Risk and Price in the Bidding Process of Contractors

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Abstract: Formal and analytical risk models prescribe how risk should be incorporated into construction bids. However, the actual process of how contractors and their clients negotiate and agree to price is complex and not clearly articulated in the literature. With participant observation, the entire tender process was shadowed in two leading U.K. construction firms. This was compared with propositions in analytical models, and significant differences were found. A total of 670 h of work observed in both firms revealed three stages of the bidding process. Bidding activities were categorized and their extent estimated as deskwork (32%), calculations (19%), meetings (14%), documents (13%), off-days (11%), conversations (7%), correspondence (3%), and travel (1%). Risk allowances of 1–2% were priced in some bids, and three tiers of risk apportionment in bids were identified. However, priced risks may be excluded from the final bid to enhance competitiveness. Although risk apportionment affects a contractor's pricing strategy, other complex microeconomic factors also affect price. Instead of including pricing contingencies, risk was priced primarily through contractual rather than price mechanisms to reflect commercial imperatives. These findings explain why some assumptions underpinning analytical models may not be sustainable in practice and why what actually happens in practice is important for those who seek to model the pricing of construction bids. **DOI: 10.1061/(ASCE)CO.1943-7862.0000293.**

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Introduction

Formal and analytical risk models that contractors can incorporate into the bidding process for the purpose of allocating risk contingencies have proliferated in recent years [e.g., a fuzzy set model by Zeng et al. (2007); a fuzzy logic-based artificial neural network model by Liu and Ling (2005); a fuzzy set model by Paek et al. (1993); a fuzzy set model by Tah et al. (1993); and an influence diagramming-based technique by Al-Bahar and Crandall (1990)]. However, several empirical studies of contractors have shown that they are rarely used in practice [seven contractors in the United Kingdom studied by Tah et al. (1994); 30 in the United Kingdom studied by Akintoye and MacLeod (1997); 12 in the United States studied by Smith and Bohn (1999); 84 in the United Kingdom studied by Akintoye and Fitzgerald (2000); 38 in Hong Kong studied by Wong and Hui (2006); and 60 in Hong Kong studied by Chan and Au (2007)]. This paper will demonstrate that the relationship between risk and price in the process used by contractors to calculate their bids for construction work is not articulated sufficiently in the literature although it is summarized in Laryea and Hughes (2008).

Most analytical risk models proposed by academic researchers have sought to prescribe how risk should be included in a bidding price. However, the actual process of how contractors and their clients negotiate and agree on price is complex and not clearly documented in most of the literature. As explained in a construction contracts textbook by Murdoch and Hughes (2008, p. 128), many contracts for construction work are created by the process of tender, which often involves some form of market competition that clients use to obtain the lowest price from contractors.

The fact that the pricing of work occurs in the tender process means that first, a basic understanding of the whole tender process used by contractors to arrive at a bidding price is needed. Second, a basic understanding of how and in what circumstances price is influenced by the apportionment of risk is needed. However, little empirical research exists about the process used by contractors to put together a bidding price, as shown in Appendix I. Without a precise understanding of how contractors price a bid and account for risks in reality, it would be difficult to conceptualize analytical models for approaching risk response in the way that it normally happens in practice. Risk assessment should have a serious influence on a contractor's pricing strategy, but other factors also affect price.

The price clients are willing to pay for construction work depends not only on their available resources, but also on what other sellers (i.e., contractors) in the market are willing to offer for the same product. (See the microeconomic theory of the behavior of individual competitive markets in Lipsey 1979, p. 93.)

A bidding price may be dependent on the market or competitive environment in which it takes place. Brook (2004) explains that bidding often involves two processes. First, estimating is the stage in which the actual project costs are considered. This process may depend on the level of expertise in a contractor's estimating department. Second, adjudication is the stage in which the directors of a firm take a commercial view of the estimated cost in the context of the firm's particular circumstances, market conditions, and risk. Management will ultimately try to pitch the bidding price between cost and value to win the work. (See the explanation in Murdoch and Hughes 2008, pp. 138–139.)

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The approach used by contractors to evaluate risk in the process of pitching their bidding price to respond to these factors is not always clearly explained in the literature, as shown in Appendix I. However, several analytical approaches have been proposed to help contractors deal with risk when bidding. Without a sufficient understanding of how contractors actually price a bid and consider risks in reality, it would be hard to conceptualize analytical models that align with what contractors actually do. However, as Skitmore and Wilcock (1994, p. 142) acknowledged, it is hard to get contractors to participate in studies of this nature primarily because of the commercially sensitive data involved.

Several studies of contractors have shown that contractors are often reluctant to fully account for the cost of risk in their bidding price to avoid inflating their price with risk allowances and become uncompetitive. [See, for example, an interview study of 12 U.S. contractors by Smith and Bohn (1999) and a questionnaire study of 400 U.S. contractors by Mochtar and Arditi (2001).] Thus, it is not surprising that several studies have shown that most contractors rarely approach the incorporation of risk in their bid proposals according to the contingency allocation theory prescribed by most analytical models. It also implies that other risk response mechanisms are probably used by contractors that could be shared and used to guide practical risk analysis techniques.

Background

Risk is a part of business endeavors because of uncertainty (Flanagan and Norman 1993; Fischer and Jordan 1996). Portfolio theory and capital market theory stipulate that total risk consists of two types of risk (Fischer and Jordan 1996). First, systematic risk, which cannot be controlled, emanates from external factors such as acts of God, natural disasters, market risk, interest-rate risk, and purchasing-power risk. Second, unsystematic risk, which can be controlled, relates to organization-specific factors such as business risk and financial risk. These forms of risk are fundamental to the construction (internal and external risk) and the insurance (pure and speculative risk) industries. [See, for example, a study on risk allocation in tenders by Tah et al. (1993) and the textbook about insurance by Dorfman (2002).]

