SMALL TO MEDIUM CONTRACTOR CONTINGENCY AND ASSUMPTION OF RISK

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ABSTRACT: This paper is the result of an investigation into the use of contingency in smaller construction firms. It summarizes recent literature classifying construction contract risks and mitigation measures. Eight major classifications are used to organize the types of risk found in the literature. The risks are described in detail with associated risk mitigation strategies. Risk modeling techniques are briefly reviewed for their contribution to the risk categorization and contingency estimating. After reviewing the researcher's concepts of risk management in the literature, interviews were conducted with estimators and/or construction managers involved in the bidding process at 12 small to medium construction firms. The purpose of the interviews was to investigate the current risk management practices of small and medium size construction firms. The times when smaller companies used contingency had specific interest for the research. The literature findings were compared with important risk factors identified from the interviews. The main conclusion drawn from the comparison was that small to medium size contractors predominately use contingency in those situations where they are construction managers in a reimbursable contract. Generally, they do not use line item contingency in competitive bidding situations. Thus, these firms are assuming proportionally greater business risk than suggested by the literature on contingency.

INTRODUCTION

Contractor contingency can be thought of as a contractor's estimated value of the extraordinary risks they will encounter in a project. Extraordinary risk would be those risks not covered by bonds, insurance, or the contract. For example, unresolved scope issues or unforeseen conditions would contribute to extraordinary risk. A significant business risk in construction is procuring contracts at a price that will yield a profit. A contractor is less likely to win a contract, if contingency is set too high. Contingency set too low could result in significant financial losses. Therefore, contractors would be wise to consider the likelihood that a particular risk will occur, identify the potential financial impact, and then determine the contingency.

Current Sources of Contingency Information

Construction risk and contingency literature has generally focused on theoretical and analytical models for determining risk levels in contracts. Some models permit a direct evaluation of the contingency to be set for a particular contract. These models show that contingency can be organized in a predictable fashion and elements of contingency quantified. Modern estimating textbooks usually represent the contractor's contingency as a fixed percentage of direct cost. Generally the percentage reported is around 5–10% of the contract value. It is also assumed that contractors also have their own historical records to consider in setting contingency values. Without further investigation, the models and literature suggest that all contractors use contingency for every contract. This research set out to define factors considered by small and medium contractors in establishing their contingency markup. To understand how and when contingency is used, a general discussion of risk ''ownership'' from each contractual party's perspective is given and followed by a discussion of risk models and risk characterization.

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Background

Construction involves unforeseen and predictable risks (Smith 1992). Predictable risks are events or conditions that the contractor can foresee before construction begins. Problems like delays due to weather, loss of productivity because of construction changes, and delays caused by constructability issues or differing site conditions are forms of predictable risks. Risks related to natural disasters or gross design errors are usually unforeseeable during project planning. Smith also categorized the risk source as contractual risk or construction risk. Construction risks include, for example, weather, site conditions, and resource availability. Contractual risks arise from the documentation and administration of the construction contract.

Risk Perspectives

Each party in a contractual relationship will perceive risks from their unique perspective. Example risk perspectives representing owners, engineers, and contractors are discussed briefly. These perspective scenarios do not cover all risks and are provided only to highlight some important relationships.

Owners, who are the ultimate beneficiaries of the contract, may only be considering the project from a market share or production requirement perspective. Their greatest overall risk could reside in the ultimate product and not with the finished facility. The facility becomes a disposable asset, when the market conditions change. Owners generally procure design services needed to construct their facilities using traditional design services agreements or contracts similar to them. Within the description of services the design firms may be expected to advise the owner of specific construction related risk (time and cost estimates) as part of the design services. In some cases, a sophisticated owner may have a dedicated project management staff to perform many of the tasks necessary to design and construct facilities. Many use external consultants to perform project design. This transfers the design risk to the consultant, while the owner retains the general project risk. The project general conditions and specification language often reflect the owner's willingness to accept certain forms of risk in the project. For many owners, who lack sophistication in contracting construction, the use of a construction manager to oversee the process may be their best strategy. However, Matyas (1991) noted that, because they work in a building, some owners feel they know how to build a building. These

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unsophisticated owners may not solicit construction risk advice from a designer until it is too late.

