QUANTITATIVE STUDY OF CONTRACTOR EVALUATION PROGRAMS AND THEIR IMPACT

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ABSTRACT: This paper's dual intent is to assist contract administrators in better understanding the impact of contractor failure and to aid them in establishing adequate evaluation programs prior to contract award using quantitative data. Failure is defined in this study as a significant breach of the contractor's legal responsibilities to the owner (for example, bankruptcy or material breach of contract related to meeting the desired project objectives such as cost, schedule, and quality). This study quantitatively documents both the amount of owner evaluation performed prior to contract award and subsequent monitoring during the construction process and correlates these efforts with the actual project outcome, either failure or nonfailure. A survey used to collect data prompted responses from 82 different organizations representing both public and private owner concerns; they provided information for a total of 107 projects. Of these, 44 involved a contractor failure. Results demonstrated a significant increase in final project cost and schedule duration as a result of the contractor's failure. The practical considerations regarding contractor failure are also presented.

INTRODUCTION

This paper's dual intent is to assist contract administrators in better understanding the impact of contractor failure and to aid them in establishing adequate evaluation programs prior to contract award using quantitative data. Until now, no documented research has been reported that quantitatively analyzes the amount of contractor evaluation performed by owner organizations along with its impact on project outcome. Our hypothesis is that owner-performed contractor evaluation and subsequent monitoring will reduce the chance of contractor failure. In this study, failure is defined as a breach of the contractor's legal responsibilities to the owner sufficient to permit the owner to terminate the contract. This includes a contractor who becomes financially insolvent, which results in bankruptcy, or who fails to meet project objectives such as cost, schedule, or quality that are explicit clauses contained within the contract that give an owner grounds to terminate the contract.

DESCRIPTION OF DATA COLLECTION PROCESS

A diverse sample of 1,000 respondents consisting of public owners (150), private owners (650), and construction managers (200) was compiled from various listings of professional organizations and from the writers' professional contacts. Based on the data collected in the literature review phase, a questionnaire survey was developed to facilitate the data collection process [see Russell (1991a) and Russell and Radtke (1991)]. A sample copy of the

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questionnaire survey can be obtained by contacting the first writer. Each potential respondent was mailed a questionnaire survey to complete.

A total of 120 organizations (a response rate of 12%) completed the questionnaire. Of the 120 respondents, only 82 provided complete and usable data on their organization characteristics. Although 82 different organizations responded to the first part of the questionnaire, many supplied multiple projects for the second part of the questionnaire. Of 107 projects collected, 44 involved a contractor failure. The entire questionnaire consisted of two parts: (1) Organization data; and (2) project data. The first part contained nine questions related to the characteristics of the respondent's organization, including type of owner, construction type performed, annual volume of construction activity, and number of construction personnel. General questions pertaining to their contractor evaluation procedures were also posed.

The second part of the questionnaire requested project data related to contractor evaluation and achieved project outcome. Both general and specific information was solicited for each project. General information included construction type, contract type, and items related to cost and schedule performance. Project-specific information included the following: the number of contractors analyzed, person hours and cost expended, number of analyzed contractors that had previously worked for the owner, amount of data collected to analyze contractors, items related to monitoring the contractor during construction, and whether the contractor failed. If so, the causes of and cost of failure and the method used to resolve the failed project were also solicited.

Data Analysis

The statistical analysis technique involved numerous hypothesis tests comparing the responses for failed and nonfailed projects. Numerical data were analyzed using a Student's t-distribution while qualitative data involved a chi-square test. A typical one-tailed hypothesis test was performed (Mendenhall and Reinmuth 1982). For each factor analyzed (e.g., evaluation person hours expended per contractor and evaluation cost per contractor), the data were separated into two outcome categories: (1) Failure; and (2) nonfailure. A calculation was performed to determine the critical t-value by using the appropriate distribution. When the calculated t-value exceeded the critical t-value, the null hypothesis was rejected and it was concluded that a statistical difference existed between the means of the two outcome categories. Otherwise, it was concluded that no statistical difference existed. For purposes of identifying significant factors in this investigation, the writers selected an alpha equal to 0.10 as the critical significance level for rejecting the null hypothesis.

