CHARACTERISING PROJECT CONTINGENCY BUDGET IN CONSTRUCTION

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Project contingency estimation is based on a percentage allocation of the total project budget and is often established by a rule of thumb. The use of contingency in the construction industry provides a tacit acknowledgement of the perennial problem of cost overruns in the delivery of projects. The effects of cost overruns are adverse consequences such as projects becoming non- viable, or in extreme cases being abandoned. The economic impact of cost overrun includes delays in payback for investment by the client and occupancy of the facility or development by the end-user. Within this paper, the authors argue that the occurrence of cost overruns can be deemed as symptomatic of inadequate planning and budgeting of projects. The planning inadequacy in turn is a consequence of the accuracy of costing data employed for estimating project budgets. It has been argued that the elimination of cost overruns on projects or zero-cost growth on projects requires an improved understanding of the nature and scale of current cost overruns on projects. Understanding the nature and factors that account for the overruns should assist in establishing more accurate project costs. Within this paper, the authors present the first phase of a study that is aimed at exploring the nature and scale of project cost overrun in construction to provide information for planning future projects. The study is based on projects drawn from the roads sub-sector. It proposes an outline of a concept for accounting for the overruns in the contingency budgeting of similar future road projects.

Keywords: construction, projects, budget, contingency, cost, roads.

INTRODUCTION

The occurrence of cost overrun for projects implemented in the construction industry, is a common phenomenon (Skitmore and Marston, 1999). Such overruns are often the source of friction between clients and contractors on the issue of price or budget variation. Although the causes of project cost overrun are well known, the methodology used in handling its evaluation, especially with regard to *contingency* allocation on projects is at best described as inadequate (Sohail and Edum-Fotwe, 2000).

The use of contingency in construction provides a clear and tacit acknowledgement of the perennial problem of cost overruns in the delivery of construction projects. Contingency allowances are established in order to compensate for the unfavourable deviations from estimated cost (Touran, 2003). To some extent the cost overruns can be deemed as being symptomatic of inadequate planning and budgeting of projects that in turn is a consequence of accuracy of costing data employed for estimating

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project budgets. In particular, while the establishment of budget estimates for projects is often conducted from first principles, the allocation of contingency to account for possible cost overrun is either a lump sum or a simple percentage. Understanding the nature and factors that account for the overruns should assist in establishing more accurate project costs. Equally, an appreciation of the relationship between project budget estimates and final budget for completed projects should provide insights on the general profile of budget contingency to adopt for different scales of projects (Assaf et al., 1995; Sultan, 1999). The aim of this paper is to address the early stage of a study to explore the nature and scale of project budget overrun in construction so as to provide more accurate information for planning future projects. The study will utilise project data from road schemes to establish the magnitude of the budget overrun and propose a framework which will help to account for the overruns in the budgeting of similar future road projects. This paper addresses the first phase of this study.

CONCEPT OF BUDGET OVERRUN

There are several writers on the subject of project cost and budget who concur on a definition of cost overruns on projects as the deviations of actual from estimated cost (Bartholomew, 1987; Royer, 1986; Morris and Hough, 1989; Arditi and Patel, 1989; Voster and De La Garza, 1990; Abd Majid & McCaffer, 1997). Clearly, such deviations can either be positive or negative depending on the conditions surrounding the implementation of a project. Project budget overrun represents the amount by which actual expenditure in completing a project *exceeds* the baseline or approved budget. Figure 1 provides a schematic representation of the notion of budget overrun associated with construction projects.