The designer, working with the owner, develops the scope of the project through detailed specifications and plans. The design contract delineates the designer's responsibilities and allocates the risks. The owner's risk in selecting a designer includes the possibility of negligent design or preparation of substandard quality specifications and drawings. Engineers subscribe to errors and omissions insurance to cover the circumstances where the design falls short of commonly accepted ''standards of care.'' The design documents language greatly influences project risks. Complicating issues further, on many occasions designers work with owners who believe it is the design engineer's obligation to protect them against all project risks using whatever exculpatory language they can find in defense of their position. These owners blame any project problem on the designer or contractor. However, owners must recognize that design liability insurance does not constitute an additional contingency fund (Fleischer 1991). Design contracts, in comparison to construction contracts, are predominately labor and overhead. With proper care a designer can estimate the hours required for completing a design with some confidence. To recover costs, design contracts can include a stipulated sum for the basic design, additional design services costs, and reimbursable expenses. Errors and omissions insurance can cover possible shortcomings in the design. The majority of the risk encountered in the design process evolves from the relationship of the parties and the flow of information.

A contractor's overall business risk can be thought of as a portfolio of risks made up of individual project risks. Their portfolio changes frequently as some projects are completed and new projects are added. Unlike the designer, construction contractors work at higher risks created by the complexity of design and estimating total project costs. Recognizing this risk, owners often request bid, payment, and performance bonds from the contractor. The owner is paying for additional assurance that the contractor will perform the project as described in the contract documents. While the owner and designer can insure or bond many of their risks, a contractor cannot purchase ''insurance'' or obtain a ''bond'' for poorly prepared drawings and specifications, biased inspections, or significant scope changes. They must self-insure by adding contingency or assigning risk into change orders. The level of contingency to add to a contract depends on many factors. Researchers have sought to model risk on projects to determine contingency.

Formal Risk Modeling

Analytical models have been developed that contractors can use to estimate or evaluate their risk exposure. Ibbs and Crandall (1982) developed their risk decision model based on utility theory. Utility theory models are useful for modeling human value systems into a mathematical formulation. This decision modeling approach allows a contractor to estimate the impact of their risk decisions based on Bayesian probability analysis. The researchers' goal was to provide a consistent set of choices for specific circumstances. Due to the complexity of the model calculations it was recommended that analysis be limited to six factors.

Ashley et al. (1988) proposed using Bayesian probability analysis, influence diagrams, and simulation to identify high-risk situations affecting project cost and schedules. Uncertainty in construction bid estimating can be modeled using probabilistic estimating techniques. Both Spooner (1974) and Touran (1992) separated project activities according to risk potential. High-risk activities are assigned probability distributions using minimum, mean, and maximum activity costs. Low-risk activities do not have as much uncertainty. They are assigned a single value. A total project cost function is developed from the cost assignments. A Monte Carlo simulation is used to generate the project cost cumulative density function. After numerous trials, the project cumulative probability density function can be developed. Contingency is determined as a function of the confidence level, representing the level of risk the contractor is willing to accept. The Construction Industry Institute's (1989) publication on *Management of Project Risks and Uncertainties* also describes a Monte Carlo technique to evaluate risk.

Fuzzy mathematics has been used to estimate risk probabilities, which are difficult to measure using traditional mathematics. Project risks are often discussed using terms such as good or bad and high or low. Quantifying judgmental variables is difficult in any situation. Fuzzy sets provide a convenient way to include a measure for this type of variability. Boyer and Kangari (1989) suggested using fuzzy set theory, in an expert system environment, to evaluate risk based on perceived severity and sensitivity to project changes. The fuzzy-set-based expert system would permit a contractor to determine the probability or risk rating of detrimental outcomes and add contingency appropriately. Paek et al. (1993) presented a fuzzy set model for contractors to quantify project level risks. Risk elements of the contract are identified. Several estimators estimate the cost or duration for each element. The most likely and least likely intervals of time or cost are determined from this data. The output represents the potential outcomes at a particular uncertainty level. Once all risk elements are summed, a ranking process can be used to determine an average value of the total potential loss. This loss represents the optimum contractor contingency. Paek et al. suggested that the complex model process is applicable to only high-risk projects, such as tunnels and environmental remediation projects.