Characteristics of the project data are summarized in Table 1. The average project size is approximately \$16,400,000. A more complete description of the organization and project characteristics can be obtained by contacting the first writer.

Data Analysis Results

First, the survey data were divided into two outcome categories: (1) Failed; and (2) nonfailed projects. The data were then grouped into three distinct project categories: (1) All projects; (2) public-owner projects; and

TABLE 1. Relevant Project Characteristics

Variable description (1)	Sample Characteristics: Failure cases[a] (%) (2)	Nonfailure cases[b] (%) (3)	Total[c] (%) (4)
Organization type			
Public owners	71	15	38
Private owners	26	77	55
Construction management	3	8	7
Construction type			
General building	41	46	44
Industrial	27	32	30
Heavy	30	16	22
Manufacturing	2	6	4
Contract type			
Fixed price	93	74	82
Reimbursable cost	2	21	13
Both	5	5	5

[a]Sample size is 44.
[b]Sample size is 63.
[c]Total sample size is 107.
Note: Hypothesis testing was not performed on data presented in this table.

(3) private-owner projects. Comparisons between failed and nonfailed projects were performed for each grouped category. The compared factors were organized into three sections: (1) General project characteristics; (2) amount of owner analysis performed prior to bidding; and (3) the amount of monitoring effort by the owner during the construction phase.

All Projects—General Characteristics

Fig. 1 presents the mean values for factors that demonstrated a statistical significance between failed and nonfailed cases for all project data. General project characteristics show that the project size for the nonfailure cases is slightly over three times greater than for the failure cases. The average anticipated duration at contract award was found to be approximately 13 months. The average increase in project duration for failure cases is 97%, and 13% for the nonfailure cases. This increase, measured from the anticipated duration at contract award to final acceptance, includes scope changes, design errors and omissions, and contractor failure.

Another significant project characteristic is the cost outcome of failed versus nonfailed projects. Fig. 1 shows a 50% increase in total project cost for the failed cases compared to 16% for the nonfailed cases. The project cost increase is calculated from the contract award amount and includes increases due to any additional scope changes, design errors and omissions, additional owner-monitoring cost, and cost of contractor failure.

Cost increases due to scope changes include increases in project cost as a result of an owner's change from the original project scope that was established at contract award. The average project cost increase due to scope changes was 11% for nonfailure cases and only 5% for the failure cases. It may be inferred that a smaller percentage of scope changes were

