Cost Control Models for Housing and Infrastructure Development

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ABSTRACT

Housing and infrastructure development represent an important aspects of capital development that Governments all over must pay attention to as part of their social responsibilities. Developed and developing countries are constantly engaged in activities aimed at maintaining, improving or adding new stock to their housing and infrastructure amongst others in order to help overall developmental goals. As stated earlier, development in this area is continuous over many, many years. It follows that in any country or location there exist a wealth of information on previously executed projects. The objective of this paper is highlight in general terms the services that could be offered by the Quantity Surveyor or Cost Engineer in organising the available information into a data bank and use it as a basis to plan for future projects, including cost control activities at the implementation stage. We will also highlight the fact cost control models are more critical to developing countries, largely because of the unstable nature of their economies. This in turn led to the failure of many projects.

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1. INTRODUCTION

This paper will discuss "cost control models" for Housing and Infrastructure development. The compound word "cost control model" actually comprises two key activities of the services offered by Quantity Surveyors (or Cost Engineers) in the project procurement process. We need to identify and briefly define these activities.

1.1 Cost Modelling

This is the process of developing a basis for estimating cost of projects, or portions of a project or services by reducing all key variables and inputs into a formulae or model. The key property of a good cost model is its ability to predict future project cost within predetermined range of accuracy and also its responsiveness to changes in any of the key variables built in. This is to say a good cost model should be useful in predicting cost of projects, giving a set of parameters, and changes in any of the key variables or set of parameters should result in corresponding adjustment to the cost of the project.

1.2 Cost Control.

This is another key service offered by the Quantity Surveyor or Cost Engineer, hence they are some times referred to as cost control managers. Cost control is basically the process of ensuring that a given project is executed within the estimated cost budget or target cost. The project cost may have been initially determined by a cost model, hence the use of the compound word "cost control model" follows naturally. The processes of cost control consist of several sub-units, including cost checking, which is the process of matching and comparing the estimated cost generated with the cost model against the actual cost generated from the final project designs. Effective cost control activities usually take place from early conception stage through completion of designs for the project. The cost control mechanism is intended to provide an early warning system, alerting of possible budget problems in good time for remedial action to be taken. The Quantity Surveyor or Cost Engineer may be required to use the cost control process to develop a range of options for the design team to consider and select one option within the prescribed budget limit.

2. KEY USES OF COST MODELLING

- It helps provide reliable estimate for budgeting purpose. This will in turn assist in facilitating efficient distribution of resources and reduce the incidence of abandoned projects arising from budgetary allocation and/or procedures, especially for public sector projects.
- It helps provide reliable estimates to be used in feasibility/viability studies for investment purposes or project prioritisation.

- It helps provide reliable estimates that are flexible, and sensitive to changes in key variables. The key objective is obviously to generate estimates with in-built mechanism for adjustment over time.

3. DIVERSITY OF HOUSING SCHEMES

There are a wide variety of housing schemes differing in size, complexity and location, which may influence the appropriate cost model selected for estimating purposes as well as subsequent cost control activities.

3.1 Urban/Rural Divides

Demand for housing, infrastructure requirement, construction methods and procurement process differ widely depending on location of the scheme. The estimate generation process (cost modelling) need to reflect these peculiarities.

3.2 Site and Services Schemes

Governments often intervene to facilitate planned development in selected areas through these types of schemes. Private developers may be granted concessions to promote the schemes and sell the plots to the public on commercial basis. As the name suggests, this is largely infrastructure development, making plots available for development to members of the public. The impact of these types of schemes on cost models is the likely increase on cost of land acquisition while at the same time reducing the need to factor the cost of infrastructure into the model.

3.3 Public Housing

Governments are often involved in direct provision of large scale housing to members of the public or its employees. The following public housing schemes in Nigeria illustrates the diversity (or complexity) of such schemes:

3.3.1 Bwari Resettlement Scheme

The development comprise units of single room brick hits with thatched roof located on previously undeveloped site devoid of any infrastructure. Water supply to the scheme is through a single borehole with hand pump. Pit latrines were provided for individual houses screened by thatched fence while cooking was to be carried out in open air. Access to the scheme is through unpaved earth road network. The scheme was provided for the Indigenous inhabitants of the Federal Capital Territory, Abuja as part of the relocation process. The main objective of the scheme is to provide facilities that represent the cultural expectations of the displaced persons as closely as possible.

3.3.2 Lagos State Government Housing Schemes

The Lagos State Government had executed several housing schemes in the past, all of different scale and complexity. The schemes provide housing for various levels of the social strata, from “low cost” to” high income” depending on size, location, quality of finishes and extent of infrastructure development. Some of the schemes provide only the building frame or carcass for the buyer to complete the rest to his taste.