Paek et al.'s paper was the subject of a discussion by Moselhi (1995) where he performed a program evaluation and review technique- (PERT-) like analysis on the same illustration used by Paek et al. Because this analysis yielded similar results, Mosheli presented two issues: (1) What are the benefits of the proposed fuzzy method over the simple PERT-like approach; and (2) which of the two values presented by the models should a contractor have more confidence in and why? It is appropriate to extend these questions beyond the comparison of these two methods.

Given all of the analytical techniques, which of them gives a contractor any improved level of confidence? A serious drawback to the analytical models is their analysis complexity, including the approach of a PERT-like analysis. Because of their complexity, either the number of variables is limited or the project application is limited. By limiting the model or variables in solution, more contractors are likely to explore using analytical models, but their reliance on the technique is reduced. Also, the risks encountered in the flow of information are not modeled. Ultimately, the question of the benefits and value of these models posed by Mosheli should be addressed. One clear benefit of analytical models is contingency values that may represent a contractor's conditional risk paradigm.

RISK CHARACTERIZATION

An alternative approach to modeling key project risks is to categorize risks and to identify alternative risk management methods, including contingency. While this will not establish a contingency for the contractor, improved recognition of potential risk sources is needed in the decision to include contingency or other risk mitigation techniques.

Tables 1–8 were created from information collected by Smith (1991), Wideman (1986), Perry and Hayes (1985), and Al-Bahar and Crandall (1990). Project risk was classified into

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TABLE 1. Natural Risks

Risk (1)	Risk classification (2)	Responsible party (3)	Method of management (4)
Acts of God	External Unpredictable Construction	Shared owner and contractor	Insurance Delay clause Contingency
Loss due to fire or accident	Internal Unpredictable Construction	Contractor	Safety controls Insurance

eight broad categories for consideration. Each project risk category is subdivided into types of risk, risk classification, party responsible, and methods of management. Specific contract language, the contract documents, and management practices greatly influence when potential risks will become actual risk management problems. Risk is classified as internal or external. Internal risks are those found within the project and are more likely to be controlled. External risk indicates that the risk is generated outside the project and, in many circumstances, is not a controllable risk. The predictability of a risk captures the responsible party's ability to anticipate the likelihood that the risk will occur. A predictable risk has a reasonable certainty of occurring. Unpredictable risks are those that occur randomly. The final classification evaluates the source of the risk. The source can be contractual when the risk is based in the contract documents. It is a construction risk, if the source is likely to occur from project execution. In some cases the risk's exposure can be both contractual and construction. The tables are not presented as all-inclusive listings of risks. Only those risk features discussed in the selected articles are classified.

Natural Risks

Table 1 addresses forms of natural risks such as catastrophic events, losses due to accidents, and fire. Contracts usually consider these risks and minimize their influence with required insurance or clauses to provide equitable adjustments for the delays. However, without a contract clause addressing natural risks, the contractor will assume the complete risk of these losses. Contingency would be the only mechanism for managing physical risk in these cases. Contingency in this event would be a form of self-insurance.

Design Risks

Table 2 shows a more persistent use of contingency as a loss management technique for risks created by the design. The owner traditionally assumes most of these risks, and the owner's project budget should have some level of contingency. The contractor has some risk exposure with new technology installation risks. It is difficult to estimate productivity and potential delays without a basis for making the estimate. Rather than include contingency, contractors adjust their productivity rates or unit costs to reflect anticipated difficulties. In design-build or construction management it is common to add additional sums for unknowns and difficulties. This form of contingency is not allocated to overall project risk but for specific work related risks. In the event of scope changes without proper contract language contractors would include con-

TABLE 2. Design Risks

Risk (1)	Risk type (2)	Responsible party (3)	Method of management (4)
Scope changes	Internal Predictable but uncertain magnitude Contractual	Owner Designer	Preproject planning Allocation—changed conditions Mitigation—constructability review or design-build
New technology	Internal Predictable Contractual Construction	Owner Designer—function risk Contractor—installation	Analysis of technology risks Warranties Design liability insurance Contingency—owner and contractor
Specifications	Internal Technical Predictable Contractual	Designer Owner	Design and constructability reviews and check procedures Contingency—owner
Loss or delay due to differing site or design change	Technical Predictable Contractual Construction	Owner—site selection Designer—negligence	Allocation—changed Conditions clause Analysis—adequate site investigation Contingency