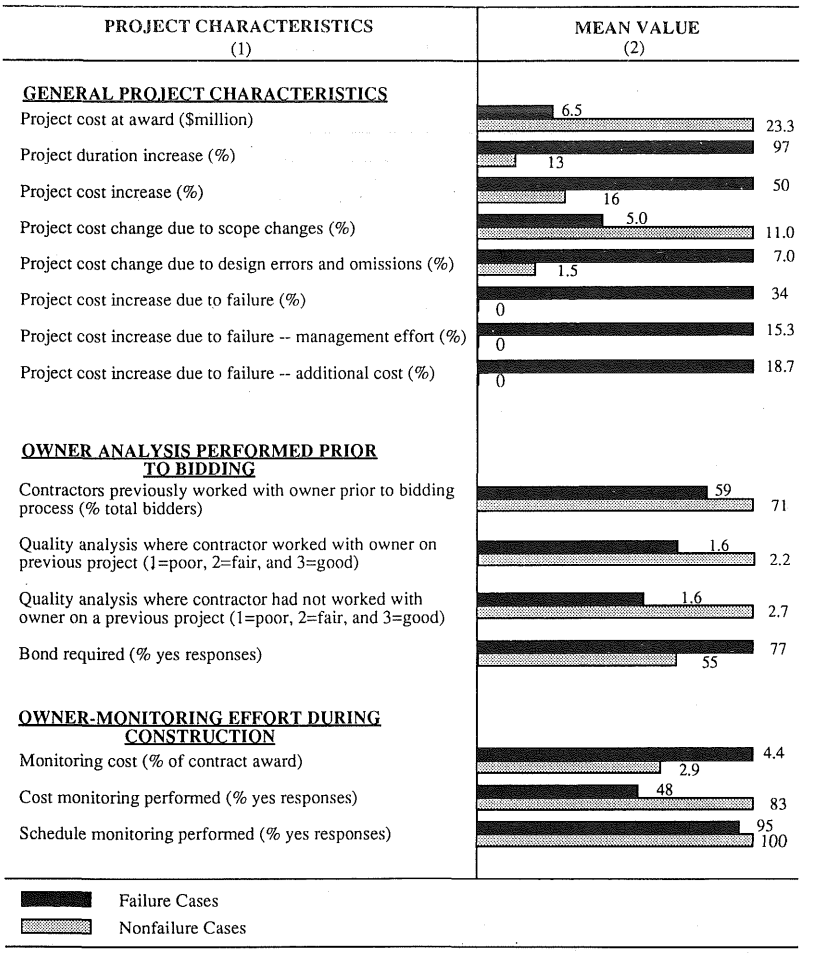

FIG. 1. Project Characteristics for All Projects

approved on projects that failed. Subsequent discussions by the writers with numerous defaulted contractors revealed that many owners, in their opinion, did not fairly compensate them for "additional" changes in the scope of work; this lead to cash-flow shortages that contributed to the contractor's eventual default.

Design errors and omissions costs refer to necessary changes or clarifications to the construction documents after contract award. The average cost increase due to design errors and omissions was 7% for failure cases and only 1.5% for the nonfailure cases. This supports previous research findings by the first writer that show that the financial stability of a contractor is severely threatened by projects that involve poorly conceived construction documents. A greater percentage of design errors and omissions implies more management effort, reduced productivity of craftsmen, and additional materials and equipment. This impact on cost can significantly weaken a contractor's financial strength. Hence, it may be concluded that more con-

struction contractors should carefully consider the risks associated with projects that have poorly conceived plans and specifications. To assess these risks, contractors can investigate the past practices and reputation of the owner and architect/engineer.

The cost of failure represents inefficiencies as a result of the contractor's inability to complete the project. It includes items such as lost profits, administrative expenses, cost to complete facility beyond money yet unpaid to contractor, fees associated with resolution of conflicts, and negative publicity and loss of good will. The average cost increase due to the contractor's failure was approximately 34% for failed cases. Of the 34%, 15.3% of the average cost increase was attributed to the additional management effort required and 18.7% was attributed to the additional project cost required. Additional management effort required represents cost for additional work necessary as a result of the contractor's failure; it includes items such as management time, staff and administrative support expenses, fees associated with resolution of conflicts, and additional monitoring cost. Project cost increase as a result of the contractor's failure includes items such as lost profits, cost to complete facility beyond money yet unpaid to the contractor (this includes any necessary rework), and outstanding bills from subcontractors and material suppliers not paid by contractor.

Prebid Analysis

Characteristics of practical importance related to the amount of owner analysis performed prior to bidding were also investigated. It was found that owners analyzed approximately five candidate contractors per project in both the failure and nonfailure cases. The average analysis cost and person hours per contractor were found to be $1,680 and 21 hours, respectively, for both project cases. A larger percentage of candidate contractors evaluated prior to the bidding process had previously worked with the owner on nonfailure cases than had on the failure cases (71% versus 59%); 65% of the contractors who were awarded construction contracts had worked with the owner on previous projects.

