few weeks before the actual start.

Both types of subcontractor consider the cost of equipments especially in the case of the subcontractors undertaking concrete works who are typically responsible for providing mixers, hoists and poker vibrators amid other tools such as the steel bending and cutting machines, etc. Also, in the case of concrete works the subcontractor would be responsible for providing the timber (still the most widely used construction material in Egypt) for the formworks. The depreciation of this item particularly in the case of special structures would have significant impact on the unit rate of concrete works for subcontractors who bid for providing labour and equipment and to a lesser extent on the subcontractors who bid for the comprehensive supply and installation of the entire package including the building material.

7.4.1.5 The Specialised Subcontractor

Traditionally, the specialized subcontractors in Egypt maybe the most envied subcontractors in the construction industry. Borrowing the expression "differentiation" from the strategy and marketing jargon, this type of subcontractor was perceived to accrue higher profit margins due to the differentiation factor. In most cases, the specialized subcontractor would supply and install the work items and in many cases the material was imported by the specialized subcontractor being the agent or the dealer for the foreign producers. This type of subcontractors would normally rely on the fact that they are quite scarce compared to the traditional subcontractors. In other words the competition in the

construction market for special works tends towards oligopoly. Also the examination of the demand forces within this market indicated that there was shortage in supply with a few specialized subcontractors relative to the amount and value of works items.

It is worth noting that the jargon used above was introduced by the interviewer on reflection and as part of the interpretation and the analysis of the collected data since the interviewed practitioners did not seem to realize some of the above mentioned concepts. However, they intuitively provided very useful insight about the competitive forces within this segment as well as the details of the cost estimating process conducted by this type of subcontractor.

In this segment, the subcontractors tend to base their cost estimates basically on historical data and past experience. One of the interviewed experts mainly specialized in fire-fighting systems reflected that they still use the unit rate method then would add the overheads and finally include the profit margin. In general the specialized subcontractor sets higher profit margins to hedge against the unknowns mainly the exchange rate since the exported element comprised a considerable portion of the cost.

7.4.2 Project Specific Parameters

The above classification was based on the role of the firm in the construction market let it be the client, the main contractor or the subcontractor. In the following section it was resolved to lay emphasis on two critical factors as indicated by participants, mainly the project duration and the project duration since both were pinpointed as crucial parameters which had significant influence on the cost of building projects.

7.4.2.1 Project Duration

The project duration was classified into three main categories; short; medium and long term. The short term project would last up to six months. The relatively high risk to complete the project on time imposed the inclusion of additional provisions to account for possible mitigating actions such as crashing some of the activities to meet the tight time

schedule. The profit margin was usually set at relatively higher rates due to the size of the project that was in most cases directly proportional to the duration of the project. The exception to this rule would be specialized works such as the case of refurbishment projects whereby special work items, for example, fire fighting systems, CCTV systems and repair works would hike up the total value considerably compared to the fairly short duration of the project.

In this type of projects, the change orders were usually critical due to the comparatively short duration. This factor would typically impose further risk that was usually embraced within the profit margin as most respondents indicated. In medium term projects (6- 24 months), typically, the size of the project is larger than short term projects. The fixed costs seemed to be more significant compared to the case of short term projects. On the one hand, there was more room for implementing remedial actions which reduced the risk of completing the project on time. On the other hand this type of project was more exposed to the changes in price levels of the key factor inputs. In addition, in medium term project and particularly in the case of public sector projects, there was a relatively higher probability of delays in payments compared to short term projects. Also the impact of such delays on the progress of work would be quite detrimental. In many cases the contractor could finance short term projects from start to finish from own resources, yet the case was different with medium- long term projects due to the size of the project and subsequently the amount of required resources.

It was more common in medium term projects comprising a significant amount of special works to include a down payment. This reduced the risk due to price fluctuation compared to the case of traditional projects which seldom included a down payment.

The long term projects that extended for longer than 2 years were significantly exposed to the economic conditions and its impact on market prices of key factor inputs. The longer the project would last, the higher the probability to witness delays in payment and hence the higher the chances that delays in the progress of work would occur.

The counter argument presented in the interviews claimed that in longer term projects, there was more room for remedial actions and catch-up plans. Still, it might be reasonable to assume that such measures had an impact on the cost of project. In the case of the public

sector projects, the contracts were described as very strict and seldom was the case when the contractor would be compensated for the extra cost incurred due to the delays in payment. Needless to mention that if the contractor decided to slow down the progress of work to match the pace of payments this would lead to extra costs due to higher fixed costs plus the anticipated penalties for delays.

Also, in the case of long term public sector traditional projects where no down payment was provided, the cost of finance was more significant compared to the short and even medium term projects. This was coupled with the fact that most long term projects were significantly higher in monetary value compared to the other two types.

Some participants reflected that general contractors in Egypt were classified into 7 grades based on their financial capabilities and experience whereby grade 1 is the top grade and grade 7 indicated a relatively small or medium size contractor. In tenders and particularly in the case of public sector building projects only top grades were allowed to bid for large size projects which were in most cases long term projects.

It might be claimed that such a large size contractor had a well established technical office capable of producing a more accurate cost estimate meanwhile embracing the above mentioned factors. However, there was no evidence that even large size contractors did undertake any different approach to cost estimating in order to include those factors. The interviewed sample indicated that cost estimators relied on historical data and previous experience in setting provisions for anticipated risks. This approach seemed to ignore, in most cases, the economic conditions illustrated by the prevalent economic indicators.

Table 7.4 summarises the main factors considered by the cost estimators as identified by the interviewed sample in relation to the project duration.

Time-Span	Economic Factors	Contractual Factors	Project Specific Factors
Long Term	More exposed to economic conditions High risk due to fluctuation in market prices	Delays in payment will lead to slowdown Down payment mostly in Private sector and rarely in public sector Changes are imperative	Typically correlated with size Project complexity Room for mobilisation in remote and rural projects Room for remedial actions
Medium Term	Exposed to economic conditions Prone to fluctuation in market prices more than short term projects.	Delays in payment are detrimental for the contractor Down payment in rare cases in public sector and more often in private sector Changes are critical	Larger size projects impose extra pressure Location is a critical factor Time slippage will be critical. Room for remedial actions yet quite limited in most cases.
Short Term	Less emphasis on economic conditions Higher profit margins (%) compared to medium and long term projects	Delays in payment are less likely Mostly associated with down payment Changes are very critical due to the limited time duration	Any time slippage will be very critical. Remedial actions are very limited due to the time constraint

Table 7.4 Classification of Influential factors based on the Project Duration

7.4.2.2 Project Location

The location of projects could be classified into three main categories; urban; rural and remote locations. In urban locations, the challenges that faced the project team were

mostly due to the characteristics of the cities or towns whereby the density of population was much higher than in rural areas. Hence, the building sites were more likely to be close to the existing buildings and the main roads busy with heavy traffic throughout the day. Typically, in towns and cities, especially in residential areas, the working hours would be restricted due to the high level of noise associated with the various activities on the construction site. Experts reported that despite the lack of clear regulations in this regard, the police were called by the neighbours in many cases to stop some noisy activities such as concrete pumps especially when operating after midnight. The relatively limited flexibility in working hours was an important factor considered by cost engineers. In the most direct effect, it would lead to a higher percentage of the fixed cost element.

The transportation and logistics activities inside busy cities tended to cost more than in rural areas. Heavy trucks were only allowed on certain times and this restricted the supply of key building material such as steel, cement, sand and gravel. Also, the local authorities were usually more vigilant about the health and safety issues in busy cities than in rural areas. For example, in Cairo and other main cities, the cost of scaffoldings was considerably higher compared to rural and remote areas due to the regular inspections by the local authorities.

Another challenge that faced contractors in the main cities and crowded towns was the dumping of waste. Typically, trucks carrying waste had to travel a fairly long distance to the designated areas.

This cost was either factored into the unit rate of each task in ratio and proportion or (as the majority of respondents indicated) was rather included in the overheads as a fixed cost. Only when the waste disposal contributed to a significant percentage of the project total cost, the cost estimator tended to undertake a detailed analysis of the cost of dumping the waste. This mostly occurred in refurbishment and repair projects.

In rural areas, on the other hand, sometimes there are no paved roads for heavy vehicles to facilitate the supply of key building materials at reasonable cost. The availability of the essential utilities mainly water and electricity imposed an operational problem in some rural areas.

The accommodation for staff mainly the engineers and the supervisors was a key influential factor on the cost of the project. In most cases, building projects in rural areas needed to factor in extra time for the delivery of supplies which would impact on the cost of the project due to the higher fixed costs. Also the Sub-contractors would request accommodation on the site in the case of projects in rural areas unlike the case with urban projects since local work force was usually more available in main cities and towns.

Remote locations mainly the Oasis and deserted areas imposed even higher costs. Over and above the aforementioned factors in case of rural locations, buildings in remote areas incurred high transport costs for both stuff and supplies. The main utilities accounted for a considerable portion of the cost for almost all items since the water was quite expensive and electricity had to be sorted out via the deployment of expensive generators. The accommodation for the staff might mean either building temporary facilities or using mobile caravans. The basic requirements for living such as food, potable water, etc … were another cost factor that contractors considered over and above the utilities need for executing the various work items.

The delivery time of building materials exceeded those in urban and even rural areas by more than 20% in some remote locations. Also, the security issue was vital in remote locations. Some respondents mentioned that they had to pay hefty fees for the local tribes to guarantee their personal safety as well as to hedge against steeling the supplies on the site. Also sub-contractors typically asked for a significant premium over and above the nominal rates they would normally accept in the urban and rural areas.

In general, the fixed costs in remote locations projects were usually much higher compared to the urban and even rural locations. Consequently any extensions imposed significant impact that might turn a profitable project to lass. Unfortunately, as reported by most experts during the interview, the projects in remote locations usually faced delays due to the above challenges. This time slippage was most likely to occur. Contractors who had previous experience in the same location tended to be more familiar with the impact of those challenges on both cost and time.

Hence, previous experience was pinpointed as critical factor that would give the contractor the competitive edge in the case of projects executed in remote locations.

Add: Table 7.5 summarises the main factors unsoldered by cost estimators as identified by thninterviend Sample in rotation to the prefect location.

Location	Critical Factors
Urban	Regulations (H&S)
	Transport restricted hours, hence higher
	Restricted Working Times
	Restricted Access for Heavy Trucks restricted
	to smalls quenches hence gist & time
Rural	Utilities
	Access Roads
	Staff Accommodation might be needed
	Availability of Local Skills can reduce the
	premium asked by sub contractors.
	Material Delivery Time
	Subcontractors ask for premium
Remote	Security
	Utilities
	Access Roads
	Staff Accommodation is imperative
	Living Conditions is expensive
	Premium for Subcontractors much ling he than rural
	Material Delivery Time takes longer than rural
	Higher Fixed Costs

Table 7.5   Influential Factors based on project location

7.4.3 The Impact of the Economic Conditions on the Cost of Building.

7.4.3.1 Awareness of the Key Economic Concepts

The majority of participants explicitly stated that they had limited background about economics. The jargon used by economists was not perceived as an easy to understand

terminology. The reason as interpreted by the interviewer was mainly due to the education system in Egypt. The majority of the experts in the construction industry in Egypt would typically hold a first degree in Engineering (most likely Civil, Architectural, Mechanical or Electrical Engineering) whereby there were barely any modules on economics, finance or accounting to provide the graduate with an adequate minimum background about the key concepts within these disciplines. The responses obtained during the interviews indicated that the budgeting for building projects was divided into two main phases. Phase one included estimating the unit rates for various work items. This was typically undertaken by civil engineers who have specialized over time in cost estimating. Phase two built on the output of phase one and was usually performed by specialized practitioners who would hold a degree in management (known as commerce in Egypt). Adding the over hands deductibles & taxes & producing priced bock

During the interviews, the participants body language and furthermore their answers reflected that they could barely define the key economic variables such as GDP or balance of payment. The answers provided varied significantly. Only 4 out of the 18 respondents mentioned that the performance of the economy was reflected in the standard of living through the price levels. One of the interviewed practitioners stated that when the economy was witnessing turbulence, the market prices of key commodities were quite volatile.

This sub-sample emphasized the impact of the exchange rate of the Egyptian pound versus the US Dollar on the level of prices for various commodities. Six out of the 13 participants provided general statements such as "*when the economic conditions are better, the contractors can ask for higher prices since there will be higher demand and the market will be more dynamic*" while others reflected stating that "*under better economic conditions, there will be better opportunities for everybody, hence the prices are expected to increase. Favourable economic conditions mean more investments, hence more projects and more tendency to see higher prices*".

Such general statements despite indicating the intuitive awareness of the forces of supply and demand as well as the relationship between economic stability and investment fell short of pinpointing a clear understanding of the inter-relationships between the economic variables and the cost variables. There are some implicit assumptions that were neither valid nor testable in the above statements provided by the interviewed sample. For

example, it was not clear whether the assumed increase in demand would lead to higher prices due to higher profit margins set by the contractors or was it due to higher prices of factor inputs. Also, practitioners did not seem to reflect on the periods when the economic conditions were not favourable since it might not be reasonable to assume that the provided statement would still be valid vice versa, i.e. in dire conditions the prices will fall.

On the contrary. the secondary data collected during the course of this study and discussed in the previous chapter provided evidence that the steel prices increased significantly when the construction market was nearly in a state of stagnation and maintained a steady increase over the period from 2003-2008. Then the prices fell down dramatically in the second half of 2009 whilst the construction market was still in stagnation. Similarly, the relatively high cement prices were not affected by the significant slowdown in the building activities in particular and the construction market in general.

Neither did the prices of most of the key building material decreased over the same period. In fact, most of the key building material witnessed year on year increase due to the relatively high rate of inflation. The overall outcome of such increase in factor inputs coupled with a relatively high inflation was a significant increase in the cost of buildings.
It can therefore be concluded that practitioners did acquire the common sense about market forces in general and to some extent. However, they did not clearly demonstrate adequate understanding of the interaction of these forces in context.

The interviewer was under the impression that it was the typical human nature (and maybe the culture as well in this case) that people would tend to answer the questions even if they provide general statements rather than saying that they did not know especially when they have been approached and invited to participate in this study being experts in their profession. The interviewer benefited out of the comments that were noted during the interviews about the body language and the facial expressions that reflected a clear difference compared to those noted when the sample was responding to the questions about the current practice and the key factors that affected the cost estimating process. There was a clear evidence that the participants were very confident when discussing the topics they knew inside out whilst they were fidgety and clearly restless when discussing the economic issues.

Only two respondents explicitly mentioned that they were unaware of how to assess the performance of the economy. These were the two most confident amongst the sample. Both stated that they were more inclined to pay attention to the market price level of the key factor inputs rather than tampering with such an important and sensitive issue like cost when they knew very little about the direct economic impact on the cost of buildings. Also, according to this small sub-sample view, the market prices did reflect the effect of the economic fluctuations so why the need to try to "*disentangle the mysteries of what seemed to be unknown territories*" as stated by one of the two respondents. The other mentioned "*decisions involving money has to be built on facts and a very clear understanding of the basis on which the decision will be made*"

It is worth noting at this point that most respondents indicated that they did not believe that the economic reports announced by the government were credible. For example, over the period 2004 – 2008 the government reported healthy growth figures, every year. Meanwhile other reports by independent international bodies indicated that the level of poverty in Egypt was on the rise during the same period.

Clearly, respondents did not seem to realize the difference between the growing economy and the fair distribution of wealth. The latter was, maybe, one of the main reasons that caused higher poverty levels, a drawback of the fast-forward shift towards open market economy in quite an unplanned manner and without establishing the adequate social safeguards. Recently the Egyptian government has started paying more attention to the impoverished social strata through injecting more investments to improve the infrastructure and enhance the development of the distressed villages. The national project for building schools was one of the earliest steps on what is expected to be a fairly long-lasting journey of economic reforms. The demographic factors displayed in the previous chapter highlighted the distribution of populations according to age and income level across the 29 governorates of Egypt and indicated the magnitude of the problem facing the government whereby a considerable percentage of the population is under the age of 15.

 It is imperative that such a young population would need education, jobs and in the near future there will be a higher demand for independent housing. Therefore the demand for residential buildings and for school buildings is thought to be on the rise year on year.

This increase is expected to consume a considerable share of the Egyptian budget given the relatively high poverty level which will render the government responsible to build more housing projects in addition to the school buildings since the constitution mandates the provision of free education available to all Egyptian citizens. Needless to say that any attempt towards enhancing the accuracy of cost estimates will be very helpful to the government and practitioners alike.

7.4.3.2 Identification of the Significant Economic Indicators

This question was the most contentious among the entire set of questions during the interviews. The question was set to ask the respondents to identify the key economic indicators that would have significant impact on the cost of building projects. However, given the answers provided in response to the previous question, the interviewer decided to introduce a slight change to this question. It was decided to start by asking the interviewee to provide examples of economic indicators before proceeding to the main question about identifying the significant indicators. Only two respondents were able to start answering this question without the need for further clarifications. In the first case, the respondent mentioned unemployment, poverty level and market prices. The second respondent mentioned inflation and the rate of interest as examples of the economic indicators.

The rest of the respondents requested that the interviewer would rather give examples to clarify what was meant by economic indicators. It was more than likely that the sample was not aware of the jargon rather than the ignorance of this branch of knowledge that affects "every day" matters. Like the example of the grocer who runs his business successfully when he can hardly read or write. He does not have a university degree in business but he has learned by experience. This experiential learning seems to be the prevailing case amongst cost practitioners in the construction industry in Egypt.

The interviewer was ready with a list of economic indicators as shown in table 7.6. Once the participants reviewed the list there was a common agreement amongst the entire sample including the first two respondents above mentioned that the most significant indicators were the exchange rate, the interest rate and the rate of inflation. Other indicators were selected by a few respondents such as the consumer price index, the GDP,

the rate of unemployment and balance of payment. The interviewer did not interfere in the selection of factors on the list and even suggested that the respondent could add any other factor to the list if needed. The observations noted by the interviewer about the expressions and body language of the interviewed sample indicated that the majority seemed confident about the exchange rate and the interest rate whilst the rest of the factors were rather ticked in most cases because the list had many indicators so there might have been an impression that they should tick at least a few. What supports this interpretation was the clear awareness illustrated by the respondents through their remarks and comments while reading through the list when they came across the exchange rate and the interest rate. On the other hand, when asked to define inflation, not a single respondent was able to provide a clear definition. A number of the respondents, though, were able to relate it to the increase in the price levels in general statements such as "*it is the increase in prices*" or "*inflation means everything will be more expensive*"

The confusion was even more conspicuous when those who ticked the consumer price index factor were asked to define what it meant and how could it be useful for cost estimators. One of the practitioners commented sarcastically that he read once in the daily newspaper that it reflected the market prices but he could not understand how this could be relevant to his job; estimating costs for building projects. It is worth noting that none of the eight practitioners who selected this factor were aware of the conceptual meaning of a price index.

The majority of the sample seemed familiar with the terms on the list. As one respondent stated "*we see these terms everyday in the newspapers but we cannot rely on the news papers in deciding on costs. It is mostly politicized news and we have to deal with absolute facts when deciding upon money*"

On reflection, reviewing such general statements, it was not clear whether practitioners did not consider the economic indicators in their cost estimates due to the lack of trust or the lack of knowledge. In both cases the conclusion would be the same: **practitioners did not consider the impact of the performance of the economy on the cost of buildings explicitly but rather through the market prices at the time when they were preparing the cost estimates**. In some cases there would be a considerable time lag between the

planning phase and the actual execution of the project. This would render the cost estimated just roughly accurate due to the expected movements in market prices.

Notably, the majority of the practitioners interviewed seemed to believe that both the exchange rate and interest rate had significant impact on the cost of building projects despite being uncertain about how to describe the relationship between each indicator and the project cost. Table 7.7 presents the frequencies of the influential economic indicators as identified by the interviewed sample. In Figure 7.5, these frequencies were plotted in the form of a frequency distribution which indicated that the three most influential factors were:

1. Rate of exchange.

2. Rate of interest.

3. Rate of inflation.

S.N.	Description of Economic Indicator
1	GROSS DOMESTIC PRODUCT
2	GROSS NATIONAL PRODUCT
3	RATE OF INFLATION
4	RATE OF UNEMPLOYMENT
5	RATE OF EXCHANGE
6	RATE OF INTEREST
7	CONSUMER PRICE INDEX
8	BALANCE OF NO NEED TO CHANGE
9	BALANCE OF TRADE
10	GDP PER CAPITA

Table 7.6   List of Economic indicators (Probes)

S.N.	Description of Economic Indicator	Frequency
1	GROSS DOMESTIC PRODUCT	8
2	GROSS NATIONAL PRODUCT	0
3	RATE OF INFLATION	18
4	RATE OF UNEMPLOYMENT	4
5	RATE OF EXCHANGE	18
6	RATE OF INTEREST	18
7	CONSUMER PRICE INDEX	5
8	BALANCE OF PAYEMENT	6
9	BALANCE OF TRADE	6
10	GDP PER CAPITA	2

Table 7.7   Frequency of the Identified Economic indicators
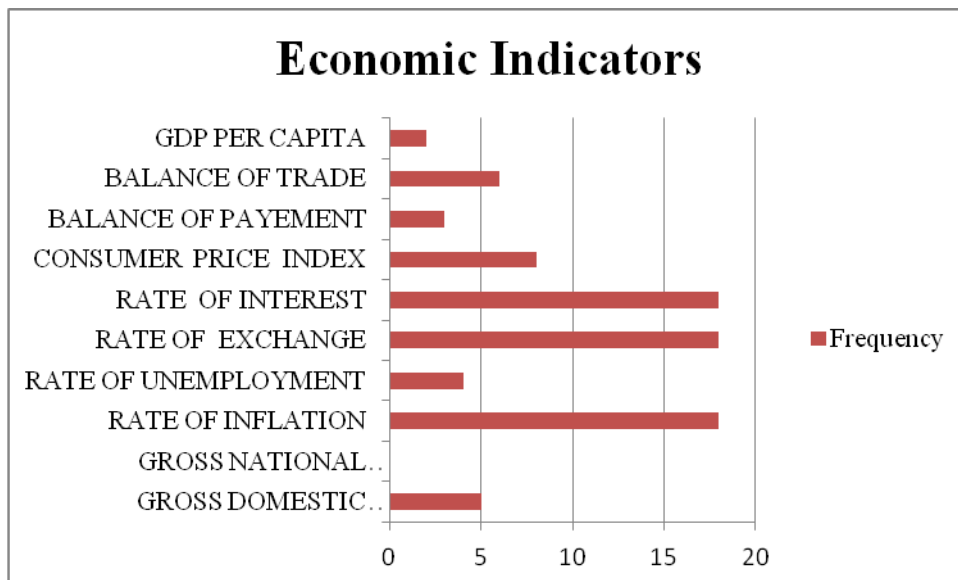
Figure 7.5 Frequency distribution of Influential Economic indicators

7.4.4. Summary of the Findings of the Interview

7.4.4.1 Influential Cost Factors

The interviews results were indicative that the unit rate method (priced BoQ) was the most prevalent technique applied in cost estimating for the different types of building project at the detailed planning stage across the various categories of practitioners. This was in agreement with the works of several scholars such as Akintoye and Fitzgerald, (2000); Beeston, (1983) and Ashworth and Skitmore, (1983)

However, different parties within the Egyptian construction industry portrayed some variation in their perceptions of the significant factors considered when estimating building costs, as aforementioned. The factors identified by the interviewed sample are summarised in Table 7.9. Except for the public sectors clients who relied mostly on the Manufacturer's lists of material, all other parties seemed to rely on market prices prevailing at the time of preparing the cost estimates.

There was as a considerable difference, though, in the approach towards the cost of labour and equipments. Subcontractors in particular seemed to be implementing a more critical analysis on the productivity and efficiency levels of the involved skilled labour.

Specialised sub-contractors laid more emphasis on the historical data and previous experience. Still their prices were a function of other factors such as the percentage of down-payment and the type of client as well as the duration of the project.

In general, the time lag between the preparation of the building costs (costs estimating activity) and the actual implementation of the work items seemed to be significant. However, there was no evidence of any methodology or structured approach in considering this factor. Instead, the finding of the interviews indicated that the impact of the time lag was mostly included in the provisions for risk, typically illustrated in the mark-up asked by the contractors. The findings of the interviews indicated that clients in general did not consider this factor and rather relied on the quotations or bids submitted by contractors and sub-contractors.

The uncertainty about the price movements for building materials were mentioned to be the most critical factor influencing the accuracy of cost estimated for building projects across the various roles within the construction market in Egypt. The second most important factor was the changes introduced during the implementation phase. However this was less significant in the medium and large size traditional public sector projects such as housing projects and school building due to the propensity to apply a standard design.

Furthermore, other factors were named as significant when estimating the cost of holdings, mainly, the location of the project, the size of the project, the type of works and the type of client. These were identified as being essential constituents of any cost estimating process informing about the relevant cost items to be included in each case. However, these factors were thought to be of less significance when addressing the factors that established the current perception about the level of accuracy of the produced estimates compared to the fluctuation in the market prices of building materials. In other words, the responses indicated that practitioners were more confident that the applied cost estimating method embraced the product physical variables and other variables pertaining to the location of the project quite accurately. Still, when it came to market related variables, there was no mechanism to factor in the anticipated fluctuations in the prices of key factor inputs other than mere speculations. In the best case scenario, the figures would be based on historical data. For example, as one of the experts mentioned: "*When we were studying a three years project, we reviewed a similar project that we completed a few years ago and found that prices moved up by nearly 18% over the three years duration of the project, so we took this into consideration in the project under study*"

In conclusion, it was clear that the indentified factors were in agreement with the findings of the literature review as presented in Table 4.1 in section 4.4 of this study (see chapter 4).

7.4.4.2 Significant Economic Indicators

Overall the interviewed sample reflected a limited awareness of the key economic concepts. This was interpreted mainly due to the background of the experts being mostly engineers who hardly studied the basics of economics, accounting and finance.

Consequently the impact of economic fluctuation was hardly considered in the cost estimating process. However the interviewed sample indicated the significance of the interest rates and the exchange rates, both were thought to have direct impact on the market prices of building materials.

In Egypt, the wages were considerably lower than the average wages in the developed countries. The building material comprised a relatively higher percentage of the total project cost. Still, the interviews indicated that exchange rates would affect the price levels of most commodities. Hence, by induction this was expected to affect the wages of skilled labour as well.

In addition, Egypt still relies on importing the majority of the raw materials used in the manufacturing of building material which justifies the importance of the exchange rate and interest rates as significant factors affecting the cost of buildings.

Physical Factors	Economic Factors
1- Project Size	1. Rate of Exchange
2- Project Type	2. Rate of Interest
3- Project Duration	3. Inflation
4- Project Location	
5- Type of Client	
6- Experience in Similar Projects	

Table 7.8 Main Factors identified by the interviewed sample

7.5   Review of the Current Practice in the Context of the Research Case Study

The cost estimating process for school buildings constructed by GAEB can be perceived as a special case of the aforementioned prevailing trend due to the nature of the national project for building schools. The standardized design approach applied to school buildings eliminated a number of the physical product variables. In addition, the relatively large number of schools built yearly since 1993 has rendered the cost estimating process within this project a repetitive operation whereby the cost estimators of GAEB has acquired a relatively advanced position on the learning curve, at least from the respondents' point of view. However, it was not clear why this noted efficiency did not contribute to better accuracy levels. It is the interviewer interpretation that the process output will always depend on the input regardless the efficiency in handling the tools and techniques applied within the process.

