Estimating Project Cost Contingency – A Model and Exploration of Research Questions

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The cost performance of building construction projects is a key success criterion for project sponsors. Projects require budgets to set the sponsor's financial commitment and provide the basis for cost control and measurement of cost performance. A key component of a project budget is cost contingency. A literature review of the concept of project cost contingency is presented from which a model for the estimating of project cost contingency is derived. This model is then used to stimulate a range of important research questions in regard to estimating project cost contingency and the measurement of its accuracy.

Keywords: cost contingency, project cost performance, project risk management

INTRODUCTION

The cost performance of construction projects is a key success criterion for project sponsors. Project cost overruns are commonplace in construction (Touran 2003). Cost contingency is included within a budget estimate so that the budget represents the total financial commitment for the project sponsor. Therefore the estimation of cost contingency and its ultimate adequacy is of critical importance to projects.

The primarily focus of this paper is a literature review, leading to a tentative model for the concept of project cost contingency. The literature on project cost contingency tends to focus predominately upon the micro-process of estimation. There is no model that sets out a macro perspective to provide a holistic understanding of the estimating process for project cost contingency. A model for project cost contingency, from the perspective of the project, is presented to stimulate the identification of research questions regarding the estimating of project cost contingency and measurement of its accuracy.

CONTINGENCY - DEFINITION

There are three basic types of contingencies in projects: tolerance in the specification, float in the schedule, and money in the budget (CIRIA 1996). There is no standard definition for contingency as Patrascu (1988:115) observes, 'Contingency is probably the most misunderstood, misinterpreted and misapplied word in project execution. Contingency can and does mean different things to different people". Contingency has been defined as "the amount of money or time needed above the estimate to reduce

the risk of overruns of project objectives to a level acceptable to the organization" (PMI 2000: 199)

Some authors distinguish between 'contingency', 'allowance' and 'management reserve'. Allowance is for specific, known but undefined items (Clark and Lorenzoni 1985, Patrascu 1988, Querns 1989, Rad 2002). Management reserve is a provision held by the project sponsor for possible changes in project scope and quality (Wideman 1992). The management reserve should also be expected to cater for extraordinary, unforeseen external risks e.g. currency-exchange fluctuation, force majeure (Yeo 1990).

CONTINGENCY - ATTRIBUTES

An analysis of the literature identifies the following key attributes of the concept of project cost contingency:

- *Reserve* – Cost contingency is a reserve of money. A reserve is a provision in the project plan to mitigate cost risk (PMI 2000).
- *Risk and Uncertainty* – The need and amount for contingency reflects the existence of risk and uncertainty in projects (Thompson and Perry 1992). Contingency caters for events within the defined project scope that are unforeseen (Moselhi 1997, Yeo 1990), unknown (PMI 2000), unexpected (Mak et al 1998), unidentified (Levine 1995), or undefined (Clark and Lorenzoni 1985, Thompson and Perry 1992).
- *Risk Management* – Contingency is an antidote to risk. There is a range of risk treatment strategies for managing risk in projects such as risk transfer, risk reduction, and financial treatments for retained risks e.g. contingency. So contingency is used in conjunction with other risk treatment strategies.
- *Total Commitment* - Cost estimates are prepared and contingencies added in order to indicate the likely total cost of the project. The inclusion of contingencies within a budget estimate means that the estimate represents the total financial commitment for a project. Contingency should avoid the need to appropriate additional funds and reduces the impact of overrunning the cost objective.
- *Project Outcomes* - Contingency can have a major impact on project outcomes for a project sponsor. If contingency is too high it might encourage sloppy cost management, cause the project to be uneconomic and aborted, and lock up funds not available for other organisational activities; if too low it may be too rigid and set an unrealistic financial environment, and result unsatisfactory performance outcomes (Dey et al 1994).

CONTINGENCY - COVERAGE

Contingency caters for two categories of risk - known unknowns and unknown unknowns (PMI 2000, Hillson 1999). Known unknowns are risks that have been identified, analysed and it may be possible to plan for them (PMI 2000). They are identifiable sources of uncertainty (Chapman 2000). Unknown unknowns cannot be managed although they may be addressed them by applying a general contingency

based on past experience with similar projects (PMI 2000). So a contingency should be set up to allow for residual unidentified risks not revealed during the risk identification process (Hillson 1999). Unknown unknowns cannot be anticipated and therefore are not manageable and the realisation of some of them is usually inevitable but they exclude risks like '*the world may end tomorrow'* (Chapman 2000).