Two levels of analysis were considered depending on whether the owner was familiar (contractor had previously worked with owner) or unfamiliar (contractor had not worked previously with owner) with the contractor's abilities. Within each level of analysis, a justification scheme was established by the writers to categorize the evaluation effort as good, fair, or poor. For owners familiar with the contractor's abilities, a "good" amount of analysis (with a rating of 3) represented an owner who required a contractor to fill out a qualification questionnaire that included financial data, telephoned references, and contacted personnel within the organization familiar with the contractor's recent performance capabilities. "Fair" amount of analysis (a 2 rating) was assigned to an owner who telephoned references and contacted personnel within the organization familiar with the contractor's recent performance capabilities. "Poor" analysis (a 1 rating) was defined when no information from the contractor was requested by the owner and no inquiries regarding the contractor's recent performance capabilities were made.

For owners unfamiliar with the contractor's abilities, "good" was assigned an owner who required a contractor to fill out a qualification questionnaire that included financial data, telephoned references, obtained credit rating reports on the contractor (for example from Dun and Bradstreet), formally interviewed contractor and staff, and visited the contractor's home office and current sites of operation. "Fair" described an owner who required a

contractor to fill out a qualification questionnaire that included financial data and telephone references; and "poor" was assigned to the owner who simply telephoned a few references.

When a contractor had worked previously with an owner, in general, the quality of the analysis performed prior to the bidding process was better on projects that did not fail. This is illustrated in Fig. 1, in which the average level of evaluation was between good and fair (2.2). When a contractor had not previously worked with an owner, the quality of evaluation was 2.7 and also followed a trend similar to when the owner was familiar with the contractor.

Monitoring

The amount of monitoring effort expended by the owner during the construction phase of the project is also shown in Fig. 1. All respondents performed some level of monitoring. However, the amount of resources expended and the areas monitored varied. The nonfailure cases expended 2.9% of the contract amount at award, while 4.4% was expended at that point for the failure cases. These data support prior research that revealed that successful projects expend fewer resources in monitoring than failed projects [see Jaselskis and Ashley (1991)].

Monitoring was considered in the areas of cost, scheduling, quality, and safety. Cost monitoring involves verification of the monthly resources expended by the contractor. Cost monitoring was performed on 83% of the nonfailure projects; only 48% of the failure cases included a cost verification program. Schedule monitoring relates to the owner's effort in observing construction progress as it meets various project milestones. Schedule monitoring was performed on 100% of the nonfailure cases and 95% of the failure cases. Quality monitoring includes quality control and assurance necessary to ensure conformance of the completed work with the project specifications. This includes material testing such as concrete, structural steel connections, and soil and installation of the project components. Safety monitoring relates to all efforts required to comply with state and federal regulations and includes providing a safe place to work and maintaining accident records. Quality monitoring was performed on 97% and safety monitoring was performed on 74% of the failed and nonfailed projects.

Public Projects—General Characteristics

Fig. 2 presents project information that demonstrated a statistical significance between failed and nonfailed cases from the public-owner respondents. The average anticipated duration at contract award for nonfailure cases is 15.9 months—and only 11.7 months for failure cases.

The average increase in project duration for failure cases is 112.2%, and 26.8% for the nonfailure cases. Subsequent interviews conducted with respondents found that in some failure cases, the processes to terminate the contract with the defaulted contractor were not initiated until after the completion date was exceeded. Hence, in many cases, a significant loss of time resulted in the project taking approximately twice as long to complete as initially anticipated. Other items, however, such as litigation, also contributed to the increase in the project duration.