TABLE 3. Logistics Risks

Risk (1)	Risk type (2)	Responsible party (3)	Method of management (4)
Loss or delay due to damaged or late materials	Internal Predictable Construction	Contractor	Insurance Mitigation—site controls, quality control
Loss or delay due to resource availability	External Predictable Construction	Owner—selection Contractor—assess at time of bid	Mitigation—plan for limited resources Contingency—contractor
Site access	Internal Predictable Contractual	Owner	Allocation—site access disclaimer Mitigation—plan ahead to secure access
Delays in addressing or solving problems	Internal Predictable Contractual	All	Conflict resolution clause
Delay in presenting problems	Internal Predictable Contractual	All	Notice provisions

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TABLE 4. Financial Risks

Risk (1)	Risk type (2)	Responsible party (3)	Method of management (4)
Adequacy of project financing	Internal Predictable Contractual	Owner	Analysis—cash flow requirements during construction Contingency
Adequate cash flow	Internal Predictable Contractual	Contractor—submit accurate pay request Owner—payment	Mitigation—project cost controls Allocation—measurements and payments clause
Exchange rate and inflation	External Predictable Construction Contractual	Contractor—guess at time of bid Owner—only if provisions provided in contract	Analysis—economic Allocation—escalation clauses Contingency—contractor
Underestimation of cost	Internal Predictable	Contractor	Analysis—probability analysis to estimate budget Contingency
Contractor default	Internal Predictable Contractual	Contractor—internal financial control Owner—selects contractor	Payment and performance bonds Mitigation—owner should prequalify contractors; contractors should avoid bidding where they lack expertise
Cost overruns due to schedule delays	Internal Predictable Construction	Party who caused delay	Contract clauses

TABLE 5. Legal and Regulatory Risks

Risk (1)	Risk type (2)	Responsible party (3)	Method of management (4)
Problems with permits and licenses	External Unpredictable Construction	Shared	Mitigation—party best able to secure permits or licenses
Third party liability	External Unpredictable Contractual	Party implicated	Insurance Dispute resolution methods
Direct liability	Internal Predictable Construction Contractual	Party causing loss	Insurance Dispute resolution methods
Contractual failure	Internal Predictable Contractual	Party creating breach	Mitigation—clearer contract language to reduce interpretation errors and open communication systems
Changes in regulations	External Unpredictable Construction	Owner	Contingency Allocation—delay clauses

TABLE 6. Political Risks

Risk (1)	Risk type (2)	Responsible party (3)	Method of management (4)
Loss or delay due to war; revolution at site location	External Unpredictable Construction	Owner Contractor	Contingency Allocation—termination or delay clauses
Changes in trade laws	External Unpredictable Construction	Owner	Contingency Allocation—delay clauses Mitigation—specify domestic products

tingency. However, the recommended method for handling scope changes is through proper allocation in the changed conditions clause. Differing site conditions and changed design are similar to scope changes.

Logistics Risks

Table 3 shows that logistics risks are predominately contractor risks, yet the primary risk management recommendations are not contingency amounts. For logistics risks, the commonly suggested management method is to mitigate the risk through better planning. The one area where a contingency is recommended is for covering losses or delays due to resource availability. Contingency would cover the costs of expediting the resource or subcontracting the work. This opens the possibility that a contractor could use contingency to offset poor project planning and estimating. In the future, logistics risks should include information flow and relationships. Partnering is an example of a mitigation technique to overcome the risks associated with communication problems and relationships.

Financial Risks

Table 4 shows that most project related financial risks are carried by the contractor, with the greatest exception being the overall project funding by the owner. Contractor default is a form of financial risk that the owner can reduce by prequalification, but performance and payment bonds are more directly aimed at shifting the risk to the surety. The contractor obviously has a major risk in the event of contract default. They can minimize the extent of this risk by carefully selecting projects and avoiding ventures where they have little expertise.