It is not only important to understand the factors covered by contingency but also those factors that it is not intended for: *Scope changes* (Querns 1989, Moselhi 1997). Scope changes occur when what is now expected is materially different from what was previously reasonably expected. Contingency does cover for cost created by scope development i.e. scope remains constant even as the product characteristics are progressively elaborated (PMI 2000); *Escalation,* which is usually shown as a separate item within the project budget (Querns 1989, Moselhi 1997); *unforeseeable major events* such as extreme weather, earthquakes, riots, acts of war new government regulations, and economic collapse (Heinze 1996, Moselhi 1997).

CONTINGENCY - ESTIMATION

A range of estimating techniques is available for calculating project cost contingency- see Table 1.

Table 1: Contingency - Estimating methods

Contingency Estimating methods	References (Examples)
1. Traditional percentage	Ahmad 1992, Moselhi 1997
2. Method of Moments	Diekmann 1983; Moselhi, 1997, Yeo 1990;
3. Monte Carlo Simulation	Lorance & Wendling 2001
4. Factor Rating	Hackney 1985, Oberlander & Trost 2001
5. Individual risks – expected value	Mak, Wong & Picken 1998
6. Range Estimating	Curran 1989
7. Regression	Merrow & Schroeder 1991; Aibinu & Jagboro 2002
8. Artificial Neural Networks	Chen & Hartman 2000; Williams 2003
9. Fuzzy Sets	Paek, Lee, & Ock, 1993
10. Controlled Interval Memory	Cooper and Chapman 1985;
11. Influence Diagrams	Diekmann & Featherman 1998
12. Theory of Constraints	Leach 2003
13. Analytical Hierarchy Process	Dey, Tabucanon & Ogunlana 1994

Traditional Percentage

It is worth briefly describing the long-established percentage approach to estimating contingency because it provides an understanding for the search for alternative estimating methods. Traditionally cost estimates are deterministic [i.e. point estimates for each cost element] based on their most likely value (Mak et al 1998). Contingencies are often calculated as an across-the-board percentage addition on the base estimate, typically derived from intuition, past experience and historical data.

The percentage addition method is based on a subjective approach and may consider project characteristics such as type of work, phase of the project, and level of scope definition (Lorance and Wendling 2001). This calculation method is satisfactory for simple projects under stable conditions but is unsuitable for large and complex projects (Newton 1992).

A different contingency percentage can be calculated for each major cost element, which reflects that some parts of the project may have greater uncertainty than others (Ahmad 1992, Moselhi 1997). Each major segment of the estimate is classified in terms of its degree of uncertainty or accuracy and then attracts its own appropriate contingency (Bent and Humphreys 1996). This method is considered more rational and reliable than the simple application of one overall percentage to the total cost because it encourages close examination of each cost area (Moselhi 1997).

Traditional Percentage - weaknesses

Thompson and Perry (1992:1) observe "all too often risk is either ignored or dealt with in an arbitrary way: simply adding a 10% 'contingency' onto the estimated cost of a project is typical". This arbitrary bottom percentage may not be appropriate for the proposed project (Heinze 1996). And it is difficult for the estimator to justify or defend (Newton 1992, Yeo 1990). It is an unscientific approach and a reason why so many projects are over budget (Hartman 2000). Furthermore, allocating a contingency percentage is insufficient unless linked to a confidence level. i.e. the level of probability that the final project cost will be within the estimate including contingencies (Moselhi 1997)

There is a tendency to incorporate hidden contingency within the individual cost elements ('padding') as well as an additional percentage to the total cost (Mak et al 1998). The project manager may not be aware of the padding and therefore will not be able to control this hidden contingency. A padded cost element can become a self-fulfilling prophecy as the entire amount is spent unnecessarily to justify the estimate (Hamburger 1994).

A percentage addition results in a single-figure prediction of estimated cost which implies a degree of certainty that is not justified (Mak et al 1998). It does not encourage creativity in estimating practice, promoting a routine and mundane administrative approach requiring little investigation and decision making, which may propagate oversights (Yeo 1990, Mak et al 1998). Also, the percentage addition indicates the potential for downside risk. It does not indicate any potential for cost savings and may therefore mask poor project management (Mak et al 1998).

It is claimed that contingency is often set too high for low-risk projects and too low for high-risk projects *(*Mok et al 1997). There is a tendency to overestimate contingency because an underestimated contingency may attract negative comment whilst there is no penalty for overestimation; and to avoid the need to seek additional funds if budgets become overspent (Mak et al 1998).