The average increase in cost as a result of contractor failure was 30% (13.5% attributed to additional management and 16.5% attributed to additional project costs). The large cost associated with management effort supports a finding by the General Accounting Office (GAO) ("Use" 1975)

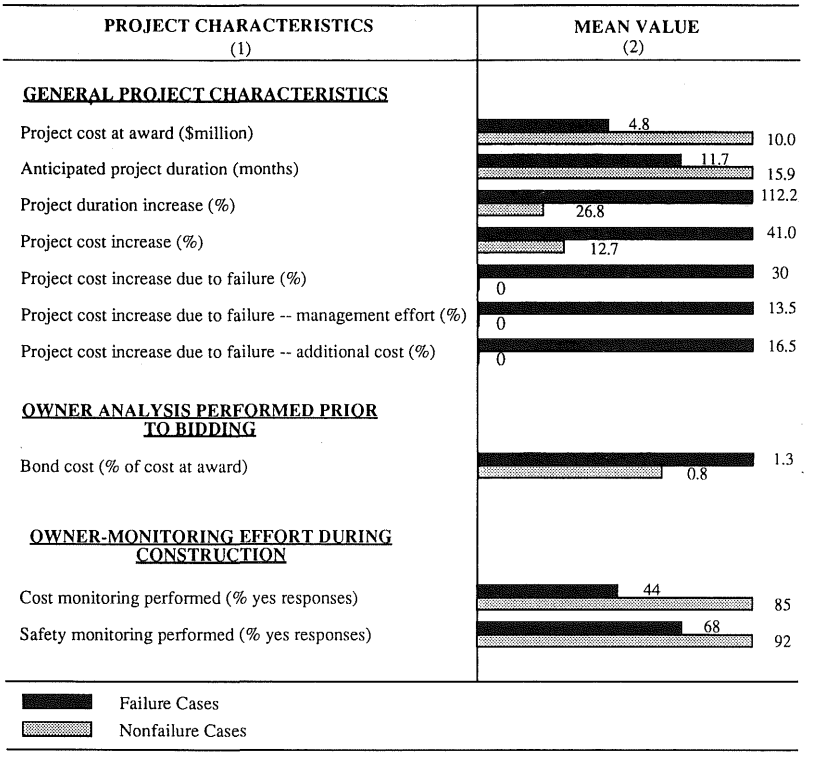

FIG. 2. Project Characteristics for Public Owners

that significant costs are incurred by government agencies as a result of a contractor failure. The GAO study was attempting to make a case for sureties to reimburse the public owner for management efforts expended related to a contractor failure. A significant part of the cost of failure (55%) was paid by a surety company as a result of their obligation under the payment and performance bonds. In three project cases, however, the surety company became financially insolvent and the increase in project cost became the responsibility of the public owner.

Prebid Analysis

Public owners were insensitive to factors related to prebid analysis when comparing failure and nonfailure cases. An average of 4.4 candidate contractors per project were analyzed. Many of the respondents such as state departments of transportation perform prequalification annually; this value represents the average number of contractors per project. On the other hand, many public owners only analyze the lowest bidder; and hence perform a postqualification or a preaward survey. The average analysis cost and person hours per contractor was found to be $235 and 7 hr, respectively, for both project cases. Several other factors related to the amount of analysis performed prior to the bidding process did not indicate a statistically significant difference between failure and nonfailure cases. A complete listing of these factors can be obtained by contacting the first writer.

The average cost of surety bonding measured as a percentage of the final contract cost, however, was significant. The bonding cost was 1.3% for failure cases compared to 0.80% for nonfailure cases. It is possible that the contractors involved in the failure cases may have been perceived to be more risky than their nonfailure counterparts and thus were required to pay more for contract bonds. Another possible explanation can be that the average project size for failure cases is much smaller than that of the nonfailure cases. Hence, contractors involved with failed projects may be smaller with regard to annual turnover.

Previous research performed by the first writer suggests that in order for the surety company to make a sufficient return on a smaller construction account, they must charge a higher premium rate because their premium fee is computed on the basis of the final project cost (Russell 1991b). The amount of effort required for a surety to evaluate a contractor account for the most part is not a function of the project or company size. In most cases, an insurance agent offering surety bonds prefers to have bond accounts with qualified contractors on large projects, because the amount of effort to prepare a bond request is similar for large and small projects, but the premium fee generated for the larger projects is greater.

