Fourth International Conference on Construction in the 21st Century (CITC-IV)
"Accelerating Innovation in Engineering, Management and Technology"
July 11-13, 2007, Gold Coast, Australia

AN ANALYSIS OF COST INFORMATION MANAGEMENT IN THE ELECTRICAL CONTRACTING SECTOR

Tomas White
(Graduate Student, Department of Construction Management, Florida International University, Miami, Florida, USA)

Yimin Zhu, Ph.D.
(Assistant Professor, Department of Construction Management, Florida International University, Miami, Florida, USA)

Abstract
Cost information is processed by different departments and follows different paths within a company. By statistically analyzing cost data from several electrical contracting companies of different sizes in the country, the main intent is to show the similarities as well as the disparities in both cost tracking and forecasting depending on the annual revenue of the organizations under study. A discussion of the results obtained from analysis is presented to identify current practice methods and to propose future research geared towards three main areas: estimating, accounting, and project management.

Keywords
Business processes; electrical contracting; cost tracking; cost forecasting

1. Introduction

Currently, Information Systems (IS) are a key tool for many construction companies. They facilitate the exchange of intraorganizational information and also provide a competitive advantage when compared to competing organizations. This view is supported by Davis and Yen (1999) stating that "an information system is a set of hardware, software, data, human, and procedural components intended to provide the right data and information to the right person at the right time."

The importance of information systems relies on its capabilities of making business processes run more efficiently. Departments in any given organization can reduce time spent on paperwork by using a digital platform to keep track of all activities. Also communication between different departments within the company can be performed easier when a common integrated system is used for data processing.

In the case of electrical contracting companies, there has not been a documented process related to how cost information is managed by the different actors involved in the business processes, which are geared towards obtaining the business goal of the subcontracting businesses studied.

The possibilities of organizations to use Information Technology (IT) tools have increased due to a reduction of costs related to the informatization of the company; therefore an increment in the use of specialized software has been seen. As Attaran (2004) observed, "In the 1990's, significant reduction in

the cost of IT resulted in enormous investments in IT applications that have stimulated increasingly complex organizational change."

2. Methodology

It is the intent of this study to establish the foundation of future research for specialty occupations in the construction industry by identifying data flow patterns within a specific group of electrical contracting companies that provide services for the construction industry. The data flow patterns are concentrated within the business processes showing how cost information is managed for the estimating, accounting and project management functions. A set of answers obtained from a data collection practice performed to 57 companies in the electrical industry was analyzed by the use of cross tabulations, using the chi-square testing procedure. A linear regression analysis is presented to help identify patterns in the data compiled.

3. Information Systems

3.1 Business Processes

Business processes were defined by Davenport (1993) as "the specific ordering of work activities across time and place, with a beginning, and end, and clearly identified input and output." In a similar manner, Casati and Sahai (2005) understood business processes as those activities "that are performed in order to provide services or produce goods." In other words, business processes comprise all the steps required to complete a given company activity. By improving business processes and making them more efficient, tasks performed by a company will consume fewer resources in both time and money.

Previous studies (Alter, 1996) showed that IS can increase the flexibility in business processes. IS can make it easier to handle the variations in product specifications; additionally, it can help control production processes based on computer-generated product specifications. Joshi (1998) concluded that IS that support and link computer-aided design (CAD) and computer-aided engineering (CAE) enable different functions to directly utilize the electronic information flows between them with little manual support.

According to Leymann *et al.* (2002), "being able to change a flow model or create a new one quickly is providing one competitive advantage; carrying out business processes efficiently provides another one." By having an efficient business process, the goal of cost reduction is also being addressed due to the time savings accomplished to obtain a given "product" following the aforementioned change. "The scope of a business process can be limited to a particular department in an enterprise, it may span multiple divisions within an enterprise or it may require interenterprise collaborations" (Leymann et al., 2002).

Back and Moreau (2000) perceived a process "as a set of interrelated activities necessary for the performance of a specific business mission." The common view of business processes is one of hierarchical precedence that flows coherently depending on the importance of the process to complete the business activity. Referring to business needs, Back and Moreau (2000) emphasized on the need of "a methodology that permits planning, analysis, and (re)design of a process independent of the execution platform or the technologies that enable it."

Business processes define the work operations of departments within a company. They typically show the way business is performed. Also, responsibilities by any given department are well defined by a business

process. Usually, data flow back and forth from one department to the other as defined by specific business rules depending on the company's operational structure.

