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An Investigation Into Computerized Estimating Software Used In Accounting For Cost Estimates By Residential Builders

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ABSTRACT

The purpose of this study was to investigate the utilization of information technology in the estimating functions, related to the scale of operations, by Pennsylvania's home building contractors. Firm size was examined as to its impact on three issues in construction cost estimating practices; type of estimating technology, whether or not the primary estimating function was computerized, and if computerized, the primary program used for the estimating functions by home builders. Significant differences existed among firm sizes in the information technology used for estimating costs. Secondly, significant differences existed among firm sizes as to the use of a computerized estimating system verses a manual estimating system. Larger firms utilized more advanced technology. However, the results revealed that there are not significant differences among firm sizes in the primary program used for estimating when a firm has a computerized estimating procedure. Small firms that are computerized in many cases are taking advantage of the same software used by larger firms.

INTRODUCTION

Technology changes will continue to play a major role in the construction industry. Some of these technological improvements can help an organization bid more accurately by helping to reduce uncertainty in the bidding process. However, reducing uncertainties is a difficult task, which begins with understanding the changes in processes. Changes in technology must co-exist with changes in process. These impending technologies in the construction industry need be observed by educators and researchers in the fields of education, construction, and technology. Unprecedented opportunities exist to provide construction education, but strategies need to be devised on how to manage these changes and provide educational alternatives to students and practitioners. Current information must be gathered to understand the practices and needs of the of Pennsylvania Home Building firms with respect to their estimating functions. In order to attain this goal, three research questions were posed to examine these information technology issues as affected by the size of the firm.

PURPOSE

The purpose of this study was to investigate the utilization of information technology in the estimating functions, related to the scale of operations, by Pennsylvania's home building contractors. Differences in firm size was examined as a factor in the estimating practices, whether or not the primary estimating function was computerized, and if computerized, the primary program used for the estimating functions by home builders.

LITERATURE REVIEW

In the construction industry, there is a universal perspective that the precision of cost estimates is fundamental to the success of all groups involved in a construction project (Akintoye, 2000). Competitive bidding, in which the cost estimate is the critical element, is the most conventional and established method for procuring construction work. As a result, bidding becomes a frequent and repetitive construction practice for contractors

seeking work in a highly competitive industry. As such, competitive bidding is the main vehicle through which contractors receive the majority of their work. Contractors, who do not deal with cost estimating effectively, will eventually be driven out of business (Fu, Derek, & Lo, 2002).

Cost estimating can best be articulated as a mixture of technical procedures, analytical functions, and subjective processes whose combined purpose is to predict the costs of construction of a project to be completed in a given time. By using all of the information available for the project, the tender sum is then calculated by combining the cost estimate and a mark-up. The mark-up consists of the allowance for general and fixed overhead, profit, and adjustment prices (Akintoye, 2000).

In a study of cost estimating practices, Akintoye and Fitgerald (2000) identified that "standard estimating procedure" was the highest ranked technique employed overall by contractors in the United Kingdom. In the study conducted, standard estimating procedure was defined as the costs of construction, as established by the estimate, in addition to allowances for overhead and profit. The study stratified contractors in one of four ranges: very small, small, medium, and large contractors as recognized by size grouping techniques. In each of these ranges, "standard estimating procedure" was the highest rated technique for job procurement.

For successful bids, the cost estimates form the framework for the work to be undertaken on the projects. For this reason, cost estimates are vital and are the central element in project management. They serve as the conduit through which budgeting, accounting, and cost control among other items flow (Wang & Huang, 2000). Al-Jibouri (2003) added "the estimate prepared for any project forms an important means for financial control of that project" (p. 150). An estimate determines the contractors' budgeted direct costs and forms the basis for the project. The direct costs are the significant costs, which when factored in with overhead and profit, ascertain whether it would be cost-effective for the firm to take on the project (Akintoye, 2000). Hicks (1992) calls attention to the importance of cost estimating: "without an accurate cost estimate, nothing short of an act of God can be done to prevent a loss, regardless of management competence, financial strength of the contractor, or know how" (p. 545).

Accurate cost estimating practices are crucial for any construction company's continued success. Inaccurate estimates can result in two different but both harmful consequences**.** First, recurring underestimates of jobs will lead to work, but also cost overruns. As a result, those jobs will result in losses. Over the course of time, underestimating will have a direct negative impact on the firm's profitability. Consequently, such practices will ultimately lead to business failures and bankruptcy. Second, overestimates and bidding too high, will result in the contractor not receiving contracts. Overestimates will lead to a shortage of work and, ultimately, business failure. Contractors' inaccurate estimates are a problem in the construction industry because of its highly competitive market and lower profitability margins compared to other industries (Akintoye & Fitgerald, 2000). Akintoye (2000) states the importance of an accurate estimate, "thus, overestimated or underestimated cost has the potential to cause lost strategic opportunities to a construction contractor" (p. 77). Paulson (1995) sums up the role of the estimator:

The estimator must practically build the project on paper, assessing quantities not only of the contract materials reflected in the drawings but also of the temporary materials, such as formwork for concrete and temporary plant. Such estimates may require the estimator to hypothesize alternative methods for different components of the project, determine the labor, equipment, and materials required by each method, evaluate the productivity and costs, and select those methods that, taken together, will complete the project on schedule and at the lowest overall cost. Computers can assist the estimator every step of the way. (p. 353)

Tools used to calculate a project estimate by construction firms include spreadsheets, specialized estimating programs, and digitizers. In 1979, Bob Frankston and Dan Bricklin created the first spreadsheet program called VisiCalc to run on an Apple II system. VisiCalc was seen as one of the most important reasons for the acceptance of personal computers in the business community. In 1984, Lotus 1-2-3 hit the market with even more capabilities and finally, in 1987, Excel for Windows was introduced. Excel is currently the dominated spreadsheet being used with an estimated market share from 60% to 90% (Cox, 2000). In the construction industry, spreadsheets, for the most part, have replaced manual calculations. Time savings are considerable, estimated to take a third of the time of that of a manual calculation while also increasing the accuracy of bids (Christofferson, 2000).

Specialized estimating programs have also increased in use over the last decade. Programs such as Timberline, MC2, and WinEst have additional features not found in spreadsheets. These programs add features such as databases to store information about various facets of the business, allowances for multiple organization structures, and enhancements for report resources. The use of spreadsheets and estimating software to its fullest capabilities increases the accuracy of the estimate; thereby, improve the likelihood of receiving the project (Miller, 2001).

Information and experience, in the form of knowledge and skill, gained on past projects can facilitate the procurement of future work. This concept, called the experience effect, maintains that experienced estimators are typically more competitive than inexperienced estimators in their bids. Feedback plays an important part in this process. Feedback, both positive and negative, received from historical projects form the nucleus of the contractor's experience. The knowledge gained through the repetitive process of construction estimating is invaluable. The experienced contractor should constantly be using this feedback in making decisions and refining the process as necessary in order to procure work (Fu, Derek, & Lo, 2002).

The use of a system to provide access to past project performances, comparative data, and lessons learned is vital to a construction firm looking to improve efficiency of estimating. Amor, Betts, Coetzee, and Sexton (2002) state "In construction, it is essential to rely on past project knowledge and information when dealing with new projects. The implication of this theme is that the industry will require strategic systems, which allows capturing of previous knowledge" (p. 254). By using a system, the contractor has information available that can easily be used for estimating on subsequent jobs. This process allows for a more accurate and timely cost estimate and increases efficiency to create or maintain a competitive advantage. Fu, Derek, and Lo (2002) perceive "that the effect of experience has a significant contribution to the bidding competitiveness of contractors who are continually learning" (p. 665).

RESEARCH QUESTIONS

Research Question One:
To what extent are the differences in estimating practices related to the scale of operations?

Research Question Two:
To what extent are the differences in whether or not the primary estimating function is computerized related to the scale of operations?

Research Question Three:
To what extent are differences in the primary program used for the estimating functions when home builders are computerized related to the scale of operations?

DATA

The population of this study was exclusive to home building firms in the state of Pennsylvania. Therefore, Pennsylvania home building firms served as the unit of analysis for data analysis, results, and conclusions. No single list exclusive to Pennsylvania home building firms was known to exist. Subsequently, the study used a cluster approach through a multi-stage sampling technique as a means to collect data. In particular, the study used an area probability sampling technique implementing three phases. The first phase divided the counties of Pennsylvania into three regions, east, central, and west. The second phase called for systematically selecting a sample of counties from each of the regions of the state in order to determine the county clusters. In the final step, a list of Pennsylvania home building firms from the sampled counties was compiled and the survey was distributed to all Pennsylvania home building firms whom could be identified in those counties. Surveys were distributed to 1,320 firms which generated a useable sample of 365 firms, a response rate of approximately 28 percent.

RESULTS

Research Question One:
To what extent are the differences in estimating practices related to the scale of operations?

In order to answer research question one, the survey addressed which estimating practices were used by home building firms. First, a one-way analysis of variance (ANOVA) was performed. Table 1 shows the statistical results of the one-way analysis of variance for the survey items based on firm size regarding these estimating practices.

Table 1
Estimating Practices Examined by Firm Size

Estimating Process	Mean						
	n	Small	Medium	Large	Total	F	*p*
Use of design software	364	2.00	2.17	2.92	2.36	12.264	< 0.001
Use of estimating software	360	1.54	1.80	2.36	1.90	11.156	< 0.001
Use of computerized spreadsheets	364	2.41	3.11	3.84	3.12	24.333	< 0.001
Use of pencil and paper calculations	362	4.23	3.96	3.39	3.86	14.717	< 0.001

Note: Application Scale: 1 = Never; 2 = Seldom; 3 = Sometimes; 4 = Most Times; 5 = Always

The results reveal that there are significant differences based on firm size on the use of design software (F = 12.264; p <.001), use of estimating software (F = 11.156; p <.001), use of computerized spreadsheets (F = 24.333; p <.001), and the use of paper and pencil calculations (F = 14.717; p <.001) by Pennsylvania home building firms.