As shown in the financial analysis textbook by Fischer and Jordan (1996), one way of pricing a product to meet expected profit is to quantify risk and build a required rate of return that represents a riskless rate plus compensation for individual risk factors. Connolly (2006) explained that risk has cost, which can sometimes be catastrophic. However, it is not easy to predict or to price risk, as shown in a survey of the top 400 U.S. contractors, which revealed that pricing is a complex and difficult task for entrepreneurs (Mochtar and Arditi 2001).

According to a conceptual study by Mulholland and Christian (1999) in which an analytical approach was proposed for risk assessment in construction schedules, construction projects are initiated in complex and dynamic environments, resulting in circumstances of high uncertainty and risk, which are compounded by demanding time constraints. Flanagan and Norman (1993) explained that every construction project is unique in its features and risk. However, risk is not unique to the construction sector, as explained in the textbook about subjective probability by Wright and Ayton (1994). In the definitive guidance on economic theory and the construction industry, the writers observed that it is more often the way a set of factors combine to affect construction work that makes the industry unique (Hillebrandt 1985). In a historical overview of the construction industry, Hughes and Hillebrandt (2003, p. 508–510) showed that these factors relate to the economic, contractual, political, and physical environments in which construction projects take place, and they tend to affect the way construction work is described, awarded, and documented. These factors include the necessity to price the product before production, competitive tendering, low fixed-capital requirements, preliminary expenses, delays to cash inflow, the tendency to operate with too little working capital, seasonal effects, price fluctuations, government intervention, the activity related to development, uncertain ground conditions, unpredictable weather, and no performance liability or long-term guarantees. These factors are also explained in Calvert et al. (1995) and Kwakye (1997) who also show that construction projects are mostly complex, have a long production cycle, and involve the input of many participants.

In some aspects of construction management (e.g., Baloi and Price 2003, p. 262, and Ahmed et al. 2002, p. 4), researchers have argued that contractors are poor at managing risk, simply because the experiential-based mechanisms they are reported to use in approaching risk are not systematic in nature. However, this assertion does not ring true, in the light of other descriptions of the construction sector. A historical overview of the construction industry by Hughes and Hillebrandt (2003, p. 511) shows that from the early part of the nineteenth century, contractors have responded to risks in the construction industry by using various means. Most contractors have resorted to the construction of speculative housing in the nineteenth and twentieth centuries to sustain the labor force and business costs through the peaks and troughs of contracted work. A growing tendency exists for contractors to use their positive cash flow to invest in public/private partnerships (PPP) and private finance initiative (PFI) projects in which governments encourage the use of private-sector capital to procure public services. More recently, successful contractors are diversifying into businesses whose cycles counteract those of the construction industry. Contractors are mitigating risk by declining work perceived as too risky, subcontracting large portions of their work to others, and apportioning risk in wage structures. In essence, they are passing risk on to others in the supply chain. These contractors do seem adept at managing risk. However, by its very nature, risk is difficult to mitigate fully in all business sectors not just in the construction industry.

Construction practitioners are often trained to account for risk in projects, particularly, for example, with the compilation of a risk register, as outlined by the Project Management Institute (PMI) (2004, pp. 237–268). This demonstrates that the importance of risk analysis is understood by practitioners. However, a detailed description of how contractors get from their understanding of risk to setting a price is not typically explained in the literature.

The construction management literature articulates experience and intuition as the primary mechanisms that contractors use for pricing risks. For example, a survey of 400 U.S. contractors by Mochtar and Arditi (2001) showed that

> In setting their bid offer, most contractors rely on their intuition after subjectively assessing the competition; most contractors do not use special pricing software. However, most analytical approaches appear to argue that experience and intuition do not form an adequate professional and objective basis for serious project management decisions (Al-Bahar and Crandall 1990). More than 60 systematic and rational approaches have been proposed as logical substitutes for the traditional, intuitive, unsystematic approach used by most contractors for assessing and pricing risk (Laryea and Hughes 2008). However, in most of the studies reviewed, no reference was made to any comprehensive empirical work that explains

how contractors actually account for risk in the whole tender process.

Several writers (Kangari and Riggs 1989; Paek et al. 1993; Tah et al. 1993; Liu and Ling 2005) have also proposed analytical models that contractors can use to assess risk in the bidding process. Citing the lack of significant work in construction risk analysis by fuzzy sets, Kangari and Riggs (1989) proposed a fuzzy set risk assessment methodology that can give contractors "…a more rational basis on which to make decisions." The writers showed how a risk value, calculated by using fuzzy set principles, may be included as a risk premium in bids. However, no reference was made to any empirical research about what contractors actually do.

By using the same fuzzy set theory, Paek et al. (1993) proposed a risk-pricing method that contractors can use for analyzing and pricing risk when "…faced with the problem of deciding the bidding price of a construction project when the likelihood of the occurrence of risk events and the risk associated consequences are uncertain." The model prescribed how an optimum risk premium should be included in construction bids. Here too, no reference was made to any empirical research about what contractors actually do.

Tah et al. (1993) developed a conceptual model for "contractor's risk assessment during tender preparation for the purpose of allocating contingencies to cover the risks" by using the principles of fuzzy set theory. Liu and Ling (2005) introduced a fuzzy logic-based artificial neural network model to help contractors in the "… estimation of markup in a changeable and uncertain construction environment." In justifying the model development, Liu and Ling argued that

> …it is important to be able to model markup estimation as the model can act as a decision aid to help contractors to overcome their shortcomings in judgment and limited short-term memory, which prevents them from processing large amounts of information. However, the study cited no evidence to show that contractors do indeed have shortcomings in their judgment or a limited short-term memory, for which reason they require a sophisticated model to help in markup estimation.

This paper argues that the mechanisms used by contractors to price risks in the bidding process should guide practical risk analysis techniques. The way that contractors and their clients negotiate and agree on price is complex and not well explained in most of the literature. Several experiential-based textbooks and materials about estimating and bidding were identified (Brook 2004; Buchan et al. 2003; Hinze 1993; Harrison 1981; Skitmore 1989; Smith 1986; Geddes 1985; Wood 1982; Enterkin and Reynolds 1978; Wainwright and Wood 1977; Hall 1972; Willis 1929). However, just a few empirical studies about what contractors actually do were identified (see Appendix I), and these did not seem to articulate sufficiently what contractors actually do during the entire bidding process.