3.2 Application of Information Systems

Love and Irani (2003) stated that "organizations vary in size and technological capabilities, and this makes it difficult to manage project-related information" when referring to IS implementation within companies with different sizes. The research by Love and Irani also observed that "with having a centralized project management IS in place, all information regarding contract variations, requests for information, etc. would be stored on a central database that project participants can access." It was found that certain organizations have their customized project management IS, which requires other companies working for them to use the same identical system.

Leymann et al. (2002) stated that "being able to change a flow model or create a new one quickly is providing one competitive advantage; carrying out business processes efficiently provides another." Leymann subsequently pointed out that "during the design of the business process, the different parts of the flow model, such as activities or transition conditions, are instrumented to measure relevant metrics, such as the time it takes to carry out an activity." Back and Moreau (2000) affirmed that "to date, a methodology has not been developed for the engineering and construction industry to examine the potential contribution of information management strategies in efforts to reduce overall project schedule and cost."

Business processes in electrical contracting companies may vary with respect to the annual volume of the company and it is the purpose of this study to find certain patterns of information flow according to the annual value of the company. Certain processes can be more refined for larger companies with more experience as they overcome mistakes from past experience. It is much more difficult to change a business process that affects different departments of the company when data are not kept and analyzed by an integrated information system.

4. Statistical Analysis of Data

Data from an ongoing research (Zhu, 2007) were analyzed by statistical analysis software (Windows SPSS). The data of concern was asked to a variety of electrical contracting companies in the U.S. For the purpose of this paper, the two questions analyzed concerning project cost tracking and project cost forecasting will be presented.

The chi-square test was selected as the statistical test that can adapt better to the available data. Its strength resides in its power to compare sets of data defined by categorical values such as the ones under study in this research paper. The chi-square test is usually applied to two-way tables. A null hypothesis (H_0) needs to be defined. Moore and McCabe (2004) stated that usually the null hypothesis means that the variables compared are related.

The null hypothesis (H_0) states that the business activities illustrated, mainly cost tracking and cost forecasting, vary in terms of the function they pertain to depending on company size. Thus, a certain procedure to carry out a business process or function is closely related and depends on the annual volume of the company.

4.1 Company Size/Volume vs. Number of Employees

The answers obtained were analyzed according to the companies' size/volume. There were three identifiable categories: less than or equal to $10 million, between $10 and $30 million, and more than $30 million, totaling 57 responses. Each category accounted for approximately 1/3 of the total respondents, making it a heterogeneous distribution of revenue among the participants studied.

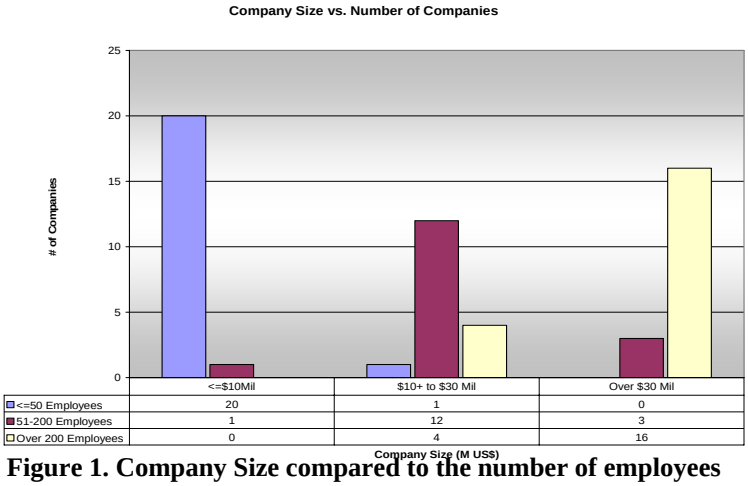

Figure 1. Company Size compared to the number of employees

Table 1: Chi-square test for

Chi-Square Tests	
	Value
Pearson Chi-Square	67.976(a)
a. 1 cells (11.1%) have expected count less than 5. The minimum expected count is 4.77.	

The chi-square test results (table 1) imply that the relationship between the companies' size and their number of employees is not significant. The results can be explained by the low number of cases in some of the categories to be able to make a strong relationship between the two factors. For the test to be considered of significance, the Pearson Chi-Square (p-value) must have a value that is less than or equal to 0.05.

