Budgeting Owner's Construction Contingency

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Abstract: This paper attempts to find ways to reduce an owner's construction contingency budget such that just enough contingency is allocated that will allow the owner to deal with uncertainties but at the same time not tie up valuable funds that can be used for other activities. It is suggested that the common practice of allocating a fixed owner contingency (e.g., 10% of the contract value) to all projects contracted out by an owner is not appropriate. Instead, a methodology is proposed whereby the owner (1) analyzes historical project data; (2) identifies the line items that are problematic; (3) takes the necessary measures at the preconstruction stage to streamline these line items with respect to site conditions, time constraints, constructability issues, and project scope; and (4) finally budgets contingency funds based on this information. A case study was conducted to analyze the contingencies budgeted and actually spent by an owner in nine parking lot projects. The findings indicated that a systematic approach such as the methodology proposed in this paper is likely to minimize the owner's contingency budget.

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Introduction

Contingency is generally defined as the source of funding for unexpected events. Contingencies are included in construction budgets to help conduct financially successful projects. Project complexity, the inherent uncertainty in the performance of the parties involved in the construction project, development funding issues, and the control of design and construction management costs and schedules make exact budget needs very difficult to forecast accurately. Therefore, contingency funds are included in budgets to provide managers with the flexibility required to address uncertainties and deviations that threaten achieving objectives. According to Ford (2002), contingency funds are established such that (1) emergencies are resolved by providing funds for future unforeseen expenses; (2) completion is assured by the project deadline by accelerating progress; (3) value is added to the constructed facility, typically by implementing design and scope changes; and (4) contingency savings are maximized.

Given the uncertainties associated with these objectives, managers tend to allocate contingency funds intuitively rather than systematically. Although on the one hand, contingency guarantees that design and construction will be completed smoothly (i.e., with no delay caused by unavailable funds), on the other hand, the funds tied up as contingency prevent the parties from undertaking other activities such as owners commissioning other projects and contractors bidding new jobs. It is therefore important that just enough contingency be allocated to a project that will allow the parties to deal with uncertainties, but at the same time not tie up valuable funds that can be used for other activities. This can be achieved only if the party allocating the contingency knows which items are likely to cause problems and consequently takes measures for preventing these problems from occurring. A methodology to minimize the owner's contingency budget is presented in this paper after a detailed description of different contingencies in the life cycle of a construction project.

Contingency in Construction

There are three types of contingency depending on the phase of the project and the party involved.

Designer contingency is included in the preliminary budget by the estimating party for potential cost increases during the preconstruction phase. As the project grows into detailed construction documents, design contingency is expected to be absorbed by different line items in the budget. As unresolved or risky design issues remain, the contingency left over will become part of the construction budget. The ideal case is to nullify designer contingency by the time construction starts.

Contractor contingency is included in the construction budget to cover unforeseen conditions that may occur during the construction phase. It is controlled by the general contractor. Accurate prediction of the contingency is vital to the contractor's successful financial performance as construction is a high risk business. Contractor contingency can be used to pay for schedule-related issues caused by overtime requirements to meet completion date, or consequential damages of outside influences, such as owner's requirements, permit issues, or design changes that can impact the start and end dates of the overall construction schedule. Other issues include unexpected expenses that are not covered by insurance, missing project scope items, subcontractors' faults, differing site conditions, changes in market conditions such as price increases due to material shortages and unexpected increases in wages.

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Owner contingency is controlled by the owner and is included in the owner's project budget. All changes that were not previously defined in the project scope are funded by owner contingency. For example, change orders may change the scope of work by adding extra work, deleting work or changing the standards of work, and may be quite costly (Barrie and Paulson 1992). The use of the owner's contingency fund is not limited to changes in scope, but also covers overtime money due to owner requested acceleration of the project, added cost due to use of more expensive substitute materials, and changed conditions that occur when the nature of the work encountered on a project is significantly different from that described in the contract documents. Contract terms are very important to understand if a particular change is funded by the general contractor's contingency or it is a modification to the contract that is funded by the owner's contingency. It is the owner's responsibility to predict the amount of contingency that will cover additional expenses to the project.