Before embarking on the discussion of the respondents' detailed feedback and views on the accuracy of the produced estimates, it was resolved to introduce and review the current practice undertaken by cost estimators at GAEB.

7.5.1 Standardised Design

In 1992, upon the establishment of GAEB with the primary task to build 1500 new schools every year for the 5 year plan 1992-1997, it was resolved to apply a standardised design approach to facilitate achieving this task. Hence, GAEB with the help of professional architects produced a set of templates for the various types of schools. The standardized model was based on standard dimensions for the classroom and the facilities. A limited number of templates were produced based on multiples of this standard module to fit the needs of the three main types of school: primary, preparatory and secondary. The finishing items were limited to the basic standards and were also unified across the various types of school. Each template was given a code number. The variation across various school buildings were mainly the number of stories; the type of foundation and the location of the school.

7.5.2 Cost Estimating by GAEB

Based on the templates for different categories of school buildings, the BoQ (Bill of Quantities) was developed. Also, GAEB technical office produced detailed specifications that were published in two volumes and were updated where appropriate. The detailed specifications for each work item guided the cost estimator towards breaking down the work item into its principal components: material, labour and equipments.

The GAEB cost estimators relied mainly on the manufacturer's price list for the key components such as steel and cement when estimating the cost of the key structural elements. It is worth noting that the most significant work packages that contributed to the total cost of the building were reinforced concrete, bricks walls and rendering works.

Respondents indicated that these work packages would typically contribute to approximately 50-60% of the total project value due to the basic finishing specifications. The labour and equipment cost estimates were quite contentious since they were produced based on the estimator experience. In most cases this experience was based on the informal communication with the contractors' representatives. In many cases GAEB cost estimators had previous experience working for contracting companies with a majority of them maintaining effective communications with contractors and sub-contractors. It is worth noting that the same approach did apply to other work items such as electrical and sanitary work items. Recently in the late 1990s, GAEB, approved a list of suppliers for key building material such as tiles, components for electrical work items, sanitary products, etc… This procurement strategy had two main advantages:

1. It provided a useful data set to aid in the estimating of the cost of material within different work items.

2. In addition, it reduced the quality control burden, having to test samples of the delivered material since the quality control measures were centralized through the random inspection of the producers' plants.

This facilitated the quality management operations, especially at remote locations and expedited the execution of various work items. Once the contractor supplied an approved item, the GAEB project manager would approve the use of the supplied item without

needing to wait for the quality control test results. However, on the other hand, this practice was claimed by some respondents to have created some kind of oligopoly.

The contractor was squeezed between two difficult options, either to purchase the relatively expensive yet approved material or to take the risk of using material from other sources subject to passing the quality control test at the GAEB laboratories. The former option impacted on the cost of work items due to the relatively higher cost of material whereas the latter involved a hidden cost due to the time lag between the delivery and the approval by GAEB quality control department. There was also an element of risk if the supplied material failed the quality control test. Clearly the contractor's decision affected the estimated unit rate of the relevant work item.

Reviewing the cost estimating practice within GAEB at the detailed design stage, it was noted that as a starting point, GAEB cost estimators, in pursuit of estimating unit rates for various work items, did not study individual projects on case by case basis but rather dealt with work items for the various templates in the general context while discarding the project specific variables such as the type of school, the size of building or the location of the project. Furthermore, these priced work items were collated for the various work packages to produce the general price list for GAEB which formed the basis for the valuation of individual projects. In addition, this price list was the reference document in the valuation of any change (new items) introduced during the execution phase if the latter was not included on the project specific priced BoQ.

For individual projects, the unit rates for the various work items on the project specific BoQ were extracted from the general price list then the total cost of the project was calculated. The produced list of quantities and unit rates facilitated developing a priced BoQ for the project as a whole whereby the total cost for each work package was calculated by multiplying the unit rate by the quantity. Then the standard templates for the foundation appropriate to the bearing capacity and other soil properties of the same project were used. The foundation cost items were estimated in the same manner using the unit rates pre-calculated for the various foundation items and included in the general price list. Similarly, the costs for the landscape items are estimated using the relevant cost items on the general list. The total cost of the project would equal the summation of the total cost of

all work packages. This would form the principal document amongst the tender documents released to the contractors.

It was not clear whether the unit rates included a mark-up for overheads and deductibles. The interviewed experts representing the contractors' side mentioned that they believed that GAEB included the mark-up and deductibles in estimating the unit rates for each and every work item.

On the other hand, the participants representing GAEB did not provide a clear answer and tried to avoid providing further details about how the overheads and deductibles were included in the cost estimates. One of the respondents working for GAEB provided a subtle hint stating that "*contractors should do their homework and they are allowed to request for a mark-up over and above the released priced BoQ*".

The unit rates on the general GAEB price list were reviewed every year whereby adjustments are introduced based on the prevalent market prices. The interviewer was under the impression that the unit rates produced by GAEB included some sort of mark-up over and above the direct costs for each work item but this was most likely done whilst producing the earlier versions of GAEB price list then the updates only considered the incremental increase in the prices of key factor inputs.

The annual tenders for approximately 1500 schools continued over a period of time that might extend throughout the financial year (July – June). The initial round of tenders that usually took place in early August would indicate the level of mark up asked by the contractors over and above (in most cases) the prices set by the GAEB cost estimators.

Clearly, GAEB embraced the traditional cost estimating technique identified in the literature as the quantity surveyors method (Akintoye and Fitzgerald, 2000).

The outcome of this method has been criticised in the literature (Flanagan and Norman, 1983; Beeston, 1983; Ashworth and Skitmore, 1983 and others). The accuracy of the cost estimates produced by GAEB will be discussed in further depth in the following section.

7.5.3   Perceived Accuracy of GAEB Cost Estimates

The interviews indicated that practitioners in general were not satisfied by the level of accuracy of the cost estimates produced by GAEB.

First and foremost was the time lag factor. The cost estimates were typically produced based on the market prices in February - March. There was barely any evidence that the market prices did stabilise over the period of 6-8 months which was the typical duration between the cost estimating process and the tendering for the school projects. Furthermore, the finishing items would take place no earlier than January of the following year since the execution would start no earlier than July – August and the typical duration for school projects would range from 8 – 12 months.

The second factor that was deemed by respondents as of significant impact on the accuracy of the produced estimates was the location of the project. The location was identified as the most important factor that determined the mark-up level asked by the bidder. Projects in rural and remote areas would normally attract higher levels of mark-up that exceeded in some projects 50% over and above the set total value for the project based on the priced BoQ released by GAEB.

On the one hand, following the standardized approach applied by GAEB, cost estimators did not seem to take into consideration the impact of location on the unit rates of various items. However, it was evident that contractors did incur significantly higher costs when building schools in remote areas and some rural areas as well. Primarily these additional costs were due to the above mentioned factors discussed in section 7.4.2.2 under the impact of location on the additional costs contractors would incur.

On the other hand, the explanation provided by respondents advocating GAEB strategy agreed that this variation was a shortfall of the standardization strategy. Still, those respondents believed that the advantages of the standardization did outweigh this shortcoming. The main advantage was the notable speed achieved in producing individual project documents. The tender documents under this standard approach would be ready in just a few weeks which enabled the technical office at GAEB to cope with the number of projects meant to be released for tendering over a relatively short period of time.

This justification might not seem convincing and would rather indicate the need for some empirical method to complement the unit rate method (priced BoQ) applied in order to enhance the accuracy level of the produced estimates. For example, in this case, the impact of the location on the unit rate should be considered. It might be reasonable to assume that a simple yet effective method could enhance the level of accuracy significantly, meanwhile would not deter the speed of producing the desired tender documents.

It is worth noting that the quantitative section of this study aimed at establishing a simple cost model that besides being an explanatory tool clarifying the relationships among the key variables, would also aid in the pursuit of enhancing the accuracy level of the estimated costs.

Another factor that was investigated during the interviews was the size of the project. It was reasonable to assume that as a rule of thumb, bidders would consider the size of the project when calculating their overheads. This did not seem to be realized in the standard approach applied by GAEB when calculating the unit rates. Bearing in mind that the school buildings followed a standard design meanwhile using the same material and the same construction techniques, it was reasonable to assume that the unit rate will be inversely proportional with the size of the project. However, the interviewed practitioners mentioned that the size of school buildings was not among the factors that they considered as influential when deciding upon the mark-up level.

The fact that bidders persistently continued to ask for a mark-up in both cases (small and large size projects) indicated the importance and significance of the economic dimension even though it was not explicitly mentioned by the interviewed sample. The market price movement was obviously a reflection of the prevailing economic conditions, but the argument that this study is trying to put forward is that some economic indicators may provide early signals about the later to occur market price movements.
It was therefore, resolved that the project location was the most influential project specific factor that contractors considered when setting the mark-up level for school buildings.

In addition, it was resolved as an outcome of the conducted interviews that even when practitioners were intuitively aware of this cause and effect relationship between the economic fluctuation and market prices for factor inputs, they seemed to lack the expertise

as how to include the economic impact on the cost of building projects. The provided responses would in aggregate indicate that the typical reaction to the economic fluctuations can be classified as mere speculations about the future prices of building material. During the periods of economic turbulence, practitioners tended to hedge against the anticipated price movements which were most likely to occur during the execution phase by asking for a higher mark-up based on mere speculations rather than following a systematic methodology with well defined inputs and clearly understood inter-relationships amongst the significant variables.

The standard design applied to school buildings rendered the cost estimating process much simpler by eliminating many of the product physical variables (factors) that were identified by practitioners whilst discussing other traditional and even special types of project.

The fairly large number of school buildings constructed over a relatively short period of time should help practitioners in GAEB and contractors companies to establish a rich set of historical data which could be utilised to enhance the accuracy level of the estimated costs. This was the driver for the quantitative analysis conducted in the following chapters of this study.

Finally, the findings of this section supported the hypothesis set at the beginning of this study that in the absence of considering the economic factors explicitly, the level of accuracy of the cost estimating process will remain questionable as long as practitioners continue to use the traditional unit rate method widely applied in the construction industry for various types of project. Furthermore, the findings of the literature review indicate that applying other traditional cost estimating methods will not yield any significant improvements.

7.6 Summary

This chapter aimed at reviewing the current practice in cost estimating by conducting semi-structured interviews with experts in the Egyptian construction industry with emphasis on building projects. The interviewed sample was purposively selected in order to cover the various stakeholder categories as well as the different types of building

projects in the context of cost estimating at the detailed design stage. The objectives of the interviews were clearly aligned with the research objectives. The chapter described the details of the interviewing process including the data coding system applied prior to conducting the interviews and the coding system applied to the data collected. The data analysis was conducted on two dimensions; the wider context of the Egyptian construction industry and the specific context of the research case study that is the national project for building schools. The key attributes of the cost estimating method applied by the different categories of stakeholders were discussed and the main influential factors were identified in relation to the various types of building project. Due to the standardised design applied by GAEB, some of the identified factors had limited influence on the cost of school buildings. The unit rate method (priced BoQ) seemed to be the most common estimating technique applied to the vast majority of projects including school buildings. Across the board, practitioners were not satisfied by the level of accuracy of the produced cost estimates

Overall, the findings of the interviews indicated that practitioners in Egypt had a relatively limited awareness of the impact of the performance of the economy on the cost of building projects. Still, the interviewed sample identified the exchange rate, the interest rate and the rate of inflation as significant factors that impact the cost of building projects in Egypt. However, it was noted that experts did not explicitly consider these factors when producing cost estimates for buildings but rather focused on the prevalent market prices of key factor inputs.

PART III

THE QUANTITATIVE RESEARCH

CHAPTER 8

DISCUSSION OF VARIABLES

8.1   Introduction

The cost estimating is predominantly based on cost data which is inherently numerical. Hence, it was imperative that this study whilst seeking better understanding of the inter-relationship between the various cost variables would include quantitative analysis of the relevant cost data.

In this chapter, the survey methodology is discussed. In addition, the data collection method and the identified variables are presented. Furthermore, this chapter presents the preliminary analysis of the quantitative data set and the introductory discussion of the relevant cost variables included in the developed cost models. The latter will be discussed in the following chapter.

8.2   Survey Methodology

8.2.1   The area of study (Context)

The study is primarily concerned with the cost estimating process for building projects. The main aim was to investigate the impact of including the economic variables which proxy the state of the economy on the produced cost estimates for building projects. The review of the literature indicated that the existing models did not explicitly include economic variables but rather focused on other product physical variables and used the prices of factor inputs to proxy the market conditions. Hence, it this study claims to have addressed an existing gap. Furthermore, the study aimed at testing the hypothesis that the economic variables were significant explanatory variables for the cost of buildings.

8.2.2 Survey within the Case Study

As mentioned in chapter 5, the research strategy applied an embedded case study design. In chapter 7, the qualitative research based on a set of semi-structured interviews was presented. In this chapter, the survey approach was elected to conduct the quantitative research within the selected case study.

The survey comprised a random sample of 400 school buildings constructed by GAGB over the period from 1994-2006 with emphasis on the cost incurred by GAEB, that is the price asked by the main contractors (bidders). Before embarking on the detailed discussion of the survey methodology which included the data collection methods and the data analysis technique, the following selection will provide a brief introduction about the templates used by GAEB, an illustration of the standard design strategy that GAEB applied.

8.2.3 Design templates for School Building

In order to meet the challenging target of building 1500 school every year, GAEB decided to implement a standard design strategy using a limited number of templates to cater for the variation in the requirements amongst the various key stages in school education, namely primary, preparation and secondary. The main attributes of the applied templates can be summarised as follows:

- All templates were based on the same standard module that is a classroom with the dimensions of 5.8m x 8.0m in addition to a corridor 3.0m wide.

- All templates applied a reinforced concrete structural system that comprised slabs and beams supported on structural columns.

- The templates utilised a multiple of this standard module to provide the number of classrooms needed. The special spaces such as laboratories in preparatory and

secondary schools as well as staff rooms were multiples of the aforementioned standard basic module.

- The number of floors did differ across various schools. Typically schools comprised 5 floors. In some cases the school building would have 2, 3 or 4 floors; yet, the same basic standard module was applied.

- Furthermore, the specifications and finishing material are standardized for all school buildings with minimal variations. For Example, the typical aluminum windows are rarely substituted by wooden windows based on the location of the school.

- In locations where there was no sewage system, the school would be provided with a septic tank. The variation in the total cost due to using a septic tank was typically less than 5% of the total project cost (after deducting the value of the relevant works needed in the typical case).

- The selection of the templates to be used depends on the number of classrooms as well as the type of school required in the catchments area. Both factors were functions of the demographics of the area in which the school.

- GAEB prepared different templates for the foundation to match the super-structure templates mean while varied according to the soil bearing capacity. For example, template A for super-structure would have several corresponding templates for foundation structural design. The bearing capacity of the soil would be included in the soil investigation report for the relevant site and subsequently the appropriate foundation template could be selected. This (off-the-shelf) approach saved valuable time and helped GAEB to prepare the tendering documents for a significant number of new school building projects in a fairly short period of time.

Despite, the standard design strategy applied by GAEB, each school retained an element of variation illustrated in the landscape work package. However, upon examining the final invoices of over 350 schools, the landscape work package was in the range of 4%-9% of the project total cost (depending on the size of the school).

8.2.4 Epistemological Issues within the survey

It was resolved as mentioned in chapter 5 that this study followed the positivism epistemology and realist ontology. This was clearly illustrated in the survey design due to the nature of the problem in hand being quantitative i.e. estimating the total cost of the school building.

Bryman (2004, p.63) mentioned that the key steps within the positivist quantitative research should start with a theory thus signifying a deductive approach. In the research design, the researcher would aim at devising measures of the concept under study. Hence, it was resolved that in the initial stage of the survey design these terms needed to be discussed namely, concepts, measures and indicators.

Typically the concept refers to the building blocks of the theory or the label for the elements that seem to have common features. For example the cost estimating is a concept. It might be reasonable to consider the accuracy of cost estimates as a concept in its own right.

Once a concept is identified, it has to be measured. Measurements serve for three main purposes; to delineate the fine differences, to act as a consistent device or a yard stick for making distinctions and to provide the foundation for precise estimation of the relationship between concepts. Furthermore, in order to provide a measurement of the concept under investigation it is imperative to use indicators that will proxy the concept Bryman (2004 p.66)

In this study it was resolved that there are two main concepts namely the accuracy of cost estimates and economic conditions.
It was also resolved that there was a need to devise multiple measures (indicators) for each concept before embarking on investigating the relationship between both concepts through an appropriate statistical analysis.

The review of the literature indicated that total cost of school building can be expresses as follows:

> **Total cost = f (product variables, Contractors related variables, Economic Variables**
>
> **, Location Variables)**

In the following section each of these variables was discussed in order to construct the set of variables (variate) to be included in the statistical analysis. This in turn informed the data collection method.

8.3 Sampling

A random sampling approach applied in this survey. The headquarters of GAEB were contacted in 2004 requesting final invoices of schools built over the period starting 1993 up to date (2004). A total of 400 final invoices were collected for various types of schools, primary, preparatory and secondary.

During the period of data collection that extended from 2004 till 2007, a flux of final invoices was obtained. The researcher did not have direct access to the archives of GAEB instead; the requests were submitted to the relevant authority within GAEB. Hence, it was reasonable to assume that all schools had equal probability to be included in the sample of final invoices collected, given the total number of schools built during that period which exceeded 13500 schools.

In the submitted request, the researcher specified that the provided list of schools should include schools built in various governorates. The headquarters of GAEB is the central unit where all final invoices are archived, hence was the decision to deal with the head-quarter rather than the individual branches of GAEB in various governorates.

The sample included schools in almost every governorate in the country. It was realized that the number of schools in the sample were roughly in ratio and proportion with the distribution of the population in various governorates. For example, the heavily populated governorates such as Cairo and Giza were more frequently presented in the sample compared to the remote governorates with low density of population such as El Wadi, El

Gadeed and South Sainai. This observation indicated that the sample provided a good representation of the population.

A total of 47 cases were discarded due to missing information, particularly, the template code without which the total area could not be calculated (see section 8.5.1). The resulting sample that comprised 353 schools indicated that the cases were distributed across the duration of the study (1994- 2006) as shown in Figure 8.1
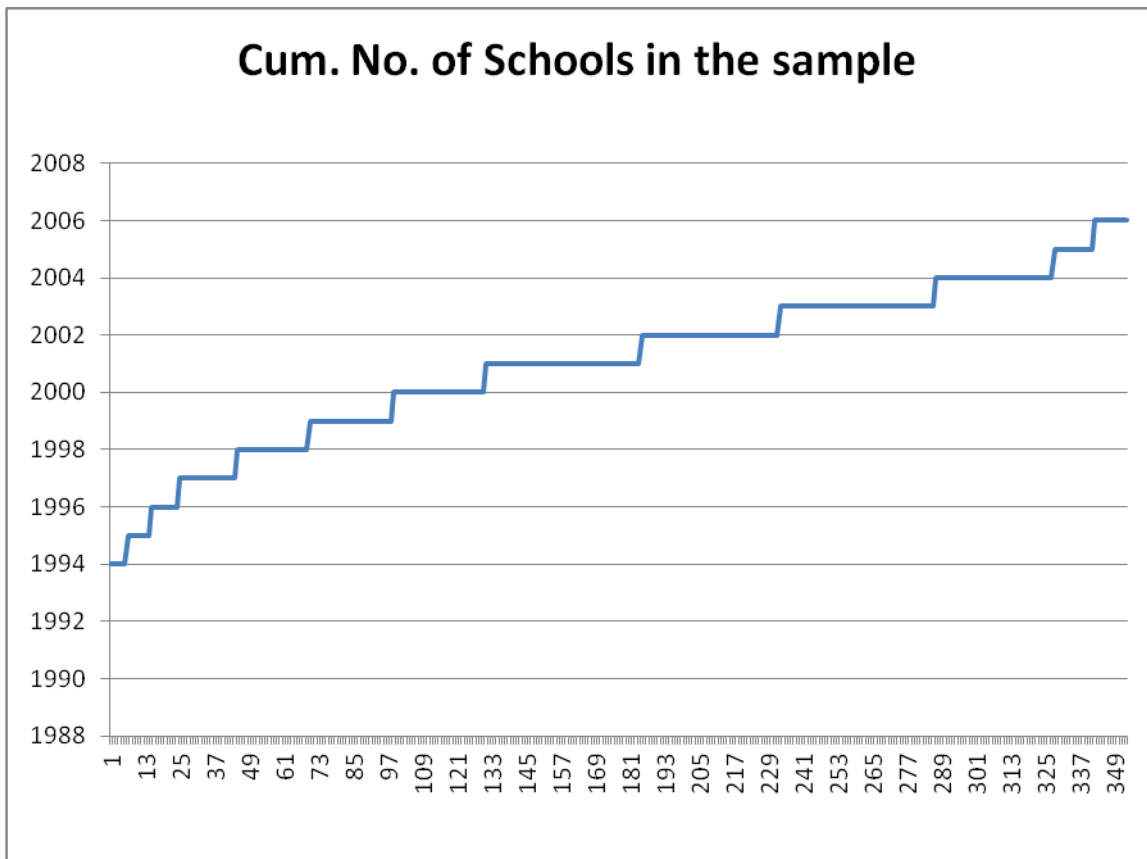
Figure 8.1   Cumulative Number of Schools in the sample during the period 1994- 2006

In addition, the sample comprised various templates as indicated by the frequency distribution of the number of classroom shown in Figure 8.5. (See P.207)

The three main categories of the location variable; urban, rural and remote were included in the sample. The number of the cases representing projects built in remote locations was considerably less compared to the urban and rural locations which indicated that the sample provided a reasonable representation of the population. Similarly the number of cases representing schools buildings constructed on deep foundation was significantly less

than the shallow foundation cases. The details of the sample will be discussed in anther depth in section 8.5.

8.3.1   Limitation of the Sampling Technique

Despite the above mentioned precautions, it was noted that the early years i.e. 1995-1998 were not presented as intensively as the more recent years 1999-2007 in the sample collected. The main reason was the archive system within GAEB whereby it was quite tedious to get access to the final invoices for schools built more than 10 years ago. The researcher contacted a number of main contractors known to have built schools over this period in various governorates.

A few contractors provided a limited number of final invoices for schools built during the period 1995-1998. It might be reasonable to assume that this practice did not distort the probability sampling approach. Still the schools built during this period were less presented in the sample compared to the more recent years 1999-2006. This limitation will be further discussed in the analysis and findings presented in chapter 9.

8.4   Discussion of Variables

8.4.1   The Dependent Variable

The dependent variable for this study was typically the cost of the school building. However, it might be reasonably argued that the total cost would vary considerably due to the variation in the size of the building. In other words it was imperative that the larger the size of the building the greater the value of the total cost of the building.

By the same token it might be reasonably argued that the cost per unit area would provide a better indication whether the size of the building had any significant impact on the cost of the building. For example, if the cost per unit area was found to increase in the case of larger buildings then this would be a meaningful finding. Hence it was resolved to elect the

cost per unit area, particularly the **cost per square metre** of the school building as the dependent variable in this study.

8.4.2 Product Variables

In the case of school buildings applying standard design as previously discussed, many of the product specific variables could be eliminated such as the type of finishing, the complexity of the construction and other design related variables. Yet, some other product variables were worth investigation. It might be reasoriable to assume that the total cost of the school building would be function of the size of the school.

There are several variables that could be used to proxy the size such as the quantity of reinforced concrete which will be an indicator of the built area given the standard structural design. By the same token, the quantity of the brick works (walls), the number of doors and the number or the surface area of windows could be a measure of the size of the school building.

The various work items were examined. It was noted that some work packages had minimal contribution to the total cost of the school building such as the fences and landscape. Reviewing the final invoices of the school buildings in the collected sample indicated that the total value of this work package as a percentage of the total cost of the school building varied from as low as 4% to a maximum of 9% in rare cases with an average of 5%. It was, therefore resolved to discard this element from the analysis. The complication resulting from the added variables was not justified due to the limited contribution (Ashworth, 1999).

The gross (built) area of the school building did provide a good indication of the size due to the standard design applied. The quantity of reinforced concrete in the superstructure was directly related to the gross area due to the standard structural design.

In the school buildings the reinforced concrete works for the super structure accounted for more than 40% of the total cost of the super structure due to the basic finishing specifications applied to the school buildings. By and large cement and steel were the most

dominant building materials. Any changes in the market prices of these items would directly inflict on the total cost of the school building. The rationale behind considering the selection of the quantities of reinforced concrete (rather than the value) as proxy for the size was mainly an attempt to separate the physical (product) variables and to confine the impact of the market conditions in the economic variable that will be discussed in the following section.

Among the other variables that reflected the size of the school and meanwhile varied across various templates school buildings were the quantities of brick work, the number of doors and the number of windows. However, following the same rationale applied in the discussion about the total cost and since the cost per square metre was elected to proxy the cost of the school building, it might be reasonable to assume that the number of classrooms would encompass the above mentioned work items and would therefore, provide a better representation of the size of the school building.

Also, at the first glance, the total cost of school building might seem to be a function of the type of the school since the preparatory and secondary schools would have laboratory unlike the case with primary school. But since the total cost of school tendered by GAEB did not include the furniture work package, it might be reasonable to assume that the type of school would have little significance since the built area would most likely be the roughly the same for school buildings with the same number of classrooms.

8.4.2.1 Number of Classrooms

The standardised design applied to the school buildings comprised a set of templates that were mainly categorised based on the number of classrooms required to serve the needs of the catchment area. Therefore, it might be reasonable to assume that the number of classrooms provided a realistic proxy to the size of the school. For example a school that had 40 classrooms would be logically much larger in size compared to a school with 6 classes only.

Also following the same logic applied in the selection of the dependent variable, it might be reasonably argued that the other variables discussed in the previous section such as the

quantities of work items (reinforced concrete, brick work, etc...) would not constitute a better proxy to the size given that the dependent variable was decided to be the cost per unit area. In other words the aforementioned variables would certainly indicate the size of the building but might not have any significance on the cost per unit area. Hence, it was resolved to elect the number of classrooms as the variable representing the size of the school.

8.4.2.2 Type of School

In order to cater for the needs of the educational system comprising different key stages, GAEB had to build various types of school, most commonly; primary, preparatory and secondary schools. However, from a technical point of view and due to the standardised design applied, the schools did vary based on the number of classes rather than the type of school. Also, given the context of this study which envisaged the cost of the building excluding the cost of furniture and other finishing elements that might vary according to the type of schools such as laboratories in the case of preparatory and secondary schools. The modular design applied provided a significant level of flexibility in using the space with minimal changes that was mostly limited to some of the finishing work items. For example, the primary schools would have an open-plan play area allocated to the activities needed for kindergarten and key stage one.

A similar area would be allocated to the laboratories in preparatory and secondary schools. Hence, it was resolved to discard the type of school as explanatory variable for the cost per square metre of the school buildings. This was also confirmed through the findings of the interviews as discussed in chapter 8.