Given the results obtained, by which no significant relationship between company size and number of employees can be reached, simple observation can be of help to understand these results. According to the responses gathered, it is evident that companies with few employees (less than 50 in number), totaling 95.2% of them, have total revenues (volume) of less than $10 million. This is a considerable percentage which relates small companies (low volume) with a low number of employees. For companies in the range of 51 to 200 employees, 70.6% of them are comprised within a company size between $10 and $30 million, locating them at exactly the mid-point regarding company size. In conclusion, these companies don't usually have few employees but they don't have a large number either. Companies with a number of employees of 200 or more involve a total of 84.2% of them are located in the upper division of revenue, with more than $30 million per year. This is a high percent in order to assert for this sample that companies with higher volumes usually have a higher number of employees.

4.2 Cost Tracking vs. Company Size

Cost tracking is regarded as an essential activity for the successful completion of a construction project. It has been used as a tool for decision-making personnel to manage risk by planning ahead with less uncertainty.

The first question (Q1) that companies answered in the study in progress by Zhu (2007) was related to the way cost tracking is performed within the organization. Specifically, the question read: "Does your company treat cost tracking, i.e., recoding actual cost, comparing actual cost with budget and maybe forecasting cost status, as part of accounting function or project management function?" This question was aimed at answering the behavior of each company regarding how cost tracking is performed by the departments or business units involved in that process, in particular by either as an accounting function, as a project management function, or other.

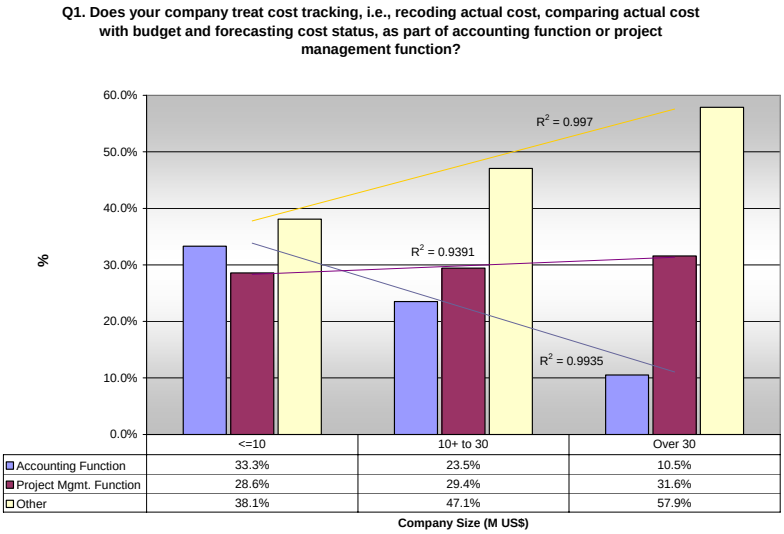

Figure 2. Cost tracking by company size

Table 2: Chi-Square test for question #1 (Q1)

Chi-Square Tests	
	Value
Pearson Chi-Square	3.138(a)
a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is 3.88.	

According to the Pearson's chi-square value (p-value) of 3.138 > 0.05 (table 2), there is no significant relationship to be drawn from question No.1 (figure 2); the variables are not significantly related by the use of the test.

The inferential statistics approach used did not prove to suggest a strong relationship between the variables graphed in figure 2. An analysis can be made by simply observing the trends that a graphical analysis can provide. Using linear regression, a trend can be established when the R^2 value approaches the unitary value. For values in the range $0.9 < R^2 < 1.0$, a linear pattern is said to exist between the variables in question for the purposes of this study.

It is seen with help of the linear trends found that as companies grow in size, cost tracking function is less considered as part of accounting function only, although this cannot be surely stated by the chi-square test results. Also, a similar percentage of companies in each size category treat cost tracking as part of a project management function. At the same time, as companies grow in size, the cost tracking process is considered as "other" category, which includes in its majority a combination of the prior two functions, accounting and project management functions.

4.3 Cost Forecasting vs. Company Size

Cost forecasting requires great ability in predicting the future costs which the company will incur. The prediction is a combination of understanding the market and also the company's own capabilities. Usually by the use of historical data from past projects, the certainty in forecasting future costs increases, to obtain a higher degree of accuracy for the estimates values.

The p-value obtained for the chi-square test is greater than 0.05 (table 3). No significant relationship can be drawn from the data. From observation only, it appears that as companies grow in size, project managers perform the cost forecasting for their own projects. This can reflect that project managers for larger companies have more responsibilities and/or better tools to analyze current project data and convert it into useful information to predict future costs for the remainder of the project.