In practice, contractors clearly account for risks when calculating their bids for construction work. Analytical risk models could be useful. However, no comprehensive study exists that explains the entire bidding process of contractors and particularly how risk is accounted for in the process. Without a precise understanding of what contractors actually do when they calculate their bids for construction work, it would be difficult to prescribe improvements, and the basis of the information used in teaching about bidding processes in construction schools would remain open to question.

Therefore, the following questions should be addressed:

- What basic tasks are involved in a bid calculation process, and to what extent do they consume in the time needed to prepare the bid?
- What basic stages and roles are involved in the bidding process?
- How is risk accounted for in the calculation of construction bids?
- To what extent is the bid calculation process systematic in nature?

Without empirical work explaining what actually happens in practice, which would guide or justify the development of a new approach, the vicious circle seems inevitable. Our ability to prescribe improvements (e.g., analytical models) is dependent on our ability to precisely describe reality. With the current empirical understanding of what contractors actually do during the entire bidding process, we can safely prescribe very little. Our purpose in this paper is to conduct a comprehensive, inductive, and intensive study (see Mintzberg 1973, pp. 230–231) that captures the entire bidding process and describes the specific manner in which contractors account for risk when pricing work, thus providing a basis for comparing theoretical risk analysis models with the actual practice of risk analysis. This understanding will help to guide future developments to support contractors in their pricing of work.

Specific Objectives

The specific objectives of this study are

- to review the analytical approaches proposed by academic researchers for contractor's risk analysis (i.e., theory);
- to ascertain how contractors actually account for risk in the bidding process (i.e., practice); and
- to compare the theory with practice to show how the findings can guide future developments to support contractors in their pricing of work.

General Research Approach

To achieve the research objectives, three things are necessary. The first, identifying and examining analytical approaches proposed in the literature for contractor's risk analysis, requires a comprehensive method for capturing the analytical models and learning about their propositions and underlying assumptions. The second, ascertaining what contractors actually do about risks during the entire bid-pricing process, requires a comprehensive method for capturing pricing activities, observing what contractors do when they put together a price, and learning about what features they account for, including the extent to which they apportion risk and the mechanisms that they use for building up their contingencies. The third, comparing results from the first two objectives to identify potential areas of significant difference, allows for recommendations that will guide future developments.

Objective 1: Review of Analytical Risk Models

The research method for achieving the first objective consisted of an examination of construction management journals, each from their first issue to articles in press as of May 2008. The purpose was to identify all papers about risk and to document papers containing proposals for risk analysis at the tender stage. This helped the writers understand the underlying assumptions in the existing analytical propositions. A paper by Chau (1997) about "the ranking of construction management journals" provided a basic idea about the journals in the field. The remaining papers were identified through a rigorous Internet search that was followed by another search with a snowballing approach by using references in papers previously identified. A comprehensive table of the risk models identified can be found in Laryea and Hughes (2008). Altogether, 67 analytical approaches for risk analysis were identified, beginning with a probabilistic model by Gates 1971 for quantifying the contingencies for bidding mistakes, uncertainties, and variations in monetary terms. The frequency of this type of article proved to increase: five in the 1970s; 11 in the 1980s; 24 in the 1990s; and 25 in the 2000s to date.

Analytical risk models may be useful. However, several studies of contractors provide evidence and reasons why contractors rarely use the analytical risk models that have proliferated in the literature. In separate research studies involving more than 30 contractors each, Akintoye and MacLeod (1997) and Ahmed et al. (2002) identified eight problems contractors face when confronted with project risk analysis models. Smith and Bohn (1999) criticized risk models for their complexity and other shortcomings. Their interviews with 12 U.S. contractors showed that contractors often consider market competition as an overriding concern when pricing work, but most analytical risk models hardly address this.

Most of the 60+ analytical risk models for contractors examined and classified in Laryea and Hughes (2008) were hardly derived from the kind of information commonly used in practice. First, they were found to be primarily analytically derived models. They were essentially developed because of the mathematical modeling ability of the writers rather than the exigencies of actual bidding practice. Not to mention the sophistication involved, the propositions hardly incorporated the reality that market premium may, in fact, override risk premium (Smith and Bohn 1999, p. 106), especially because estimators deal with costs whereas directors deal with premiums. Most analytical risk models did not seem sensitive to the commercial exigencies of bidding practice.

Second, most analytical models prescribed a three-step process for approaching risk in the bidding process: risk identification, risk assessment (i.e., risk analysis and evaluation), and risk response (i.e. contingency allocation). The classical proposition in most analytical approaches (Tah et al. 1993; Paek et al. 1993) is that a risk premium derived from the evaluated risk value of a project should be included in the bid price to cover risks. However, contractors studied by Smith and Bohn (1999) indicated that, in reality, they try to avoid inflating their bid prices with risk allowances to beat the competition to win work. In fact, an ethnographic study of seven tendered projects by Rooke et al. (2004, pp. 658–659) showed that contractors strategize to win the work first and then use mechanisms (e.g., claims) to recover the cost of risk. Thus, contractors may be adept at dealing with risk, although authors like Al-Bahar and Crandall (1990), Tah and Carr (2000), and Zeng et al. (2007) assumed that the intuitive and experiential-based approach used by most contractors when dealing with risk did not form an adequate professional and objective basis for serious project management decisions.

Third, no comprehensive study was found in the literature to capture the entire bidding process of contractors; describe how risk is accounted for throughout the process; and show that pricing is indeed systematic in nature. To this end, the systematic models proposed to help contractors in their pricing of work and risk may have no justifiable empirical basis.

Objective 2: Case Studies about Bidding Process

Research Design

The primary issues considered in formulating the research design were the nature of the question asked, the unit of analysis, the validity of the research findings, and how others have approached similar research problems. Most studies in construction management seem to be developed on the routine questionnaire and interview surveys. Here, however, the unit of analysis was an entire tender process from start (i.e., the receipt of a tender document in the office) to finish (i.e., the submission of the bid). The research question was, how do contractors account for risk when calculating their bids for construction work? A comprehensive, intensive, and inductive strategy for capturing pricing activities, observing what contractors do when they put together a price, and learning about what features they account for, including the extent to which they apportion risk and the mechanisms that they use for building their contingencies, was required. The research required to determine the answers to these questions needed to be designed to capture what contractors do rather than merely asking questions about what the literature reports.