8.4.2.3 Type of Foundation

Typically the vast majority of the schools constructed by GAEB were built on shallow foundation. In the odd cases when the soil conditions implied that shallow foundation would not suffice, the deep foundation option, particularly pile foundation, was applied to

support the school building. The shallow foundation could be divided into three main types; isolated footings; inverted T-section foundation and raft foundation.

Needless to mention, the cost of the deep foundation would significantly exceed the cost of shallow foundation. On the other hand, the variation in the costs amongst the various types of shallow foundation was generally less than 5% of the total cost of the school building. Therefore it was resolved to include the type of foundation as a categorical variable with two categories; shallow foundation and deep foundation.

8.4.2.4 Project Duration

Typically the majority of the schools built by GAEB were tendered with a set completion period of 8 – 12 months. The size of the school was main factor based upon which GAEB set the duration. It might be reasonable to assume that this variation had limited (if any) impact on the market conditions and hence the price level of the factor inputs.

Following the same rationale applied in section (8.3.2.1.), it might be reasonable to assume that the duration of the project might be directly related to the total cost of the building rather. However, there was no theoretical evidence to justify the assumption that such limited variation would have any impact on the cost per square metre of the school building.

This was also confirmed by the findings of the interviews as discussed in the previous chapter. Furthermore, the duration of the project in this case would be directly related to the size of the building which was already represented in the set of variables by the number of classrooms. Needless to say that the latter provided a more realistic proxy to the size of the building compared to the duration of the project that was set with considerable approximation by GAEB. For example, by examining the collected set of data, all schools with a number of classrooms ranging from 6 - 16 classrooms were tendered with specified project duration of 8 months.

Hence it was resolved to discard the duration of the project from the list of explanatory variables that would contribute to the variation in the value of the dependent variable.

8.4.3 Mark- Up

Bidders usually request a mark-up over and above the priced BoQ set by GAEB and included in the tender documents. It is reasonable to view the mark-up as a correction factor to bridge the gap between the prices set by GAEB and the market conditions which would include the impact of the competition conditions as well as the actual level of prices for the factor inputs as perceived by the bidders. In addition, the mark-up would capture the impact of the project location on the construction costs incurred by the contractors.

A preliminary analysis of the mark up levels was conducted as a pilot study at the early stages of this research. The results were published in the proceedings of ARCOM conference held in Birmingham in 2006 as show in Appendix (1). The results of the multiple log-linear regression analysis indicated that the mark-up was directly related to location of the project as well as the economic variables, particularly the exchange rate and the interest rate.

As aforementioned, the cost per square metre of the school buildings was selected as the dependent variable. It was obvious that the mark-up would be perfectly related to the cost per square metre since the former represented an incremental percentage of the latter. Hence it was resolved that the inclusion of the mark-up as an explanatory variable for the cost per square metre would be statistically inappropriate.

8.4.4 Project Location

The national project for building schools was implemented across all governments within the territory of Egypt. It was imperative that various locations had different characteristics. The access roads, the availability of skilled labour, the proximity to key material manufacturers and the availability of infrastructure such as water, electricity and sewage were amongst the factors that varied across different locations meanwhile had significant impact on the cost of building. Hence, was the importance to collect data on the location of each school included in the sample.

As discussed in chapter five, the population density varied significantly across the different governorate as shown in Table 8.1 It was noted that in general, upper Egypt (Saeed) was less developed compared to the delta region. The urban and rural categories referred to the cities/towns and villages in the delta region respectively. Remote locations included governorates of North Sainai, South Sainai, Matrouh. and El Wadi El Gadeed. Thus it was resolved that the location of schools would fall into three categories; Urban, Rural, Remote. The schools included in the sample were in ratio and proportion with the density of the population. It is therefore reasonable to claim that the sample provided a realistic representation of the population of school building, across the Country.

The location of the project on the other hand seemed to have clear impact on the bidding value and hence the cost incurred by GAEB. Examining the bids of some of the large size main contractors, it was noted that the same contractor would ask for different prices for the same school (template) if built in different locations *cet. par.* i.e. all other variables being the same including time. Further examination of this phenomenon would elucidate three categorically different locations with respect to the bidding values; rural, urban and remote locations.

It was therefore resolved to include this variable in the analysis. It is worth noting that this variable is a categorical variable. Hence it needed prior treatment in order to be included it in the statistical analysis. This was discussed in section 8.5.4.

	Governorates	Total	%	Cum %
1	Cairo 01	7,764,731	11.09%	11.09%
2	Giza 21	5,644,246	8.06%	19.15%
3	Sharkia 13	5,115,365	7.31%	26.46%
4	Dakahleya12	4,932,256	7.05%	33.51%
5	Bohira 18	4,693,150	6.70%	40.21%
6	Mina 24	4,048,847	5.78%	46.00%
7	Gharbeya 16	3,928,987	5.61%	51.61%
8	Kalyoubeya 14	3,875,097	5.54%	57.15%
9	Alexandria 02	3,821,203	5.46%	62.61%
10	Sohag 26	3,807,883	5.44%	68.05%
11	Asyut 25	3,422,279	4.89%	72.94%
12	Monofeya 17	3,230,489	4.62%	77.55%
13	Kena 27	2,935,206	4.19%	81.74%
14	Kafr El Sheik 15	2,589,580	3.70%	85.44%
15	Fayoum 23	2,422,284	3.46%	88.90%
16	Beni Sueif 22	2,255,161	3.22%	92.13%
17	Aswan 28	1,120,275	1.60%	93.73%
18	Domyat 11	1,077,979	1.54%	95.27%
19	Ismaileya 19	863,278	1.23%	96.50%
20	Port Said 03	537,814	0.77%	97.27%
21	Suez 04	488,501	0.70%	97.97%
22	Luxor 29	421,770	0.60%	98.57%
23	North Sina 34	309,533	0.44%	99.01%
24	Marsa Matrouh 33	270,095	0.39%	99.40%
25	Red Sea 31	186,373	0.27%	99.66%
26	Wadi El Gadeed 32	169,647	0.24%	99.91%
27	South Sina 35	65,083	0.09%	100.00%
	Total	**69,997,112**	**100%**	

Table 8.1   National Demographic Distribution

Source: CAPMAS

8.4.5 Economic Variables

The schools included in this study were built over the period 1994-2006. During this period the Egyptian economy witnessed significant turbulence. In chapter six a brief review of the socio-economic characteristics in Egypt was presented. It was clear that the privatization programme implemented by the Egyptian government had serious impact on the steel and cement industries which in turn inflicted on the market prices of both material.

There was emphasis in the literature on the market prices of material as well as the competition condition. This study decided to take a different route. The review of the economic literature established the theoretical frame work informing about the relationship between the performance of the economy and the price levels for factor input such as cement and steel. In this study, the main aim was to address the factors affecting the produced cost estimates at a grass root level. The economic theory indicated that the price level is a product of other economic variables.

Hence, was the importance of the concept of leading economic indicators and lagging economic indicators. The leading economic indicators could be regarded as an early signal of the market conditions and particularly the price levels. Typical examples of the leading economic indicators as identified in the economic literature were interest rates and the exchange rates. Other economic indicators such as GDP and balance of payments were identified as lagging indicators

Therefore, it is reasonable to view the leading economic indicator as early predictors of the dependent variable, the total cost of the school building. Traditionally, the cost estimators would rely on the market prices of factor input at the time of producing the cost estimates. However, these prices are the result of the economic conditions that could have been predicted based on a set of indicators and particularly the leading indicators.

Therefore, the leading indicators could be utilised to predict the market conditions during the execution phase that would typically start a few months after the cost estimates and would last for 8-12months.

This was the main hypothesis of the quantitative study in an attempt to explain the relationship between the relevant leading economic indicators and the cost of the school building.

Hence, it was resolved to include the **exchange rate** and the **interest rate** in this study as proxy to the performance of the economy in order to produce a cost estimating model. In addition, the lagging indicators; the Gross Domestic Product (GDP) and the Balance of Payment were included in the second stage of the analysis whereby there was more emphasis on developing an explanatory model.

Before concluding this section, it was worth noting that the competition conditions will be discussed in the following section under contractor related variables.

8.4.6 Contractor Related Variables

The literature identified a number of variables related to the contractor which had impact on the total cost of the project. Among those variables were the type of contractors; the experience of the contractors with similar projects, the financial structure of the contractor and the capacity of the contractor.

The main type of contractors working with GAEB can be limited to public sector main contractors, private sector, large size main contractor and private sector small and medium size main contractors. In addition, some of the public sector main contractors would pass on the project to a smaller size private sector contractor in a turn-key approach and the public sector main contractor's role was reduced to undertake the project management activities.

It was also realized that, occasionally, some of the small and medium size private sectors contractors acted as main contractors working directly with GAEB whilst in other projects the same contractors would act as sub-contractors for another private sector main contractors. The public sector main contractor would provide incentives to attract the small and medium size contractors. Incentives would typically fall into 2 categories.

- *The financial incentives* in the form of down payment besides the timely payment of the monthly invoices once approved by GAEB technical office. In many occasions GAEB would delay the payment of the invoices for a period that may extend to two months after the approval of the invoice. Some of the small and medium contractors would accept to sacrifice a percentage of their profit margin in return for such crucial financial incentives.

- *The administrative support*. Most of the small-medium size contractors lack the capacity and experience to administer the paper work as required by the bureaucratic GAEB. The experienced large size public sector main contractor would undertake these tasks, including the approval of the samples of material, the quantity surveying activities producing invoices to be presented to GAEB and above all managing the relationship with GAEB.

However, it was realised that the same contractor who acted as a subcontractor for a public sector main contractor would ask for higher prices when dealing directly with GAEB. There was no evidence that the small or medium size private sector contractors would bid cheaper than their large size public sector counter parts.

Regarding the competition, the tendering procedures set by GAEB required that all bidders should be technically approved as a pre-requisite to participating in the second stage in which the financial envelops are opened and then evaluated. Due to the relatively large number of the contractors registered with GAEB i.e. technically approved, the competition condition was more inclined towards the perfect competition case rather than oligopoly. In other words the bidder could be reasonably considered as price takers rather than price makers.

This should not be seen as a contradictory stance given the previously stated reservations about the assumptions of perfect competition. This might stand as a reasonable approximation in order to facilitate the construct of the variate. Also, the findings of the interviews discussed in chapter 7 indicated that the size and experience of the contractor did not have any significant impact on the value of the winning bid as perceived by the interviewed experts. Hence, it was resolved to eliminate this variable from the analysis.

8.5 Data Collection

In order to embrace the various measures sought and following the discussion on the four types of variables presented in the previous section it was resolved that the data collection would comprise primary and secondary data.

The primary data pertaining to the school building was extracted from the final invoices of the sample of schools included in this study. Other information such as the details of the various templates of school building design and the type of foundation were extracted from the school folder kept in archives of GAEB.

The information about the details of the tendering process, the approval of contractors, the cost estimating process by contractors and GAEB engineers and the details of the tendering process were collected through direct observation by the researcher over the period 1993-2003. However the actual note-taking stage which started in 2003, when the researcher was directly involved in the national project for building schools, informed and furthermore enriched the data collection process.

The secondary data pertaining to the economic indicators were collected from the economic reports published by the government on the official websites of the relevant authorities including GAEB, Ministry of Economic Development, Ministry of Finance and the central agency for public mobilization and statistics (CAPMAS).

The secondary data included the demographic data, the population data, the numbers of schools built across the country and the economic indicators such as interest rates, exchange rate and the rate of inflation. In the following sections the details of the data collected regarding each of the identified variables was discussed.

8.5.1 Cost per Unit Area

The final invoices were examined and the value for the total cost for each school building including the mark-up was extracted. The information about the template applied for each the school was obtained from the school folder (typically not included in the invoices).

GAEB had compiled all the plan views for the typical floor for each template into an A3 sheet that listed the area per floor as well as the number of floors for each template. Therefore, the total area could be calculated and subsequently the cost per square metre. The resulting figures represented the nominal cost per square metre for each school building. The staring date and finishing dates were mentioned in the final invoice.

It was resolved that the obtained figures needed correction for inflation. The data pertaining to the rate of inflation in Egypt for the period of the study were collected from the website of the central agency for mobilization and statistics (CAPMAS) as shown in Table 8.2. Then the inflation correction factors (ICF) shown in Table 8.3 were calculated using the year 1998 as a base year and the annual inflation rate which was the average annual inflation rate for the period (1994 – 2006) covered in this study.

The distribution of the collected data for the dependent variable was examined as shown in Figure 8.2. Also, the results obtained by running the K-S test indicated that the distribution of the cost per square metre was a normal distribution as shown in Table 8.4. The details of the K-S test will be discussed in further depth in the following chapter.

1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
8.13	8.43	7.23	4.66	3.88	3.09	2.68	2.29	2.73	4.22	11.8	4.97	6.67

Table 8.2   Annual Rate of Inflation (%)

Source: The central agency for public mobilization and statistics (CAPMAS)

94	95	96	97	98	99	2000	2001	2002	2003	2004	2005	2006
74	81	88	95	100	103	106	108	111	116	130	136	145

Table 8.3   Inflation Correction Factor (ICF)

	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Real_C_sqm	.04	353	.20(*)	.97	353	.00

Table 8.4   Tests of Normality

* This is a lower bound of the true significance.
* Lilliefors Significance Correction

Histogram
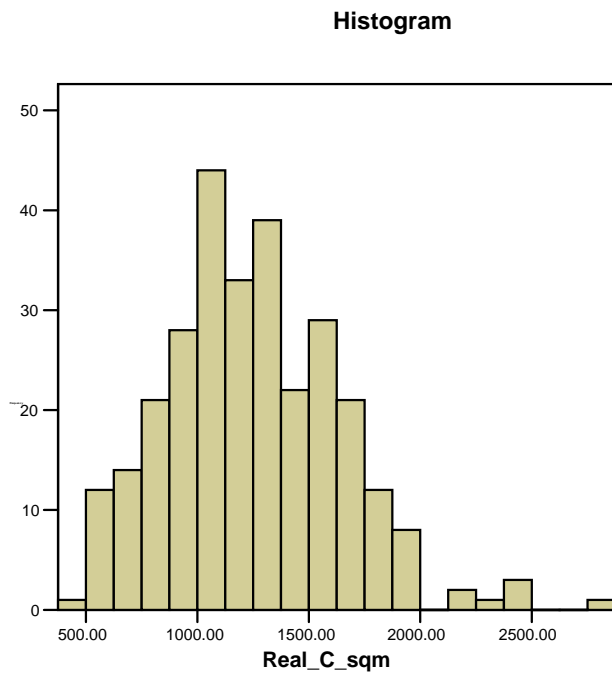
Figure 8.2   Frequency Distribution of the real cost per square metre

Normal Q-Q Plot of Real_C_sqm
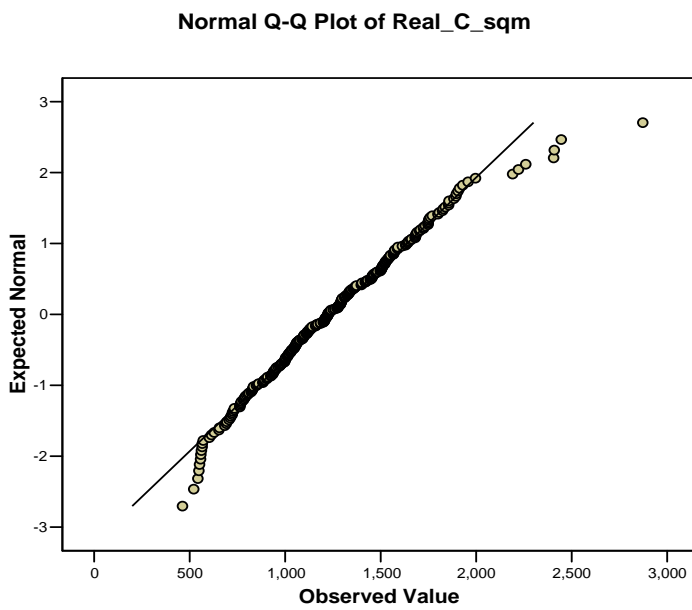
Figure 8.3   Normal P-P Plot of real cost per square metre

8.5.2   Number of Classrooms

The data pertaining to the number of classrooms for each school building included in the sample was collected from the project file saved in the archives of GAEB since this information was not included in the final invoice. The distribution of the number of classrooms was plotted as shown in Figure 8.5 where the Y-axis represented the number of school buildings and the X-axis represented the number of classrooms. The data collected indicated that the sample included a variety of templates comprising school buildings with classrooms number ranging from 5 – 40. The values for this variable were measured on an interval scale. The distribution indicated that the schools with 8 classrooms were the most frequently occurring template. This was a realistic finding since this type of school was the typical school building type according to the feedback received from the relevant authority in GAEB.
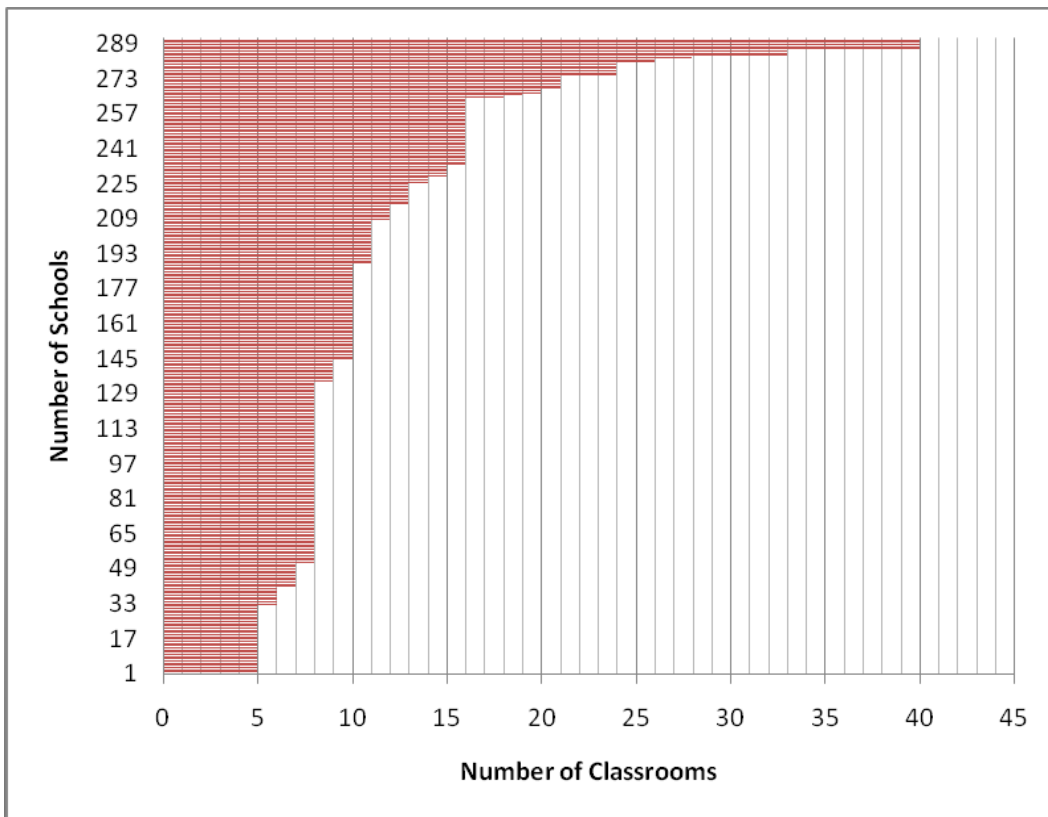
Figure 8.4   Distribution of the number of classrooms

Frequency Distribution of the Number of Classrooms
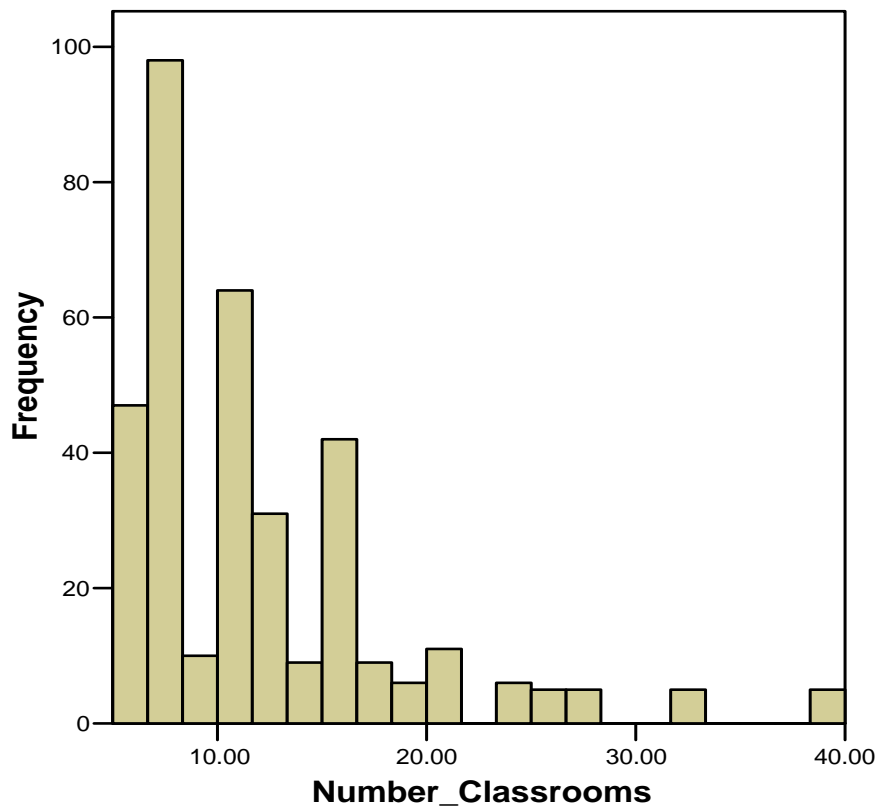
Figure 8.5   Frequency distribution of the number of classrooms in the sample

8.5.3   Type of Foundation

Typically the type of foundation is a function of the soil bearing capacity. As observed by the researcher less than 5% of the school buildings needed deep foundation (piles). In 95% of the cases the shallow foundation was adequate to support the school buildings. GAEB applied three main types of shallow foundation namely; isolated footings, T-section and raft foundation.

The data collected indicated that the vast majority of the cases within the sample were schools built on shallow foundation. This variables was included as a categorical dichotomous variables with two values (shallow foundation = 0) and (deep foundation = 1)

8.5.4 Location

The information about the location of the school buildings was not included in the final invoices. Similar to the case of the number of classrooms, the data pertaining to the location of the project was extracted from the file of the school saved in the archives of GAEB. The collected data provided information about the name of the governorate where the school was built. Further investigation through direct queries served in identifying the exact location of the school building in the relevant governorate. For example whether the school was built in one of the main cities/towns or the building was located in a rural village. Hence, the case was given the label urban, rural or remote. This task did consume a considerable amount of time to ensure the reliability of the information gathered. In some cases, the relevant branch of GAEB was contacted to provide information about the exact location of the school building in order to be able to categorise it accurately. Deciding upon the category of the location was easier in the case of remote locations since the name of the governorate provided sufficient indication about the category of the location. The data collected indicated the reasonable spread of the sample across various locations. Furthermore, the more populated governorates portrayed higher frequencies which was clear in the distribution shown in figure 8.6.
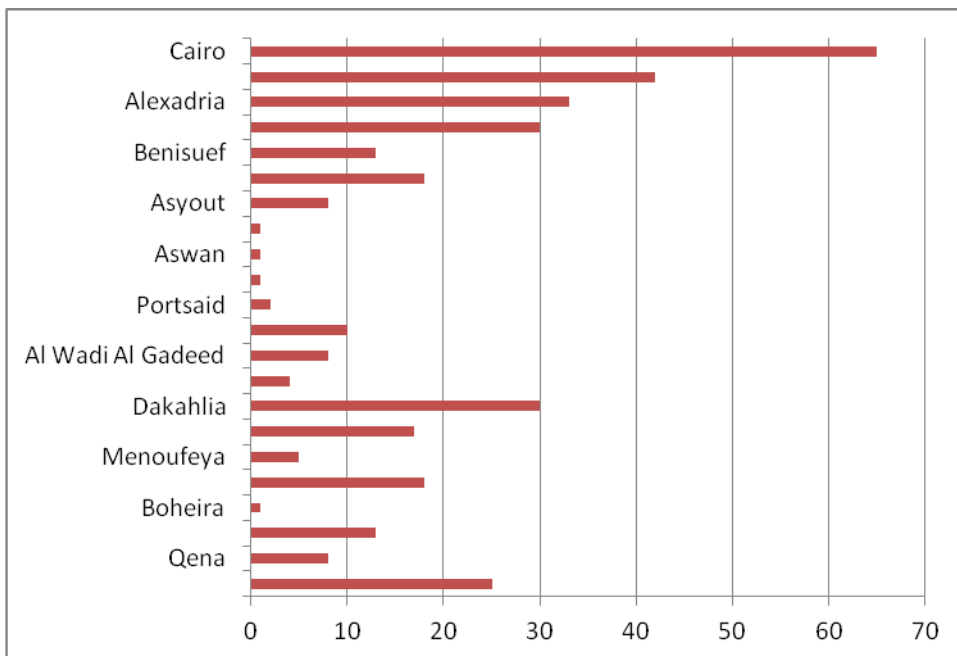
Figure 8.6   Distribution of schools in the sample based on location
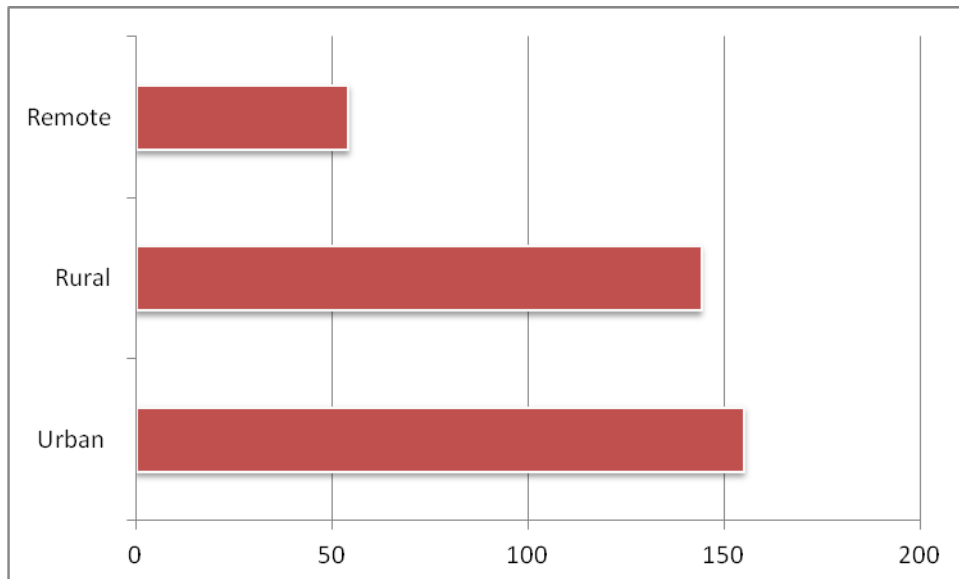
Figure 8.7   Frequency ditribution of the three catrogries of the location variable

8.5.5   Exchange Rate

In general, the collection of economic data was conducted via secondary sources. In chapter six, a brief review of the socio-economic conditions across the different governorates in Egypt was presented with emphasis on the privatization programme pertaining to the cement and steel industries.