Private Projects—General Characteristics

The general characteristics of the private-owner projects include an average project size of $24,000,000 and anticipated duration of about 14 months. Relevant characteristics that demonstrated a statistical significance are presented in Fig. 3. The average project cost increase due to scope changes was 12.1% for both the failure and nonfailure cases. The average cost increase due to design errors and omissions was 17.8% for failure and 1.6% for nonfailure cases. It appears that the increase in project cost as a result of the failure is large. The increase in schedule duration, however, is smaller than for public owners.

Prebid Analysis

On average, 6.8 candidate contractors were analyzed per project by the private owners in failure cases and 5.0 for nonfailure cases. On projects involving nonfailure, perhaps the private owners may have been more selective and let only the most qualified companies participate in the bidding process. The average analysis cost per contractor was found to be $2,670 for both types of projects. The average person hours per contractor were found to be 25 hr for nonfailure cases. For failure cases, an insufficient amount of data were reported and hence results were inconclusive.

A rather large percentage of candidate contractors evaluated prior to the bidding process had previously worked with the owner (69%) for both cases. Of the contractors who were awarded the construction contract, 56% had previously worked with the owner on other projects in both the failure and nonfailure cases. This supports previous research findings by the first writer that found a majority of owners work closely with a select number of contractors familiar with their organization and who understand how it conducts its business operations.

When a contractor had worked previously with an owner, the quality of the analysis performed prior to the bidding process was the same for both cases. The average level of evaluation was between good and fair (2.5). When a contractor had not previously worked with an owner, the quality of evaluation also followed a trend similar to that of the case when the

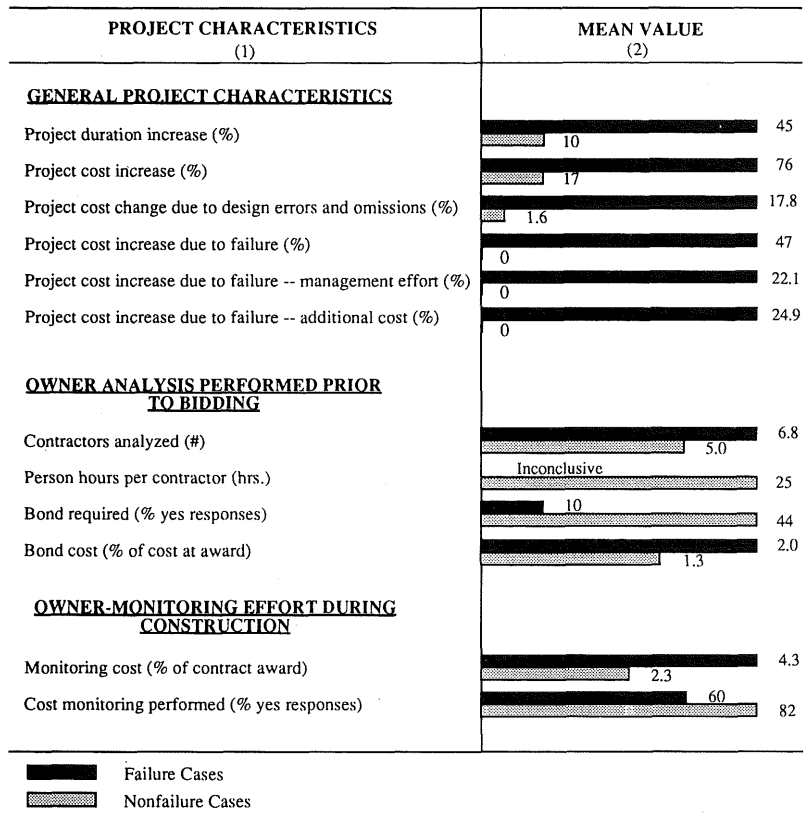

FIG. 3. Project Characteristics for Private Owners

owner was familiar with the contractor. However, the average level of evaluation was slightly higher (2.8). Intuitively one would expect the level of evaluation expended to be larger on contractors unfamiliar to the owner when compared to familiar contractors.