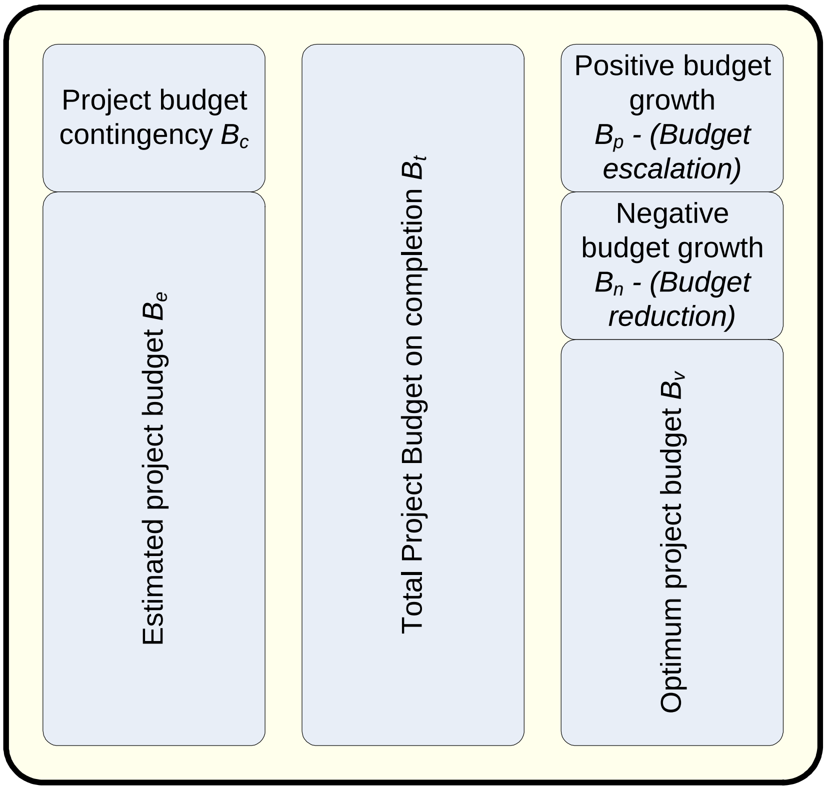

Figure 1. Conceptual representation of project budget growth options

It shows the possible growth options for the estimated budget of a construction project $\boldsymbol{B_e}$ as either negative $\boldsymbol{B_v}$ or positive $\boldsymbol{B_p}$. A negative growth results in a saving and can be the result of value engineering. A positive growth on the other hand presents an undesirable outcome, and is addressed by the provision of a contingency budget. The level of the contingency would be influenced by the type and perceived risk associated with the project.

The project budget represents the sum established by the client as available for the entire project, including the construction budget, land costs, costs of furniture, furnishings, and equipment, financing costs, compensation for professional services, cost of owner-furnished goods and services, contingency allowance, and similar established or estimated costs. From the contractor's perspective, project budgets are used to plan, track and forecast project costs. The budget in this case represents the price at which the project is executed for and comprises the total cost incurred and any allowance to cover the contractor's overheads and profits. The project cost information collected during task and resource requirements analysis is used in feasibility and cost benefit studies, as well as preparing project budget and cash flow projections, and in project cost tracking. The budget process determines what a project will cost, and when outlays will occur.

Budget deviations

In general project estimates tend to be too optimistic. Projects are easier to justify if their costs are low, so the general inclination from the owner's perspective is to underestimate costs. From the contractor's viewpoint, the forces of competition that determines the way projects are acquired potentially encourages under-pricing, and thus making the project liable to budget overrun during implementation.

Sources giving rise to budget overruns

For the purposes of the research, and within this paper, the authors have concentrated primarily on the budget overruns caused by the parties to the contract in the study. In addition to these, budget overruns caused by third parties were also considered. The principal sources that account for project budget overruns can be classed as follows:

(i) Cost overrun caused by the client/Consultant

(ii) Cost overrun caused by the contractor

(iii) Cost overrun caused by third parties i.e. Parties not in the contract.

Each of these sources is given a brief consideration in the subsequent sections.

Budget overruns caused by client / consultant

The categories of events under this type of budget overruns are ones that result in additional payment under the conditions of contract. For example if delay occurred as a result of client inaction or action, then the contractor is entitled to additional monetary compensation which could increase the project cost and budget (Trauner, 1990). In this regard there are many actions or inactions of the client which can result in budget overrun on projects. Some of these are faulty design, incomplete drawings, changes in scope of work, delay in interim payment, and client's failure to disclose vital information to the contractor among others. Bramble and Collahan (1992), identify some actions of the client that causes cost overrun on projects. These include, delay in giving access to the project site, defective specifications, inspection delays, design defects, delay notice to commence, project financing, approval from governing authorities and client interference among others. The Aqua

Group (1992) also identified these variables as having significant increase on the project cost and budget.