The discussion presented earlier in this chapter in an attempt to construct the variate included in the statistical analysis informed the data collection and portrayed the rationale and the epistemological stance of this study. Rather than focusing on volatile factor inputs such as cement and steel, it was resolved in alignment with the research objectives to investigate the impact of the economic leading indicators preceding and leading to the price movement of the key factor inputs.

Typically, the economic indicators are published as time series. The selected economic indicators including the official exchange rates, the unofficial exchange rate, and the interest rates were collected on annual basis for the period 1994-2006 from websites of the

central agency for public mobilization and statistics (CAPMAS) and the Central Bank of Egypt as shown in table 8.5

Year	Official Exchange Rate	Unofficial Exchange Rate	Interest Rate
1994	3.41	3.41	14.5
1995	3.41	3.41	14.5
1996	3.40	3.40	14
1997	3.40	3.40	13.5
1998	3.41	3.41	13
1999	3.42	3.93	13
2000	3.65	4.20	13
2001	4.07	4.86	13.3
2002	4.63	5.33	13.8
2003	5.92	6.20	13.5
2004	6.12	6.30	13.4
2005	6.00	6.00	13
2006	5.70	5.70	12.6

Table 8.5   Exchange Rates and Interest Rates 1994 - 2006

Source: CAPMAS and Central Bank of Egypt *(unofficial exchange rates were collected from suppliers & importers financial reports)*
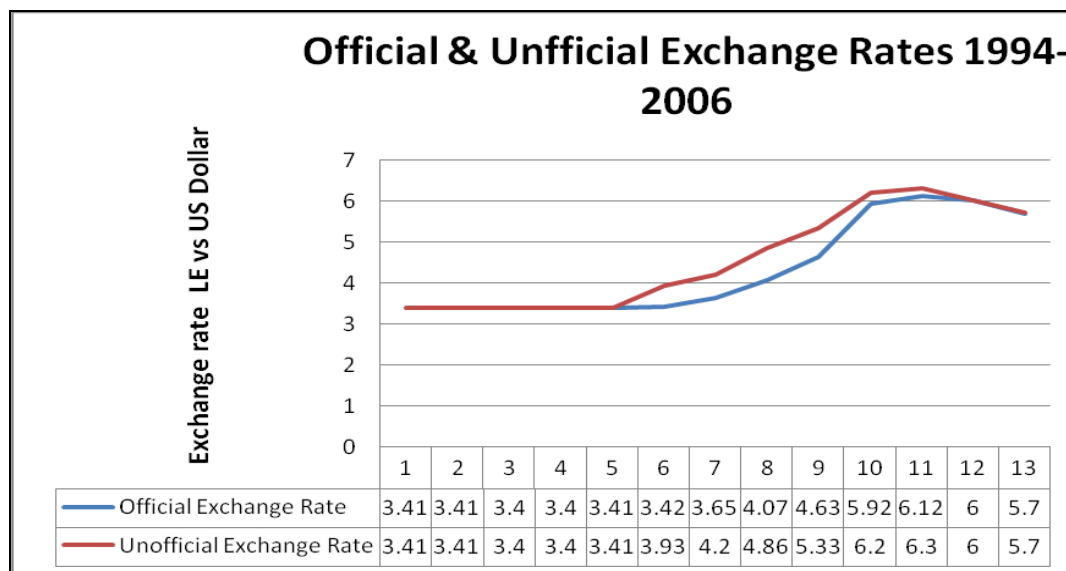
Figure 8.8   The official & unofficial Exchange rates for the Egyptian pound vs. the US Dollar 1994- 2006\

8.5.5.1 The unofficial exchange Rate

This variable was collected from the archives of the main contractors and suppliers, particularly the suppliers involved in the import business. These figures were approved by the tax inspectors and were included in the details of the profit and loss accounts reviewed and approved by the tax authorities. To elaborate further on this last statement, it was worth noting that before the floatation of the Egyptian pound, the banks failed in providing importers with the foreign currencies needed to pay for the letters of credits upon the value date. The banks would agree to open the L/C but the importer should obtain the foreign currency by his own means. This created a black market and the exchange rate in that market was perceived as the realistic value for the Egyptian pound against the other currencies, the most popular of which was the US Dollar. Also, the unofficial exchange rate used to be listed in some of the daily newspapers since it was regarded as an important indicator that concerned a wide range of businessmen. Furthermore, the tax authorities used to approve the cost incurred by imported based on the unofficial exchange rate at the maturity date of the L/C unless there were evidence that the bank provided the foreign currency. This used to happen only in rare cases and limited to the L/C's opened to import good for the government and public sector.

8.5.5.2 The Official Exchange Rate

The data pertaining to official exchange rate of the Egyptian pound against the US Dollar was collected from the official websites of Ministry of Economic Development, Ministry of Finance, CAPMAS and as shown in Table 8.8

8.5.6 Interest Rate

Typically, the nominal rate of interest reflects the rate at which people are borrowing money (bank lending rates) whereas the real interest rate reflects the real cost of money. Kumaranayake (2000), mentioned that in practice, the distinction between the nominal and

real interest rates needed to be considered with higher levels of inflation higher than 7%
Hence it was resolved to use the nominal rate of interest since the average rate of inflation
over the period of study was 5%. The data collected was presented in Table 8.8. The
figures represented the Banks' lending rates for less than one year loans. The reason that
the lending interest rate was selected rather than the discount rate can be illustrated as
shown in figure where the discount rate portrayed a quite stable profile compared to the
lending rate of interest. This indicated that the latter provided a better reflection of the
economic conditions.
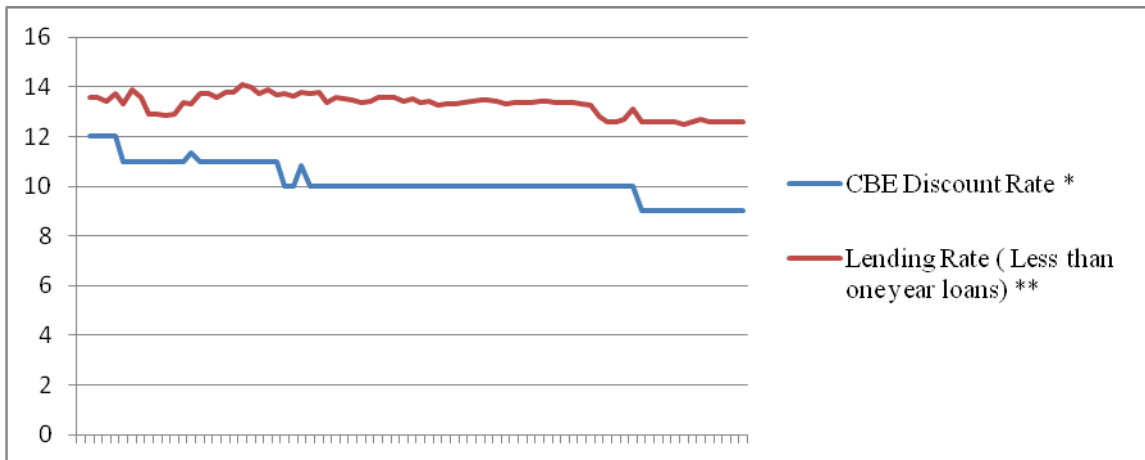
Figure 8.9   CBE Discount Rates vs. Lending Rates (monthly values for the period Jan2001-Dec2006)
Source: Central Bank of Egypt

8.5.7   The Gross Domestic Product (GDP)

The data pertaining to the Egyptian GDP over teh period of 2004 - 2006 were collected
from the CAPMAS website and then treated then deflated using the inflation correction
factor (ICF) presented in Table 8.3 in section 8.5.1. The values of the GDP expressed in
real terms are shown in Table 8.6.

94	95	96	97	98	99	00	01	02	03	04	05	06
147	174	206	252	287	314	377	420	470	543	577	612	650

Table8.6   Values for GDP in real terms LE bn

8.5.8   The Balance of Payment

The data pertaining to the Balance of Payment over the period of 2004 - 2006 were collected from the CAPMAS website and then deflated using the inflation correction factor (ICF) presented in Table 8.3 in section 8.5.1. The values of the Balance of Payment expressed in real terms are shown in Table 8.7.

94	95	96	97	98	99	00	01	02	03	2004	05	06
806	643	513	1814	-135	-1804	-3360	-1019	-565	710	753	800	849

Table 8.7 Values of Balance of Payment in real terms LE 000'000

8.5.9   Coding of Dummy variables

The *location* variables needed further treatment in order to be included in the statistical analysis, being categorical variables. The three categories were urban, rural and remote. Hence the number of variables included in the analysis representing the three categories would be (n-1 i.e. 3-1 = 2) variables (Field 2010) as shown in Table 8.8.   The remote location was selected as the reference variable and it was resolved that the two variables to be included in the analysis were Urban and Rural

Variable	Urban	Rural	Remote
Urban	1	0	0
Rural	0	1	0
Remote	0	0	1

Table 8.8   Effect Coding for the three categories of the location variable

Similarly the *foundation* variable had two categories; shallow foundation and deep foundation. The foundation variable being a dichotomous variable was represented in the analysis by one variable that had two values either 0 or 1. It was resolved to select the foundation category as the reference variable with a value of 0 whilst the deep foundation cases were represented by the value 1.

8.5.10   Construct of Variate

Following the previous discussion the conceptual prediction model can be expressed as follows:

Cost per square metre = f (Number of classroom, Type of Foundation, Type of Location, Official Exchange Rate, Unofficial Exchange Rate, Interest Rate).

In addition, the conceptual explanatory model over and above the mentioned economic variables includes GDP and Balance of Payment.

The previous discussion of variables served in establishing the model specification before embarking on the statistical analysis which will be presented in the following chapter.

The right hand side included variables representing the size of the project, the type of the foundation and the location of the project; all three could be perceived as product related (physical and location) variables. In addition the remaining three variables represented the forward looking at the economic conditions through the selected leading indicators for the predictive model. For the purpose of developing the explanatory model, the two lagging indicators were added.

8.5.11   Reliability of Scale

The reliability of the scale aims to provide an indication about the internal consistency of the measures i.e. that the scale, in fact, measures the phenomenon that is meant to be measured. The statistic known as Cronbach alpha provides an indication about the

reliability of the scale with value ranging from $0 - 1$. (Field, 2010) suggested an acceptable cut-off value of 0.7 and argued that a cut-off value of 0.6 can be applied in the case of a few number of variables. The Cronbach alpha calculated for the data set using SPSS was 0.7 which indicated that the scale reliability test was verified.

8.6 Summary

The chapter presented the details of the survey conducted within the case study; the national project for school buildings. The conceptual model was constructed based on the findings of the literature review. The discussion of variables informed the selection of variables that were included in the model and furthermore, informed that data collection method. A random sampling method was applied and the collected data set was described. The cost per square metre was identified as the dependant variable and was corrected for inflation. The location and foundation variables were treated appropriately in preparation for the cost modelling stage that was discussed in chapter 9.

CHAPTER 9

REGRESSION ANALYSIS AND COST MODELLING

9.1 Introduction

In the previous chapter, the data collected were examined. The analysis was limited to the descriptive statistics and frequencies of the identified variables. This chapter aims at building a cost model applying the regression analysis technique. Primarily, the model seeks to identify the significant explanatory variables; particularly the economic factors and their impact on the dependent variable, the cost per unit area of the school building (Cost per sqm).

9.2   Regression Analysis. A Theoretical Review

Regression analysis is an interdependence technique that is mainly applied to predict the values of the dependent variable from one or more independent variables. In some cases, though, the study is more concerned with identifying and explaining the interdependence between the dependent variable and one or more explanatory variables.

The above statement might seem bewildering. The main safeguard lies in establishing the conceptual model and the underpinning theory informing the design of the conceptual model. This should be regarded as a crucial step preceding and a pre-requisite to embarking on the statistical operations involved in the regression analysis technique.

The conceptual model endorsed by the theoretical framework would justify the interpretations and conclusions derived from the statistical model. Moreover, the conceptual model and the underpinning theory would guide the decision making

process during the various steps of the model building stage. In the case of this study, the economic theory together with the construction cost theory informed the selection of the independent variables which were included in the conceptual model. The discussion of the economic variables clearly identified the conceptual relationship between the rate of exchange and the rate of interest as economic indicators and the price levels. Hence, both indicators can be assumed to influence the cost of building projects. The nature of both variables being leading indicators should help practitioners embarking on estimating the cost of buildings in Egypt once they have future values for both variables.

In the case of explanatory econometric regression models even though the generalisability factor might have been verified, the model might not maintain the high accuracy level in the prediction of the dependent variable over time, particularly, beyond the time horizon of the sample. However, the power and hence the effectiveness of the model in this case would lie in identifying the significance level and the relative impact of the various explanatory variables on the dependant variable. For example, the coefficients of various explanatory variables may change yet maintain the relative impact on the dependant variable. This last statement is discussed further in the interpretation of the results in section (9.3.9)

9.2.1 The Method of Ordinary Least Squares

Regression analysis can take various forms. When two or more explanatory variables are used in the regression analysis, it is called *multiple regression*. If the relationship between the dependant variable and the explanatory variables is a linear relationship then the result would be a *multiple linear regression model* which can be represented by then the following equation:

$$Y_i = b_o + b_i X_i + \varepsilon_i \qquad\qquad (9.1)$$

Where b_o and b_i are known as the regression coefficients and ε_i is known as the residual term.

Clearly, this equation represents a straight line equation which is produced by the ***method of ordinary least squares***. This method aims at finding the line that best fits the data set provided by the sample. Normally the line of best fit will not go through all the observed points in the data set. The best fitted line is that where the sum of the squared distance between the individual observed points and the estimated line is the least amongst all other possible lines. For each of the observed points this distance represents the deviation between the estimated value and the actual value. In the regression analysis, these distances are called residuals. The analysis of the residuals is discussed in section 9.2.3.

9.2.2 The Regression Coefficients

As shown in equation 9.1, b_o represents the intercept of the straight line while b_i represent the gradient of the line. Hence, both are essential to identify the nature of the relationship (position and direction of the line). In addition, the regression coefficient b_i represents the change in the dependant variable corresponding to a unit change in the explanatory variable. Therefore, if b_i equals zero for any of the explanatory variables then any change in this variable will have no effect on the dependent variable i.e. it is not significant in explaining the change in the value of the dependent variable.

The *t*- statistic tests the null hypothesis that the value of b_i is zero which if significant will indicate the confidence level in the hypothesis that the value of b_i is different from zero. Consequently the explanatory variable can be claimed to have significant contribution to the value of the dependent variable. The *t*-test is calculated using the following equation:

$$t = (b_{observed} - b_{expected}) / SE_b \qquad (9.2)$$

i.e. $t = (b_{observed}) / SE_b \qquad (9.3)$

since $b_{expected} = 0$ according to the null hypothesis and SE_b is the standard error of b that is the standard deviation of the distribution of b if the value of b were collected from a number of various samples from the population. In other words it indicates the error in the estimated value of b.

The value of t depends on the degree of freedom and can be found in the tables with two confidence levels; $p= .01$ and $p = .05$ i.e. confidence levels of 99% and 95% respectively. Typically if the value of t is large then this will indicate that the value of b is significantly different from zero. For example, for a sample comprising 310 observations and 10 parameters i.e. df = 300, the critical value of $t= 2.6$ for $p = .01$ for the Two-tailed test.

9.2.3 The Goodness of Fit & Analysis of Residuals

Despite that the line of best fit represents the best possible representation of the observed point in a linear relationship; it does not provide information about the goodness of fit. Hence the following equation is used to assess the goodness of fit:

$$\text{Deviation} = \sum (\text{observed} - \text{model})^2 \qquad\qquad (9.4)$$

This is also known as the residual sum of squares SSR which represents the degree of inaccuracy when the model is fitted to the actual data. In the same context, it is essential to discuss two other statistics; the total sum of squares SST and the model sum of squares SSM.

SST represents the difference between the observed data points and the mean value of Y (dependent variable) i.e. it indicates how accurate the mean value of Y can model the relationship. SSM represents the difference between the mean value of Y and the regression line. Hence, the comparing SSM to SST would indicate the portion of improvement due to the model.

$$R^2 = \sqrt{\frac{SSM}{SST}} \qquad\qquad (9.5)$$

$$\&\quad R = \frac{SSM}{SST} \qquad\qquad (9.6)$$

Where R is known as Pearson's correlation coefficient (i.e. the multiple correlation coefficient between the explanatory variables and the dependent variable) and it indicates the overall goodness of fit of the regression model while R^2 indicates the substantive size

of the relationship. For example, if R^2 is equal to 0.9 then the model can explain 90% of the variation in the value of the dependent variable Y. In addition the SPSS package provides another statistic that is the adjusted R^2 which gives an idea about the generalisability of the model. It represents the value of R^2 if calculated from the population rather than the sample (Field, 2009, p.221).

Another important statistic is F- ratio which is the ratio of SSM to SSR. In other words, it provides a measure of how much the model has improved the prediction of the value of the dependent variable. It is also known as the ratio of systematic variance to unsystematic variance. However, F- ratio is calculated based on the Mean Sqaures so both SSM and SSR are divided by the degree of freedom that is the total number of observations minus the number of parameters being estimated including the constant b_o. The result is mean squares for the model (MSM) and the residual mean squares (MSR). Therefore F- ratio can be represented by the following equation:

$$F = \frac{MSM}{MSR}$$
(9.7)

If the model provides a good representation between the dependent variable and the explanatory variables then F-ratio is expected to have a value that is at least greater than 1. The critical value for F-ratio as well as its significance can be obtained from the tables for any given degree of freedom. For example for a sample size of 310 with 10 parameters the critical value for F-ratio is 2.38 at a confidence level p= 0.01 (99%).

9.2.4   Assessment of the Model Accuracy

In this section the assessment of the model accuracy will be discussed in three main dimensions:

- The impact of outliers and influential cases.

- Checking the regression analysis assumptions.

- Cross validation of the model.

9.2.4.1 The impact of outliers and influential cases

The outliers are cases that differ substantially from the main trend portrayed by the data set. Outliers can cause the model to be biased because they affect the values of the estimated regression coefficient. The standardised residual is a useful statistic that can indicate the presence of outliers that might affect the accuracy of the model. Following the normal distribution characteristics, 99% of the standardised residuals should lie within -3.29 and +3.29, hence, absolute values greater than 3.29 should give rise to concern. Also if more than 1% of the cases have standardised residuals with an absolute value greater than 2.58 or more than 5% of the cases have standardised absolute value greater than 1.96 then this would indicate that the accuracy of the model needs review (Field, 2009).

This statement needs further elaboration. When the nature of the problem under investigation can provide a justified explanation of the source of variance within the observed data then the outliers should be examined carefully in the context of the conceptual framework. For example, in the case of this study, the cost of deep foundation is much higher than the cost of shallow foundation. This is expected to affect the cost per square metre for school buildings constructed on deep foundation. If the deep foundation cases are significantly less compared to the shallow foundation cases within the sample, the former might appear to be outliers. In this case the analysis should seek to identify the impact of the type of foundation on the cost of buildings rather than regarding the deep foundation cases as outliers.

Similar to the effect of the outliers, the presence of influential cases can affect the accuracy of the model. One way to detect the influential cases would be to compare the *adjusted predicted value* with the *predicted value*. The former is calculated after omitting the influential case. Hence the model can be considered stable when the adjusted value is very close to the predicted value. The difference between the adjusted predicted value and the predicted value for any case is given by a statistic known as **DFFit** which can be obtained in SPSS. However, the use of the standardised version of the DFFit values that is known as **Standardised DFFit** is recommended since it is not affected by the units of measurement. A stable model is expected to have small Standardised DFFit values.

The statistic known as **DFBeta** indicates the difference in the value of the regression coefficient b when one case is excluded. The **standardised DFBeta** provides an easier method since it is not affected by the units of measurements. Cases with absolute values greater than 2 are worth investigation. Another statistic that can reflect the effect of a single case on the model as a whole is **Cook's distance** whereby values greater than 1 would give rise to concern indicating that the corresponding case might need to be investigated as an influential case.

The statistics known as **leverage,** on the other hand indicates the influence of the observed value of the dependent variable on the predicted values whereby the average leverage value is calculated by the formula $(k+1)/n$ where k is the number of the explanatory variables and n is the number of cases. The term $(k+1)$ reflects the total number of parameters including the constant b_o.

If no cases exert significant influence over the model then the average leverage values should be close to $(k+1)/n$. A conservative value of twice the average leverage can be used as a cut-off point for identifying influential cases and less conservative value of three times the average leverage value might be applied as a cut-off point (Field, 2009).

Similarly the statistic known as **Mahalanobis distances** measures the distance of cases from the mean of the explanatory variable. Some critical values for Mahalanobis distances are give in table 8.1 based on the number of cases in the sample N and the number of explanatory variables.

No of Independent Variables	Critical Value	No of Independent Variables	Critical Value	No of Independent Variables	Critical Value
2	13.82	4	18.47	6	22.46
3	16.27	5	20.52	7	24.32

Table 9.1   Critical values for evaluating Mahalanobis values

Source: Pallant (2007, p.157)

In addition, the **covariance ratio (CVR)** statistic indicates whether a case influences the variance of the regression parameters b_i. When CVR is close to 1 then this case is exerting very little influence on the variances of the parameters. According to Belsely, Kuh and Welsch (1980), If CVR for any case is smaller than 1- (3(k+1)/n) then deleting the case will improve the model, where k is the number of explanatory variables and n is the number of cases (sample size).

9.2.5   Checking the regression analysis assumptions

The main purpose of checking the assumptions is to be able to draw conclusions about the population based on the regression model. In other words when the assumptions are verified, there is more confidence about the generalisability of the model i.e. it provides a true representation of the population.

This section will start with the rather simple assumptions.

1.   First,   all independent (explanatory) variables should be quantitative or categorical with two categories whilst the dependent variable must be quantitative, continuous and unbounded. So if the range of the dependent variable in the population were different from the range in the sample then the data set would be regarded as constrained.

2.   Second, the explanatory variables should have some variation in the observed values. Obviously, if any of the explanatory variables is portraying a pattern of constant values meanwhile the value of the dependent variable is changing then there is little evidence if any whether this explanatory variable contributes to the variation in the value of the dependent variable.

3.   A third logical assumption is the assumption of linearity. This assumption is based on   the conceptual definition of linear regression whereby the relationship is assumed to be linear. Applying the linear regression technique to a   non-linear relationship would not yield reliable findings that can accurately model the interdependence between the

explanatory variables and the dependent variable in the population i.e. limits the generalisability of the findings.

4.   No perfect Multicollinearity: when two or more explanatory variables are highly correlated (more than 0.9) then the standard error of the regression coefficient SE_b will increase. In other words, the value of b will vary across various samples, hence, b_{sample} will be significantly different from $b_{population}$ and the model will be unstable, i.e. will not be a good representation of the relationship between the dependent variable and the explanatory variables.

Also, multicollinearlty masks the unique variance. In order to elaborate further on this point the discussion needs to shed some light on two statistics; the partial correlation and part correlation.

The partial correlation is the correlation between the explanatory variable and the dependent variable which might include the part shared with other explanatory variables particularly in the case of highly correlated explanatory variables, i.e. the case of multicollinearity. Part correlation, on the other hand, is the unique variance that is the unique correlation between the explanatory variable and the dependent variable after excluding the part shared with other explanatory variables.

Therefore the part correlation indicate the unique contribution of the explanatory variable to the variation in the value of the dependent variable In other words the part correlation indicates the relative importance of the explanatory variables whereby the explanatory variable with high values of part correlation contribute more than those of lower part correlation to the variation in the value of the dependent variable.

Multicollinearlity can be detected by examining values in the correlation matrix, particularly the correlation coefficients between the explanatory variables. The statistics known as the Variance Inflation Factor (VIF) indicates whether any of the explanatory variables has a strong linear relationship with other explanatory variables. VIF values closer to 1 indicate that there is no perfect multicollinearity amongst the explanatory

variables. Myers (1990) suggested that VIF values higher than 10 should give rise to concern about multicollinearity whereas Menard (1995) suggested a more conservative cut-off value of 5 (Tolerance lower than 0.2)[1]. Also, Field (2009) mentioned that the average of the VIF for the explanatory variables should be close to 1 and when the average value is significantly higher than 1 then the data should be investigated for multicollinearity.

5.   Homoscedasticity: the variance of the residual terms should be constant at each level of the explanatory variables. This is an important assumption to ensure the genralisability of the model to the population. If the variance of the residual terms is significantly different then this case is known as Heteroscedasticity. An easy way to detect heteroscedasticity is to examine the scatter diagramme when the residual is plotted against the predicted value of the dependent variable. A uniform distribution (rectangular shape) that does not reflect any significant pattern of increase or decrease in value of the residuals with the predicated value of the dependent variable would indicate that the assumption of homoscedasticity is met. (Cohen et al. 2003).

6.   Normally distributed errors: If the residuals are random and normally distributed with a mean of zero then the difference between the predicted value and the observed value is most likely to be zero or close to zero in most cases. This assumption can be verified by examining the distribution of the residuals which can be obtained in SPSS. Also, the Kolmogorov-Sminov (K-S) test compares the scores provided by the sample (residual values) to a normally distributed set of scores with the same mean and standard deviation.   If the K-S test is not significant ($p > 0.05$) then the distribution of the residuals is not significantly different from the normal distribution and the assumption is met.

In addition to the above mentioned assumptions which were perceived as the most relevant to the context of this study, some scholars (Hair et al., 2007; Field, 2009; Pallaton, 2007 and others) mentioned two more assumptions. The first assumption is the assumption of independence whereby the all values of the dependent variable are assumed to be independent i.e. each comes from a separate entity.

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[1] Tolerance is the reciprocal of VIF

In other words and in the context of this study this assumption means that each observation should relate to separate project and no observations should relate to the same school building over different points in time. It is worth noting at this stage that all the observations included in this study were obtained from different school building i.e. the number of observations is equal to the number of projects surveyed. Hence this assumption was met.

The second assumption related to the high correlation between any of the explanatory variables and an external variable that was not included in the model. Hence, other explanatory variables that were not included in the model might as well predict the value of the dependent or can explain the variation in the value of the dependent variable accurately. This might be true from a purely statistical point of view. However, the selection of the explanatory variables to be included in the model should be grounded on a well defined theoretical framework as discussed in the development of the conceptual model in section 8.2.4. For example suppose that the performance of the students in Heriot Watt Dubai campus on a particular exam was reported to be better than their counterparts sitting the same exam on the same day at the same time in Edinburgh. And obviously the reported temperature in Dubai was higher than the temperature in Edinburgh during the period of the exam. From a pure statistical point of view a positive correlation can be established between the performance of the students and the temperature.

However, since there is barely any theoretical evidence that the higher temperature would enhance the student performance on the exam, this correlation would be meaningless. Also, the lack of underpinning theory would support the decision to exclude the temperature from the explanatory variables if the student performance were investigated as a dependent variable.