The nature of the questions asked required a method that gave a high degree of ecological validity of the research findings (Gill and Johnson 2002). Hence, a two-stage research approach was formulated to deeply explore how contractors calculate prices for their bids for construction work and how risk is accounted for. The first stage of the research project was a preliminary investigation with some national contractors to gain an initial understanding of their actual bid-pricing practices, a review of queries developed during the literature review, and an identification of themes to help formulate an appropriate research design for the second stage of the research project. The first stage, which involved documentary analyses and in-depth interviews with five U.K. contractors, was reported in Laryea and Hughes (2008). Therefore, in this paper, the focus is on the second stage of the research project: to observe examples of tender preparation in practice to see pricing strategies at the operational level. Because of a similarity in the nature of the question asked, the approach used for conducting this study was guided by the one used by Mintzberg (1973, pp. 221–229) to investigate what managers actually do.

By using participant observation, interview, and documentary analysis, two live cases of the entire bidding process were shadowed in the offices of two of the top 20 U.K. civil engineering contractors (Hansford 2008), hereafter referred to as Gamma and Delta. The time spent in Gamma and Delta in observation was 6 and 7 weeks, respectively. In both cases, working hours were 0800–1730, including one hour of break time. The tender period in Gamma started on July 3, 2008, and ended on August 13, 2008, instead of the originally stated August 6. The reason was to allow bidders more time to incorporate changes in the original tender documents. In Delta, the tender period was September 1 to October 17, 2008, instead of the originally stated end date of September 17. Here, the extension was caused by a change in the procurement method (i.e., from a design-build to build-only scheme), which required changes to the original tender documents.

Bidding processes are unique and should be contextualized. The average turnover of the firms is £543 million, and their average workforce of 2,466 people includes both office and site staff. The case studies required the close observation of every aspect of assembling a bid. The project at Gamma for a local county council in England consisted of major infrastructure works proposed to enable a wide area of marshland to be used for residential and commercial property development. The project was to be executed as a guaranteed maximum fixed price (GMFP) contract. The project in Delta for a railway terminal in England consisted of proposed infrastructure works including a platform, a footbridge, track works, overhead line equipment (OLE) works, and signaling works. The project was to be executed as a fixed price contract.

Difficulties were experienced in negotiating access. For example, the director in charge of estimating in one firm e-mailed the following response: "…I'm afraid that much of the detail we think you are likely to need will be too commercially sensitive for us to grant your request or release to you as this is effectively into the public domain." In short, negotiation for access was difficult. The firms that agreed primarily did so because of the importance and influence of the gatekeepers used to negotiate access, the academic purpose of the study, and the written assurances of confidentiality and anonymity in reporting the study.

Engaging with the bid teams and assisting them throughout the bidding process helped obtain a chronological record of basically everything involved in preparing a bid. Data was collected in the researcher's own field notebook (see Appendix II), in diaries given to some members of the bid team to complete for each day's work, and voice recordings. Apart from asking direct questions to clarify observations, several interviews were conducted with directors and others involved in the bidding process from an operational, market, and policy perspective. Content analysis was used to interrogate the interview data; this was interpreted to support some of the theory developed from observations.

The chronology record noted basic activities observed in the firms and the extent of time involved in performing them in the bid calculation process, as was done in the live observational study of five U.S. chief executives, each over a one-week period, by Mintzberg (1973, p. 235) in 1967–1968. Most observations were quite straightforward to categorize and code, but a few were more difficult, particularly because of their overlapping features. Bidding activities were operationalized as calculations (i.e., the start and finish times for tasks associated with resourcing, pricing, and take off); correspondence (i.e., the start and finish times for tasks associated with incoming and outgoing post, e-mail, and phone calls); and conversations (i.e., the start and finish times for tasks associated with unscheduled meetings and informal discussions about the bid by the bid team); document study (i.e., the start and finish times for tasks associated with studying the tender documents); meetings (i.e., the start and finish times for tasks associated with formal, scheduled discussions about the bid); deskwork (i.e., the start and finish times for tasks associated with writing letters, inquiries, and tender notes; completing administrative work, and answering queries), travel (i.e., the start and finish times for tasks associated with traveling to attend meetings such as site visits or client interviews); and off-days (i.e., the start and finish times for holidays or time off by a member of the bid team). It was fairly straightforward to sort the data in the chronology record by using an Excel spreadsheet, to code it according to the categories described, to tally activity durations in each category, and then to estimate each activity category as a proportion of the tender process (Tables 1 and 2). Relevant documents used in the bidding process were also collected and analyzed, for example, risk schedules, meeting agenda and minutes, and commercial review reports.

Analysis of the Chronology Record of Observations in Gamma and Delta

The chronology record (Tables 1 and 2) captured the basic tasks of the bidding processes at Gamma and Delta and the extent of time involved in performing them in the bid calculation process.

Gamma Case Study

Table 1 shows that the most time consuming task in the tender process for Gamma was deskwork activities (39%). This was followed in magnitude by off-days (20%), meetings (13%), calculations (12%), document study (7%), conversations (5%), correspondence (3%), and travel (2%), respectively. Although the six-week tender period was approximately 288 hours, the total combined work on the tender lasted 307 hours; a difference of 19 hours. This shows that some activities overlapped. The analysis of the chronology record showed a total of 17 meetings lasting 41.32 hours, 61 conversations lasting 15.7 hours, and 38 unique periods of calculations lasting 36.32 hours. Eleven members of the bid team answered at least 363 phone calls and 282 external incoming and outgoing e-mails and addressed 90 tender query responses with nine tender addenda. They spent 6.39 hours studying more than 571 pages of drawings and specifications, sent 20 queries to consultants, sent 55 subcontract inquiries and 22 supply inquiries. More than 50% of the 90 tender query (TQ) responses, which had major project scope implications, were received in the final two weeks of the tender process, requiring an extension because of these changes. Altogether, at least 313 major bidding activities were recorded and analyzed. The bill of quantities contained 1,053 items for pricing. The commercial review highlighted 105 clauses in the Institution of Civil Engineers (ICE) 7th Edition contract conditions (ICE 1999) that had been amended by the client. Two estimators worked on the bid for 78% and 22% of the tender period because of the scheduling of holidays. Subcontract quotations were received within two to five weeks. Supply quotations were received much earlier, within one to two weeks. The consultants took an average of four days to reply to queries and most query responses introduced changes that affected the bid team's work. This sporadic nature of the bidding process hardly seems to model the kind of systematic or rational behavior most analytical models assume.