Budget overruns caused by contractor
There are certain events which are within the contractors control or are can be foreseen by an experienced contractor (Trauner, 1990). Such events when they occurred increase the contractor's expenditure and the project budget. Bramble and Collahan (1992) identified several practices associated with contractors that give rise to this category of budget overrun. They include: underbidding; improper scheduling and planning; management failure; poor material procurement; inadequacy of labour; inadequate equipment resources; construction defects; and failure to evaluate the site before bidding. The effect of each of these practices is a potential delay in the project completion with a concomitant cost implication for the project budget. While provision can be made in the contract to transfer the risk associated with practices to the contractor, the client still suffers the opportunity cost of timely delivery of the project. The contractor pays liquidated damages in the event of such occurrence to offset any expenditure to the client as the result of the project not completed within time.

Budget overrun caused by third party
These types of overruns are caused by events which are unforeseen and beyond the control of the parties to the contract. These are normally unquestionable and include earthquakes, exceptional or adverse climatic conditions, war, force majeur, and strikes. These types of events lead to increases in the cost of the project and for which none of the parties to the contract are compensated. These events are beyond the control of the parties to the contract and therefore no provision is normally made for its occurrence. Budget overruns caused by these events are classified as third party induced. Pohl and Mihaljek. (1992) indicated that none of the parties under the contract is compensated in this category of event. However the contractor is normally allowed an extension of time in the event of such occurrence. According to Ibbs (1984) and Arditi and Patel (1989) both parties to a construction contract can incur loss due to this type of overrun.

Measuring budget overrun

There has been considerable effort made in both Europe and USA to develop metrics and norms for assessing the cost and budget performance of projects. The key performance indicators published by the Constructing Excellence initiative, as well as the performance benchmarking initiative of the Construction Industry Institute are typical of such efforts. However, the traditional approach for assessing budget overrun is by the use of liquidated and ascertained damages. These provide a predetermined amount that is indicated in the contract document for the purposes of covering any such eventuality. A typical contract clause that incorporates liquidated damages is as follow:

"*Should the contractor fail to complete the contract within the time allowed by the contract to include time extension allowed by executed change order, then for each calendar day of delays, the client has the right to withhold the amount equivalent to 0.2% of the contract amount per calendar day as liquidated damages. These liquidated damages are compensation to the client for the costs he may experience due to the contractor's delays, and not construed as penalties*". The level at which the liquidated damages are set are often guided by rule-of-thumb.

Other measures adopted for evaluating the budget overrun for construction projects include the Cost Performance Index (CPI). This represents the cost efficiency factor of the relationship between the actual costs expended and the value of the physical work performed. This is defined as the ratio of budgeted costs to actual costs.

$$CPI = \left(\frac{BCWP}{ACWP} \right) \qquad [1]$$

The norm for the CPI is 1:1 ratio. A positive value (interpreted as a ratio greater than 1) indicates that costs are running under budget. A negative value (interpreted as ratio less than 1) indicates that costs are running over budget.

The CPI is often used to predict the magnitude of a possible cost overrun. This is achieved by evaluating the original cost estimate ($\boldsymbol{B_e}$) divided by the CPI to give the projected cost at completion ($\boldsymbol{B_t}$) as follows:

$$B_t = \frac{B_e}{CPI} \qquad [2]$$

While the CPI can give an indication of what the potential overrun would be for a particular project there are no current guidelines on what levels of the overrun should be considered acceptable.

QUANTIFYING BUDGET OVERRUNS

Traditionally, the quantification of budget overruns in construction requires the meticulous measurement of the value of the project at completion and relating it to the original estimate (Kallo, 1996). This involves the following two principal valuation documents.