Practical Considerations Regarding Contractor Failure

The following list of practical considerations regarding contractor failures is divided into three main categories: (1) All projects; (2) public projects; and (3) private projects.

All Projects

It appears from the data collected that failure cases occur more frequently on smaller projects than larger projects, perhaps because larger projects benefit from more attention and higher-quality management from both the owner and contractor organizations. Hence, it may behoove the owner to dedicate more effort in the contractor evaluation process on smaller-sized projects. Additionally, both owners and contractors may wish to analyze

how managers are assigned to projects; perhaps smaller-sized projects should be assigned to the higher-quality managers.

In general, there are many more contractors that can potentially perform smaller-sized projects than larger-sized projects. Thus, with smaller projects, the chance of working with a contractor unfamiliar to the owner is higher, as is the chance for experiencing contractor failure. The increased chance of contractor failure is attributed to many smaller contractors being undercapitalized and lacking staying power, that is, long-term performance records and adequate financial capital to remain in business during economic downturns.

Cost increases due to scope changes was statistically significant. The average project cost increase due to scope changes was found to be larger on nonfailure projects than failure projects. This result may be due to the following reasons: (1) The owner and/or architect/engineer was unreasonable by not approving legitimate changes to the scope of work; (2) the contractor was understaffed, which resulted in poor documentation and lost opportunities to recover additional monies owed; or (3) contractor was experiencing cash-flow difficulties that motivated him or her to settle change orders for a reduced amount in order to be paid promptly.

The average cost increase due to design errors and omissions was also statistically significant. Design errors and omissions for the failure cases were larger than for the nonfailure cases. Poorly conceived construction documents represent significant risk to both the owner and contractor, and contribute to an increased likelihood of contractor failure. Negotiations between the owner and contractor as to the extent, justification, and cost of design errors and omissions usually requires numerous meetings, a large amount of documentation, and time. Disputes frequently occur regarding what constitutes design errors and omissions; owners and architect/engineers frequently claim that contractors should have assumed standard industry work practice or that the intent of the information presented in the project drawings and specifications was sufficient.

The payment due contractors for work stemming from design errors and omissions typically lags the normal payment cycle. Depending on the scope of the errors and omissions, payment may occur a significant time (i.e., three to six months) after the work is completed. Contractors experiencing cash-flow difficulties, that are financially weak, or that employ inexperienced project management in negotiating can be adversely impacted by delayed payment. Additionally, a greater percentage of design errors and omissions interrupts the construction process. As a result, the attention of the contractor's management is preoccupied with resolving disputes and disagreements and not on ensuring that the field operations are completed efficiently.

In the nonfailure cases, a larger proportion of the contractors had previously worked with the owner prior to the bidding process. Hence, the owner had actual experience and knowledge of the contractor's performance capabilities. This suggests that the owner may be better off conducting business with a carefully selected number of contractors to reduce the likelihood of failure. This factor aids both the owner and contractor because they are familiar with each other's organization structure and the means by which they conduct their business. When conducting the evaluation process, a good to fair amount of analysis is performed in nonfailure cases regardless of whether the contractor is familiar with the owner. More effort in the evaluation process is expended when an owner is unfamiliar with a con-

tractor's organization. This suggests that an owner should expect to expend more effort in understanding the capabilities of a contractor who has not previously worked for their organization. Additionally, whether an owner is familiar or unfamiliar with a contractor's capabilities, the more evaluation effort expended, the higher the chance of not experiencing a construction contractor failure.

A poorer quality of analysis was performed for failed projects even though a higher percentage of these projects required surety bonds. This fact may suggest that the organizations involved in failed projects relied heavily on the surety company to analyze the contractors and determine their capability to perform the work. It may also suggest that the owner's organization had a limited role in the evaluation and construction monitoring process, relying instead on consultants such as a surety to represent their interests. If successful project results are desired, then owners must become involved in the project from inception to completion to ensure that their objectives are met. This involvement includes contractor evaluation and ongoing monitoring of the contractor's performance during the construction process.