The most common approach for any type of contingency prediction is to use previous experience. Owner contingency is calculated in various ways depending on the owner's organization and level of sophistication. One of the simplest and most common methods is to consider a percent of the estimated contract value, such as 10% across all the projects commissioned by an owner (Touran 2003). Another method takes a deterministic and conservative approach to project cost estimating and then adds a contingency that varies depending on the level of project definition, past experience, and other factors. These approaches fall short of conducting a rigorous assessment of uncertainty associated with such decisions (Molenaar 2005). Modern estimating textbooks usually represent the contractor's contingency as a fixed percentage reported to be around 5–10% of the contract value (Smith and Bohn 1999). The usual practice is for this amount to be a single lump sum with no attempt made to identify critical line items and possible areas of uncertainty and risk (Mak and Picken 2000).

Researchers have also developed contingency prediction techniques based on different theories. For example, Smith and Bohn (1999) highlighted risk modeling approaches that include Bayesian probability analysis, Monte Carlo simulation, and the use of fuzzy mathematics. From the general contractor's point of view, the findings of Smith and Bohn (1999) indicate that only the firms engaged in the procurement of highly complex projects would be willing to invest in a formal analytical analysis of contingency. None of the managers interviewed in the study by Smith and Bohn (1999) had any knowledge of the mathematical models used to formulate contingency, nor did they use a formalized technique for estimating contingency. It appears that complex models are applicable only in high-risk projects such as tunnels and environmental remediation projects. Findings by Ford (2002) also indicate that there is no evidence of formal or standardized models, prescriptive contingency management methods, or advanced or objective analysis tools directed at contingency management.

A literature review indicates that owner contingency may be determined by a number of modeling approaches. For example, Mak and Picken (2000) present a technique called "estimating using risk analysis (ERA)" developed by the Hong Kong Government. They compare ERA and non-ERA projects and find that the mean and variance of the cost estimates in ERA projects were consistently smaller than those in non-ERA projects. According to Touran (2003), using a simple and common method such as adding 10% for owner contingency, based on previous experience with similar projects does not justify the degree of confidence that the contingency will provide against cost overruns. Touran (2003) therefore recommends the use of a probabilistic model to estimate