Secondly, a post hoc analysis was performed. A Tukey multiple comparison test was utilized to examine differences among the individual firm sizes; small, medium, and large. For item one, the post hoc results for the use of design software reveal that small firms do not differ from medium firms (p = .678); small firms use less than large firms (p <.001); and medium firms use less than large firms (p = .001). For item two, the use of estimating software, the post hoc results demonstrate that small firms do not differ from medium firms (p = .321); small firms use less than large firms (p <.001); and medium firms use less than large firms (p = .005). For item three, the use of computerized spreadsheets, the post hoc results reveal that small firms use less than medium firms (p = .002); small firms use less than large firms (p <.001); and medium firms use less than large firms (p = .001). For the last item, the use of paper and pencil calculations, the post hoc results reveal that small firms do not differ from medium firms (p = .197); small firms use more than large firms (p <.001); medium firms use more than large firms (p = .001).

Research Question Two:
To what extent are the differences in whether or not the primary estimating function is computerized related to the scale of operations?

The survey was used to address the second research question by gathering information pertaining to whether or not the principal method used in the firms' business for estimating process is computerized. A chi square test was used to evaluate this question. Table 2 shows the statistical results of whether or not home builders use a computerized system in their estimating procedures.

Table 2
Computerization of Estimating Practices Examined by Firm Size

Estimating Process	Firm Size				χ^2	*p*
	Small	Medium	Large	Total		
Non-Computerized	70	53	19	142		
Computerized	52	63	97	212		
Total	122	116	116	354	43.838	< 0.001

The results of the chi square analysis show that there are significant differences (χ^2 = 43.838; p <.001) in the use of a computerized estimating process among the three home building firm sizes.

Research Question Three:
To what extent are differences in the primary program used for the estimating functions when home builders are computerized related to the scale of operations?

The survey was used to address the third research question by gathering information pertaining to firms using computerized packages to determine the primary program used for their estimating functions and whether differences existed among the companies based on size. Chi-square tests were used to analyze this question. The results are shown in Table 3 broken down by spreadsheets, estimating software, and other.

Table 3
Computerized Estimating Programs Examined by Firm Size

Estimating Process	Firm Size				χ^2	*p*
	Small	Medium	Large	Total		
Spreadsheets	28	39	58	125		
Estimating Software	17	21	25	63		
Other	7	3	14	24		
Total	52	63	97	212	4.709	< 0.001

The results of the chi square analysis show that there are not significant differences (χ^2 = 4.709; p = .318) in the primary program used for project cost estimating by home builders when computerized in the estimating process among the three home building firm sizes.

CONCLUSIONS

The research questions were designed to address the home builders' use of information technology related to their cost estimating practices. First, research question one dealt with the use of four estimating methods; use of design software, use of estimating software, use of computerized spreadsheets, and use of paper and pencil calculations, used to calculate estimates by home builders. According to the findings, there are significant differences among firm sizes in the use of information technology in regard to the four estimating methods discussed. Generally speaking, the difference in estimating methods is isolated to the large firms when compared to small firms and medium firms. There are no significant differences between small and medium firms except for the significant differences between the use of computerized spreadsheets where, overall, small firms use spreadsheets less than medium firms. The data illustrate that larger firms are, by in large, taking advantage of information technology while being compared to medium and small firms. Conversely, evidence points to the fact that small and medium firms are still relying primarily on paper and pencil calculations to perform their estimating functions.

Secondly, research questions two and three dealt with determining the principle program used in their estimating practice. The data supported research question two that significant differences exist among firm sizes between the use of a computerized estimating system or manual estimating system. However, the data also reveal

that there are not significant differences among firm sizes in the primary program used for estimating when a firm has a computerized estimating procedure. This is a very important finding as it clearly demonstrates that small firms which are computerized are in many cases taking advantage of the same software used by larger firms. This is evidenced by the results for research question three which find no significant differences among firms of all three sizes on the type of computerized estimating programs used; spreadsheets, estimating software, and other packages, when a firm has a computerized estimating procedure.

This study provided a perspective on the current use of information technology with respect to estimating software in the Pennsylvania home building industry. Spreadsheets are the main resource for computerized estimating while estimating software is shown to be used in a smaller percentage by firms. However, paper and pencil calculations are still dominant in the industry. The data show that many small and medium firms are not taking advantage of the technology in managing a complex building process. The results of this study have shown that there are some Pennsylvania home building firms operating at a high of level of sophistication in the areas of information technology with respect to estimating procedures. However, there are also many firms identified to be operating at lower levels of sophistication in respect to cost estimation. In the pending years, survival in the home building industry will require higher levels of sophistication to manage the complicated building process involved in its profession.

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