(i) Original estimate document

(ii) Final account document

Original estimate document
This is the document that describes all the items of work to be done with the corresponding cost or budgetary allocation. It is prepared from the original design drawings, typically with the Standard Method of Measurement for building works (SMM) and Civil Engineering Method of Measurement (CESMM).

Final account document
This is the document that indicates the actual expenditure on the project. It contains all events with a cost implication for the project. The final cost/budget of construction project is indicated in this document. The cost overrun on construction projects could only be quantified after the completion of the project. This is because the final cost of the project is obtained only after practical completion. The actual cost of each individual activity indicates the overrun in that activity when compared with the estimated cost of that activity but not the cost overrun of the project.

BUDGET OVERRUN FORECAST

Records available on past projects indicate that schedule and budget overruns have always been common in construction projects. Poor performances of projects in terms of cost/budget overruns were common in the construction industry Tah et al. (1993). In 1882 for instance, the Amazon province of Brazil, at the height of its financial might, awarded a contract to Portuguese Engineering Council of Lisbon to construct a theatre at Manaus at the cost of 500 cruzerio. Carelli (1989) reported that the project was completed at a staggering cost of 20,000 cruzerio twelve years later. Akpan and Odinaka (2001) also reported the case of National Westminster Bank Headquarters' building where the cost overrun was placed in the region of five times more than its original estimate. Serious cost overruns have also been reported in more recent times. These include the Channel Tunnel Development and Scottish Parliament for which a 400% cost overrun has been reported. NEDO (1992) revealed that cost overruns of up to 50% were found on some key projects in the UK. The Building Research Advisory Board of the National Academy of Science (1978) quoted that cost may run US$10 million for contracts over US$20 million to US$50 million on projects involving tunnels. It has been indicated by Household et al. (1990) that costs overrun due to delays were experienced by both contractor and the client. It can be concluded that substantial reduction in cost overruns can be achieved if schedule delays are improved. Abd. Majid and McCaffer (1997) reported that almost fifty percent of causes of cost overruns on construction projects are due to improper management. The improper management is contributed to, in no small measure, by the lack of clarity on the nature of overruns that occur on projects. Elinwa and Buba (1993) revealed that cost overruns on building projects ranges from 8% to 142%. This was the outcome from a study related to nuclear power plant in which cost overruns of US$30 million to US$35 million was reported. In a good number of cases the estimation of budget contingency often is based on a simple principle akin to the rule-of-thumb, or business as usual approach. This incorporates a higher level of risk associated with project budget certainty. The development of norms would provide an opportunity for achieving greater clarity on the nature of budget extensions on AEC projects. Such development can also provide a means for minimizing the risks and uncertainty associated with estimating budget contingency for the whole project as well as task or activity budgets.

PROJECT BUDGET MODELLING

Several mathematical models for deriving and forecasting cost and budget of a project are already in existence. These include models developed by Seeley (1996), and other works. The use of these and similar models have been greatly facilitated by the recent developments in IT. Although there have been advances in the deployment of IT systems to facilitate the establishment of the project budget estimation, the allocation of appropriate levels of contingency is not addressed by these systems. Existing models that address project characteristics are based on records drawn mainly from large-scale projects, and for which data is readily accessible with occasional input with records from medium-sized projects. Cole (1991) and Popescu and Charoenngam (1995) provide examples that typify the large project orientation of schedule control in construction.

Early works in the control of project characteristics include developments by McCaffer (1975). This utilised regression techniques to establish a basis for predicting project costs from historical data. The main thrust of these developments was to identify a generic pattern of the value and time relationships for the different stages of a project. Subsequent developments focused on further exploration of the relationship between the value and duration of projects. This includes work undertaken by Kumaraswamy and Chan (1995), Walker (1995), and Kaka and Price (1991). More recently, Lee and Kyoo (1999) made use of a numerical approach to address the integration of the time and cost data sets for construction projects. They relied on the use of mathematical matrices, which are introduced to show the option from which the duration of projects as welinterrelationships between the time and cost data sets and to demonstrate their effect on each other. These interrelationships are exploited to solve the conflict that often arises from the differences between work breakdown structure and cost breakdown structure. This is achieved through several time and cost related matrix equations that are used for project planning or control. Feng et al. (1997) also employed a time-cost trade-off analysis to examine the relationships between project costs and duration. They utilised a genetic algorithm procedure for their analysis and argued that it enabled them to handle large volumes of data, the sort of which are associated with large projects. These models provide a strong basis for employing one of the two variables of duration and cost as a predictor for the other. Of the two variables, the project budget provides the more stablel as the nature of escalation that represent contingency, can be estimated.