9.2.6   Cross Validation of the model

If all the above assumptions are met then the model should provide a good representation of the interdependence relationship between the explanatory variables and the dependent

variable based on the sample. The cross validation of the model would indicate whether the model can still be valid if applied to a different sample. If this is true then it might be logical to assume that the model provides a good representation of the relationship between the explanatory variables and the dependent variable in the population and hence the results are not just limited to the sample from which the model was derived. The following two methods were recommended to verify the generalisability of the model (Field, 2009):

1. Adjusted R^2: As aforementioned the value of R^2 indicates the amount of variance in the dependent variable explained by the model. On the other hand the value of the Adjusted R^2 indicates the amount of variance in the dependent variable if the model were derived from the population rather than the sample. If the value of Adjusted R^2 is close to the value of R^2 then it might be reasonable to assume that the model provides a good representation of the relationship between the dependent variable and the explanatory variables in the population. Hence, the generalisability of the results obtained by the regression model is verified.

2. Data Splitting: In this method, the data set is divided into two randomly selected subsets (approximately 50% each). By running the linear regression analysis on both halves and comparing the results, the stability of the model can be verified. If the resulting models portray very similar results then it might be reasonable to assume that the same results can be obtained from any other sample derived from the population. Hence, the generalisability of the obtained results (model) is verified.
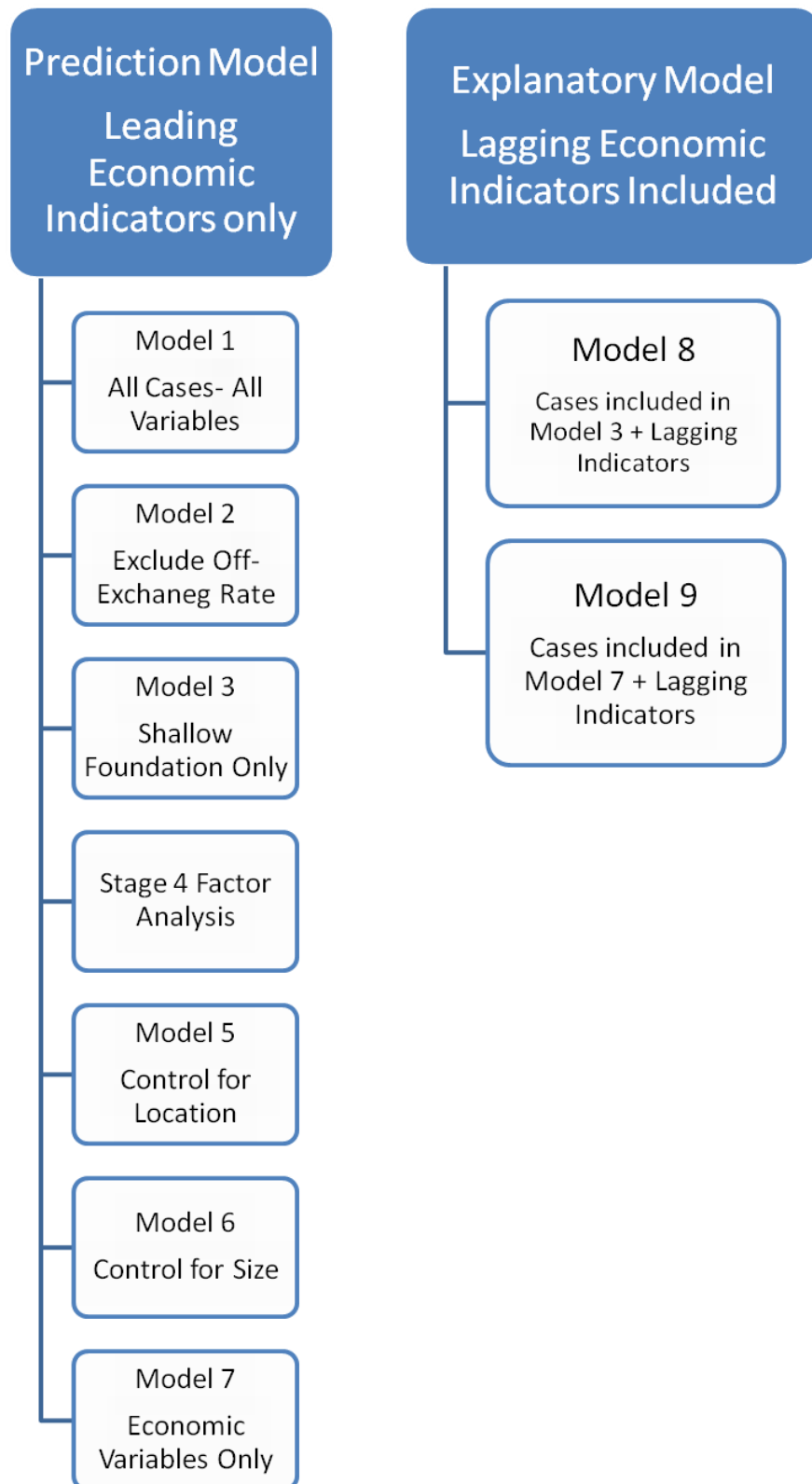
Figure 9.1 Mapping the Main Stages of the Regression Analysis

In the following sections of this chapter the details of the regression analysis conducted on the data set is discussed. A general layout illustrating the two phases of the analysis; the estimating (prediction) model and the explanatory model is shown in Figure 9.1

9.3   The Multiple Linear Regression Analysis

The theoretical discussion provided in section 9.2 informed and guided the regression analysis conducted on the data set derived from the sample projects. The data set was examined and the main descriptive statistics pertaining to the identified variables were presented in the previous chapter in section 8.5. Before embarking on running the regression analysis a randomly selected sub-set of 70 cases were excluded from the analysis and were used in the validation of the model as discussed in section 9.3.7. The linear regression analysis was undertaken on two phases, each included several stages to ensure and moreover verify the findings obtained. In phase one **(Model 1 -7)** the aim was to focus on the leading economic indicators only. In phase two which comprised two models **(Model 8 & 9),** both the leading and lagging indicators were included seeking to develop an explanatory model over and above the prediction model developed in phase one. **In the following sections the details of each stage is discussed.**

9.3.1   Stage One: Model 1 - All Variables – All *Cases*

As a starting point, it was resolved to include all the identified variables as shown in table 9.2 and run the linear regression analysis on all 283 cases. This approach is known as forced entry or confirmatory approach (Hair *et al.*, 2010). The summary of model obtained using SPSS is shown in table 9.3

Model	Variables Entered	Variables Removed	Method
1	Off_ex_Rate, Rural, Int_Rate, Found, No_Class, Urban, Unoff_Ex	.	Enter

Table 9.2   Model (1) Variables Entered/Removed
* All requested variables entered.
* Dependent Variable: Real_C_sqm

		Int_Rate	Urban	Off_ex_Rate	Found	No_Class	Rural	Unoff_Ex
Correlations	Int_Rate	1	-0.01	0.08	0.16	-0.04	-0.04	-0.10
	Urban		1.00	0.00	0.11	-0.06	**0.85**	-0.04
	Off_ex_Rate			1.00	-0.08	-0.10	-0.01	**-0.97**
	Found				1.00	-0.25	0.08	0.06
	No_Class					1.00	-0.24	0.07
	Rural						1.00	-0.01
	Unoff_Ex							1.00

Table 9.3   Model (1) Coefficient Correlations * Dependent Variable: Real_C_sqm

Goodness of Fit

The relatively high value of R^2 (0.871) indicated that the model explains 87% of the variation in the value of the dependent variable, the cost per square metre of the school building. Also the value of F-ratio is significantly higher that the critical value from the tables (2.76) at confidence level greater than 99% (*p<0.01*). These results indicated that the goodness of fit was verified.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	Df2	Sig. F Change
1	.935(a)	0.87	0.87	139.47	0.87	273.01	7.00	275.00	0.00

Table 9.4   Model (1) Summary

* Predictors: (Constant), Int_Rate, Urban, Off_ex_Rate, Found, No_Class, Rural, Unoff_Ex

* Dependent Variable: Real_C_sqm

Model 1		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	37174565.39	7.00	5310652.20	273.01	.000(a)
	Residual	5349419.73	275.00	19452.44		
	Total	42523985.12	282.00			

Table 9.5   Model (1) ANOVA

* Predictors: (Constant), Int_Rate, Urban, Off_ex_Rate, Found, No_Class, Rural, Unoff_Ex

* Dependent Variable: Real_C_sqm

The Regression Coefficients b$_i$

The values of the regression coefficients are shown in table 9.6. All values except for the official exchange rate were different from zero and the values for t- statistic for the coefficients of all other variables were significant at confidence level greater than 95% ($p<$ 0.05).

The standardised coefficients provided an indication about the relative importance of the explanatory variables in explaining the variation in the value of the dependent variable. It was clear that the number of classrooms was the least important amongst the significant variables with standardised b value of 0.087, i.e. when the value of the number of classrooms changed by one standard deviation the corresponding change in the value of the dependent variable, the cost per square metre, would be only 0.087 standard deviations. This could be compared to a change of 0.784 standard deviations in the value of the cost per square metre when the value of the unofficial exchange rate changed by one standard deviation. The exchange rate came as the highest contributor to the change in the value of the dependent variable, the cost per square metre of the school building.

The standardised regression coefficients for the dummy variables representing the location (Urban &Rural) indicated the relative difference between each of the two variables and the reference variable, the remote location.

The results provided a realistic indication. Typically bidders would request a higher price for remote locations than rural locations. Also, the requested prices for rural projects would typically be higher than the prices for Urban projects cet. par. Hence, the cost per square metre of the school building would be higher in remote projects compared to the rural projects which in turn would be higher than in the case of urban projects. Similarly the deep foundation would result in higher values for the cost per square metre of the school building compared to the shallow foundation.

This was portrayed in the positive value for the standardised regression coefficient of the variable representing the type of foundation. The congruence between the results and the underpinning theory conferred meaning and also verified the findings of the statistical analysis.

Model 1	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3635.22	317.98		11.43	0.00					
No_Class	5.30	1.48	0.09	3.58	0.00	0.29	0.21	0.08	0.78	1.28
Found	448.50	38.46	0.27	11.66	0.00	0.43	0.58	0.25	0.87	1.15
Urban	-411.19	33.75	-0.53	-12.18	0.00	-0.23	-0.59	-0.26	0.24	4.14
Rural	-252.89	34.73	-0.32	-7.28	0.00	0.17	-0.40	-0.16	0.23	4.31
Off_ex_Rate	9.20	32.26	0.03	0.29	0.78	0.76	0.02	0.01	0.05	18.37
Unoff_Ex	280.99	32.81	0.78	8.56	0.00	0.76	0.46	0.18	0.06	18.33
Int_Rate	-268.46	24.09	-0.25	-11.15	0.00	-0.19	-0.56	-0.24	0.95	1.06

Table 9.6   Model (1) Regression Coefficients

* Dependent Variable: Real_C_sqm

Impact of outliers and influential cases

Three main statistics were calculated using SPSS; the covariance ration, the leverage statistic and Mahalanobis. The covariance ratio CVR was compared to the suggested criteria {1- (3(k+1)/n) < CVR < 1+ (3(k+1)/n)}. Similarly the leverage statistic was compared to the cut-off value of 3{(k+1)/n)} and the Mahalanobis distance was compared to the values shown in table 9.1 (for more details see section 9.2.4). In general the results did not identify any critical case with significant deviation from the above mentioned cut-off values.

Checking the Regression Assumptions

1.   Multicollinearity: Examining the correlation matrix as well as the VIF values indicated that the variables representing the official exchange rate and the unofficial exchange rate were highly correlated ($r = 0.97$ &VIF = 18) which suggested that there was a case of multicollinearity. This could be regarded as a logical finding since both variables are measuring the same variable that is the exchange rate. During the periods of economic turbulence, the unofficial exchange could be regarded a more realistic representation of the true value of the exchange rate as perceived by the market compared to the official exchange rate that is typically set by the central bank. Hence it was resolved at this stage to

omit the official exchange rate. This decision was also endorsed by the fact that the regression coefficient of the official exchange rate was found insignificant meanwhile its standardized b value was comparatively very small (0.026).

The VIF value for the location categorical variables (Urban &Rural) was relatively high (4.14 &4.31 respectively). However, since the VIF value was significantly lower than the suggested cut-off value of 10 and even less than the conservative cut-off value of 5, it was resolved at this stage to take no action given the special nature of these non-parametric variables.

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	460.91	2466.62	1244.45	363.08	283.00
Std. Predicted Value	-2.16	3.37	0.00	1.00	283.00
Standard Error of Predicted Value	14.69	49.01	22.03	8.05	283.00
Adjusted Predicted Value	427.65	2410.96	1244.39	362.69	283.00
Residual	-385.21	405.47	0.00	137.73	283.00
Std. Residual	-2.76	2.91	0.00	0.99	283.00
Stud. Residual	-2.94	3.10	0.00	1.01	283.00
Deleted Residual	-435.09	461.13	0.05	143.88	283.00
Stud. Deleted Residual	-2.98	3.15	0.00	1.01	283.00
Mahal. Distance	2.13	33.83	6.98	6.82	283.00
Cook's Distance	0.00	0.17	0.01	0.02	283.00
Centered Leverage Value	0.01	0.12	0.03	0.02	283.00

Table 9.7   Model (1) Residuals Statistics

* Dependent Variable: Real_C_sqm
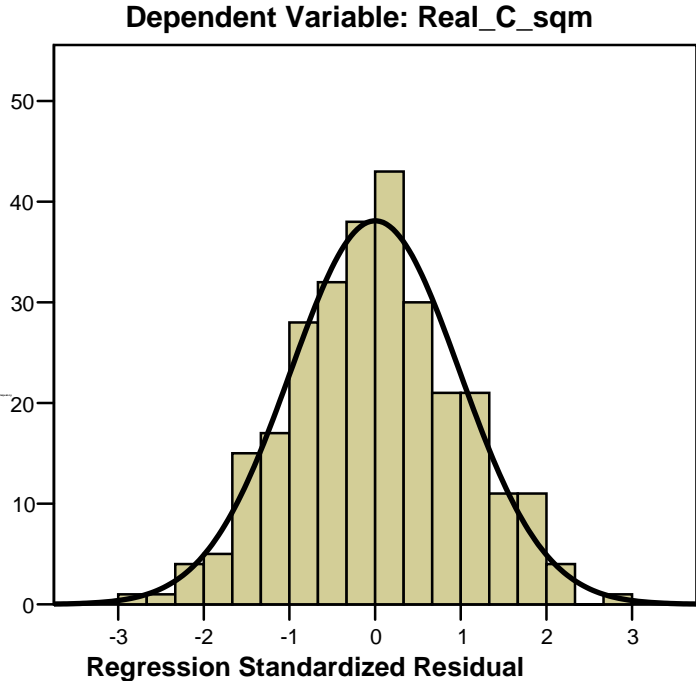
Figure 9.2   Model (1) Frequency Dist. Of Dep.

Dependent Variable: Real_C_sqm
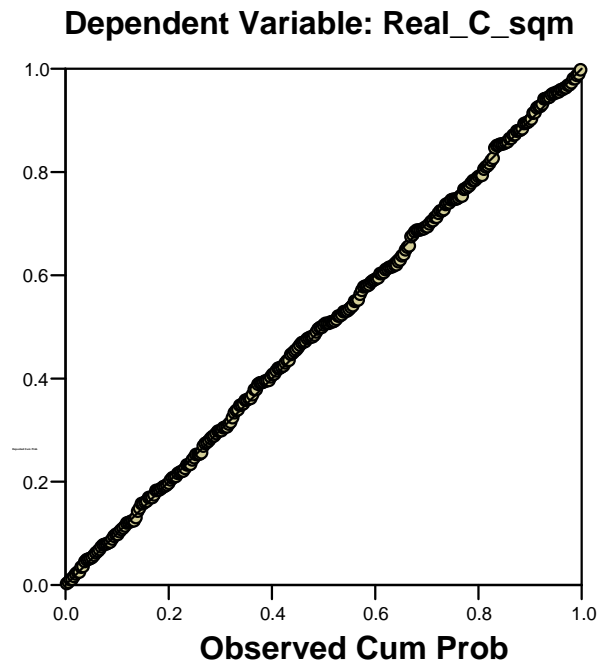
Figure 9.3 Model (1) Normal P-P Plot of Residuals

2. Normally distributed errors: The distribution of the regression standardised residual was plotted as shown in figure (9.1). The histogram showed that the distribution is roughly normal. Also, the normal probability plot shown in figure (9.2) suggested that the assumption of normality was met. This was confirmed by the K-S test.

3. Homoscedasticity: The regression standardised predicted value was plotted against the regression studentised residual. The scatter plot did not show any clear pattern of increasing or decreasing residuals which suggested that the homoscedasticity assumption was met (Hair *et al.*, 2010).

In addition, the value of Adjusted $R^2 = 0.871$ is very close to the value of $R^2 = 0.874$ and the adjusted predicted value (1244.39 LE/sqm) was very close to the predicted value (1244.45 LE/sqm) which suggested that the model provided a good representation of the relationship between the dependent variable and the explanatory variables in the population.

Summary of the Findings of Model 1

The key findings of the produced model can be summarised in the following points:

- The cost per unit square metre of the school building is positively related to the number of classrooms. As the number of classrooms increase, the cost per square metre increases. This increase seems to be of a relatively small magnitude as reflected by the value of the beta coefficient of the variable representing the number of classrooms. Also, the standardised beta coefficient of the variable representing the number of classrooms reflected the relatively little contribution of this variable to the variation in the cost per square metre of the school buildings. This can be attributed to the standardised design which rendered the fluctuation in the cost per unit area quite limited. This should not be confused with the total cost of the school building project which would definitely increase with the increase in number of classrooms. In other words, the increase in the number of classrooms will lead to an increase in the total area of the school building and hence the total cost.

- The deep foundation causes an increase in the cost per square metre of the school building compared to the shallow foundation.

- The cost of square metre for remote locations is higher than the cost per square metre for the rural locations and the latter is higher than the cost of square metre for schools built in urban locations.

- The economic variables particularly the unofficial exchange rate and the interest rate are both significant explanatory variables of the cost per square metre of the school buildings. There seems to be a positive relationship between the unofficial exchange rate and the cost per square metre cost i.e. the increases when the value of the unofficial exchange rate increases. Whereas the cost per square metre seemed to increase when the rate of interest decreases as reflected by the negative value of the regression coefficient of the variable representing the interest rate. For further discussion of this point, see section 9.4.

9.3.2   Stage Two: Model 2 - Official Exchange Rate Omitted – All Cases

The clear multicollinearity between the official exchange rate and the official exchange rate coupled by the statistical insignificance of the latter (t-test = 0.776) suggested the need to run another round of regression analysis after omitting the official exchange rate. The multicollinearity would suppress the value of R^2 and more importantly would distort the value of the regression coefficients. Also, it would most likely distort the value of the part correlation i.e. the unique variance between the unofficial exchange rate and the cost per square metre of the school buildings (Field, 2009 & Hair et al., 2010).

Model	Variables Entered	Variables Removed	Method
2	Int_Rate, No_Class, Unoff_Ex, Urban, Found, Rural	.	Enter

Table 9.8   Model (2) Variables Entered/Removed

* All requested variables entered.

* Dependent Variable: Real_C_sqm

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
2	.935	0.87	0.87	139.24	0.87	319.56	6.00	276.00	0.00

Table 9.9   Model (2) Summary

* Predictors: (Constant), Int_Rate, Urban, Unoff_Ex, Found, No_Class, Rural

* Dependent Variable: Real_C_sqm

Model 2		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	37172982.96	6	6195497.16	319.55	.000(a)
	Residual	5351002.15	276	19387.68		
	Total	42523985.11	282			

Table 9.10   Model (2) ANOVA

* Predictors: (Constant), Int_Rate, Urban, Unoff_Ex, Found, No_Class, Rural

* Dependent Variable: Real_C_sqm

Goodness of Fit

The two models built in stages one and two (Model 1 & Model 2) provided relatively similar results. The values for R, R^2 and Adjusted R^2 for Model 2 were very close to the values obtained in Model 1 as shown in table 9.9. However, the value of F-ratio has improved significantly from 273 to 319.6 which showed that model 2 provided a better representation of the relationship between the explanatory variables and the dependent variable.

The Regression Coefficients b_i

The values of the regression coefficients bi for most of the variables were very close to the corresponding values obtained in model 1 except for the two highly correlated location variables; Urban and Rural as shown in Table 8.10.

This was expected due to the relatively high collinearity between the two variables. However, the most significant difference between the two models was the part correlation for the unofficial exchange rate which indicated the unique correlation between the unofficial exchange rate and the dependent variable, the cost per square metre of the school building.

The value of part correlation obtained in model 2 indicated that the omitted variable (the official exchange rate) screened the true unique correlation between the unofficial exchange rate and the cost per square metre due to the high correlation between the unofficial exchange rate and the omitted variable. The relatively high value of the part correlation (0.786) coupled with the value of the standardised regression coefficient of the unofficial exchange rate (0.81) indicated that the latter had the highest impact on the dependent variable compared to the rest of the explanatory variables included in the model. This confirmed the findings of model 1 and also provided the true value of the unique variance (part correlation), a valuable information that would elucidate the relationship between the unofficial exchange rate and the cost per square metre, further.

Model 2	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3639.10	317.16		11.47	0.00					
No_Class	5.34	1.47	0.09	3.63	0.00	0.29	0.21	0.08	0.79	1.27
Found	449.39	38.27	0.27	11.74	0.00	0.43	0.58	0.25	0.88	1.14
Urban	-411.19	33.69	-0.53	-12.20	0.00	-0.23	-0.59	-0.26	0.24	4.14
Rural	-252.83	34.68	-0.32	-7.29	0.00	0.17	-0.40	-0.16	0.23	4.30
Unoff_Ex	290.07	7.88	0.81	36.79	0.00	0.76	0.91	0.79	0.94	1.06
Int_Rate	-268.97	23.98	-0.25	-11.22	0.00	-0.19	-0.56	-0.24	0.95	1.05

Table 9.11 Model (2) Regression Coefficients

*Dependent Variable: Real_C_sqm

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	458.45	2465.06	1244.45	363.07	283.00
Std. Predicted Value	-2.17	3.36	0.00	1.00	283.00
Standard Error of Predicted Value	11.95	48.07	20.28	8.28	283.00
Adjusted Predicted Value	426.44	2409.99	1244.48	362.70	283.00
Residual	-388.15	407.03	0.00	137.75	283.00
Std. Residual	-2.79	2.92	0.00	0.99	283.00
Stud. Residual	-2.95	3.12	0.00	1.01	283.00
Deleted Residual	-435.72	462.10	-0.03	143.43	283.00
Stud. Deleted Residual	-3.00	3.17	0.00	1.01	283.00
Mahal. Distance	1.08	32.61	5.98	6.71	283.00
Cook's Distance	0.00	0.19	0.01	0.02	283.00
Centered Leverage Value	0.00	0.12	0.02	0.02	283.00

Table 9.12 Model (2) Residuals Statistics

* Dependent Variable: Real_C_sqm

	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Studentized Deleted Residual	.02	283	.200(*)	.99	283	1.00
Standardized Residual	.02	283	.200(*)	.99	283	.99

Table 9.13   Model (2) Tests of Normality

* This is a lower bound of the true significance.

a Lilliefors Significance Correction

Histogram

Dependent Variable: Real_C_sqm
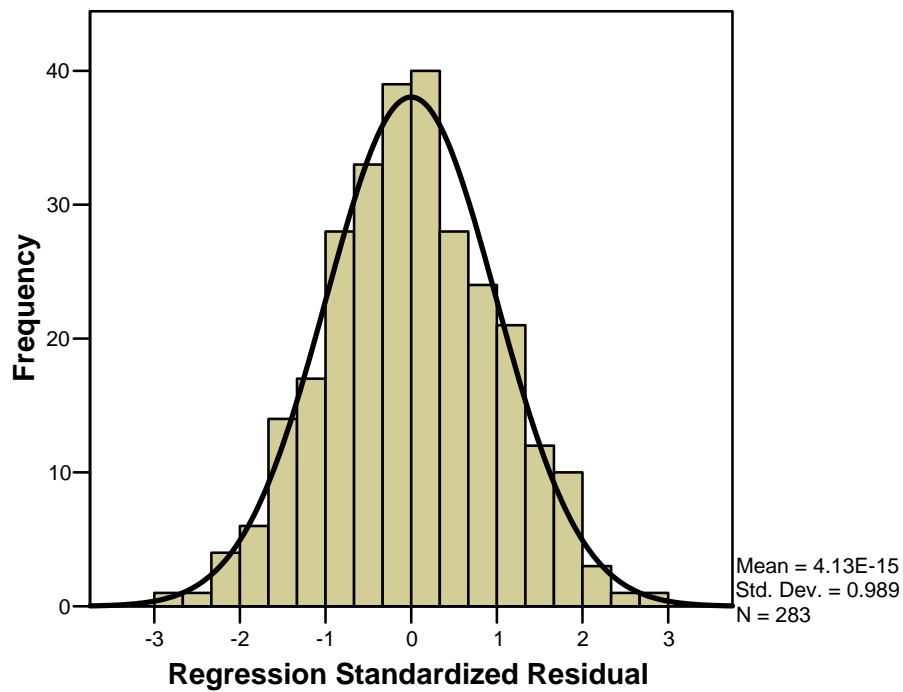
Figure 9.3   Model (2) Freq. Dist. Of Dep. Variable

Normal P-P Plot of Regression Standardized Residual

Dependent Variable: Real_C_sqm
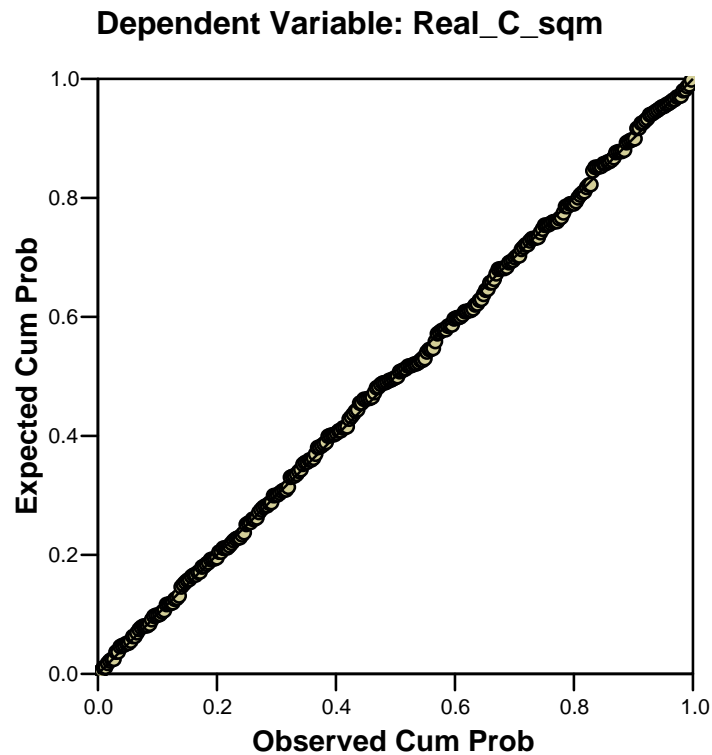
Figure 9.4   Model (2) Normal P-P Plot of Residuals.