3.3.3 FHA Housing Scheme, Gwarimpa

This is a complete new town development in the suburbs of the Abuja, complete with infrastructure, religious and social facilities. It is a mixed, commercially oriented housing scheme. Prototype units include bungalows, block of flats, duplexes and various grades of stand alone houses. Prospective buyers of the housing contributed to financing of the project by making deposits for the housing in advance.

3.3.4 Federal Government 1004 Flats Housing Scheme, Lagos

This is one of the largest public housing schemes in Nigeria and has some peculiar properties such as:

(a) A mixture of high-rise and medium rise block of flats, of relatively complex construction, including lifts.
(b) Propriety construction methods used, system buildings, most of the components are imported into the country.
(c) Integrated infrastructure, including road network, alternative water supply (borehole and water treatment plant) and standby generators.

4. INFRASTRUCTURE

For the purpose of this paper, we shall consider infrastructure relating to that is necessary to support housing schemes. Infrastructure by its very definition is much wider than that. Empirical studies have shown that infrastructure development contributes immensely to the GDP of countries, largely by creating a multiplier effect growth on other aspects of the economy. A study conducted by the World Bank resulted in creation of a database of World infrastructure stocks and estimated growth impact of four types of infrastructure- roads, rails, telephone lines, electricity generation and transmission capacities for about 100 countries (1998). The results of the study showed a direct correlation between provision of infrastructure and economic activities, resulting in positive growth. It was also noted that most of the infrastructure development in Developing Countries are publicly funded. The attention of many governments is being turned to provision of private capital as a key contributor to infrastructure development.

With the move towards private provision of public services, Governments are increasingly using competitive bidding to award infrastructure concessions to private sponsors.

The following infrastructure (availability or lack of it) may have a direct impact on cost models for housing schemes:

(a) Roads and drains
(b) Electricity supply and distribution
(c) Water supply, treatment and distribution network
(d) Sewage treatment plant or alternative disposal system
(e) Railways
(f) Airports/airfields.

Provision of each item of infrastructure listed above could be considered as a project with its own life and "cost control models" of its own in addition to that of the housing scheme that may be associated with it. Generally, insufficient provision of any infrastructure item will result in higher values of related factor(s) in the cost model and will subsequently translate into higher project cost.

5. IMPACT OF THE PROCUREMENT PROCESS

The procurement system adopted for the housing and/or infrastructure project may have impact on the cost models developed or cost control measures employed. There are many procurement options available, which includes the following:

(a) Traditional approach- This include open or selective single stage, or multiple stage tendering, with traditional bills of quantities
(b) Schedule of rates- Sometime referred to as measure and value contracts.
(c) Cost Plus Contracts- Contractor to be reimbursed on cost plus agreed lump sum or percentage for overheads and profits.
(d) Design and Build Contracts- In this case the responsibility for design and construction is with the contractor. There are many varieties of this arrangement.
(e) Direct Labour Contracts-This implies that the client will organise the project internally, usually useful on small projects.
(f) Build, Operate and Transfer- This procurement option and its many varieties is feasible only on commercially oriented projects, where the investor is hoping to recoup his investments and achieve some level of profits over a given period.
(g) Negotiated Contracts- Suitable for selection of contractors with special skills or proprietary building system.

Prior knowledge of the procurement system to be adopted for the provision of housing and/or infrastructure will assist in developing suitable cost models and subsequent cost control techniques.

6. FACTORING ENVIRONMENTAL AND MACRO ECONOMIC FACTORS

A good cost model should factor in the impact of environmental and macroeconomic indices such as:

6.1 Environmental Factors

These are factors that will arise because of the location of the project. These include the following:

(a) Nature of the Location: The proposed project location may be riverine, desert, rain forest or plain savannah the impact of the location on the project cost should be reflected through the cost model.
(b) Transportation: Access to project location is important for the movement of materials, plant and manpower. Any special difficulties should be reflected in the project cost through the cost model.
(c) Availability of Specified Materials: Particular difficulties in procurement of materials also affect project cost and should be discounted into the cost model.

6.2 Macroeconomic Factors

One of the important properties of a good cost model as earlier stated is its usefulness in predicting future cost within reasonable range of accuracy. Macroeconomic factors, particularly in developing countries are notoriously unstable and poses great challenges to the budgetary and implementation stages of projects.

(a) **Inflation**: Historical data of previous levels of inflation in the past few years should serve as a useful guide in projecting probable inflation covering the years of project implementation. Inflationary pressures have the impact of increasing (in most cases) the values of every other factor relevant to the project cost mix.

(b) **Interest Rates**: Changes in interest rates in the long run impact on cost of funds and may directly also affect inflation rates. This factor becomes very important if the scheme is to be wholly or partially funded with borrowed funds.