INVESTIGATION AND RESEARCH METHOD

While there have been several investigations exploring the causes of budget escalation to identify the salient factors that should be planned for, there is no justifiable basis for the allocation of contingency budget for a project. The scale of escalation that is likely to occur on a project can be estimated by collating the behaviour of the budgets of similar projects. The study is aimed at exploring the scale of escalation that occurred on several completed projects to establish a generic model for potential use in the allocation contingency budgets.

The projects employed for the study were drawn from the roads sub-sector. There were 35 projects in the sample employed for the analysis, which were all completed between the years 2000 to 2004. The main method employed for the analysis of the data is regression modelling.

PRELIMINARY RESULTS AND DISCUSSION

Table 1 below presents the lower and upper boundary values for the data employed in the analysis. Table 1 was derived by ordering the sample data, which forms the first step in descriptive statistical analysis. The boundary cases provide the range of the sample, which will be employed subsequently for modelling the budget growth on projects. The data-points for the boundary cases were ordered on the basis of the magnitude of budget growth. The budget growth is accounted for in the main by variation orders issued by the client as a result of changes dictated by site conditions.

Table 1: Boundary characteristics of sample data for modelling escalation

ESTIMATED NET COST	CONTINGENCY	TOTAL BUDGET	TOTAL BUDGET AT COMPLETION	BUDGET GROWTH	% BUDGET GROWTH
61,657,500.00	12,331,500.00	73,989,000.00	84,554,349.90	10,565,349.90	14.28
4,679,187,000.00	932,737,400.00	5,611,924,400.00	5,781,418,587.49	169,494,187.49	3.02

The preliminary analysis of the data appears to suggest an inverse relationship between the initial estimated cost (and/or total budget) on the one hand and the budget growth on the other hand. This preliminary observation forms the basis for the subsequent stages of the investigation, and would inform the selection of appropriate regression modelling techniques. The subsequent stages of the analysis will provide a mathematical derivation of the generic form of the budget growth with the projects in the sample. The generic function will then be tested with data from the year 2005 to establish the accuracy of the derived model for practical use.

CONCLUSIONS

Within this paper, the authors have argued that the occurrence of budget overruns can be deemed as symptomatic of inadequate planning and budgeting of projects. The planning inadequacy in turn is a consequence of the accuracy of costing data employed for estimating project budgets. By the same token, the elimination of cost overruns on projects or zero-cost growth on projects requires an improved understanding of the nature and behaviour of current budget overrun profiles on projects. Understanding the nature and factors that account for the overruns should assist in establishing more accurate project budgets. The authors have presented the first phase of a study that is aimed at exploring the nature and scale of project cost overrun in construction to provide information for planning the budgets of future construction projects. The study is based on projects drawn from the roads sub-sector. It proposes an inverse relationship between the initial budget estimate and the final outturn budget on completion of the project.

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REFERENCES

Abd. Majid, M.Z and McCafer R; (1997b), Factors of Non Excusable delays that Influence Contractors Performance. *Journal of Management and Engineering*.

Akpan, E.O.P, and Odinaka, I., (2001), Methodology for determining price variation in project execution, *Journal for Construction Engineering and Management*, pp. 367-373.

Arditi, D. and Patel, B.K., (1989), Impact analysis of owner-directed acceleration. *Journal of Construction Engineering and Management*, ASCE. **115**(1), pp. 144-157

Assaf, S.A; Al-Khalil, M; and Al-Hazmi, M (1995), Causesof delay in large buildings construction projects. *Journal of Management in Engineering*, ASCE, **11**(2), pp. 45-50.