	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Studentized Residual	.03	283	.200(*)	.99	283	.24
Standardized Residual	.03	283	.200(*)	.99	283	.36

Table 9.14   Model 2 - Tests of Normality

* This is a lower bound of the true significance.

* Lilliefors Significance Correction

Similar to the results obtained in Model 1, the results of the normality test provided in Table 9.14 as well as the histogram shown in Figure 9.3 indicated that the assumptions of the regression analysis were met

Furthermore, the value of R^2 was very close to the value of the adjusted R^2 (0.874 & 0.871) and the mean predicted value (1244.45) shown in table 8.11 was the same as that

obtained in Model 1 which suggested that the model provided a good relationship between the dependent variable and the explanatory variables in the population.

Summary of the findings of Model 2

- The omission of the insignificant meanwhile highly correlated variable, the official exchange rate, improved the value of the *F*- ratio, and hence enhanced the confidence in Model 2 compared to Model 1. This was confirmed by the relatively high value of both R and R^2 (0.935 &0.874) indicating the goodness of fit of the model.

- The unique variance of the economic variable, the unofficial exchange rate, with the dependent variable was better spelled out after omitting the official exchange rate having eliminated the effect of the collinearity between the two economic variables.

- The unofficial exchange rate was confirmed as the most important explanatory variable, explaining the variance in the value of the dependent variable compared to the rest of the explanatory variables.

- The findings obtained in Model 1 pertaining to the location variables as well as the impact of the type of foundation on the cost per square metre of the school buildings were confirmed.

- The mean predicted value of the cost per square metre (1244.45L.E.) was very close to the adjusted mean predicted value (1244.47L.E.). Also the adjusted R^2 was very close to the value of R^2 (0.871 & 0.874) which indicated that Model 2 provided a good representation of the relationship between the explanatory variables and the dependent variable in the population. It is worth noting that the mean predicted value and the adjusted mean predicted value of the dependent variable was very close to the corresponding values obtained in Model 1.

9.3.3   Stage Three: model 3 - Deep Foundation Omitted – All Cases

Rationale

The cases with deep foundation are significantly less in number compared to the schools built on shallow foundation (approximately 5%). The analysis in the previous two stages indicated that the type foundation had significant impact on the cost per square metre of the school building. This was a logical finding that matched reality since the cost of the deep foundation is significantly higher than the cost of shallow foundation *cet. par.* It was therefore resolved to run another round of regression analysis on the typical case of school buildings that is the shallow foundation.

The aim was to confirm the findings of the previous stage for the typical case of school buildings constructed on shallow foundation. The significant impact of the deep foundation is quite likely to have distorted the mean predicted value for the entire sample given the relatively less number of the schools built on deep foundation compared to the typical case of shallow foundation.

On the one hand, and from a statistical point of view, the previously calculated mean predicted value for the dependent variable did provide a good representation of the population given the fact that some schools are built on deep foundation. On the other hand, it was expected that the mean predicted value for the dependent variable would be quite different if the cases built on deep foundation were eliminated from the sample. Therefore, it was imperative to investigate the impact of deep foundation further, in order to quantify this impact on the cost per square metre of the school building meanwhile providing a more realistic mean predicted value for the cost per square metre for the typical school case since the majority of schools are built on shallow foundation.

Model	Variables Entered	Variables Removed	Method
3	Int_Rate, Urban, Unoff_Ex, No_Class, Rural(a)	.	Enter

Table 9.15   Model (3) - Variables Entered/Removed

* All requested variables entered.

* Dependent Variable: Real_C_sqm

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
3.00	.930	0.87	0.86	126.50	0.87	333.55	5.00	260.00	0.00

Table 9.16 Model (3) - Model Summary

* Predictors: (Constant), Int_Rate, No_Class, Unoff_Ex, Urban, Rural

* Dependent Variable: Real_C_sqm

Model 3		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	26688982.90	5.00	5337796.58	333.55	.000(a)
	Residual	4160809.76	260.00	16003.11		
	Total	30849792.66	265.00			

Table 9.17 Model (3) - ANOVA

* Predictors: (Constant), Int_Rate, No_Class, Unoff_Ex, Urban, Rural

* Dependent Variable: Real_C_sqm

Goodness of Fit

The relatively high value of R^2 (0.865) indicated that the model could explain 86.5% of the variation in the value of the dependent variable, the cost per square metre of the school building. Also the value of F-ratio is significantly higher that the critical value from the tables (2.76) at confidence level greater than 99% (*p<0.1*). These results indicated that the model provided a good representation of the relationship between the explanatory variables and the dependent variable based on the sample.

The Regression Coefficients b_i

The values of the regression coefficients are shown in Table 9.18. All values were different from zero and the values for *t*- statistic for the coefficients of all other variables were significant at confidence level greater than 95% (*p< 0.5*). The standardised coefficients provided an indication about the relative importance of the explanatory variables in explaining the variation in the value of the dependent variable. Similar to the results obtained from Model 1 and Model 2, it was clear that also in Model 3 the number of classrooms was the least important amongst the significant variables with standardised b

value of 0.076, i.e. when the value of the number of classrooms changed by one standard deviation the corresponding change in the value of the dependent variable, the cost per square metre, would be only 0.076 standard deviations. This could be compared to a change of 0.887 standard deviations in the value of the cost per square metre when the value of the unofficial exchange rate changes by one standard deviation. Also, in this model, the unofficial exchange rate came as the highest contributor to the change in the value of the dependent variable, the cost per square metre of the school building.

The standardised regression coefficients for the dummy variables representing the location (Urban &Rural) indicated the relative difference between each of the two variables and the reference variable; the remote location. The results provided a realistic indication. The results were similar to those obtained from Model 1 and Model indicating that the cost per square metre of the school building would be higher in remote projects compared to the rural projects which in turn would be higher than in the case of urban projects. The congruence between the results and the underpinning theory conferred meaning and also verified the findings of the statistical analysis.

Model 3	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3544.38	313.95		11.29	0.00					
No_Class	4.47	1.44	0.08	3.09	0.00	0.14	0.19	0.07	0.87	1.15
Urban	-395.65	33.14	-0.58	-11.94	0.00	-0.18	-0.60	-0.27	0.22	4.55
Rural	-230.68	34.10	-0.33	-6.77	0.00	0.15	-0.39	-0.15	0.21	4.69
Unoff_Ex	288.84	7.36	0.92	39.23	0.00	0.83	0.93	0.89	0.95	1.05
Int_Rate	-261.66	23.50	-0.26	-11.13	0.00	-0.15	-0.57	-0.25	0.98	1.02

Table 9.18 Model (3) – Regression Coefficients

* Dependent Variable: Real_C_sqm

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	489.88	1951.63	1201.66	317.4	266
Std. Predicted Value	-2.24	2.36	0	1	266
Standard Error of Predicted Value	11.06	45.91	17.85	6.51	266
Adjusted Predicted Value	486.94	1982.34	1201.88	317	266
Residual	-298.58	296.89	0	125.3	266
Std. Residual	-2.36	2.347	0	0.99	266
Stud. Residual	-2.47	2.42	-0.00	1.00	266
Deleted Residual	-330.97	315.84	-0.22	129.2	266
Stud. Deleted Residual	-2.49	2.44	-0.00	1.00	266
Mahal. Distance	1.02	33.90	4.98	5.38	266
Cook's Distance	0	0.12	0.005	0.01	266
Centered Leverage Value	0.00	0.12	0.01	0.02	266

Table 9.19 Model (3) - Residuals Statistics

* Dependent Variable: Real_C_sqm

	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Studentized Deleted Residual	.03	266	.200(*)	.99	266	.68
Studentized Residual	.03	266	.200(*)	.99	266	.63

Table 9.20 Model (3) - Tests of Normality

* This is a lower bound of the true significance.

* Lilliefors Significance Correction

Histogram

Dependent Variable: Real_C_sqm

Mean = -2.48E-15
Std. Dev. = 0.991
N = 266
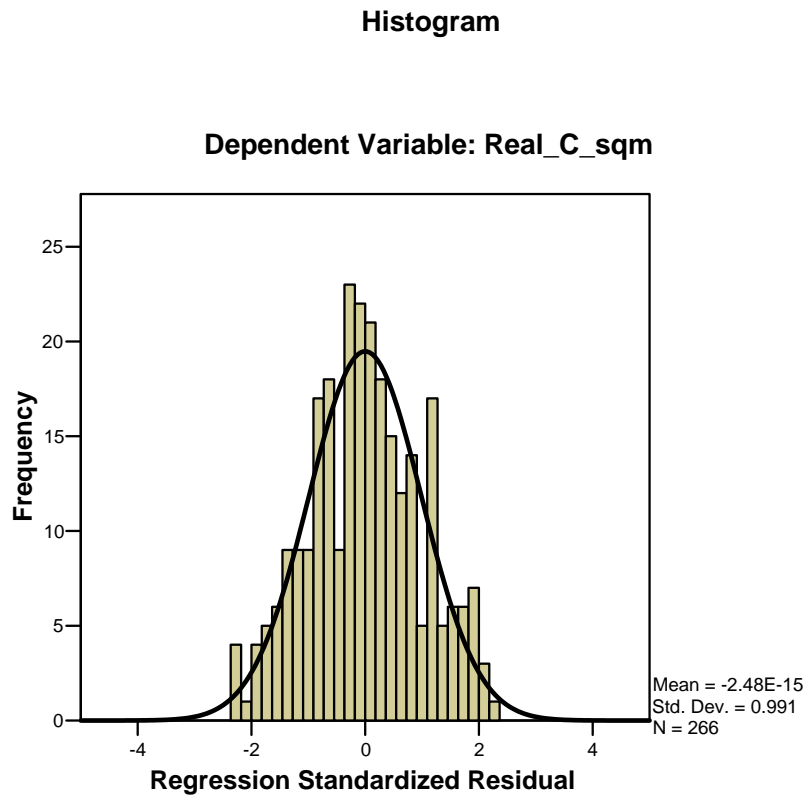
Figure 9.5 Model (3) Freq. Dist. Of Dep. Variable

Normal P-P Plot of Regression Standardized Residual

Dependent Variable: Real_C_sqm
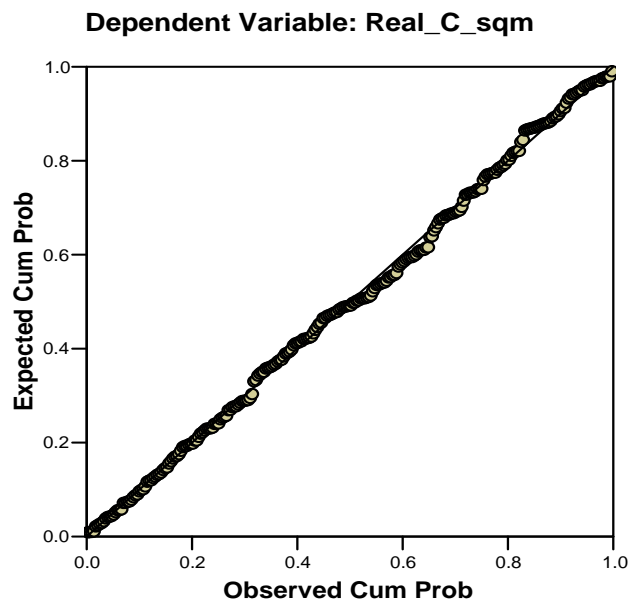
Figure 9.6   Model (3) Normal P-P Plot Of Residuals.

Similar to the results obtained in Model 1 and in Model 2, the regression assumptions were checked and the results did not indicate any serious issues (Table 20 & Figures 9.5, 9.6). Furthermore, the value of R^2 was very close to the value of the adjusted R^2 which suggested that the model provided a good relationship between the dependent variable and the explanatory variables in the population.

Summary of the findings of model 3

- The relatively high values of R and R^2 (0.93& 0.865) indicated the goodness of fit of the model. Also, the value of *F*-ratio indicated that the model provided a good representation of the relationship between the explanatory variables and the dependent variable.

- The value of the standardised regression coefficients and the value of the part correlations confirmed the findings of the previous two models indicating that the unofficial exchange rate was the most important explanatory variable contributing to the variation in the value of the dependent variable, the cost per square metre for school buildings.

- The value of adjusted R^2 (0.863) was very close to the value of R^2 (0.865) which indicated that the model provided a good representation of the relationship between the dependent variable and the explanatory variables in the population.

- The drop in the value of the mean predicted cost per square metre (1201.67 LE down from 1244.45LE) could be reasonably attributed to the effect of eliminating the deep foundation cases. In other words it might be reasonable to assume that the results provided a quantification of the impact of deep foundation on the cost per square metre of school building that can be calculated using weighted averages as follows[1]:

  (1244.45*283 – 1201.67*266) / 17 – 1201.67 =

  1913.84 – 1201.67= 712 LE / sqm

---

[1] The total number of cases = 283 and the number of deep foundation cases only = 17

Furthermore, this model provided a more realistic estimate about the typical mean value for the cost per square metre of school buildings (1201.67 LE) given that almost 95% of the school buildings are constructed on shallow foundation.

9.3.4 Stage Four: Factor Analysis

Rationale

The relatively high correlation between the categorical variables representing the location as shown in Table 9.21 provided the rationale for this stage i.e. running a factor analysis twice; first on the complete data set including the deep foundation cases then a second round after separating out the deep foundation cases. This was mainly to verify the findings of Model 2 and Model 3. However after running the first round (complete data set) it was resolved that there was no need to run the second round for the reasons stated in the following section.

Extraction and Rotation:

The factor analysis applied the principal component method in the extraction of factors (components). The scree plot shown in Figure 9.7 suggested that 4 four components would rather give a better result than the 3 components that were selected by SPSS based on the Eigen-value cut-off value of 1.0. Hence, it was resolved to set the number of components as four (Hair *et al.*, 2010). The component matrix shown in table 9.23 did not provide clearly distinctive factors which suggested the need for further treatment through rotation. The Varimax rotation method was selected since it was recommended when orthogonal factors were sought (Hair *et al.*, 2010). The rotated component matrix indicated that there were four distinctive components (Tables 9.24 – 9.26); the first component represented the location, the second component represented the size and the type of foundation the third component represented the interest rates and the forth component represented the exchange rate. In other words, the components 3 and 4 represented the economic variables.

Correlation	No_Class	Found	Urban	Rural	Unoff_Ex	Int_Rate
No_Class	1.00	.28	-.30	.37	.11	.02
Found		1.00	-.15	.12	.07	-.14
Urban			1.00	-.86	.09	-.02
Rural				1.00	-.02	.05
Unoff_Ex					1.00	.12
Int_Rate						1.00

Table 9.21 Correlation Matrix

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.54
	Approx. Chi-Square	482.29
Bartlett's Test of Sphericity	Df	15
	Sig.	.00

Table 9.22 KMO and Bartlett's Test

Scree Plot
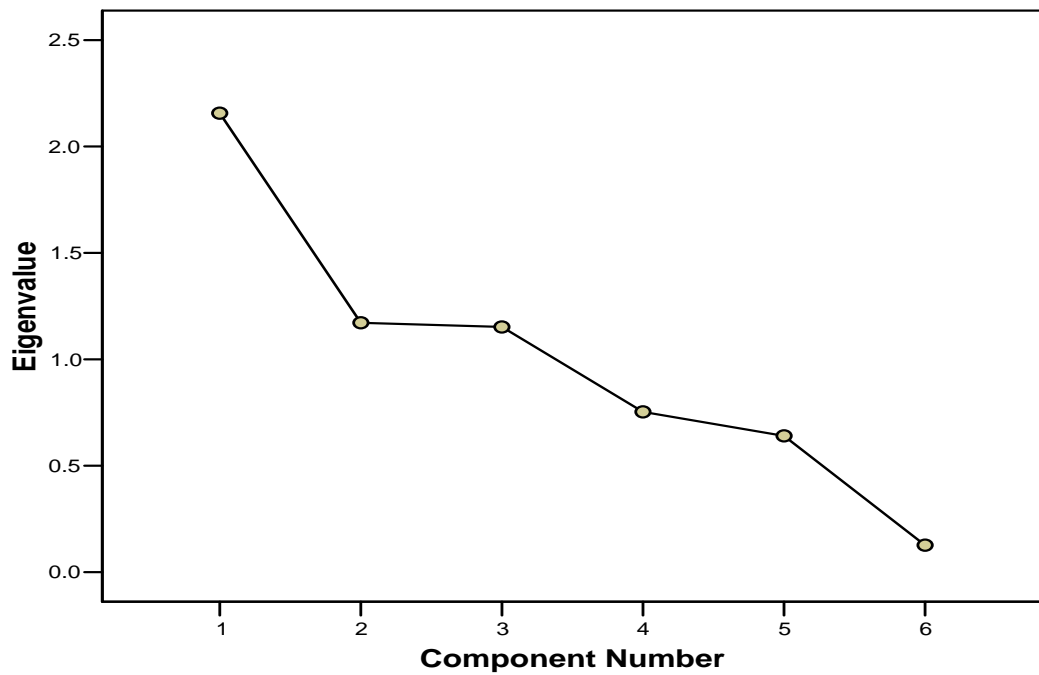
Figure 9.7 **Scree Plot**

	Component			
	1	2	3	4
No_Class	.62	.42	.04	.26
Found	.37	.62	-.40	.33
Urban	-.89	.29	-.01	.15
Rural	.91	-.23	.09	-.17
Unoff_Ex	-.01	.67	.50	-.53
Int_Rate	.02	-.09	.84	.48

Table 9.23   Component Matrix

* Extraction Method: Principal Component Analysis.

* a 4 components extracted.

	Component			
	1	2	3	4
No_Class	.34	.68	.16	.12
Found	-.01	.87	-.18	-.01
Urban	-.94	-.11	.01	.07
Rural	.95	.12	.03	.00
Unoff_Ex	-.04	.06	.05	.99
Int_Rate	.01	-.05	.97	.05

Table 9.24   Rotated Component Matrix

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a Rotation converged in 5 iterations.

Component	1	2	3	4
1	.89	.44	.03	.00
2	-.34	.69	-.09	.61
3	.10	-.27	.82	.48
4	-.26	.48	.56	-.61

Table 9.25   Component Transformation Matrix

* Extraction Method: Principal Component Analysis.

* Rotation Method: Varimax with Kaiser Normalization.

	Component			
	1	2	3	4
No_Class	.04	.53	.20	.03
Found	-.18	.75	-.08	-.11
Urban	-.51	.09	.06	.02
Rural	.52	-.09	-.02	.06
Unoff_Ex	.03	-.06	-.08	1.00
Int_Rate	-.05	.06	.97	-.08

Table 9.26   Component Score Coefficient Matrix

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Component Scores.

Regression Analysis with the Rotated Components as Regression Factors

Since the correlation between the two economic variables was 0.12 as shown in the correlation matrix, it was logical to find that each variable represented a different factor. It might be reasonable to assume that the unofficial exchange rate was an unbiased indicator that was purely set by the market forces whereas the interest rate was set by the Central Bank hence it was subject to other considerations than the market forces.

The four components despite providing interesting significance about the grouping of the data did not provide significant reduction in the number explanatory variables. Also given that the number of classrooms had limited importance in explaining the variation in the value of the dependent variable, it was expected that running a regression analysis on the rotated factors rather than the original variables would not yield significant improvement, if any. The results of the regression analysis conducted in this round was shown in table 8.19

Model	Variables Entered	Variables Removed	Method
4	REGR factor score 4 for analysis 1 , REGR factor score 3 for analysis 1 , REGR factor score 2 for analysis 1 , REGR factor score 1 for analysis 1	.	Enter

Table 9.27   Variables Entered/Removed

All requested variables entered.

Dependent Variable: Real_C_sqm

Model 4	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.895	.80	.79	174.68

Table 9.28   Model (4) Summary

* Predictors: (Constant), REGR factor score   4 for analysis 1 , REGR factor score   3 for analysis 1 , REGR factor score   2 for analysis 1 , REGR factor score   1 for analysis 1

* Dependent Variable: Real_C_sqm

Model 4		Sum of Squares	df	Mean Square	F	Sig.
	Regression	34041132.4	4	8510283.09	278.89	.000(a)
	Residual	8482852.74	278	30513.85		
	Total	42523985.1	282			

Table 9.29 Model (4) ANOVA

* Predictors: (Constant), REGR factor score   4 for analysis 1 , REGR factor score   3 for analysis 1 , REGR factor score   2 for analysis 1 , REGR factor score   1 for analysis 1 * Dependent Variable: Real_C_sqm

Model 4	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	1244.45	10.38		119.85	0.00					
REGR factor score 1 for analysis 1	68.81	10.40	0.18	6.62	0.00	0.18	0.37	0.18	1.00	1.00
REGR factor score 2 for analysis 1	146.11	10.40	0.38	14.05	0.00	0.38	0.64	0.38	1.00	1.00
REGR factor score 3 for analysis 1	-96.47	10.40	-0.25	-9.27	0.00	-0.25	-0.49	-0.25	1.00	1.00
REGR factor score 4 for analysis 1	292.11	10.40	0.75	28.08	0.00	0.75	0.86	0.75	1.00	1.00

Table 9.30   Model (4) Coefficients

* Dependent Variable: Real_C_sqm

	Minimum	**Maximum**	**Mean**	**Std. Deviation**	**N**
Predicted Value	357.20	2344.37	1244.44	347.43	283
Std. Predicted Value	-2.55	3.16	.00	1.00	283
Standard Error of Predicted Value	12.04	56.66	22.10	7.12	283
Adjusted Predicted Value	351.753	2337.26	1244.27	347.01	283
Residual	-394.10745	778.48889	.00000	173.43886	283
Std. Residual	-2.256	4.457	.000	.993	283
Stud. Residual	-2.286	4.623	.000	1.004	283
Deleted Residual	-404.45859	837.76581	.17492	177.31121	283
Stud. Deleted Residual	-2.303	4.803	.003	1.013	283
Mahal. Distance	.344	28.673	3.986	4.033	283
Cook's Distance	.000	.325	.005	.021	283
Centered Leverage Value	.001	.102	.014	.014	283

Table 9.31   Model (4) Residuals Statistics   * Dependent Variable: Real_C_sqm

Summary of the Findings of the Factor Analysis

- The factor analysis indentified four components.

- The four components identified in the initial solution indicated the need for further treatment through the rotation of axes.

- The Varimax rotation method provided four clearly distinctive components.

- The component scores indicated that Factor 1 represented the project location; Factor 2 represented the product specific variables i.e. size and type of foundation; Factor 3 represented the interest rate and Factor 4 represented the unofficial rate of exchange.

- The results obtained by the regression analysis conducted on the identified factors were congruent with the findings of Model 2, particularly the evolution of the economic factors as significant explanatory variables contributing to the variation in the value of the dependent variable. However, the value of R^2 and the calculated value for F-ratio as well as the analysis of residuals and the mean value of the adjusted predicted value of the dependent variable indicated that Model 2 provided a better representation of the relationship between the explanatory variable and the dependent variable. Hence, it was resolved to discard this model.

9.3.5 Stage Five: Model 5 – Control for Location - Urban Schools only

Rationale

A subset of data with 136 schools built in urban areas was selected for this round of regression analysis. The selection was done by filtering out the schools built in urban areas meanwhile having shallow foundations. Hence this subset of data included all schools built in urban areas within the original data set. The aim of this model was to further verify the significance of the economic variables using a subset of the data in order to confirm the generalisability of the findings of models 2&3 (Field, 2009).

Model	Variables Entered	Variables Removed	Method
5	Int_Rate, No_Class, Unoff_Ex(a)	.	Enter

Table 9.32   Model (5) Variables Entered/Removed

* All requested variables entered.

* Dependent Variable: Real_C_sqm

Model 5	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
	.940(a)	0.88	0.88	101.56	0.88	331.56	3.00	132.00	0.00

Table 9.33   Model (5) Summary

* Predictors: (Constant), Int_Rate, No_Class, Unoff_Ex

* Dependent Variable: Real_C_sqm

Model 5		Sum of Squares	df	Mean Square	F	Sig.
	Regression	10259300.50	3.00	3419766.83	331.56	.000(a)
	Residual	1361479.49	132.00	10314.24		
	Total	11620779.99	135.00			

Table 9.34   Model (5) ANOVA

* Predictors: (Constant), Int_Rate, No_Class, Unoff_Ex

* Dependent Variable: Real_C_sqm

Model 5	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3012.61	384.18		7.84	0.00					
No_Class	10.32	2.08	0.15	4.97	0.00	0.15	0.40	0.15	1.00	1.00
Unoff_Ex	256.64	8.35	0.92	30.74	0.00	0.90	0.94	0.92	0.99	1.01
Int_Rate	-243.87	28.94	-0.25	-8.43	0.00	-0.15	-0.59	-0.25	0.99	1.01

Table 9.35   Model (5) Regression Coefficients

* Dependent Variable: Real_C_sqm

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	522.56	1528.24	1129.72	275.67	136.00
Std. Predicted Value	-2.20	1.45	0.00	1.00	136.00
Standard Error of Predicted Value	9.18	64.72	16.11	6.66	136.00
Adjusted Predicted Value	518.83	1515.62	1130.50	276.03	136.00
Residual	-222.16	239.00	0.00	100.42	136.00
Std. Residual	-2.19	2.35	0.00	0.99	136.00
Stud. Residual	-2.23	2.38	0.00	1.01	136.00
Deleted Residual	-294.10	244.42	-0.78	105.27	136.00
Stud. Deleted Residual	-2.27	2.42	0.00	1.02	136.00
Mahal. Distance	0.11	53.83	2.98	5.10	136.00
Cook's Distance	0.00	0.85	0.01	0.07	136.00
Centered Leverage Value	0.00	0.40	0.02	0.04	136.00

Table 9.36   Model (5) Residuals Statistics

* Dependent Variable: Real_C_sqm

	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Df	Sig.
Studentized Deleted Residual	0.06	136.00	.200(*)	0.99	136.00	0.43
Studentized Residual	0.06	136.00	.200(*)	0.99	136.00	0.38

Table 9.37   Model (5) Tests of Normality

* This is a lower bound of the true significance.

* Lilliefors Significance Correction.

Summary of the Findings of Model 5

- The regression coefficients for the variable representing the number of classrooms and the economic variables were significantly different from zero which indicated that both the number of classrooms and the economic variables were significant contributors to the variation in the value of the cost per square metre of the school buildings.

- The findings of Model 5 confirmed the findings of the previous Models indicating that the unofficial exchange rate was relatively the most important explanatory variable contributing to the variation in the value of the cost per square metre of the school buildings.

- The positive sign of the regression coefficient of the unofficial exchange rate indicated that the cost per square metre for school buildings increased as the Egyptian pound got weaker against the US Dollar.

- The negative sign of the regression coefficient of the interest rate indicated that the cost per square metre increase had an inverse relationship with the interest rate i.e. lower levels of interest rate would be associated with an increase in the cost per square metre of the school buildings. Further discussion of this point is provided in section 9.4.

9.3.6 Stage Six: Model 6 – Controlled for Product Variables

Rationale

A subset of 72 schools with 8 classrooms and built on shallow foundation was selected out of the complete data set that comprised 283 cases. Hence, this subset of data was controlled for the physical variables and the analysis included the location variables alongside the economic variables.

Model	Variables Entered	Variables Removed	Method
6	Int_Rate, Urban, Unoff_Ex, Rural(a)	.	Enter

Table 9.38 Model (6) Variables Entered/Removed

* All requested variables entered.