The weaknesses of the traditional percentage addition approach for calculating contingencies has led for a search for a more robust approach as evidenced by the range of estimating methods set out in Table 1.

CONTINGENCY - MANAGEMENT

Once a contingency fund has been formulated its use must be explicitly identified and controlled. The level of contingency should be constantly monitored and reassessed throughout the project life cycle for appropriateness (CIRIA 1996). Importantly, cost contingency must be used for their intended purpose and not incorrectly used for poor performance (Levine 1995).

CONTINGENCY – A MODEL

Figure 1 set outs a model for the estimating for project cost contingency. The model is for the estimating of contingency by the project sponsor just prior to the commencement of construction phase of building projects. The sponsor has awarded a contract to a building contractor and needs an estimate of the final cost of the project for budgeting purposes. This budget is a combination of the contract sum plus contingency. The key elements of this model are:

1. Contingency is a part of an overall risk management strategy. It is a financial reserve to cater for retained risks. The selection of contingency as a risk treatment strategy leads to the need to estimate the amount of contingency required.

2. There are numerous estimating methods available for project cost contingency ranging from the traditional percentage approach to more sophisticated methods such as Monte Carlo simulation and artificial neural networks.

3. There are several influential variables that affect the estimating process and the amount of estimated contingency (e.g. cognitive bias of the estimator, organisational policies, project size and complexity, and estimator's experience)

4. Contractual variations are the means for altering the contract sum and affecting the actual final cost. The final total amount of variations will be influenced by the contingency management approach e.g. a formal rigorous method that aims to minimize contractual variations is likely to limit the final total value of variations

5. Once a contingency has been estimated it is added to the contract sum to represent the predicted final cost of the project for the sponsor. The actual final cost is the sum of the contract plus contractual variations. The accuracy of the contingency can be measured by comparing the predicted final cost against the actual final cost.

RESEARCH QUESTIONS

Using the model in Figure 1, research questions for estimating accurate project cost contingency can be identified.

1. **What is the project management community's understanding of the concept of project contingency.**

   There has been little empirical research into the concept of project cost contingency in particular project practitioners' understanding of the concept, its intended scope, methods of estimating contingency or the management process for contingency. Despite the ubiquity of cost contingency within project budgets, it has not stimulated a great deal of research interest. However, there has more recently been research into cost contingency (e.g. Mak et al 1998; Aibinu & Jagboro 2002, Williams 2003). One possible reason for this is could be the growing interest in project risk management and the realisation that cost contingency is in fact an important risk management tool. The author is presently finalising a paper into practitioners' understanding of project cost contingency.

2. **How accurate are cost contingencies?**

   The inclusion of contingencies within a budget estimate for the construction phase of a building project means that this budget represents the total financial commitment for a project. The aim is to estimate a project contingency so that Contract Sum + Contingency = Predicted Final Cost. In effect contingency is catering for variations allowable under the contract between the sponsor and contractor. Research could be undertaken to compare the Predicted Final Cost against the Actual Final Cost to discover the accuracy of contingency estimates. Broadly the smaller the difference between these two costs the more 'accurate' the project cost contingency. This would indicate whether there is a problem is accurately estimating project cost contingency. If contingencies are 'inaccurate' then this could lead to further research questions - see below.

3. **Are some contingency estimating methods more accurate than others**

   There are numerous methods for estimating project cost contingency. Research could be undertaken to investigate which if any are more accurate. This would indicate whether the use of certain estimating methods should be encouraged.

4. **What variables affect the accuracy of estimating project cost contingency?**

   Research could be undertaken to identify any variables that have a relationship to the accuracy of project cost contingency, for example project size, complexity, type or location. Any variables that do have a relationship might then be used to predict a more accurate project cost contingency; or simply highlight to estimators that when these variables are present there is a need to pay particular consideration to them when estimating contingency. Research could be undertaken to investigate whether any cognitive influences upon the estimator are related to the accuracy of contingency such as risk attitude, cognitive bias (e.g. heuristics) and conscious bias.

5. **What effect does the management of project cost contingency have on its accuracy?**

Once a contingency has been formulated its use must be managed. Research could be undertaken to investigate the nature of the contingency management process and whether the level of management of contingency during the construction process (e.g. level of reporting, formality of policies and procedures) has any relationship with the accuracy of project cost contingency.