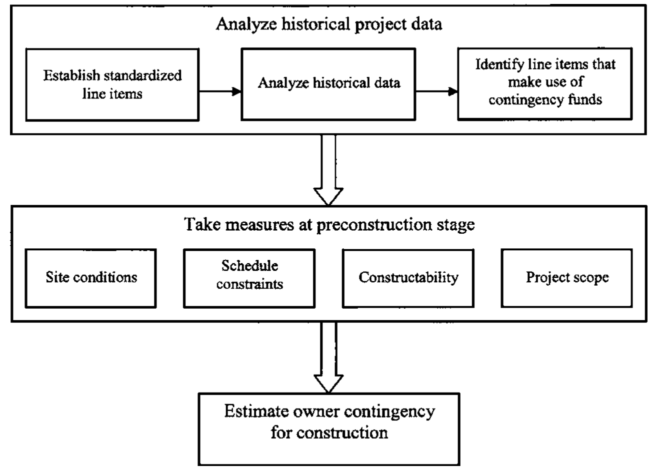

Fig. 1. Methodology for budgeting owner contingency

cost contingency. Oberlender and Trost (2001) present a quantitative procedure for predicting contingency based on an estimate and historical cost data. Molenaar (2005) describes a programmatic approach to cost-risk analysis for cost estimation of highway megaprojects contracted out by the Washington State Department of Transportation (WSDOT). Nine case studies, with a mean cumulative contract value over $22 billion, were analyzed in this study. Molenaar (2005) reports that WSDOT is successfully using the range of cost outputs obtained from this procedure to convey project costs to management and to the public. Baccarini (2004) investigated the cost data of 48 road construction projects completed by an Australian government organization. He analyzed them statistically to verify the accuracy of the contingency allocated by the government organization at the onset of the project. The organization estimated construction contingency based on past experience and expressed it in percentage of contract value. The results proved that the organization had room to improve the accuracy of its contingency estimates since the average construction contingency was 5.24% of the contract value but the average value of contract variations was 9.92%. Finally, according to Oberlender's (2000) "expected net risk model," the cost generated by the maximum possible risk is determined for each line item, the percentage probability that this risk will occur is assessed, and the expected net cost of the risk is calculated by taking the product of the cost and its probability of occurrence. The sum of the expected costs of the risks for all line items provides the total maximum contingency required.

It appears that there are various methods, some simple and some more sophisticated that facilitate the budgeting of owner contingency funds. The methodology that is presented in the next section does not only aim to estimate the contingency budget but it also attempts to reduce the amount of contingency allocated for each project.

Methodology for Owner Contingency Budgeting

Fig. 1 proposes a methodology that involves (1) systematically analyzing historical project data; (2) identifying line items that typically make use of contingency funds; (3) taking the necessary measures at the preconstruction stage to minimize the occurrence of these events; and (4) estimating the size of contingency funds based on this information. This approach was tested in a case study that is presented later in the paper.

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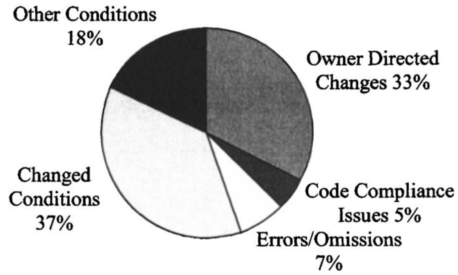

Fig. 2. Causes of change orders in school construction

According to this methodology, the owner should have access to historical data related to similar projects undertaken by the owner in the past. If the different line items in these projects are organized in standardized common categories, and if budgeted and actual cost information concerning these typical line items is available in these projects, the owner should be able to identify problematic line items. The owner will then be in a position to control these line items more carefully at the preconstruction stage and prevent the occurrence of unwanted events such as changes in scope, schedule acceleration, unexpected site conditions, etc. The process that the owner is expected to follow at the preconstruction stage is presented in the next section.

Armed with information about problematic line items, and having taken measures to minimize the occurrence of unwanted events, not only should the owner be able to anticipate contingencies with more confidence, but also it should be likely that the contingency funds necessary for the project are minimized.

Preconstruction Process to Minimize Owner Contingency

A recent study by Gunhan and Arditi (2007) analyzed a vast amount of data about construction/renovation of school buildings in a large school district to determine the major causes of change orders. Fig. 2 shows the relative percentages of these causes. It can be observed that the majority of the change orders (70%) were caused by owner-directed changes and changed conditions, both of which necessitated funding from the owner's contingency. The remaining 30% of the causes (i.e., code compliance issues, errors/omissions, and other conditions) were in general related to designer performance (for code compliance and errors/omissions) and contractor performance (other conditions); in these cases, the owner had less control and was generally relieved from using its own contingency funds.

The results of the study showed that the frequency of owner-directed changes and changed conditions can be reduced only if appropriate strategies are put in place at the preconstruction stage to eliminate many owner-directed changes, many last minute accelerations or enhancements, and many ambiguities relative to hidden/changed conditions. This can be achieved by conducting diligent site investigations, establishing a realistic work schedule, conducting constructability reviews, and achieving consensus on a well-defined project scope at the design stage. It is, of course, possible that the causes of change orders may differ depending on the type of project undertaken such as high rise buildings, bridges, roads, industrial projects, etc., but the principle that rigorous preconstruction services can reduce the frequency and magnitude of change orders and by implication the use of contingency funds does not change.