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TABLE 7. Construction Risks

Risk (1)	Risk type (2)	Responsible party (3)	Method of management (4)
Quality problems	Technical Predictable Construction	Contractor	Mitigaton—quality control procedures Contingency—rework
Poor productivity	Technical Predictable Construction	Contractor	Mitigation—organize site for maximum productivity Analysis—probability and sensitivity Contingency—schedule/estimates of workhorse
Poor site safety	Internal Predictable Construction	Contractor	Mitigation—safety control program Insurance
Labor strikes	Internal and external Predictable Construction	Contractor	Mitigation—labor relations, contract agreement
Construction changes	Technical Predicable Construction	Contractor Owner	Mitigation—review plans jointly to determine changes Contingency—owner and contractor
Inclement weather	External Predictable Construction	Contractor	Mitigation—schedule weather impacts into project schedule
Losses and delays due to improper means and methods of construction	Technical Predictable Construction	Contractor	Mitigation—review means and methods prior to implementation Contingency

TABLE 8. Environmental Risks

Risk (1)	Risk type (2)	Responsible party (3)	Method of management (4)
Ecological damage, pollution, waste treatment	External Predictable Construction	Owner—initial site Contractor—construction	Analysis—site investigations Contingency Mitigation—use strict pollution control measures Mitigation—exclude pre-existing conditons using the contract

Contractor financial risks often arise from poorly prepared estimates.

Legal and Regulatory Risk

The next category of risk, summarized in Table 5, covers legal and regulatory risk. Permits and licenses should be a shared project risk. Building permits are often the contractor's responsibility. Proper contractor licenses for the jurisdiction is also risk carried by the contractor. Many legal and regulatory liability risks are covered by the various insurance policies purchased by the contracting parties. Changes in regulation, which may create additional project expenditures, are the owner's risk to be considered in their contingency.

Political Risks

Table 6 summarizes political risks generally assigned to the owner. Political risks are external to the project and unpredictable in frequency and magnitude. The management of political actions is primarily the owner's responsibility, and the management method recommended is usually a contingency.

Construction Risks

The contractor assumes responsibility for the majority of the construction risks outlined in Table 7. However, mitigation measures are the most common management method recommended. The mitigation measures listed tend to focus on improved planning and implementation of project control systems. Contingency is listed as an alternative management method in quality problems, poor productivity (time contingency), changes, and delays. These problems are predictable, which suggests that they can be anticipated, but their magnitude and cost are very difficult to forecast. For quality problems, rework can be estimated from prior work, if rework costs have been independently tracked. Generally, rework costs are part of historical costs but are not tracked independently. Schedule contingency and related cost contingency can be allocated for potential productivity problems. The owner usually sets the schedule deadline so that schedule contingency would include mitigation measures such as increasing the number of crews. This contingency is most directly addressed by adjustment to sensitive activities or those with an anticipated higher risk. Construction changes should be included in a changes clause, but in those instances where no clause exists or the work may be disputed an allowance for contingency should be made. Losses due to the contractor's poor planning or execution would have to be recovered from internal funds. Recovery for errors in method selection may not be possible, even with a contingency account. Changes in the method of construction are highly significant when the estimate and schedule are both linked to preproject planning assumptions. This highlights the importance of performing bid reviews that include discussion of planned work sequences and feasibility.

Environmental Risks

One of the newest risks on construction projects involves environmental risk. It could be argued that it should be classified with political risks, because this legislation tends to change frequently. The owner has, perhaps, the greatest level of control on the environmental risk during the site investigation and design phases. However, the contractor is exposed to the environmental risks during construction. Environmental risks are summarized in Table 8.

Characterization Summary

Tables 1–8 clearly do not provide for every conceivable form of risk. Many of the contractor risks, particularly their

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TABLE 9. Factors Increasing Contingency Markup

Factor (1)	Number of contractors (sample size = 12) (2)
Work load	8
Smaller contract size	7
Increased project complexity	6
Lower number of bidders	6
Owner's poor reputation	4
Tough bidder mentality	4
Unclear contract documents	3
Short bidding time frame	3

construction risks, will have contingency as a secondary mitigation technique. Detailed planning and good process controls are suggested throughout the literature as the primary mitigation measures. Owner contingencies are also recommended for many risks. Designers did not have contingency listed as their internal mitigation measure, although it would be an alternative in some instances. This summary would further support the idea that the use of contingency funds is widespread and that they are common features of contractor estimates.