Bartholomew, S.H., (1987), Discussion on Concurrent delays in Construction Projects', *Journal of Construction Engineering and Management*, ASCE, **113**(4), pp. 333-338..

Bramble, B.B. and Collaham, M.T. (1992), Construction delay claims, Wiley, NY.

Carelli, G. (1989), The Manaus opera House, Icaro Vaig Inflight Mag., Sao Paulo, Brazil, 59, pp. 17.

Cole, L.J.R., 1991, Construction scheduling: principles practices and six case studies. *Journal of Construction Engineering and Management*, ASCE, **117**(4), pp. 579-588.

Elinwa U., and Buba, S.A., (1993), Construction Cost factors in Nigeria. *Journal of Construction Engineering and Management*, ASCE, **119**(4), pp. 698-713.

Feng, C.W., Liu, L. and Burns, S.A., 1997, Using genetic algorithms to solve construction time-cost trade-off problems, *Journal of Computing in Civil Engineering*, **11**(3), pp. 184-189.

Ibbs, W. JR., (1984), Key Elements of construction specification. *Journal of American Waterworks Association*, **76**(2), pp. 48-55.

Kaka, A. and Price, A.D.F., 1991, Relationship between value and duration of construction projects. *Construction Management and Economics*, **9**, pp. 383-400.

Kallo, G.G. (1996), Estimating loss of productivity claims. *Journal Management in Engineering*, ASCE, **12**(6), pp. 13-15.

Kumaraswamy, M.M. And Chan, D.W.M., 1995, Determinants of construction duration. *Construction Management and Economics*, **13**, pp. 209-217.

Lee, H. S. and Kyoo, J. Y., 1999. Application of mathematical matrix to integrate project schedule and cost. *Journal of Construction Engineering and Management*, **125**(5), pp. 339-346.

McCaffer, R., 1975. Some examples of using regression analysis as an estimating tool. *The Quantity Surveyor*, **32**(5), pp. 81-86.

Morris, P.W.G. and Hough, G.H, (1989), The anatomy of Major projects. J. Wiley, London, UK.

National Economic Development office – NEDO, (1992), Site waste 66% of time. Contract journal, A Reed Business Publication, London, UK.

Pohl, G., and Mihaljek, D. (1992), Project evaluation and uncertainty in practice: A statistical analysis of rate of return divergences of 1015 World Bank projects. *World Bank Economic Review*, **6**(2), pp. 260-275.

Popescu, C.M. and Charoenngam, C., (1995), Project planning, scheduling and control in construction. Wiley, New York.

Royer, K., (1986), The Federal government and the critical path. *Journal of Construction Engineering and Management*, ASCE, **112**(2), pp. 220-225.

Seeley, I.H., (1996). *Building economics: appraisal and control of building design cost and efficiency*, Macmillan, Basingstoke.

Skitmore, M. and Marston, V., (eds) (1999). *Cost modelling*, Spon, London.

Sohail, M. and Edum-Fotwe, F.T., (2000), Cost-duration tool for policy decision on micro and small projects. *Journal of Financial Management in Property and Construction*, **5**(3), pp. 71-84.

Sultan, M. (1999), Causes of delay in Civil Engineering Projects; M.Sc. Thesis, Loughborough University, UK.

Tah, J.H., Thorpe, A., and McCafer, R., (1993), Contractor project risks contingency allocation using linguistic approximation. Computing systems in Engineering. **4**(2-3), pp. 281-293.

Touran, A., (2003), Probabilistic Model for Contingency, *Journal of Construction Engineering and Management*, May/June, Pages 280-284.

Trauner, JR. T.J., (1990), Construction delays, R.S. Means Company Inc., USA.

Voster M.C. and De La Garza J.M.D., (1990), Consequential Equipment cost associated with lack of availability and downtime, *Journal of Construction Engineering and Management*, ASCE, **116**(4), pp. 656-669.

Walker, D.H.T., (1995) An investigation in time construction time performance construction time performance. *Construction Management and Economics*, **13**, pp. 263-274.