With regard to monitoring cost, 4.4% of the total project cost were expended on failed projects and 2.9% on nonfailed projects. It may be that the contractors involved in the failed cases lacked construction experience and thus required the owner to more closely monitor their performance. For the failed cases, the owners could spend the difference between the amount expended on monitoring for nonfailed versus failed projects to do a better job evaluating contractor qualifications prior to contract award. Such action may result in lower overall project cost and better contractor performance. More active owner involvement in project cost and schedule monitoring may also aid in achieving nonfailed contractor performance. As a matter of sound business practice, it behooves an owner to ensure that a contractor is only paid monies in proportion to the amount of work completed. Owners are more likely to experience contractor failure if they do not monitor and verify funds paid to a contractor.

Public Projects

Failure cases particularly occur more frequently on smaller-sized than larger-sized projects involving a public owner. Note that the larger public-owner projects that experienced nonfailure are half the size of the average private-owner projects reported. The average number of projects executed annually by the respondents was about 226, and the average cost per project was approximately $1,900,000. Clearly, many public-owner construction programs involve a large number of smaller-sized projects. Today, large projects undertaken by public owners are the exception rather than the rule.

Project cost and duration increase were also statistically significant. In spite of the indifference between owner evaluation effort performed prior to and after the bidding process, it appears that public owners may be able to achieve better project performance by better evaluating construction contractors. Currently, minimal effort is expended in the analysis process: an average $235 and 7 person hours per contractor, for an analysis that takes the form of a preaward survey. The quality of the contractor evaluation is 1.4, which is between poor and fair.

The procurement laws in effect are based on the "low bid" (or in some cases the "lowest responsible bid") concept. From the public owner's perspective, minimal effort on their behalf is actually expended to ensure the quality and capabilities of the low bidder. Instead, many public owners rely

on the bonds (which are required by statute), and thus the surety, to establish contractor competence. The surety provides the public owner protection only in the event of contractor default or failure to pay project labor, materialmen, or subcontractors, but it provides no protection for poor performance on behalf of the contractor. In many cases, the low bid measured strictly in terms of cost along with the required bonds does not always result in the best overall performance or the lowest total project cost. Public owners should consider developing and implementing contractor-evaluation procedures that can facilitate achieving better contractor performance. To accomplish this, legal and political difficulties must be recognized and overcome.

Private Projects

Private-owner data show that project cost, duration, and cost changes due to design errors and omissions are statistically significant. Project owners should recognize that poorly conceived plans and specifications can adversely affect the contractor's performance and may contribute to causing a contractor failure. It appears that when a contractor fails, private owners are "schedule-driven," and willing to expend large sums of money to finish the failed project in the shortest amount of time.

A larger number of contractors were involved in the bidding process on failed projects than nonfailed projects. This may suggest that owners that experienced a failed project desired to have a larger number of bidders to stimulate competition with hopes of achieving a lower project cost. To increase the number of bidders, perhaps the evaluation criteria used in the evaluation process were relaxed such that some less-qualified contractors were permitted to bid on the project. In contractor evaluations performed, private owners expend on average $2,670 and 25 person hours per contractor, with the quality of analysis being between good and fair. This may suggest that this owner group does expend significant resources in performing contractor evaluation but may not be analyzing all the factors that are good predictors of contractor failure.

Conclusions

Contractor failure causes substantial negative consequences for project owners. Results clearly demonstrated a significant increase in final project cost and schedule duration as a result of the contractor's failure. Based upon this study, it was found that contractor failure is more likely to occur when a project is small in size, involves contract documents that are poorly conceived, involves an owner that has not worked previously with the contractor, involves an owner that expends minimal effort up front to evaluate the contractor's suitability to perform work associated with project, and involves no monitoring of schedule performance or funds paid to the contractor relative to the amount of work actually completed.

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