The primary personnel involved in preparing the bid included the bid manager, the estimator, and the planner. The bid manager coordinated all activities involved in assembling the tender

Table 1. Analysis of the Chronology Record of Activity Observations in Gamma

Activities	Calculations	Conversations	Correspondence	Deskwork	Study of documents	Meeting times	Holidays and employee time off	Travel	Total
Time (h)	36.32	15.7	7.9	120.12	20.6	41.32	60.03	4.92	306.91
Percent (%)	11.83	5.12	2.57	39.14	6.71	13.46	19.56	1.60	100%

Table 2. Analysis of the Chronology Record of Observations in Delta

Activities	Calculations	Conversations	Correspondence	Deskwork	Study of documents	Meeting times	Holidays and employee time off	Travel	Total
Time (h)	88.42	33.50	8.55	91.97	68.88	54.43	15.25	2.38	363.38
Percent (%)	24.33	9.22	2.35	25.31	18.96	14.98	4.20	0.66	100%

submission in the format required by the client. He worked throughout the tender period. Two estimators, EI and EII, worked on the bid primarily because of their availability during an annual holiday. EI worked 68% of the tender period (i.e., 21/31 days). EII replaced EI from July 25, 2008 to August 11, 2008 with a two day overlap to enable a smooth estimating transition. Estimator II worked 22% of the tender period (7/31 days). No estimating duties were performed during 10% of the tender period, that is, three days, July 28–30, because both estimators were on holiday. In the final three days, EI finished the tender, having returned from his holiday. Three planners, PI, PII, and PIII, were involved in preparing the tender program. The program was assembled in 71% of the tender period (i.e., 22 days). PI worked for 55% (i.e., 17 days) of the tender period. PII and PIII worked for 13% (i.e., four days) and 3% (i.e., one day) of the time, respectively. No planning work was performed during 21% of the tender period (i.e., nine days) because of holidays and work on other bids.

Three major meetings were used in the process to create the bid submission: startup, midtender review, and final tender review. A commercial analysis of the proposed conditions of the contract was performed by the commercial manager. One hundred and five amended clauses were described as "onerous" and required a review by the client. One reason for the additional review was to avoid pricing the risks that would inflate the tender price. Gamma also thought that the client was in a better position to assume those commercial risks because of their low probability, high impact nature. In areas where the specification given about a bill item was inadequate, clear assumptions were stated to accommodate for risk. The primary risks of concern were commercial risk arising out of the proposed conditions of contract, ecological and archaeological risks, program and weather risks, and risks associated with guaranteeing price and quantities. A risk schedule was prepared and priced. However, most risks were included in the bid as qualifications to the tender program and price. Two primary types of unsystematic risk that may be price in contractors' bids were identified and residual risk. Estimator II described the inclusion of risks in the tender in this way:

> …If you can't do anything about a risk, that is the residual risk, that is often hard to quantify. Some of the risks you can do something to mitigate them—by providing a standby crane for example. These we call identified risks. So those ones, we actually price for them. The residual risk—you have to assess whether it is high, medium or low and whether or not that risk could happen, and the likely cost, the minimum cost, and the maximum cost. At the end of the day you come up with the cost of all the risks, and people will say "it's too much." So you devise ways of mitigating those you can. One way is to qualify your tender depending on the client. Some will accept, and some won't…

Thus, identified risks will normally be included in a bid price and program. But any residual risk will be left to management, who at the adjudication stage, will take a commercial view on the level of risk allowance that is appropriate to the price in the bid. For the project studied, a total allowance of £220,000 was initially priced for eight residual risks. However, the figure was reduced to £120,000 at the final tender review to enhance competitiveness. Thus, a risk allowance of £120,000 for a £6.5 million project implies a risk margin of 1.8% in the bid. The tender period lasted for 31 days; it was 25 days originally but was extended because of the several changes introduced.

Delta Case Study

Table 2 shows that, here too, the most time consuming task in the tender process was deskwork activities (25%). This was followed in magnitude by calculations (24%), document study (19%), meetings (15%), conversations (9%), off-days (4%), travel (1%), and correspondence (2%), respectively. The chronology record showed that members of the bid team had to process approximately 273 incoming and outgoing phone calls, and 124 internal and external e-mails. Pricing was required for 958 bill items. The team had to study 1,090 pages of tender documents and address 23 tender query responses, two tender addenda, 31 subcontract inquiries, and 14 supply inquiries. The project was intended to be design-build initially but the client then requested a build-only arrangement. The total combined hours of work on the bid was 363 hours. Subcontract quotes were received in an average of 16 days. Supply quotes were received much earlier in an average of five days. Six major meetings took place. These lasted a total of 54.43 hours. The bid team included 12 members. However, the primary members involved, and their periods of engagement in the seven-week tender period, were the bid manager (97%), the estimator (86%), and the planner (94%), respectively. The bid manager coordinated all activities involved in the tender process, studied and helped understand the scope of work, and priced risks. The planner produced the program of work. The estimator priced the bill of quantities by using quotations received from the supply and subcontract inquiries. The required elements of the tender submission itself (i.e., price, quality, and program) were assembled by the bid manager with assistance from an administrative staff. Here too, three major meetings were used to prepare the bid submission: tender launch, midtender review, and final tender review. The tender process was originally scheduled to end in September but was extended because of a change in the method of procurement and changes in the tender documents. A commercial analysis of the proposed conditions of the contract was performed by the commercial department. They identified 15 amended clauses as "risky" requiring a review by the client. The prpimary risks were identified as program, design, and the tight timelines for delivering the project. To address these risks, a formal risk schedule was prepared and priced.