The preconstruction process involves conceptual and schematic design, design development, and construction documents development. Owners usually focus on the construction stage and may not be aware of the importance of the preconstruction process. As stated in Fig. 1, site conditions, schedule constraints, constructability issues, and project scope are to be considered in the preconstruction phase in order to minimize contingency expenses.

Site Conditions

One of the most important issues during design is the evaluation of existing site conditions. Every construction site has unique characteristics that will influence the way the project is managed and ultimately, the project cost. It is important that these items are identified early in the process and that the associated costs are incorporated into the estimate. Exploring the site conditions thoroughly is especially important to prevent experiencing unforeseen or changed conditions once the construction process is underway.

Schedule Constraints

A detailed construction schedule should be developed whenever adequate construction detail is available. Determining an accurate construction start date and making sure that the notice to proceed is issued on schedule may have significant budget implications, because delays in start-up can generate extra cost for the temporary heating of masonry or concrete work and for the temporary cooling of humidity sensitive finishes such as millwork or plaster.

Constructability Issues

Constructability is a term which has come to encompass a detailed review of design drawings, specifications, and construction processes by a highly experienced construction engineer before a project is put out for bids. It is described as the integration of construction knowledge and experience in the planning, design, procurement, and construction phases of projects consistent with overall project objectives by the ASCE Constructability Committee (Construction Institute of ASCE 2007). Constructability reflects the ease with which a project can be built and the quality of its construction documents. The benefits of a high level of constructability include reduced construction cost, fewer change orders due to less rework of construction put in place, shorter construction schedules, and improved construction site safety. The level of constructability of a project is affected by the extent to which construction knowledge is incorporated in the planning, design, and procurement phases of the project (Dunston et al. 2005). To obtain the maximum benefit from a constructability review, it must be initiated early in the project planning phase and continue through design and construction (Anderson et al. 2000). The expertise of the general contractor/construction manager firm plays an important role when it comes to identifying weak or defective points of the design and the missing scope content. According to the study by Arditi et al. (2002), faulty, ambiguous, or defective working drawings, incomplete specifications, and adversarial relationships are the three major factors that cause constructability problems. Constructability reviews help minimize these problems and allow owners to allocate less contingency in their budgets.

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Project Scope

The scope of a project defines the specific design items or services required to meet the project objectives. According to Knight and Fayek (2002), a lack of scope definition at the onset of a project is one of the main causes of cost overruns. They claim that a poorly defined project is subject to changes initiated by the owner that will require extra work and effort to complete. The Construction Industry Institute's (1986) publication on scope definition and control ranks the lack of scope definition during engineering as having the second highest impact on cost overruns. All owners surveyed, as well as all experts interviewed in Songer and Molenaar's (1997) study concurred that a well defined scope and a shared understanding of scope were the most critical project characteristics for successful public-sector design/build projects. According to Dumont et al. (1997), a poorly defined project can experience considerable changes that may result in a disrupted project rhythm, sizeable delays, significant rework, cost overruns, lower productivity, lower worker morale, and a greater potential for disputes. It is therefore widely accepted in the literature that poor scope definition is one of the leading causes of disruptions and unexpected cost overruns that require the use of the owner's contingency funds. A well defined scope at the outset is likely to allow the owner to allocate much smaller contingency funds despite the fact that many owners and contractors share the misconception that it is not economically feasible to spend the time and/or money necessary to adequately define the scope of work early in the project life cycle (Dumont et al. 1997).

Case Study

Cost data were extracted from nine parking lot projects built at airports that belong to a major city in the United States. The information included line item costs and line item changes for each project. The cost of the projects varied between \$237,000 and \$9.45 million and the number of line items varied between 15 and 150. The scope of work was similar for all projects except one project that had service road work in addition to the parking lot. The owner routinely added 10% contingency to budgets to fund all changes. In this case study, the term contingency refers to the owner's contingency and it is under the owner's control. All contract variations were funded by using this contingency. The varying numbers of line items for each project were consolidated into 20 standard line items including traffic control and protection, demolition, utilities removal/relocation, excavation, water line, drainage work, subbase paving, asphalt paving, concrete paving, concrete work (sidewalk and curbs), structural steel, pavement marking, fencing, landscaping, canopy work, parking control devices, electrical, signage, contaminated soil disposal, and foundation and geotechnical work. The actual costs of the change orders in the different line items were analyzed by comparing them with existing budgets. The study investigated whether establishing a 10% contingency is realistic or not.