CONTRACTOR INTERVIEWS

Given the variety of formal risk models and the wide variety of risk related information available in the literature, it was desired to identify the models and those factors most frequently considered by contractors engaged in ''common size projects.'' Twelve contractors agreed to participate in interview sessions lasting from 2 to 3 h, depending on the amount of discussion generated on particular risk issues. The contractors interviewed were a fairly homogeneous group according to their operational characteristics. They were selected from those contractors known to be working on university contracts. Referrals were obtained from the University of Delaware's Facilities Planning Department and the Pennsylvania State University's Physical Plant Department for firms that recently completed contracts.

Eleven of the 12 contractors had performed work for more than one university or similar client. The firms interviewed had worked in various capacities. Three firms work exclusively as general contractors. Eight contractors worked as construction managers, either at risk or in a service agreement. The respondents used two forms of construction management. One construction manager worked only in design-build arrangements. Some construction managers worked only as agents of the owner, and provided contract administrative services. Other construction managers took contracts ''at risk,'' meaning they have total project cost and administration responsibilities. Working from both positions allowed respondents to contrast their treatment of risks depending on their project involvement. The personnel interviewed had various levels of experience in estimating and construction but had responsible charge for small to medium size contracts.

Contractor bid practices reflect two basic approaches to formulating their bids. One approach has the estimating department preparing quantity take-off and estimates, while the chief estimator or other company executive develops the bid strategy. The other approach has the project manager responsible for both bid estimating and bidding strategy.

Interview Findings

The literature on the formal contingency models suggested that only firms engaged in procurement of highly complex projects would be willing to invest in the formal analytical analysis. The interviews supported this position. None of the managers interviewed had any knowledge of the mathematical models used to formulate contingency, and they did not have any formalized technique they used for estimating contingency.

Discussions about the use of contingency were more energetic. The techniques described elsewhere in this paper assumed that contingency was primarily a line item in an estimate based on a percentage of the total project cost. Therefore, the estimate itself included all anticipated deviations from normal practices and unusual events. In reality, contractors tend to ''buffer'' bids whenever they feel uncertain about the cost of an individual work item. This was not viewed as contingency but as an adjustment to working conditions. Future risks were not considered the only difficulty of the work. The contractors did suggest that, in addition to adjusting unit rates to account for anticipated work difficulties, contingency was a percentage added to the total project cost.

Competition Factor

Competitive contracting, public and private, offers the owner an opportunity to obtain the lowest price to build a project. The participants in the interviews felt that the competition factor forced contractors into estimating costs and margins in overly optimistic terms to minimize the tendered price. They simply assumed nearly ideal conditions and ignored many factors that would suggest that problems should be anticipated. Worse yet, some estimators admitted to underestimation to obtain work that would keep work crews and equipment operating. Underestimation essentially increases financial risk to a project and greatly increases the opportunities for losses. Thus, obtaining work clearly supersedes many project risk factors. Only one contractor interviewed used a line item contingency in their bid proposals. They used a value that was set sufficiently low enough so that they did not feel it included all possible risks in the project. The other contractors indicated that they would not use contingency in competitively bid work at any time, fearing that inclusion would put them at such a disadvantage that they could not be competitive. Clearly, when 11 out of 12 contractors are not using contingency, a company using a contingency allowance is likely to be much less competitive in bidding work. Nine of the 10 contractors that competed for direct work felt that their competition never used contingency.

Factors Influencing Markup

The contractors interviewed considered contingency and markup changes separately. When asked to identify those factors creating the types of risks that would increase their markup on a project, the contractor responses were collected and categorized in Table 9. While they did not consider this increase a ''contingency,'' the increased markup addresses many of the same factors identified in the literature.

Each of the factors will be discussed briefly. ''Work load'' means that capital resources of the contractor are nearly stretched to the maximum. If the bid is successful with a higher markup, the extra income is used to offset the extended costs for staff and equipment. Smaller contracts often require as much administrative burden as projects that are several times larger. For small contracts the markup is increased to account for this use of resources. Increased complexity is the first project related factor. It would make sense that a contractor would want to be reimbursed for their efforts. Fewer bidders reduce the level of competition, and higher markups can be used without damaging the likelihood of success. The owner's reputation was identified as increasing the markup. Specifically, the comments were that this number would change on the basis of whom the owner appointed as their contract representative. A ''tough bidder mentality'' is how

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bad the competition wants the job. The bidder takes a fixed amount of markup and will not do the work for less. Increasing markup for short bidding time frames suggests that markup is being used for those contingency items where the contractor could make mistakes in bidding or for those areas where the best subcontractors could not be found to do the job.