* Dependent Variable: Real_C_sqm

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
6	.943(a)	0.88	0.88	96.56	0.88	133.27	4	67	0

Table 9.39 Model (6) Model Summary

* Predictors: (Constant), Int_Rate, Urban, Unoff_Ex, Rural

* Dependent Variable: Real_C_sqm

Model 6	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	2936.93	488.71		6.01	0.00					
Urban	-592.66	41.11	-1.05	-14.42	0.00	-0.09	-0.87	-0.59	0.32	3.17
Rural	-430.39	42.20	-0.72	-10.20	0.00	-0.18	-0.78	-0.42	0.33	2.99
Unoff_Ex	246.88	12.21	0.92	20.22	0.00	0.69	0.93	0.83	0.80	1.25
Int_Rate	-186.75	37.45	-0.21	-4.99	0.00	-0.12	-0.52	-0.20	0.94	1.07

Table 9.40 Model (6) Regression Coefficients

* Dependent Variable: Real_C_sqm

Goodness of Fit

The values of R and R^2 indicated that the model could explain 88.8 % of the variation in the value of the dependent variable, the cost per square metre of the school buildings. The relatively high value of the F- ratio indicated that the model provided a good representation of the relationship between the explanatory variables and the dependent variable.

The Regression Coefficients

All regression coefficients were significant at a confidence level greater than 95% i.e. (p < 0.05) as reflected by the values of t-test shown in table 9.4The values of the standardised regression coefficients indicated that the unofficial exchange rate was relatively the most important explanatory variable contributing to the variation in the value of the dependent variable, the cost per square metre of the school buildings. Furthermore, the values of the part correlation indicated that the unofficial exchange rate had the highest unique variance with the dependent variable. The positive sign of the regression coefficient for the unofficial exchange rate indicated that the latter was positively related to the dependent variable i.e. the value of the cost per square metre increased when the Egyptian pound was weaker against the US Dollar. Also, the cost per square metre of the school building would increase with lower levels of the interest rate as indicated by the negative sign of the regression coefficient of the explanatory variable representing the interest rate.

The regression coefficients for the location variables provided similar findings to those obtained in Models 2and 3 i.e. the cost per square metre was higher for schools built in remote locations compared to the schools built in rural and urban locations and the cost per square metre was higher in the case of rural locations compared to the schools built in urban locations.

The drop in the mean predicted value of the cost per square metre (down to 1121.59 LE from 1201.67 LE in model 3) was expected. It was logical that the mean predicted value in Model 3 which was derived from a subset of the data comprising schools with number of classrooms ranging from 5 – 40 would be higher than the mean predicted value for a subset of the data representing schools with 8 classrooms only. This confirmed the

findings of Model 2 and Model 3 whereby the regression coefficient for the variable representing the number of classes was significantly different from zero, indicating that the latter was a significant explanatory variable contributing to the variation in the value of the cost of square metre of school buildings.

The main regression assumptions were checked and the results did not indicate any serious issues.

The value of R^2 (0.888   ) was close to the value of adjusted R^2 (0.882) and the value of the mean predicted value of the cost per square metre (1121.59)was very close to the value of the adjusted mean predicted value (1121.49). This indicated that Model 6 provided a good representation of the relationship between the dependent variable and the explanatory variables in the population.

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	569.14	1675.63	1121.59	264.60	72.00
Std. Predicted Value	-2.09	2.09	0.00	1.00	72.00
Standard Error of Predicted Value	15.70	49.18	24.39	7.31	72.00
Adjusted Predicted Value	569.80	1660.65	1121.49	263.04	72.00
Residual	-150.73	215.08	0.00	93.80	72.00
Std. Residual	-1.56	2.23	0.00	0.97	72.00
Stud. Residual	-1.60	2.39	0.00	1.01	72.00
Deleted Residual	-157.69	246.51	0.10	101.44	72.00
Stud. Deleted Residual	-1.62	2.47	0.01	1.02	72.00
Mahal. Distance	0.89	17.43	3.94	3.25	72.00
Cook's Distance	0.00	0.17	0.02	0.03	72.00
Centered Leverage Value	0.01	0.25	0.06	0.05	72.00

Table 9.41   Model (6) Residuals Statistics

* Dependent Variable: Real_C_sqm

	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Standardized Residual	.09	72	.07	.95	72	.01
Studentized Deleted Residual	.10	72	.06	.95	72	.01

Table 9.42   Model (6) Tests of Normality

a Lilliefors Significance Correction

Summary of the findings of Model 6

- The regression coefficients for the location variables and the economic variables were significantly different from zero which indicated that both the location and the economic variables were significant contributors to the variation in the value of the cost per square metre of the school buildings.

- The findings of Model 6 confirmed the findings of the previous Models indicating that the unofficial exchange rate was relatively the most important explanatory variable contributing to the variation in the value of the cost per square metre of the school buildings.

- The positive sign of the regression coefficient of the unofficial exchange rate indicated that the cost per square metre for school buildings increased as the Egyptian pound got weaker against the US Dollar.

- The negative sign of the regression coefficient of the interest rate indicated that the cost per square metre increase had an inverse relationship with the interest rate i.e. lower levels of interest rate would be associated with an increase in the cost per square metre of the school buildings.

9.3.7   Stage Seven: Model 7 – Economic Variables Only

Rationale

As previously mentioned at the outset of this study, the national project for building schools in Egypt provided a unique opportunity due to the standardised design applied to the school buildings. The aim of this stage was to filter out a subset of schools with the same product variables meanwhile controlling for the type of location. A subset of data was selected for this stage comprising 42 schools with 8 classrooms and built on shallow foundation in urban locations. Hence the linear regression analysis was conducted with the two economic variables (unofficial exchange rate and rate of interest) as explanatory variables of the dependent variable, the cost per square metre.

Model	Variables Entered	Variables Removed	Method
7	Int_Rate, Unoff_Ex	.	Enter

Table 9.43 Model (7) Variables Entered/Removed

* All requested variables entered.

* Dependent Variable: Real_C_sqm

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
7	.956	0.91	0.90	70.04	0.91	205.33	2	39	0

Table 9.44 Model (7) Model Summary

* Predictors: (Constant), Int_Rate, Unoff_Ex

* Dependent Variable: Real_C_sqm

Goodness of Fit

The relatively high value of R (0.96) and R^2 (0.91) indicated that Model 7 explains 91 % of the variation in the value of the dependent variable, the cost per square metre of the school buildings. The F- ratio indicated that Model 7 provided a good representation of the relationship between the explanatory variables and the dependent variable based on the sample as shown in Table 9.44.

	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Correlations			Collinearity Statistics	
Model 7	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3484.11	568.32		6.13	**0.00**					
Unoff_Ex	212.60	10.70	0.94	19.87	**0.00**	0.91	0.95	0.94	0.99	1.01
Int_Rate	-258.61	42.67	-0.29	-6.06	**0.00**	-0.19	-0.70	-0.29	0.99	1.01

Table 9.45   Model (7) Regression Coefficients

* Dependent Variable: Real_C_sqm

The Regression Coefficients

The t-test indicated that the regression coefficients for both economic variables were significantly different from zero at a confidence level greater than 95% ($p<0.05$). The standardised regression coefficients indicated that the unofficial exchange rate was relatively more important compared to the interest rate in contributing to the variation in the value of the dependent variable, the cost per square metre of the school buildings. This was also reflected in the values of the part correlation as shown in Table 9.45.

The positive sign for the regression coefficient of the unofficial exchange rate and the negative sign for the regression coefficient of the interest rate was congruent with the results obtains in the previous Models, hence, confirmed the findings of the previous Models.

The generalisability of the model was verified by comparing the value of R^2 (0.913) and adjusted R^2 (0.909). Also the value of the mean predicted value (1099.76LE) was very close to the adjusted mean predicted value (1099.03LE) of the dependent variable.

Model 8	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	586.43	1437.46	1099.77	221.69	42.00
Std. Predicted Value	-2.32	1.52	0.00	1.00	42.00
Standard Error of Predicted Value	12.05	36.62	17.70	6.16	42.00
Adjusted Predicted Value	593.37	1371.27	1099.03	218.99	42.00
Residual	-147.26	176.04	0.00	68.32	42.00
Std. Residual	-2.10	2.51	0.00	0.98	42.00
Stud. Residual	-2.22	2.95	0.01	1.03	42.00
Deleted Residual	-163.89	242.23	0.74	77.01	42.00
Stud. Deleted Residual	-2.34	3.30	0.01	1.08	42.00
Mahal. Distance	0.24	10.23	1.95	2.38	42.00
Cook's Distance	0.00	1.09	0.05	0.17	42.00
Centered Leverage Value	0.01	0.25	0.05	0.06	42.00

Table 9.46   Model (7) Residuals Statistics

* Dependent Variable: Real_C_sqm

	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
Model 8	Statistic	Df	Sig.	Statistic	Df	Sig.
Studentized Deleted Residual	0.11	42.00	.200(*)	0.97	42.00	0.25
Studentized Residual	0.10	42.00	.200(*)	0.97	42.00	0.46
Standardized Residual	0.10	42.00	.200(*)	0.98	42.00	0.65

Table 9.47   Model (7) Tests of Normality

* This is a lower bound of the true significance.

a Lilliefors Significance Correction

Summary of the Findings of Model 7

- The value of R^2 indicated that the model could explain 91% of the variation in the value of the cost per square metre of the school buildings.

- Both economic variables; the unofficial exchange rate and the interest rate were significant explanatory variables, contributing to the variation of the dependent variable, the cost per square metre of the school buildings.

- The unofficial exchange rate relatively more important than the interest rate in explaining the variation of the cost per square metre of the school buildings.

- Whilst the unofficial exchange rate was directly related to the cost per square metre the latter was inversely related to the interest rate. In other words the cost per square metre would increase when the Egyptian pound was weaker against the US Dollar Also, the cost per square metre of the school buildings would be expected to increase with lower levels of interest rate. This last point will be further discussed in the following chapter (see section 10.4)

Cross Validation of the Regression Model

In order to further validate the findings of the regression analysis particularly the generalisability of the findings, the data split techniques was recommended by various scholars; Hair *et al.*(2009); Field (2010); Cohen *et al.*(2003) and others. As aforementioned the data set that comprised a total of 353 cases was randomly split whereby a roughly 20% (70 cases) were selected using SPSS random sample split function and were excluded from the eight stages discussed above. These cases were saved in order to be used in the cross validation of the developed models.

Since these cases were selected from the complete data set, it was appropriate to apply model 2 to this sub-set of data. The cross validation was conducted on two rounds. The first round included all 70 cases. The results shown in figure indicated that the Model 2

provided a good representation of the population. In the second round a smaller subset of 40 cases was randomly selected from the 70 cases and the observed values were compared to the calculated values based on model 2 as shown in Figures 9.8 and 9.9. The results obtained in the second round confirmed the findings of the first round. Therefore, it might be reasonable to assume that Model 2 and subsequently the rest of the models did provide a good representation of the relationship between the explanatory variables, particularly the economic variables and the dependent variable, the cost per square metre of the school buildings.
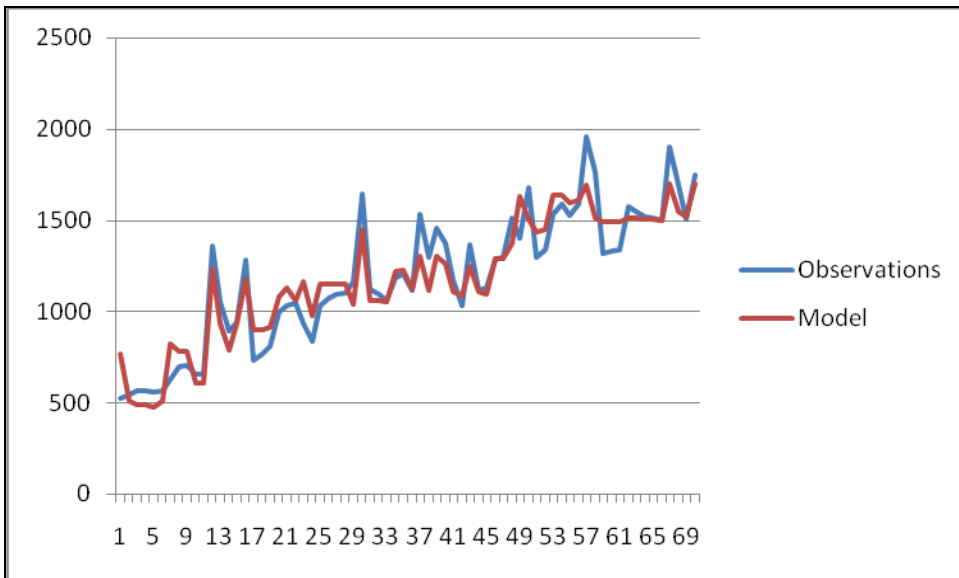
Figure 9.8   Observed values vs claculated values for a sub-set of 70 cases
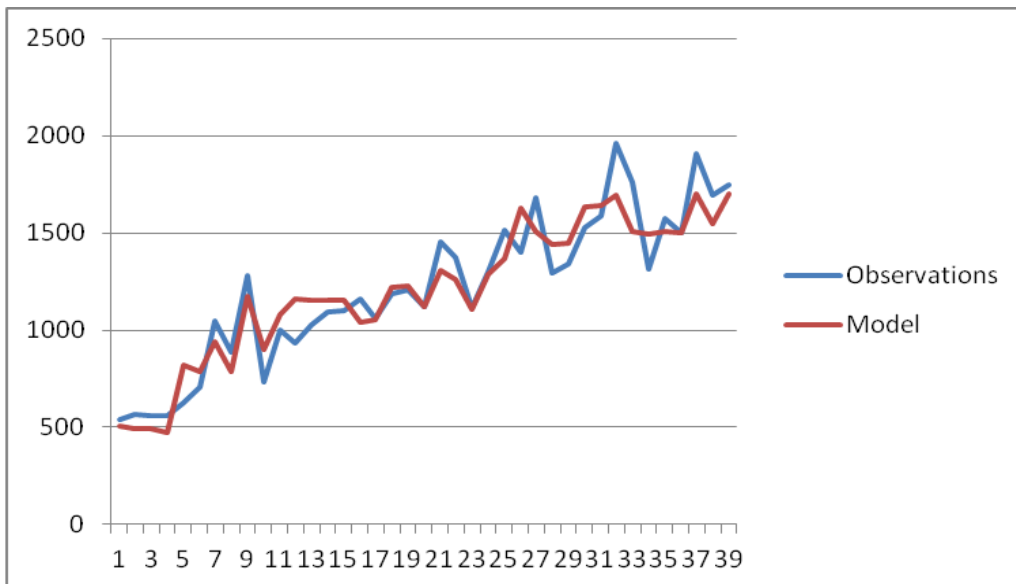
Figure 9.9   Observed values vs claculated values for a sub-set of 40 cases

9.3.8 Stage Eight: Lagging Economic Indicators Included

Rationale

The main rationale behind conducting this second phase of the regression analysis is to further investigate the relationship between the lagging economic indicators and the cost of building projects. The two new variables introduced represented the annual values of GDP and the Balance of Payment in expressed in real terms. As discussed earlier, the purpose of the quantitative analysis is to provide practitioners with a tool that would improve the accuracy of the produced cost estimates. In addition, it was resolved that developing an explanatory model would enhance their understanding of the impact of the various economic variables including the lagging economic indicators on the cost of buildings.

Step One

The analysis was conducted over two steps. In step one, the same data set used to build Model 3 was examined after including the GDP and teh Balance of Payment as the two new variables. The correlation analysis indicated some areas of concern as shown in Table 9.50. The GDP was highly correlated with the unofficial exchange rate. Hence, it was resolved to run a factor analysis applying the principal component technique in the extraction of the components with rotation of axis followed by rotation of axis using Varimax. Three principal components (factors) were extracted based on the scree plot.

			E_B_Pay	Urban	E_GDP	No_Classes	Int_Rate	Rural	UnOff_ex_rate
1	**Correlations**	E_B_Pay	1.000	-.105	-.074	-.028	-.283	-.106	.021
		Urban	-.105	1.000	.009	-.054	.001	.861	-.029
		E_GDP	-.074	.009	1.000	.064	.760	.001	-.983
		No_Classes	-.028	-.054	.064	1.000	.038	-.230	-.067
		Int_Rate	-.283	.001	.760	.038	1.000	-.020	-.754
		Rural	-.106	.861	.001	-.230	-.020	1.000	-.011
		UnOff_ex_rate	.021	-.029	-.983	-.067	-.754	-.011	1.000

Table   9.48 Correlation Coefficients

The resulting factors (components) can be described as follows:

1. Factor 1 loads on the number of classes and the location of the project.

2. Factor 2 loads on the GDP and the unofficial exchange rate

3. Factor 3 loads on the interest rate and the Balance of Payment.

Component Matrix[a]

	Component		
	1	2	3
No_Classes	-.240	.527	-.038
Urban	.590	-.697	.153
Rural	-.528	.775	-.116
UnOff_ex_rate	.834	.461	-.243
Int_Rate	.184	.330	.798
E_GDP	.809	.393	-.424
E_B_Pay	.434	.424	.549

Table 9.49 Component Matrix
 * Extraction Method: Principal Component Analysis.

Rotated Component Matrix

	Component		
	1	2	3
No_Classes	.572	.049	.088
Urban	-.918	.106	.055
Rural	.944	-.039	.024
UnOff_ex_rate	-.023	.963	.198
Int_Rate	.045	-.064	.880
E_GDP	-.036	.994	.006
E_B_Pay	.030	.283	.767

Table 9.50 Rotated Component Matrix

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

Component Score Coefficient Matrix

	Component		
	1	2	3
No_Classes	.278	.040	.036
Urban	-.447	.006	.063
Rural	.459	.019	-.014
UnOff_ex_rate	.025	.477	.015
Int_Rate	-.016	-.154	.664
E_GDP	.028	.520	-.132
E_B_Pay	-.003	.043	.532

Table 9.51   Component Score Coefficient Matrix

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Component Scores.

Model 8 Summary

Mode	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
8	.854[a]	.729	.725	154.424	.729	234.379	3	262	.000

Table 9.52   Model 8 Summary

a. Predictors: (Constant), REGR factor score   3 for analysis 1, REGR factor score   2 for analysis 1, REGR factor score

1 for analysis 1

Model 8		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	1122.581	9.468		118.561	.000
	REGR factor score 1 for analysis 1	70.731	9.486	.240	7.456	.000
	REGR factor score 2 for analysis 1	240.033	9.486	.814	25.303	.000
	REGR factor score 3 for analysis 1	-25.597	9.486	-.087	-2.698	.007

Table 9.53   Regression Coefficients

a. Dependent Variable: Real_C_sqm

These three factors were regressed as independent variables on the cost per square metre. The results of the factor analysis and the subsequent regression analysis are shown in the set of Tables 9.49-9.53. Factor 2 which represents the GDP and the exchange rate emerged as the most influential factor as reflected in the value of the standardised regression coefficient. Both the size of the project (number of classes) and the location are significant variables explaining the variation in the cost per square metre of the school buildings. The interest rate and the Balance of Payment are inversely proportional to the cost per square metre as reflected by the negative sign of the regression coefficient of factor 3. This confirms the findings of the previous analysis (Models 2 – 7).

Step Two

The data set used in building model 7 (including economic variables only) which comprised a total of 44 schools in urban locations with 8 classrooms and built on shallow foundation was treated by adding the two lagging indicators; GDP and Balance of Payment. Hence, the economic variables included in this analysis were the unofficial exchange rate, the interest rate, GDP and the Balance of Payment. The same analysis conducted in step one was repeated. The factor analysis yielded two factors only as shown in the set of tables below.

Component Matrix

	Component	
	1	2
UnOff_ex_rate	.959	-.168
Int_Rate	.203	.905
E_GDP	.909	-.392
E_B_Pay	.689	.484

Table 9.54   Component Matrix
Extraction Method: Principal Component Analysis.
2 components extracted

Rotated Component Matrix

	Component	
	1	2
UnOff_ex_rate	.958	.173
Int_Rate	-.121	.920
E_GDP	.989	-.054
E_B_Pay	.480	.692

Table 9.55   Component Matrix
Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Rotation converged in 3 iterations.

Component Score Coefficient Matrix

	Component	
	1	2
UnOff_ex_rate	.445	.018
Int_Rate	-.168	.719
E_GDP	.487	-.159
E_B_Pay	.151	.473

Table 9.56   Component Score Coefficient Matrix
 Extraction Method: Principal Component Analysis.
 Rotation Method: Varimax with Kaiser Normalization.
Component Scores.

Model 9 Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df 2	Sig. F Change
9	.931	.866	.860	79.76414	.866	132.629	2	41	.000

Table 9.57   Model 9 Summary

a. Predictors: (Constant), REGR factor score   2 for analysis 2, REGR factor score   1 for analysis 2

b. Dependent Variable: Real_C_sqm

Regression Coefficients

Model 9		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1030.586	12.025		85.704	.000
	REGR factor score 1 for analysis 2	193.140	12.164	.907	15.878	.000
	REGR factor score 2 for analysis 2	-44.098	12.164	-.207	-3.625	.001

Table 9.58   Model 9 Regression Coefficients   Dependent Variable: Real_C_sqm

The results indicated that Factor 1 loaded on the unofficial exchange rate and the GDP whilst Factor 1 loaded on the interest rate and the Balance of Payment. The regression analysis confirmed the findings of step one and model 7. Factor 1 is directly proportional to the cost per square metre whereas the negative sign of the regression coefficient indicated that Factor 2 is inversely proportional to the cost per square metre. Therefore, any increase in the value of the GDP would lead to an appreciation in the cost of buildings. The same effect would occur if the Egyptian currency loses value against the US Dollar. On the other hand, the cost per square metre tends to increase if the interest rate is reduced. The former would also appreciate when the value of the Balance of Payment decreases

9.3.9 Summary of the Regression Analysis

The regression analysis was divided into two parts. The first part aimed at investigating the impact of the leading economic indicators on the cost of buildings without including the lagging indicators. This approach was primarily aiming at developing a cost estimating model that would help practitioners seeking to improve the accuracy of the current estimates. In part two, both leading and lagging economic indicators were included since the main objective was to produce an explanatory model that would help practitioners to better understand the impact of the various economic indicators on the cost of buildings.

Phase One

The multiple linear regression analysis (based on ordinary least square method) was selected as the appropriate technique to analyse the data (Hair *et al*., 2010). The primary aim of the analysis was to test the hypothesis that the economic variables were significant explanatory variables of the cost per square metre of the school buildings. The analysis started by applying the confirmatory approach (also known as forced entry) whereby all the relevant variables identified by the conceptual model (see section 8.2.4) were included in building the model. The summary of the developed models during this phase is presented in Tables 9.59 & 9.60.

The relatively high correlation between the location variables suggested the need for factor analysis to address the doubt regarding the impact of this correlation on the produced models in the previous stages. The factor analysis confirmed that reliability of the results provided by Model 2.

Due to the relatively limited number of cases of schools built on deep foundation, it was resolved to run the regression analysis on the cases built on shallow foundation only as shown in Model 3. The main aim was to provide a better estimate of the cost for the typical case of school buildings since the majority of schools were built on shallow foundation. The results obtained from Model 4 confirmed the findings of the previous two stages meanwhile indicated the impact of the deep foundation on the cost per square metre of the school building.

The following stages were seeking to verify the generalisabilty of the findings of the previously produced models, particularly Models (2&3), in the context of the main objectives of this study after controlling for a specific variable in each stage. In other words, the following stages aimed to verify the significance of the selected economic indicators as explanatory variables contributing to the variation in the value of the cost per square metre of the school buildings.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
2	.935(a2)	0.87	0.87	139.24	0.87	319.56	6	276	0
3	.930(a3)	0.87	0.86	126.5	0.87	333.55	5	260	0
5	.940(a5)	0.88	0.88	101.56	0.88	331.56	3	132	0
6	.943(a6)	0.88	0.88	96.56	0.88	133.27	4	67	0
7	.956(a7)	0.91	0.9	70.04	0.91	205.33	2	39	0

Table 9.59   Summary of The Models

a2 Predictors: (Constant), Int_Rate, Unoff_Ex, No_Class, Urban, Rural, Found

a3 Predictors: (Constant), Int_Rate, Unoff_Ex, No_Class, Urban, Rural

a5 Predictors: (Constant), Int_Rate, Unoff_Ex, No_Class,

a6 Predictors: (Constant), Int_Rate, Unoff_Ex, Urban, Rural

a7 Predictors: (Constant), Int_Rate, Unoff_Ex

	Model 2	Model 3	Model 5	Model 6	Model 7
	Standardized Coefficients	Standardized Coefficients	Standardized Coefficients	Standardized Coefficients	Standardized Coefficients
	Beta	Beta	Beta	Beta	Beta
(Constant)					
No_Class	0.09	0.08	0.15	n/a	n/a
Found	0.27	n/a	n/a	n/a	n/a
Urban	-0.53	-0.58	n/a	-1.05	n/a
Rural	-0.32	-0.33	n/a	-0.72	n/a
Unoff_Ex	0.81	0.92	0.92	0.92	0.94
Int_Rate	-0.25	-0.26	-0.25	-0.21	-0.29

Table 9.60   Summary of the Regression Coefficients

In the final stage, Model 7 aimed at confirming the findings of the previous stages based on a sub-set of data with unified product and location attributes. Hence, the only variables included in the analysis were the economic variables. The findings of Model 7 indicated the direct relationship between the exchange rate and the cost per square metre which was sensible given the fact that most factor inputs are either imported or include an imported component.

On the other hand, the interest rate was found to be inversely proportional to the cost per square metre. This might seem a bit vague and needed further elaboration. Typically the interest rate is controlled by the central bank of Egypt. Lower levels of interest rate are usually associated (in the short run) by lower levels of inflation and vice versa. In

other words, when the economy is enjoying an upward trend this would be illustrated in abundance of investments and hence projects in various sectors within the construction industry. It is reasonable to assume that contractors would consider the opportunity cost and therefore request relatively higher margins when bidding for school building projects compared to the periods of recession. However, there is a counter argument to this proposition. It can be claimed that higher levels of interest rate are usually associated by higher levels of inflation which normally indicates higher price levels. Following this line of thought, the interest rates should be expected to be rather directly proportional to the cost per square metre. Obviously any analysis should take into consideration the difference between nominal and real costs. In this study the cost data set was deflated as shown in section 8.5.1. Hence, it can be resolved that the first argument provided a better interpretation of the findings of the statistical analysis regarding the sign of the variable representing the rate of interest.

The results obtained in Model 7 supported the hypothesis of this study claiming that the economic variables were significant explanatory variables that contributed to the variation in the value of the cost of school buildings. Hence, it might be reasonably assumed that the explicit inclusion of these variables in the cost estimating process was justified and furthermore, would improve the accuracy of the produced cost estimates.

Phase Two

The analysis in this phase built on the treatment of the data in phase one. Hence, it was resolved to conduct the analysis on the data set and the variables included in building model 3 after including the two lagging economic indicators, the GDP and the Balance of Payment. The highly correlated variables illustrated by the correlation analysis called for the need to apply a data reduction technique such as factor analysis before embarking on the regression analysis.