The actual use of contingency funds in each line item expressed as a percentage of the contract value is presented in the first column of Table 1. The line item with the largest cost overrun and contingency use is canopy work (2.29%), followed by "paving—asphalt" (1.91%). A canopy is an overhead structure that provides shade and protection for pedestrians and vehicles from sun, rain, and snow. As it can be observed in the second column of Table 1 (budgeted cost of line item expressed as a percentage of contract value), asphalt paving is the costliest item among all the line items with construction of canopy being the third costliest. These two line items could very well be planned in good detail and their cost be accurately estimated at the preconstruction stage. This type of cost overrun is totally preventable if the preconstruction process is taken seriously, i.e., the scope is well defined, constructability reviews are conducted, and effective scheduling is performed. Electrical work constituted the third largest use of contingency (1.25%). In electrical work, labor represents 30–50% of the total cost depending on the project (Hanna et al. 1999). The impact of change orders on electrical work is significant because of the labor intensive nature of the work. Data for contaminated soil disposal (1.87%) and foundation/geotechnical (1.34%) were line items that appeared in only one project, and therefore constitute special cases.

Table 1. Contingency Use per Line Item

Scope line items	Average contingency used (percent of contract value)	Average cost of line item (percent of contract value)	Average contingency used (percent of budgeted line item cost)
Traffic control and protection	0.35	1.93	18.13
Demolition	−0.21	8.40	−2.5
Utilities removal/relocation	0.53	0.09	589
Excavation	0.41	6.17	6.64
Water line	0.01	0.61	1.64
Drainage	0.37	5.50	6.73
Paving—subbase	−0.34	7.52	−4.52
Paving—asphalt	1.91	30.17	6.33
Paving—concrete	0.35	2.91	12.02
Concrete	0.12	2.48	4.84
Structural steel	0.38	4.53	8.39
Pavement marking	−0.02	0.68	−2.94
Fence	−0.09	0.90	−10
Landscaping	−0.78	3.94	−19.8
Canopy	2.29	23.97	9.55
Parking control devices	−0.69	2.17	−31.8
Electrical	1.25	26.05	4.79
Signage	−0.13	3.78	−3.44
Contaminated soil disposal	−1.87	4.26	−43.9
Foundation and geotechnical	1.34	1.37	97.8

The actual contingency funds used in each line item, expressed as a percentage of the respective line item's budget is presented in the third column of Table 1. The line items that score high in this column are those that have major cost estimating problems, but do not necessarily have the greatest impact on total project cost. For example, the originally budgeted cost of "removal/relocation of utilities" was overrun by 589% (Column 3 in Table 1), whereas its impact on the overall budget was only 0.09% (Column 2 in Table 1). Inaccurate or missing as-built drawings of previous rehabilitations probably caused this overrun.

The budget for "traffic control and protection" was overrun by 18.13%. This line item exceeded the original bid amount due to changes in traffic control plans in the field. The cost overrun may be reduced by performing an advance traffic study during preconstruction, by improving the design, and by eliminating unclear

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Table 2. Original Contract Amounts and Total Contingency Use

Projects	Original contract values ($)	Total contingency (%)
P1	4,994,173	9.2
P2	236,745	5.44
P3	4,154,193	−7.59
P4	800,800	21.37
P5	2,114,864	−1.52
P6	1,767,507	5.3
P7	7,966,300	−3.4
P8	4,555,130	6.88
P9	9,438,438	−0.89
	Total: $36,028,150	Average: 3.86%

issues. General contractors usually include the cost of traffic control and protection into their general conditions. General conditions are planned during preconstruction. From both designers' and general contractors' points of view, this line item needs to be well analyzed at the preconstruction stage. This can be achieved by precise estimating and usually by generating plans that are based on previous experience.