Given the project value of £7.5 million and the cost of risk estimated at £120,850, it follows that the risk margin in the bid was 1.6%. However, this could be slightly higher in other cases. An analysis of tender documentation for 24 previous projects having values between £1.5 and £13.8 million was performed. The data was captured from the "tender book" created in the process of building up a price for each project. The analysis indicated that 24 projects with an average value of £7.7 million priced btween 2005 and 2008 had an average risk allowance of 2% in the bids. The conditions of the contracts for the 24 projects were similar. But given potentially different levels of competition for each project, this analysis may be viewed as an approximate estimate of the risk apportionment in bids. The risk allowance seemed to cover exceptional risk, as explained by the technical services director with 23 years of experience:

> …There is a certain amount of risk that is automatically priced in the bid, based on the documents given. This is a normal risk allowance. However, the estimate often does not include an allowance for exceptional risk because they cannot be quantified and priced…

Thus, two types of internal risk may be priced in bids: normal risk, which is accounted for by estimators and planners, and exceptional risk, which directors will consider in the context of market and firm circumstances. Most of the commercial risks were accounted for by using qualifications, assumptions, and clarifications in the tender program and price. From his 25 years of experience, the chief executive of Delta classified proposed projects into good jobs (25%), normal jobs (50%), and risky jobs (25%). He explained that generally, risk influences pricing levels by 1–3% in most normal jobs. For risky jobs, risk could be up to 7.5%, and risk could be 0% for good jobs in which potential opportunities often balance out the risk.

Risk Accountability in Bids (Tiers 1–3)

The close observation, interviews, and documentary analyses of the work of contractors revealed that there may be three tiers of risk apportionment in a bid. The first level of risk apportionment in a bid (i.e., Tier 1) occurs at the individual level of the estimator and program planner. When estimators are calculating quantities and unit rates, they subjectively compensate for inaccuracies and errors by using experience and gut-feel and adjust the estimate until they feel an intuitive satisfaction about its adequacy (see Smith and Bohn 1999, p. 106, in which the writers explain that "In reality contractors tend to "buffer" their bids when they feel uncertain about the cost of an individual item"). In this tier, the risk apportionment may depend on the experience and skill of the estimator and planner. Sometimes, the risk component may be included so subconsciously that even the estimator does not realize it.

The second level of risk apportionment in a bid (i.e., Tier 2) occurs at bid team level at the point at which they think through the actual construction phase of the project and include a price for any identified or operational risks. In this tier, the risk apportionment may depend on the level of expertise in the contractor's estimating department.

The third level of risk apportionment in a bid (i.e., Tier 3) occurs at the final stage of the tender process at the point at which the firm's management ultimately determines the allocation of a residual risk allowance in a bid that is sometimes derived from a risk register and probability-impact matrix. In this tier, management considers market conditions and the firm's particular circumstances, and the risk apportionment may depend on the experience of a firm's management and their attitude toward risk.

Objective 3: Comparison of Theory and Practice

Five points are discussed. First, in comparing the analytical risk models with what contractors actually do, it was found that most models prescribe the addition of a contingency allowance in bids for risk, derived from a calculated risk value (Tah et al. 1993; Zeng et al. 2007). However, particularly in competitive markets and recessionary periods, contractors often cannot afford to price risk because of their fear of losing work (Smith and Bohn 1999, p. 107). In this study, both Gamma and Delta tried to use clever strategies and tactics in their bid proposals to insure against commercial and operational risks. In fact, both contractors conducted a commercial analysis of the proposed conditions of the contract to determine the better way to approach risks: either avoid bidding at all or qualify or clarify the commercial risks as part of the tender submission for posttender negotiations. For operational risks, both contractors stated clear assumptions upon which their offer (i.e., tender program and price) was based. Whereas analytical models prescribe contingency allocation, the contractors observed for this research managed risk primarily through contractual rather than price mechanisms to reflect commercial imperatives.

Second, the primary bidding activities during the preparation of a tender program were categorized and their extent was estimated as deskwork (32%), calculations (19%), meetings (14%), document study (13%), off-days (11%), conversations (7%), correspondence

Table 3. Bidding Process Stages and Activities

Initial stage	Middle stage	Final stage
Receive tender documents	Subcontract and supply work package enquiries (identification and dispatch)	Update prices from quotations
Log in new tender information (approximate value determines the team size)	Resource and price of bill items (with allowances for risk included in estimates)	Review final tender, commercial, and planning and program (Risk may be included in final tender program and price; in qualifications detail the price for risk. Program may include weather risk, liquidated and ascertained damages (LAD) risk, possessions, and sectional completion dates)
Appoint tender team	Conduct midterm client meeting for clarifications	Adjust tender (i.e., additions and omissions)
Conduct preliminary study of tender documents and check documents received	Conduct midterm tender review (i.e., review draft program, pricing strategy, risk, and opportunity)	Submit tender program and price (including qualifications, clarifications, and tenderer's assumptions for posttender discussions if tender price is of interest to client)
Conduct tender launch meeting (assign roles and responsibilities, discuss risks analysis and program risk, determine bid or no-bid conditions, schedule interim and final review meetings, and plan tender preparation program and pricing strategy)	Make bid or no-bid decision	
Conduct detailed study of tender documentation	Price indirect costs	
Conduct commercial review	Price fixed costs	
Conduct site visit	Bid manager onducts risk meeting and prices the risk schedule	
Conduct preliminary program to assess the risk and feasibility of the client's program		

(3%) and travel (1%). This approximation represents the average of two chronology records containing 670 hours of direct participant observation notes from the participation in the bid process at Gamma and Delta (Tables 1 and 2). Table 3 shows details of the primary bid preparation activities observed at Gamma and Delta and the three stages of the entire bidding process.