Two of the three emerging factors loaded on economic variables whilst the product variable (number of classrooms) and the location loaded on the third factor. The three factors were significant explanatory variables contributing to the variation in the value of the cost of buildings. The first economic factor loaded on the exchange rate and the

GDP and was directly related to the cost per square metre. The second economic factor loaded on the interest rate and the Balance of Payment and was inversely related to the cost per square metre. The results confirmed the findings reflected by model 3 in phase one.

The final step in this phase used the sample selected in building model 7 in phase one. Only the four economic variables were included as independent variables in the regression analysis. The correlation analysis indicated the need for factor analysis to group the variables due to the high correlation between the exchange rate and the GDP. Two factors emerged whereby the GDP and the exchange rate loaded on factor 1 whilst the interest rate and the Balance of payment loaded on factor 2. The regression analysis indicated that both factors were significant explanatory variables contributing to the variation in the cost of buildings. The exchange rate and the GDP are directly related to the cost per square metre whilst the interest rate and the Balance of Payment are inversely related to the cost per square metre. This confirmed the results obtained in model 7.

9.4 Chapter Summary

This chapter aimed at presenting the quantitative analysis of the study. Following the discussion of variables introduced in the previous chapter, the details of the regression analysis has been presented. The chapter commenced by reviewing the underpinning theory that guided the analysis and supported the interpretation of the results. The regression analysis was conducted in two parts. Part one was further divided into seven stages and yielded 5 different cost estimating models after discarding the first model and the output of the factor analysis in stage 4. Part two was divided into two steps and yielded two explanatory models. The results achieved in part two verified and further confirmed the conclusions of part one. Both indicated that the economic variables can be explicitly included in building cost models for school buildings and by doing so the accuracy of the resulting model is claimed to have improved.

CHAPTER 10

CONCLUSIONS

10.1 Introduction

Cost estimating and cost modelling have attracted a notable attention from academics over the past thirty years as reflected in the literature on the topic. However, the review of the literature indicated a clear gap in the explicit inclusion of the economic variables as proxy to the performance of the economy in the produced models. The economic theory and the construction management theory were reviewed in the context of cost estimating and particularly the cost modelling for building projects. Both theories supported the hypothesis set by this study which claimed that the performance of the economy had significant impact on the cost of building projects. Hence, this study aimed at testing this hypothesis following (what is claimed to be) a positivism epistemology meanwhile attempted to provide a justified quantification of the suggested impact.

10.2 The Research Methodology

The case study which was deemed appropriate research strategy for this study embraced a mixed methodology as shown in parts two and three of this study. The national project for building schools in Egypt was selected as the research case study due to its unique characteristics, applying a standard design to the school buildings. Hence, many of the product physical variables were constant which allowed the research to spot the light on the economic variables.

In addition the fairly large number of schools built every year across the various governorates in Egypt during the period 1993 – 2006 provided a large sample which facilitated conducting a statistical analysis in pursuit of establishing the statistical significance of the selected influential economic variables as cost variables.

The first objective of the study aimed at investing the current practice in cost estimating within the Egyptian construction industry with emphasis on building projects and particularly the school buildings as an example of the public sector building projects. This objective is primarily qualitative in nature which suggested the need for a qualitative methodology. The semi-structured interviews were selected as an appropriate method to collect data about the current practice in an attempt to reveal the details of the cost estimating process applied to building projects in general and school building in particular.

Furthermore, the interviews were utilised to address the second, third and forth objectives of the study in a qualitative approach. The third objective sought to investigate the level of awareness among practitioners about the impact of the performance of the economy on the cost of building projects with emphasis on school buildings. Following the same rationale applied in the case of the first objective the third objective is also qualitative in nature which justified the need for the qualitative interviews that was conducted in part two of this study.

The second and forth objectives aimed to identify the influential cost factors in general and the significant economic cost variables in particular. On the one hand, the interviews aimed at identifying these factors categorically based on the perception of the interviewed experts. On the other hand, the identified cost variables were typically numerical in nature. Hence, it was resolved that the statistical analysis was needed to establish the statistical significance of the identified cost variables. This justified the need for the quantitative survey which was conducted in part three of this study.

However, the discussion presented in pursuit of selecting the cost variables to be included in the statistical analysis was not limited to the findings of the qualitative interviews but was primarily based on the theoretical framework which was established via the review of the literature on construction cost estimating and building economics in a triangulation approach.

In addition, the fifth objective of the study aimed at modelling the relationship between the key economic indicators and the cost of building projects by constructing an explanatory cost model that would enhance the cost estimators' understanding of the

impact of the economic conditions on the project costs. This further justified the need for the quantitative survey whereby a random sample comprising a total of 353 school projects was utilised to construct a data set in pursuit of building the sought model.

The congruence between the findings of the qualitative interviews and quantitative survey conferred meaning and verified the findings of the statistical analysis meanwhile provided a useful quantification of the categorical findings of the qualitative research. Therefore, the triangulation approach applied in this study was justified as an appropriate methodology that served the purpose, facilitated achieving the set objectives and further validated the findings of this study.

In the following sections, the main conclusions of the study will be presented in the context of the set objectives.

10.3 Review of the Current Practice

The findings of the interviews indicated that the quantity surveyors approach to cost estimating is the prevailing trend in the construction industry in Egypt in general and the school buildings projects in particular. This was congruent with the findings of the literature review, indicating that the practice in Egypt, so far, was no different from other countries in this respect. The Bill of Quantities (BoQ) is typically produced based on the detailed drawings (also known in Egypt as working drawings).

 In the case of public sector projects, such as school building projects, the client's (GAEB) technical office would also produce a priced BoQ which is released to the bidders to form the main document amongst the tendering documents. The bidders would ask for a mark up as a percentage of the total value of the priced BoQ. In order to produce the priced BoQ, GAEB technical office estimate the cost for the various work items.

The interviews indentified the main attributes of the cost estimating process whereby the cost of materials, labour and equipments is estimated for the various work items.

The cost of materials considered by GAEB is based on the producers price lists whereas the cost of labour and equipments are mainly based on the experience of the cost estimator. This process does not seem to produce accurate estimates for a number of reasons. There is always a gap between the producers' price lists and the market prices particularly for key materials such as cement and steel due to the market mechanism for both materials whereby the contractors do not have direct access to the producers and would rather deal with wholesalers or middlemen. This entails additional margins over and above the announced price lists.

The market prices of the rest of building materials especially the finishing materials portrayed a wide range of variation. Most producers are either small or medium enterprises whereby no single producer can cope with the volume of output given the number of school buildings constructed every year. Therefore, there is no evidence that the reference price used by GAEB estimators (usually obtained from a single producer) can be regarded as an accurate indicator of the market price level.

The cost estimates for the labour and equipment might be the most contentious factor since it is mainly based on the experience of GAEB cost estimators. There was no clear evidence of how the cost estimators would consider the movement is the market level of wages for both skilled and unskilled labour in the absence of any published national statistics in this respect.

In addition, GAEB cost estimators tend to ignore the impact of the location of the project when estimating the unit rates for the various work items. It was clear from the interviews that the location of the project had a significant impact on the cost of the project whereby the school buildings constructed in rural and remote locations would witness relatively higher costs compared to those constructed in urban locations.

Consequently, it was quite unlikely to establish any significant confidence level in the accuracy of the cost estimates produced by GAEB. This was confirmed by the consistently positive value of the mark-up requested by bidders over and above the

estimated cost calculated by GAEB. It is reasonable to conclude that the mark-up was a correction factor to adjust the cost estimates produced by GAEB due to the above mentioned discrepancies. Moreover, the time lag between the estimated cost by GAEB and the tendering process which would extend to 4-8 months gave rise to the need for adjustments particularly during the periods of economic turbulence due to the dynamic changes in the market prices for factor inputs.

This is contrasted with the private sector clients who would also produce the BoQ for the project but the bidders would set the unit rates of various work items and hence the total price of the project. However, the private sector clients were found to fall into several categories with regard to the tendering process and subsequently the cost estimating practice. The two main categories are the developers and the investors.

The developers would in most cases phase out the project and tender each phase to the relevant contractor. In general developers tend to have their own staff comprising a technical office, project managers and site supervisors. In addition, developers would have a limited number of contractors for each work package In other words the developers seemed to play the role of the client, main contractor and project manager i.e. 3 in 1. In most cases the developer would supply the material and the relevant contractor is only responsible for providing the labour and equipments. It was concluded that developers were more concerned by the cost estimates produced during the initiation phase of the project, also known as order of magnitude. Any variation in the market prices for key factor inputs during the execution phase was offset by the corresponding price movement in the property market. It is rarely the case when all units are sold off plan and typically the price of the units sold at later stages would be higher than those sold off-plan. Typically developers tend to stock fairly large quantities of the key materials such as steel cement and other finishing materials using the down payments they receive from buyers.

At the first glance the developers seem to be the least category affected by the performance of the economy with regard to the cost of building. However, the state of the economy would definitely affect the property market, particularly the sales which are the main source of finance for developers. Consequently this would affect the cost

of building especially when the developers have to finance their projects through borrowing from banks. Some developers, in this case, would tend to partially finish the building with emphasis on the sold units and communal facilities in order not to delay the handover date and meanwhile reduce the need for external funding in attempt to control the cost of building. Obviously this would have operational consequences having to finish the remaining units later when some of the new occupants (buyers) have moved in.

On the other hand, the investors who engage in building projects to serve the needs of their businesses would use a project management consultant. The latter would be responsible for the cost estimating and tendering processes. In most cases the project is tendered as a turn-key project whereby a contractor would bid for the entire project. The cost estimates are typically based on the review of the market prices for building materials as well as the quotations from relevant contractors and subcontractors. Also, the time lag between the cost estimating and tendering process was found to be significantly less compared to the case of public sector projects such as school buildings. Consequently, the produced cost estimates were thought to be more realistic in the short run.

However, this approach tends to be static, only considering a snap shot of the prices at a specific point in time and ignoring the impact of the performance of the economy on the price levels of key factor inputs during the execution of the project.

Typically, the client dictates the rules of the game. Both main contractors and subcontractors follow the set rules. Hence, the traditional cost estimating technique based on the BoQ, above described, was found to be the prevailing approach amongst the main contractors and the subcontractors alike. In the case of private sector building projects, the main contractor would typically set the unit rates for the various work items on the BoQ and the bid value would be the product of the unit rates multiplied by the quantities for all work items. This is contrasted with the case of the public sector projects whereby the unit rates are set by the client and the main contractor would request a mark-up which is a percentage of the total value of the BoQ estimated by the

client. There was no clear evidence that the main contractors did consider the economic factors in calculating the requested mark-up. The main factor that seemed to affect the level of mark- up was found to be the change in market prices of key factor inputs primarily due to the time lag between the cost estimating process and the tendering process. However, the mark-up was found to be dependent on the economic factors, mainly the rate of interest and the exchange rate.[1]

The above mentioned conclusions provided a holistic review of the prevailing cost estimating methods applied within the construction industry in Egypt with emphasis on building projects. It was clear that the current method did not explicitly consider the impact of the performance of the economy and was rather based on the market prices of the key factor inputs at the time of estimating the project cost. Furthermore, the focus on the market prices which typically change over time gave rise to disputes and affected the accuracy of the cost estimates produced at the detailed design and the tendering stages due to the time lag particularly in the case of the public sector projects.

10.4   The Influential Factors

The interviews aimed at identifying the influential factors that affect the cost of building projects as perceived by experts within the various categories of stakeholder. At one end of the spectrum the public sector clients such as GAEB seemed to focus mainly on the market prices of factor inputs and ignore other factors.

The main contractors working with GAEB seemed to have a different opinion. The main factor identified was the location of the project whereby the main contractors consistently requested a notably higher level of mark-up in the case of the schools constructed in remote locations compared to the schools constructed in rural or urban

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[1] The statistical significance of this dependence was established in the published study conducted by the author and attached in appendix 1

locations. Similarly, the schools constructed in rural areas witnessed relatively higher mark-up compared to those in urban locations.[1]

In the case of private sector projects, a number of factors were identified as influential factors that affected the cost of building projects. The list included; the market prices of key factor inputs; the type of client; the type of the contractor; the type of project; the complexity of project; the type of work; the type of contract; down-payment; the location of the project; the duration of the project and the size of the project. This was congruent with the findings of the literature review. However, some of the factors identified in the literature were not mentioned by the interviewed sample such as the experience of the contractor. This can be attributed to the nature of the construction industry in Egypt which tends to be cost orientated with less emphasis on quality.

Due to the standardised design applied by GAEB to the school buildings some of the influential factors identified in the wider context of the building projects were not considered significant in the case of school building projects. Examples of these factors included the type of the project, the complexity of the project, the type of works and the duration of the project. Hence, the main influential factors identified in the case of school buildings were the market prices for key factor inputs; the project location and the project size.

10.5 Influential Economic Indicators

Primarily, this study aimed at investigating the impact of the economy on the cost of construction projects in Egypt with emphasis on building projects. Hence, the third objective was set to assess the level of awareness of the interviewed sample about the impact of the economy on the cost of building projects. Then the forth objective aimed at identifying the influential economic indicators that had significant impact on the cost of building projects as perceived by the interviewed experts.

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[1] Refer to Appendix 1. The attached study established the statistical significance between the mark-up level and the location of the project.

In general, the interviewed sample portrayed a fuzzy awareness of the basic economic concepts. The majority of practitioners involved in the cost estimating process for building projects were civil engineers who had limited background about economics, finance and accounting. Practitioners perceived economics in general and the performance of the economy in particular as a rather complex area whereby even the specialists in that area tend to differ in their interpretations and predictions. Moreover, the common view was that cost is a sensitive issue since it determines the viability of the business in the competitive construction market in Egypt that is mainly cost orientated. Hence, according to the interviewed experts, the cost estimating process should be based on solid facts and a clear understanding of the variables included.

However, the interviewed sample could intuitively identify the exchange rate and the interest rate as influential indicators that would affect the cost of building projects. Typically and historically the market price level of the majority of goods in Egypt was affected by the change in the level of exchange rate, particularly the rate of exchange of the Egyptian Pound against the US Dollar. On the other hand, according to the interviewed sample, the interest rate had implications on the cost of finance for clients and contractors who relied on the credit facilities offered by banks.

Indeed, this was contrasted by the fact that neither indicator was considered explicitly when producing cost estimates for building projects. The justification provided by experts for discarding the interest rate might be straight forward and easier to comprehend compared to the exchange rate. The common view was that not all contractors or subcontractors relied on credit in financing their projects. Self- financed contractors and subcontractors enjoyed a competitive advantage that forced the others to absorb the cost of finance within their profit margin. However, this seemingly sensible justification does not necessary mean that the rate of interest does not affect the cost of building projects. Typically, self-financed contractors and subcontractors would consider the opportunity cost when setting their profit margin. The interest rate therefore, evolves as an influential factor that affects the decision about the level of mark-up for both groups.

 The impact of the exchange rate on the cost of building projects was rather contentious. There was no clear justification provided by the interviewed experts for not including the exchange rate in the cost estimating process other than claiming that the market prices of key factor inputs reflected the impact of the fluctuation in the level of the exchange rate. However, the argument that this study is putting forward is based on the economic theory whereby there is usually a time lag between the fluctuation in the level of the exchange rate and the subsequent impact on the market prices of key factor inputs. Therefore, in theory, the exchange rate could be utilised as an early indicator of the market price level. It was not clear whether discarding the explicit inclusion of the exchange rate in the cost estimating process was due to the fuzzy understanding of the basic concepts of economic or rather due to the ambiguity about the quantification of the impact of the exchange rate on the cost of building projects.

Hence, the main conclusion was that experts were able to sensibly identify two influential economic indicators despite their fuzzy understanding of the economic concepts. This seemed to be rather based on the experiential learning and anecdotal evidence. The indentified impact was neither quantified. In addition, it was not evident based on the interviews, how the cost of buildings would increase change with the change in the levels of the interest rate. Clearly, this conclusion illustrated the need to develop a model that would explain the relationship between the influential economic indicators and the cost of building projects in Egypt.

10.6 Cost Model for School Buildings in Egypt

The quantitative part of the study aimed at developing a cost model that would establish the statistical significance of the relevant economic indicators and meanwhile explain the relationship between the influential economic indicators and the cost of buildings. The national project for school buildings in Egypt provided a unique opportunity due to the standardised design applied which eliminated many of the product physical variables. This has significantly reduced the complexity of the modelling process by

reducing the number of independent variables and meanwhile shed more light on the impact of the economic variables on the cost of school buildings.

Following the triangulation approach, the review of the construction management literature as well as the building economics literature informed the conceptual model. The cost per square metre was selected as the dependent variable. The discussion of the independent variables resulted in the selection of four product variables in addition to five economic variables. The variable representing the number of classrooms was included to proxy the size of the school building. Two categorical variables were included in the analysis to represent the three categories of the project location; urban, rural and remote locations. The type of foundation was included in the analysis as a categorical variable representing the two categories; shallow and deep foundation. In addition the five economic variables included were the GDP, the Balance of Payment, official exchange rate, the unofficial exchange rate and the rate of interest.

The findings of the statistical analysis indicated that the type of foundation had a significant impact on the total cost per square metre of the school building. This was a logical finding since deep foundation such as pile foundations used in the case of school buildings did cost more than shallow foundation for the same template i.e. the same superstructure.

Indeed, the size of school building is expected to be directly proportional to the total cost of the project. However, the statistical analysis concluded that despite emerging as a significant cost variable, the impact of the size on the cost per square meter was fairly limited. This indicated that contractors, in general, did not consider the effect of economies of scale or the synergies anticipated in the case of large size school buildings.

The main reason being the standardised design applied coupled by the repetitive nature of the school building projects whereby the same contractor would be engaged in building several schools at the same time and most likely in the same governorate. Typically, contractors working with GAEB had a well established supply chain which

included the suppliers of key materials and subcontractors due to the volume of work over time regardless the size of any particular school building. Also, the duration of the project was directly proportional with the size of the school building. Hence, the fixed costs seemed to be proportionate with the size of the school building which explained the minimal impact of the size on the cost per square metre.

In contrast with the size of the school building, the location of the school was found to have a significant impact on the cost per square metre. The latter increased in the case of remote projects compared to rural and urban projects. Similarly the cost per square metre increased in the case of rural projects compared to urban projects for the same size and the same type of foundation. This increase was mainly attributed to the building economics factors which reflected the socio-economic conditions across the territory of Egypt. The cost of the logistics activities in remote locations was significantly higher than in the case of the rural and urban locations due to the cost of transport and the scarcity of local skilled labour. In rural locations, the same factors applied but to a lesser extent which led to higher costs compared to urban locations. The latter typically enjoyed an abundance of skilled labour and meanwhile relatively reasonable transport costs for various building materials.

The official exchange rate was statistically insignificant. The other four economic variables included in the statistical analysis were found to be significant cost variables. The GDP was found to be directly proportional to the cost of school buildings whereas the Balance of payment was inversely proportional, all expressed in real terms. This agrees with the findings of Tse and Ganesan, (1997) that identified the impact of GDP on the flow of construction activities which amongst other factors would affect the cost of construction.

The interest rate was inversely proportional to the cost per square metre expressed in real terms. Typically, the higher levels of interest rate are associated with periods of relatively high inflation in an attempt from the Central Bank of Egypt (CBE) to curb inflation which is a widely accepted measure as stated in the economic literature. In periods of high inflation, the real prices reflect the corrected nominal prices using the

rate of inflation. Given the blurred understanding of the economic concepts portrayed by practitioners, it is quite likely that the cost estimators could not take into account the accurate impact of inflation on the produced cost estimates. Hence, despite the apparent appreciation in the nominal cost of school building projects during the periods of high inflation, the cost per square metre when expressed in real terms did not reflect the impact of inflation accurately.

This conclusion can be contrasted by the disparity between the fluctuations in the level of interest rates compared to the announced rate of inflation in the case of Egypt. For example, over the period 2001-2006 the inflation varied from 2.26% - 11.8% whereas the interest rate witnessed relatively less variation, fluctuating between 12.6% - 13.8%. The interest rate is set by the Central Bank of Egypt. The latter would sometimes consider a number of factors besides the level of inflation particularly during the periods of economic reforms that started from the mid 1990's. Hence, the nature of the rate of interest being set by the government rather than the market forces renders the behaviour of this variable a bit complicated d. It is therefore reasonable to conclude based on the statistical significance clearly illustrated by the applied analysis that if the Egyptian government continues to pursue the same monetary policy with respect to the level of interest rate, then the trend portrayed by the findings of this study is quite likely to prevail i.e. the inverse relationship between the real cost per square metre and the rate of interest.

The exchange rate was found to be directly proportional to the cost per square meter for school building projects expressed in real terms. The impact of the exchange rate on the cost per square metre was clearly higher than that of the interest rate as reflected by the value of the standardised regression coefficients for both variables. Higher levels of the exchange rates are, in most cases, associated with relatively high inflation. It is quite understandable that the higher levels of exchange rate would be associated with higher nominal prices yet this study has concluded that the former would, in addition, causes an appreciation in the cost per square metre expressed in real terms.

The negative sign of the coefficient of the variable representing the interest rate indicated that the real cost of building increases with lower levels of interest rates. The

latter reflects periods of recession when the government uses the tools of monetary policy to stimulate the economy at least in the short term. Typically lower interest rates are part of an expansionary policy aiming to stimulate investments. This should not be confused by the low interest rate that is associated in the longer term with favourable economic conditions. This former proposition is endorsed by the findings of the factor analysis whereby the balance of payment and the interest rate were highly correlated. The factor that loaded mainly on both variables was inversely related to the cost of building projects. This indicated that the cost of buildings increases when the balance of payment is in deficit, a sign of unfavourable economic condition. This agrees with the findings of the regression analysis with regard to the exchange rate that was directly related to the cost of buildings i.e. the cost of buildings tends to increase when the Egyptian currency is weaker against the US Dollar. The latter is a sign of unfavourable economic condition. Hence, the findings of the regression analysis suggested that the cost of building projects tend to increase during the period of unfavourable economic conditions.

The statistical significance of both economic variables that was consistent through the seven models developed during the analysis stage of this study confirms that the performance of the economy reflected in the two selected indicators has significant impact on the cost of building projects. Moreover, the explicit inclusion of the relevant economic variables in the cost modelling process should improve the accuracy of the produced cost estimates.

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10.7 Limitations of the Cost Model

The produced models aim primarily at enhancing the understanding of the cost estimators in the government as well as contractors about the relationship between the performance of the economy and the cost of educational buildings.

On the one hand the explanatory power of the model indicated that the cost of buildings tend to increase when the economy is undergoing unfavourable conditions reflected in the decline in the value of the local currency against the US Dollar together with the balance of payment in deficit. The explanatory model produced in the final round of the regression analysis indicated that the government tended to decrease the interest rate, at least in the short run, in order to stimulate the economy as part of an expansionary economic policy. Hence, the final round of the factor analysis elucidated what seemed to be puzzling when interpreting the findings of the regression analysis in models $2 - 7$, particularly the negative sign of the variable representing the interest rate. Therefore the explanatory models that included the lagging indicators together with the leading indicators explained and further clarified the findings of the first set of predictive models that, typically, including the leading indicators only.

On the other hand, the predictive model provides cost estimators in general with a useful tool that should enhance the accuracy of the produced cost estimates. However, this study does not claim to have developed a model that is a panacea but should rather be regarded within the appropriate context with clear awareness of the limitations and underlying factors considered whilst building the model. Hence, as long as the Egyptian economy maintains the current transition towards what it is arguably called "market economy" then the predictive power of the model can provide valuable contribution

towards improving the accuracy of cost estimating for standard design building projects, particularly the educational buildings. Needless to say that any backward shift towards the controlled economy will distort the relationship between the key economic indicators such as the exchange rate and interest rates on the one hand and the market prices on the other. For example, if the government intervenes in the building materials market by subsidizing cement and steel similar to the case in the 60's and early 70's then the underlying assumptions considered in building the model will be distorted which will affect the predictive power of the model.

Indeed, like the case of the majority of econometric models, there is a need for a periodical review and calibration in order to adjust the model to the changes in economic conditions. Consequently it is recommended that cost estimators, in order to optimize the utilization of the model, should acquire a minimum level of understanding of the basic concepts of macroeconomics. This does not suggest that cost estimators need to be experts in economics yet the key concepts delivered within economic courses at the Masters in Business Administration (MBA) level should suffice.

Finally, the research hypothesis could be accepted in light of the findings of both parts of the study; the qualitative semi-structured interviews and the quantitative survey in the context of the selected case study.

10.8 Contribution to the Theory of Construction Management

This study has introduced an incremental contribution to the knowledge in the context of the theory of construction management and particularly in the area of cost estimating and forecasting as follows:

- Cost estimating has developed over the past 3 decades whereby a number of researchers have been actively engaged in producing cost models applying various statistical techniques. However, there was more emphasis on the product related variables while the economic variables were implicitly factored into the cost models through the market prices of factor inputs. In the cost model produced in this study, the economic indicators were explicitly included as

independent cost factors explaining the variation in the cost of building projects (dependant variable).

- The findings of this research confirmed that the economic indicators which proxy the performance of the economy have significant impact on the cost of building projects. In this respect the study claims to have incremental contribution to the findings of Tse and Ganesan, (1997), Akintoye, Bowen and Hardcastle (1998) and (Fitzgerald and Akintoye, 1995). In addition, the suggested impact can be quantified and the relationship can be modelled.

- The produced model can be utilized a useful tool that would enhance the accuracy of cost estimating for buildings project in general and those applying a standard design in particular. In Egypt, there is a more tendency towards applying standardized design to various types of buildings in different sectors such as Education, Housing and Healthcare. Hence, the produced model can benefit cost estimators in various government departments as well as contractors in various sectors of the construction industry in Egypt yet taking into consideration the above mentioned limitations.

- The selected case study provided the opportunity to illustrate and further quantify the variation in cost for an identical set of school buildings built at the same geographical location with the same physical attributes. This variation was due to the change in the economic conditions reflected in the selected economic indicators.

Therefore the study can claim to have unravelled the knots of a relatively contentious area that (based on the literature review) seems to have reached a deadlock. This research was able to address this gap by exploiting the uniqueness and originality of the case under investigation. In the light of the scarcity of research conducted in Egypt prior to this study, the present research can be regarded as a pioneer attempt to explore a vital national project. Furthermore, this study can be of significant benefit for the relevant Egyptian authorities and practitioners concerned with the construction industry in general and buildings in particular.

10.9   Limitations and Further Directions

This study was based on the national project for school buildings in Egypt. The standardised design applied to school buildings had facilitated conducting the statistical analysis by eliminating many of the design related variables. The minimal impact of the size of the project on the cost per square metre was mainly due to the special characteristics of this case study. However, the main objective of this study was to investigate the impact of the performance of the economy on the cost of building projects through the explicit inclusion of the economic variables in the cost modelling process.

The findings of this study should encourage further studies in order to investigate the relationship between the identified economic variables and the cost buildings for different types of building projects such as residential buildings and commercial buildings in Egypt. It is suggested that the inverse relationship between the interest rates and the cost of building expressed in real terms as concluded in this study needs further investigation. In addition, it might be worth investigating in further depth the lag relationship between the exchange rate and the price of the key building materials mainly the market price of cement and steel.

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APPENDIX 1

APPENDIX 2