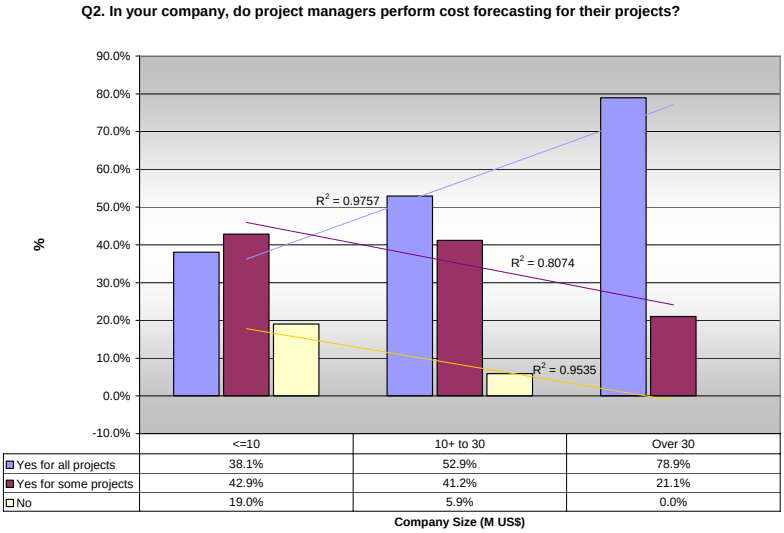

Figure 3. Cost forecasting by company size

Table 3: Chi-square test for question #2 (Q2)

Chi-Square Tests	
	Value
Pearson Chi-Square	8.973(a)
a. 3 cells (33.3%) have expected count less than 5. The minimum expected count is 1.49.	

Opposite to the results obtained from the chi-square test performed, the linear regression analysis shows a clear relationship between the size of the company and the companies' department assigned to perform cost forecasting (figure 3). For instance, as companies grow in size project managers have more responsibility of performing cost forecasting for all projects. It is also of interest to notice that companies of more than $30 million have their project management have input in the cost forecasting process for the majority of projects.

It seems important to find out that departments different from project management are performing cost forecasting when the size of the company does not rise above the $10 million mark. This behavior accounts for 19% of the respondents within the $10 million or less category.

5. Conclusions

Results found from the statistical analysis set a starting point for the understanding of cost information exchange within three main areas of the electrical contractors studied: accounting, estimating and project management. The inferential statistical analysis performed did not produce results strong enough to conclude that companies perform business activities differently depending on their size. However, by the use of graphical analysis, an identifiable trend was found for the two business processes analyzed, cost forecasting and cost tracking.

It is understood that cost tracking and cost forecasting are disregarded by small companies in the construction sector without access to many of the computational and financial resources that larger companies usually have. As the schedule compresses in the lifetime of a project, it might appear that efforts must be concentrated on other tasks. At the same time the review of work progress and resources spent as well as the assignment of available resources is required.

Nevertheless, data gathering from companies in the electrical sector and other subcontracting companies concerning their business processes must persist, with the objective of setting a benchmark of performance, with a clear classification for each category of company size.

The main purpose which consists in identifying the different patterns of information flow needs to be addressed to its roots by the use of future data analysis of internal business processes from a representative group of companies. The next step in this line of research is finding the reason behind the different operation patterns of the companies and how those operation procedures influence the efficiency of the business processes relating directly to the profitability of the companies.

References

Alter, S. (1996). *Information Systems: A Management Perspective*, Benjamin/Commings, NY.

Attaran, M. (2004). "Exploring the relationship between information technology and business process reengineering." *Information & Management, 41*, 585-596.

Back, W., and Moreau, K. (2000). "Cost and schedule impacts of information management on EPC process." *Journal of Management in Engineering, 16*(2), 59-70.

Casati, F., and Sahai, A. (2005). *Business Process: Concepts, systems and protocols*. In The Practical Handbook of Internet Computing, CRC Press LLC, Boca Raton, FL.

Davenport, T. H. (1993). *Process Innovation*, Harvard Business School Press, Cambridge, MA.

Davis, W., and Yen, D. (1999). *The systems development lifecycle*. In The Information System Consultant's Handbook (Chapter 1), CRC Press LLC, New York.

Joshi, K. (1998). "Cross-functional integration: the role of information systems." *Journal of Information Technology Management, 9*(3), 21-29.

Leymann, F., Roller, D., and Schmidt, M. T. (2002). "Web services and business process management." *IBM Systems Journal, 41*(2), 198-211.

Love, P.E.D., and Irani, Z. (2003). "A project management quality cost information system for the construction industry." *Information & Management, 40*, 649-661.

Moore, D., and McCabe, G. (2004). *Introduction to the Practice of Statistics*, W.H. Freeman and Company, NY.

Zhu, Y. (2007). "An integrated information system for electrical contractors." Electri International.