The estimating activities did not appear to follow the typical *S*-curve behavior illustrated in *The PMBOK Guide to the Project Management Body of Knowledge* (PMI 2004). In this study, the pattern of estimators' activity was loaded at the beginning (with the study of the tender documents to understand the scope of project so that supply and subcontractor quotes could be prepared to price the job well), slowed in the middle (with the wait for supply and subcontractor quotations), and loaded in the end (with the review of supply and subcontractor quotations, the consideration of addenda, the review of query responses, and the attendance of meetings near the due date of the submission). The typical *S*-curve behavior is described in Cioffi (2005):

> When displayed as a function of time, accumulated efforts or costs of a project usually take a form described as the *S*-curve (flatter at the beginning and end, steeper in the middle). The classic *S*-curve is described as having three parts: a gentle rise, a steep slope, and a gradual path to the asymptote.

However, the pattern of activity in this study appeared steeper at the beginning and end and flatter in the middle. Hence, bidding activities of estimators (Table 3) may not model the typical *S*-curve behavior. An examination of the chronology records from Gamma and Delta showed that although the two tender processes related to projects that were different in nature, the basic activities performed by the bid teams were significantly similar. Bidding practices may be dictated by company practices and not project variables and should be investigated further.

Third, the risk and price relationship of 0–3% expressed in most of the literature (e.g., Neufville and King 1991; Smith and Bohn 1999) was clearly confirmed in Gamma and Delta (1.6% and 1.8%, respectively). The analysis of past tenders at Delta showed that an average of a 2% risk margin was included in 24 bids with an average value of £7.7 million priced between 2005 and 2008. This risk allowance seemed to cover primarily the residual risk (Tier 3) of the projects. It did not seem to include allowances for identified risks (Tier 2) and intuitive risk allowances included by the estimator to compensate for estimating inaccuracies and errors (Tier 1). Therefore, before the apportionment of 1–2% residual risk allowance in some bids by management, identified and intuitive risk allowances may be included in a bid by estimators and planners. Hence, it appeared that the 5–10% margin that textbooks suggest as a risk allowance in contractor bids may ring true in this context.

Fourth, the findings show how risk is priced through contractual rather than price mechanisms to reflect commercial imperatives at the time of bidding. Contractors were concerned about getting the tender price wrong. Mechanisms used to alleviate this fear included a commercial review of the conditions of contract, commercial and planning review sessions by the bid team, and the consideration of assumptions, qualifications, and clarifications in the tender program and price. Two primary risks of concern were commercial and operational risk. Depending on the degree to which the proposed contract conditions were considered onerous, the bid teams determined the best way to approach risks, that is, either to avoid bidding at all, or to qualify or clarify the risks as part of the tender submission for posttender negotiations with the client. Operational risk related to the perceived difficulty in completing the actual project under physical conditions such as access, location, and ground. To compensate for these risks, the contractors stated clear assumptions upon which their offer was based. Instead of including pricing for risk allowances that would inflate the bid price, and probably cause the firm to be uncompetitive, strategies and tactics were devised to offer the best (i.e., lowest) price for "getting a foot in the door" or "getting to the table" to negotiate the risks with the client at the posttender stage. Contractors may not approach risks according to the contingency allocation theory proposed in most analytical risk modeling approaches because of these strategies and tactics.

Fifth, risk premiums are often decided by a firm's directors on the basis of the perceived confidence in the bid team's work. A significant difference existed in the way the two primary stages of the tender process (i.e., the estimating stage and the adjudication stage) were approached. The observation of the differences was clarified by one of the chief executives:

> The estimating process involves a lot of rational steps, in terms of the way you build up the price. But when it comes to settling the tender, that process is more of a gut-feel or art to know the right prices. Gut-feel is your instincts—is the job right, priced properly? You judge the confidence in the guys who priced it and the way they display it when they come to settle the bid.As some directors described it, the success with which the bid team pitches the final tender price to make it well received by buyers in the construction market is intuitive, unsystematic, and a skill gained from experience. Establishing the right balance among the related concepts of cost, price, and value is an important commercial exercise for a firm's directors. It is not just a technical exercise. Four primary factors considered were commercial risks, operational risks, competition, and the desire to win the work. If the directors felt confident of the bid team's work, and wanted to win a job, they may price for some of the residual risk and assume the rest, which they would hope to manage through opportunities in the construction phase. However, when a job is needed, they may compromise by assuming the residual risk and pricing a lower margin to win the bid.

Conclusions

Three primary conclusions were drawn. First, formal and analytical risk models prescribe how risk should be incorporated in construction bids. However, a review of 60+ propositions showed that most of them are analytically derived and not guided by any major empirical research about what contractors actually do in practice. No comprehensive study that captures the entire bid-pricing process of contractors. describes how risk is accounted for throughout the bid-pricing process, and shows that pricing is indeed systematic in nature was found. To this end, systematic propositions for contractors were considered to have no justifiable empirical basis. Most models prescribe contingency allocation in bids. However, in practice, contractors tend to approach risk more circumspectly than the models prescribe because of a set of complex, microeconomic factors like the scope of work, forward workload, need-for-work, competition, and other exigencies of the bidding practice that also affect price. Thus, the contingency allocation theory underpinning most analytical risk models may not be sustainable in practice.

Second, to compare the theoretical risk analysis models with the practice of risk analysis, access was negotiated and the entire tender process was shadowed in the offices of two of the top 20 U.K. civil engineering contractors. The aim here was to explore deeply rather than superficially what contractors actually do. The participant observation method, although exhausting in nature, helped achieve a high degree of ecological validity in the research findings. Three stages of the bidding process were found, bidding activities were categorized, and their extent estimated. The bidding process did not seem to follow a systematic pattern; its activities depended on the prevailing daily circumstances of the bid team. The difficulty in achieving a programmable bidding process was caused by changes to the tender documents, the poor quality of tender documents, personnel problems, and the reliance on the supply chain for information to price the bid. Thus, assumptions of systematic behavior in bidding practice does not ring true in this context.