Although most of the line items' costs were underestimated, the cost of "parking control devices" was overestimated by 31.8% on average. Parking control devices can ensure a smooth flow of traffic in parking lots. Technological advancements include sophisticated devices such as infrared array sensors, ultrasonic detectors, vehicle detectors, block guidance lights, and closed circuit television cameras. Because the rate of innovation in this field is rather rapid, estimators can often be uninformed about the new technologies and the price may change significantly based on the technology used. By the time procurement is made, the same devices can be obtained at lower prices. Designers and estimators should have access to updated information about the latest technological innovations and should follow carefully the trends in the market place and the fluctuations in prices.

The average contingency spent in nine parking lot projects was 3.86% of the total contract value (Table 2). The owner was successful in ensuring that adequate contingency was available in 9 of the 10 projects, an important objective, considering that lack of contingency funds in a project may result in serious disruption of the work and in considerable delays. But this objective was achieved at great expense, in the sense that the remaining contingency of $10.00-3.86=6.14\%$ of the total contract value was tied up, i.e, not used for contingency work and not available for additional projects either.

The maximum contingency used was 21.37% whereas the minimum was −7.59%. Negative contingency means that the allocated contingency was not used at all and that the project was completed under budget. If one throws out the outlier Project 4 (21.37%), the average contingency in the remaining eight projects turns out to be 1.68% of the contract value, much lower than the standard 10% allocated as a matter of policy by this owner. It should also be noted that the budgeted contingency could have been even lower than 1.86% of the contact value had the owner been able to pay close attention to asphalt paving, canopy work, and electrical work at the preconstruction stage. Given these findings, the owner's automatically budgeting 10% of the contract value as contingency in projects of similar nature appears to be unrealistic. A systematic approach such as the one proposed in Fig. 1 can help owners allocate contingency commensurate with the project and the conditions of the contract.

Conclusion

Given the uncertainties inherent in construction projects, owners generally experience difficulties in budgeting for contingencies. Owners often take the easy road and allocate a fixed percentage of the project value across all their projects. This approach is easy since it is based on experience and intuition, but may unnecessarily tie up valuable funds that the owner can use for other activities. A methodology is proposed in this paper (Fig. 1) that allows owners to systematically take advantage of accumulated project data relative to similar projects to the one being undertaken, and to take the necessary measures at the preconstruction stage to reduce the occurrence of unwanted events during construction. This approach was tested in a case study.

The findings in Table 2 indicate that the owner's policy of allocating 10% of the contract value as contingency was excessive in the case of all but one of the parking lot projects for which data were collected and analyzed. Indeed, except for one project where 21.37% of the total contract value was used as contingency, this number was consistently below 10% in all the other projects (average 3.86%). Also, it can be observed from the negative values in the last column of Table 2 that some of the projects did not use any contingency funds and that they were completed under budget.

A systematic and well managed process at the preconstruction stage of a project can eliminate or reduce the need to use contingency funds in many line items. The literature indicates that four factors, namely site conditions, schedule constraints, constructability issues, and project scope play an important role in minimizing the occurrence of future unexpected events and owner-requested changes. A detailed study of these factors can help initiate a series of early decisions that, in turn, can prevent the high frequency and magnitude of change orders issued later in the project life cycle, hence reducing the need for a large contingency.

The analysis of historical data obtained from only nine projects is not enough to make universal recommendations concerning the amount of contingency funds to be allocated in construction projects in general. It can, however, be stated that the methodology presented in this paper could help owners identify the line items that frequently require the use of contingency funds, and encourage the owner to take measures at the preconstruction stage to reduce the occurrence of these events and hence the size of the contingency budget. Freeing up contingency funds allows owners to undertake a larger number of projects.

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