(c) **Exchange Rates**: This have a direct impact on materials cost, particularly those that are import based. Changes in interest rates may in the long run help fuel inflation, which will in turn produce negative consequences. The converse is also true if the change in exchange rate is the other direction (i.e. the Naira appreciating against major international currencies) – this will help stabilize the economy at large.

(d) **Import duties and tariffs**: This again affects the basic cost of materials requiring importation, a vital component for most housing schemes.

It is important to note that all the adjustments canvassed above are usually translated into pricing, or rate adjustment in the cost model.

7. COST MODELLING

There are many types of cost models of varying complexities that could be applies to housing and infrastructure projects. They all have their merits and demerits. Some of the key ones includes:

7.1 Cost Model Based on Space/Functional Unit

These are the simplest of types of cost models. They generally use information generated from past projects and such information are discounted into cost per unit of utility and used as a basis for estimating cost of future projects. Adjustments could then be done when planning for future projects taking into account differences in project timing, scope and specifications.

Examples of space/functional unit based cost models include:

(a) Buildings ---------- Cost/m2 (Gross Floor Area)
(b) Road, Railways ---------- Cost/Km
(c) Hospital ---------- Cost/Bed Space
(d) Sewage Treatment ---------- Cost/Person/Dwelling Unit
(e) Markets ---------- Cost/Stall
(f) Telephone ---------- Cost/Subscriber Line
(g) Water Supply ---------- Cost/100,000 Population Unit
(h) Electricity Supply ---------- Cost/Km
(i) Storage Silo ---------- Cost/Tone (Storage Capacity)

These cost models have the obvious draw back of being too simplistic, extremely difficult to adjust for changes in any of the key variables and generally have low level of reliability.

They are however very useful at preliminary planning of projects where the designs are yet to commence. Additional draw back of these models is the difficulty of subjecting them to any cost control measures during the implementation of phase of the project.

7.2 Elemental Cost Plan Method

These types of models are based on the elemental cost planning based on the BCIS format. The approach was originally developed for application to building projects only, which are sub-divided into functional elements. The key adjustment factor is the cost/m2 of Gross Floor Area of each element of the building.

The general procedure for using the model is to take the cost analysis of a past project and use it to generate estimates for a project of similar character, making all the necessary adjustments.
Typical elemental arrangement in a building project is as follows:

ELEMENT NR	**ELEMENT**	**ESTIMATED COST/M2**
1	SUBSTRUCTURE	COST/m2 GFA
2	FRAME	COST/m2 GFA
3	UPPER FLOORS	COST/m2 GFA

4	STAIRCASES	COST/m2 GFA
5	DOORS	COST/m2 GFA
6	WINDOWS	COST/m2 GFA
7	ROOF STRUCTURE & FINISHES	COST/m2 GFA
8	WALL FINISHES	COST/m2 GFA
9	FLOOR FINISHES	COST/m2 GFA
10	CEILING FINISHES	COST/m2 GFA
11	ELECTRICAL INSTALLATION	COST/m2 GFA
12	MECHANICAL INSTALLATION	COST/m2 GFA

Even though the elemental cost plan model was developed specifically for building projects, its general principles could be applied for infrastructure and Engineering projects. The key requirement is to break parts of the projects into what we can compare with "Elements" and generate contribution of each portion to the total

Cost models based on elemental cost plan could be adjusted much more easily than those based on space/ functional unit methods.

7.3 Approximate Quantities Based Cost Models

This is the most reliable cost-modelling tool available to Quantity Surveyor. The snag is that it requires the designers to commit their intentions early something that they almost always resist or the project implementation time scale may make it impractical. The procedure is to develop detailed measurement (albeit approximate) of all items of work and subject them to individual pricing

This allows for easy isolation of every single item and adjustments could easily be made should there be changes in specifications or any variable affecting one or more items. The presentation format could either be elemental or in traditional work sections.

7.4 Computer Aided Cost Modelling

There is computer software that allows cost modelling to be instantly carried out by inputting the key parameters. Most of these programmes are developed with some specific types of projects in mind, but have inbuilt capacity for modifications by the user to suit his particular needs.

7.5 Multi-Discriminant Analysis

Computer Technology also avails us with capacity to conduct Multi-Discriminant Analysis on cost models. Multi-Discriminant Analysis allows us to project the impact of simultaneous changes of two or more variables in a given cost model changing at the same time. This is very useful because in reality several key factors do change simultaneously. Single way

sensitivity analysis could also be conducted on individual factors to determine their responsiveness to changes.

8. CONCLUSION

It should be noted that the most important first step in development of cost models is to collate and organise historical information on previous projects into accessible database that cold easily be manipulated. The database should contain relevant information as regard the scope, timing and any other peculiar factors.

Finally, it is worth mentioning that a detailed and concise cost-model is the most useful and potent tool for successful cost control, i.e. matching planned with actual project cost during the implementation stage.