High-Risk Owners

Several comments made in the interviews suggested that the contractors accounted for the owner and engineer on the project as much as the work itself. Knowledge of working with particular owners, and in many cases rumors, were justification for increasing markup. The three primary factors contributing to ''high-risk owners'' were as follows:

- Inadequate architect-engineer drawings or poor decision-making capability
- An owner that does not pay on time
- An owner that is known to be a poor contract administrator

Change Orders

Several contractors in the study admitted to manipulating change orders to ''make up'' for money lost on the project. Often their increased markup is also lost due to the inefficiencies of small material orders and work relationships. Half of the contractors relied on change orders to recoup losses due to unexpected circumstances. Four of the eight general contractors relied on changes to account for all adjustments for risk.

Subcontractors

The interviewed project managers also discussed the use of buy-out savings from subcontractors to fund contingency accounts. Or in some cases, where they suspect a subcontractor has omitted something from the contract, they will include an adjustment amount in their bid. If the subcontractor later claims for the extra payment, the money was allocated in the budget for that purpose. This practice closely resembles assigning line item contingency to bid items. An unprofessional approach to subcontractor contingency is to force subcontractors to take their contracts at lower prices if they want the job.

Contractual Risks

The lack of contractual clarity is an important issue. Yet, four of the contractors interviewed stated that competition was too tight to worry about contract clauses in the bid. The consensus among the contractors was that only the specifications and drawings were consulted during the bid. In larger firms the company counsel often reviews the contract itself. General conditions and related supplemental conditions were not reviewed in detail during the bidding process. On some occasions the contract would be referred to a contract attorney for review, particularly when nonstandard contracts were involved. Many owners in lump-sum bidding would not negotiate terms of contracts. The contractor then must decide what extra costs the contract clauses might cause in the project.

Construction Manager Contingency

As an owner's construction manager, the contractors would work for the owner and act as the owner's representative on site. They prepared the initial project cost estimates, provided coordination of prime contracts, and administered the contracts with the contractors. These professional services were provided to the owner using reimbursable contracts for fees and fixed overheads. The scope of services and the quality of the services in the construction management agreement are believed by the construction management firms to be key elements in their selection. Generally, the agency form of construction management imposed no additional risks to the construction manager; they would not use their own contingency but included project contingency for the owner. When working as a construction manager ''at-risk'' owner contingencies would be added into the project estimates. When asked about firms they compete with in obtaining work, all agreed that their competition would be using a contingency in their estimates.

COMPARISON

The apparent reluctance of small and medium contractors to include contingency in their contracts is concentrated on one factor—competition. In times when competition is high contractors are not including contingency. Most modeling techniques and the tables of risk factors did not consider the competition risk factor as an overriding concern. However, the interviews suggested that a high number of bidders and low workload would almost guarantee no contingency in the bid. However, it is not automatic that a low number of bidders and high workloads will be the only rationale for using contingency.

The next consideration discussed by the contractors was the capability or quality of the design. The higher their confidence in the adequacy of the design the lower the likelihood of bidding contingency. If the design was adequate, the owner's payment reputation was the only other critical factor considered for adding contingency.

CONCLUSIONS

Where contingencies are used in construction management contracts, the interviews revealed that contractors had no knowledge of the formal modeling techniques published on risk models. Where contingency was included in contracts, the construction managers use a percentage of the total cost approach based on their intuition and previous contract knowledge.

The analytical modeling methods tend to omit a market or competition factor. Most general contractors cannot afford to include a contingency line item due to market forces. They acknowledge the risk in the contract, but the external influence of their competitors and internal influence of maintaining a backlog of work affect the risk preferences of general contractors. A lower workload increases the importance of obtaining additional contracts to cover overhead and maintain workforce. Thus, in periods of higher competition, contractors are assuming more risk than usual. Fewer allowances in the contractor's estimate are likely to result in more changes claimed. For an owner, periods of high competition would yield bid prices that on the surface would be exceptional values. Knowing that the contractors have not conditioned their bids with contingency to cover many common risk factors, the bargain bids may not prove to be bargains.

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