Third, three tiers of risk apportionment in bids were identified (Tiers 1–3). Tier 1 described the intuitive risk allowances included in the tender program and price by estimators and planners to compensate for inaccuracies and errors in estimates. Tier 2 described the manner in which bid teams tended to include an allowance in the bid for the identified risks in a project. Tier 3 described the manner in which a firm's management determines the appropriate level of residual risk allowance to include in a bid. Thus, different individuals and teams influenced pricing levels at different stages of the bid calculation process. Sometimes, priced risks were excluded from a bid to enhance the chances of winning the project. The tender adjustments for risk may take considerable time to determine, but the actual arithmetic involved in reducing or increasing the final price tends to be simpler than the sophisticated prescription in the analytical models. Analytical models may be too time-consuming, too complex, and insensitive to the commercial exigencies of bidding practice. Risk is an important factor in the bid calculation process of contractors, which often takes place in a short time frame and in a competitive market environment. Perhaps a simple table of risk factors, which could be, for example, location or project-specific and indicate a scale or factor by which contractors could easily and flexibly adjust an estimate for risk may be handier and even appropriate.

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Appendix I. Empirical Studies in Journals about How Contractors Price Their Work

Authors	Year	Journal	Volume	Issue	Pages	Bid-pricing aspect(s)	Research method	Data points	Country
Uher	1991	CME	9	6	495–508	Risks	Questionnaire survey	47	Australia
Neufville and King	1991	JCME	117	4	659–673	Risk and need-for-work	Experiment and interview	30	United States
Mak and Raftery	1992	CME	10	4	303–320	Errors	Experiment	62	United Kingdom
Shash and Abdul-Hadi	1992	CME	10	5	415–429	Markup	Questionnaire survey	71	Saudi Arabia
Shash	1993	CME	11	2	111–118	Tendering and markup	Questionnaire survey	85	United Kingdom
Kodikara et al.	1993	CME	11	4	261–269	BQ	Interview	8	Sri Lanka
Kodikara and McCaffer	1993	CME	11	5	341–346	Estimating data	Interview	10	Sri Lanka
Tah et al.	1994	CME	12	1	31–36	Indirect costs	Questionnaire survey and interview	7	United Kingdom
Skitmore and Wilcock	1994	CME	12	2	139–154	Item pricing	Questionnaire survey	8	United Kingdom
Edwards and Edwards	1995	CME	13	6	485–491	Services	Documents	15	Australia
Ming et al.	1996	CME	14	3	253–264	Profit	Documents	221	Australia
Uher	1996	ECAM	3	1/2	83–95	Estimating practices	Questionnaire survey and interview	10	Australia
Shash and Al-Amir	1997	CME	15	2	187–200	Processing, use of information technology (IT)	Questionnaire survey	93	Saudi Arabia
Bajaj et al.	1997	CME	15	4	363–369	Risks	Questionnaire survey	19	Australia
Shash	1998	CME	124	3	219–225	Bidding practices	Questionnaire survey	30	United States
Shash	1998	JCEM	124	2	101–106	Pricing decisions	Questionnaire survey	30	United States
Ray et al.	1999	CME	17	2	139–153	Ethics	Questionnaire survey	60	Australia
Smith and Bohn	1999	JCEM	125	2	101–108	Risks	Interview	12	United States
Akintoye	2000	CME	18	1	77–89	Estimating	Survey	84	United Kingdom
Akintoye and Fitzgerald	2000	CME	18	2	161–172	Cost estimating	Questionnaire survey	84	United Kingdom
Mochtar and Arditi	2001	CME	19	4	405–415	Pricing strategy	Survey	400	United States
Asaaf et al.	2001	IJPM	19	5	295–303	Risks	Questionnaire survey	38	Hong Kong
Wong and Hui	2006	CME	24	4	425–438	Risks	Questionnaire survey	38	Hong Kong
Chan and Au	2007	IJPM	25	6	615–626	Weather risks	Questionnaire survey	60	Hong Kong

Note: CME: *Construction Management and Economics*; IJPM: *International Journal of Project Management*; JCEM: *Journal of Construction Engineering and Management*; ECAM: *Engineering, Construction and Architectural Management*; BQ: *Bill of Quantities*.

Appendix II. Chronology Record of One Estimator's Work on D30 on August 12, 2008

Reference	Time	Code	Activity description	Location
30A	0800–0933	DW	Estimator reviews all tender, adds or omits items arising from the final tender review meeting.	Estimator's office
30B	0933–1100	CA	Estimator makes adjustments from the review meeting and late-issued amendments from the client.	Area office
30C	1101	CE	Estimator reads the TQ 82 response just received and compares it to the commitments register. He reads the further response to the TQ 20 response regarding rail possession dates.	Area office
30C	1101–1107	D	Estimator reviews tender quickly to determine whether prices will be affected or qualified by responses.	Estimator's office
30D	1108–1149	CN	Estimator discusses program revisions with the planner to understand how they affect prices.	Estimator's office
30E	1150–1206	CN	Bid manager, estimator, and tender manager discuss the changes necessary to the tender. Estimator: "The job itself is a simple, straightforward job but it's been made complicated by all these ecological and archaeological works and how the tender process has been handled." Bid manager: "I think whoever wins it will depend on the amount of qualifications in the tender."	Bid manager's office
30F	1206–1402	CN	Estimator, back in his office, cross checks and transfers directs bill of quantities to Excel.	Estimator's office
30G	1403–1613	CA	Estimator cross checks and transfers indirects bill of quantities to Excel.	Estimator's office
30H	1613–1630	CN	Estimator phones drainage subcontractor to notify him of new changes and to determine if his prices will change as a result. Drainage subcontractor learned about the change from one of the other tenderers but tells the estimator that the quotation is still fine to use.	Estimator's office
30J	1630–1715	CA	Estimator calculates the savings with the consideration of alternative materials.	Estimator's office
30K	1715–1800	DW	Estimator make the final check of the documents, files, and numbers and prepares for printing. He shuts down his computer.	Estimator's office

Note: DW: deskwork; CA: calculations; CE: correspondence; D: documents; CN: conversations.

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