CONCLUSION

The cost performance of construction projects is a key success criterion for project sponsors, which can be measured by comparing project budgets against final cost. Therefore the estimation of cost contingency is an important issue in projects and worthy of research. A literature review of the concept of project cost contingency found no model to represent the elements that play a part in its estimation or the measurement of the accuracy of these estimates. Figure 1 is first attempt known to the author to provide a model for the concept of project cost contingency that can then facilitate the identification of research questions. The author is presently conducting research into some of these questions such as practitioners' understanding of the concept of project cost contingency; the estimating accuracy of cost contingency; and the development of a regression model for predicting cost contingency.

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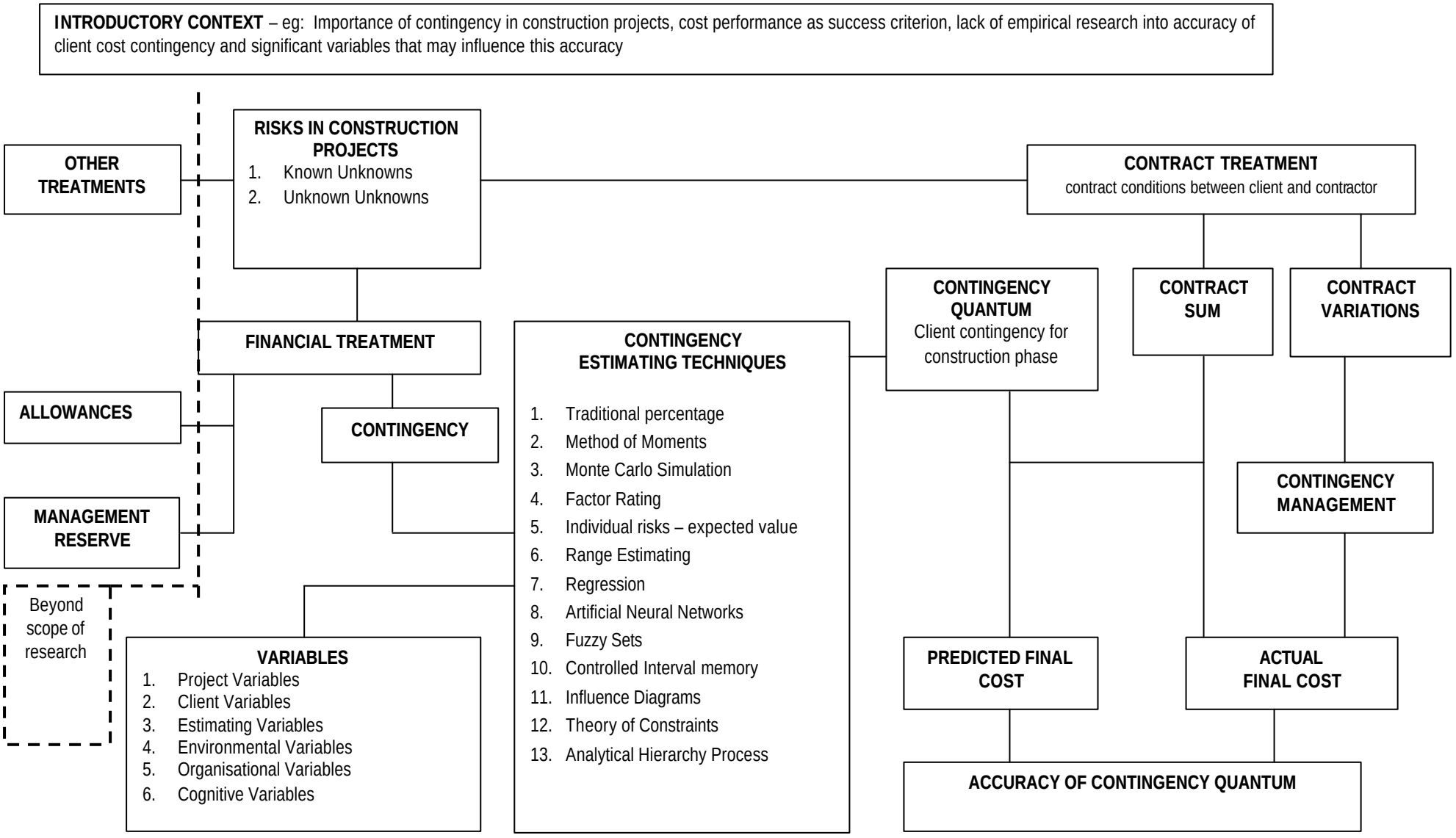

Figure 1: Model - Sponsor Project Cost Contingency