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OF ESTIMATE ACCURACY



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Quantitative Prediction of Estimate Accuracy

**Prepared by
The Construction Industry Institute
Improving Early Estimates Research Team**

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Executive Summary

For engineering and construction projects, accurate early cost estimates are extremely important to the sponsoring organization and the engineering team. For the sponsoring organization, early cost estimates are often a basis for business unit decisions.

The accuracy of an early estimate depends on four determinants: *who* was involved in preparing the estimate, *how* was the estimate prepared, *what* was known about the project, and *other factors* considered while preparing the estimate. To measure the impact of these four determinants with respect to estimate accuracy, the CII Improving Early Estimates Research Team developed the Estimate Score Program (ESP), a software tool that evaluates 45 elements, organized in four divisions. The ESP software was developed to automate the scoring procedure and to assess accuracy and predict contingency based on historical cost data. The software and user's manual are published by CII on a compact disc and publication (Implementation Resource 131-3, *Estimate Score Program Guide*). The research team also produced Implementation Resource 131-2, *Improving Early Estimates: Best Practices Guide*.

The ESP tool enables the business unit and the team to make better decisions based on statistically valid information. It improves team alignment by providing a better understanding of the estimate and the factors that can affect the accuracy of an early estimate.

This summary focuses on the research team's development of the ESP tool (CII Implementation Resource 131-3). The tool itself is a credible, readily usable software that has the potential to improve not only early estimates, but project team alignment as well.

Introduction

Background

Early estimates are critical to the initial decision-making processes for capital projects. Initial cost estimates form the basis to which all future estimates are compared. Future estimates are often expected to agree with (i.e., be equal to or less than) the initial estimates. However, too often the final project costs exceed the initial estimates. In addition, the performance of the project team and overall project success is often measured by how well the final cost compares to the early cost estimate.

The Improving Early Estimates Research Team was formed from the realization that early estimates drive the business unit decisions during the early stages of a project and that early estimates often provide the basis for approval of project funding. It is widely recognized that there is a substantial contrast when comparing the extreme importance of early estimates with the amount of information typically available during the preparation of an early estimate. Although lack of scope definition often leads to inaccurate estimates, early estimates (accurate or not) often become “cast-in-stone,” with future estimates unrealistically expected to agree with the early estimate.

Definitions

The research team recognized the importance of properly defining the term “early estimate.” After much discussion and deliberation, it concluded that each firm and organization has its own set of definitions regarding early estimates and, in addition, full funding is approved at different stages of a project, depending on the organization. As a result, the team defined an early estimate (as related to this research effort) as “any estimate that has been prepared from inception of the project up to and including funding approval.”

Contingency also was a term that received much discussion. Contingency (as it relates to this research) refers to “funds above and beyond the base estimate that are set aside to cover issues such as pricing uncertainty, scope omissions and errors, and escalation uncertainty.” Thus, contingency should not be included for significant scope changes, but would apply to normally expected scope changes.

Research Objectives

The research team established three primary objectives. The first objective was to develop a procedure to score an early estimate in order to assess the thoroughness, quality, and accuracy of the estimate. The scoring procedure would be used to score early estimates of completed construction projects and to use the score as a basis to determine the correlation between estimated costs and final costs.

A second objective was to develop a computer software package to automate the estimate scoring procedure of the first objective and to predict contingency. The purpose of this objective was to reduce the subjectivity involved in assessing the accuracy of early estimates by establishing a quantitative model and procedure for predicting contingency based on the score of an estimate and historical cost data.

The final objective was to develop a “Best Practices Guide” to capture the experience and wisdom of the research team and to document the best practices being employed by their respective firms and other firms in the industry. CII’s *Improving Early Estimates: Best Practices Guide* (CII Implementation Resource 131-2) contains the processes, procedures, techniques, and checklists that have been successfully used to prepare early estimates. That publication emphasizes what works, what does not work, and provides discussion on the precautions and pitfalls.

Scope of Research

Because good scope definition is important in preparing estimates, the research team focused initially on issues related to scope definition. However, the research team recognized that early estimates are often prepared based on limited scope definition and scant information regarding specific needs of the proposed facility. To prepare accurate early estimates, the skills and experience of the project team and the estimating procedure also play an important role.

To measure the quality of an estimate, the research team developed an estimate scoring system by identifying 45 elements that can impact the accuracy of early estimates. The 45 elements included elements from the CII Project Definition Rating Index (PDRI) as well as elements related to the team's experience and the estimating procedures used in preparing the estimate.

Data were collected to correlate estimate score with the estimated cost vs. actual cost. The data included 67 projects, representing \$5.6 billion in total installed costs. Analysis of the data was performed to identify factors (grouping of elements) that showed statistical significance. A regression analysis of the factors was performed to determine the relative weights of the 45 elements in the estimate scoring system based on collected project data.

The research team developed the Estimate Score Program (ESP) to automate the scoring of an estimate, predict contingency, and use as a tool for improving early estimates. If the desired level of accuracy is not acceptable, the elements used to determine the estimate score can be revisited to identify opportunities for improving the accuracy of the estimate.

Estimate Score and Data Collection

Estimate Score

The research team identified 45 elements to measure (or score) the quality of early estimates, including 14 of the PDRI scope definition elements that could have a potential impact on the accuracy of an early estimate and 31 elements that are not directly related to scope definition, but that have the potential for influencing estimate accuracy. The complete list of 45 elements was grouped into four divisions. Division 1 represents who was involved in preparing the estimate. Division 2 refers to how the estimate was prepared. Division 3 involves what was known about the project, and Division 4 represents other factors affecting the estimate. Figure 1 shows the 45 elements in the estimate scoring system.

After the 45 elements were identified, a rating scale for each element was determined, ranging from one to five, with one as “best” and five as “worst.” The one-to-five rating scale does not force the respondent to rate a particular element “good” or “bad,” but allows a neutral response. The team also developed descriptions for each of the 45 elements. Recognizing that a certain amount of subjectivity would still be involved in rating the elements (e.g., a rating of “two” to one person may not be the same as a “two” to someone else), the research team developed suggested ratings for each of the possible responses for each of the elements.

Data Collection

A two-page questionnaire was compiled that contained the elements to be rated (Figure 1) and requested specific project and cost data (Figure 2). Cost data were requested in the form of both estimated and actual costs. As a part of the estimated cost data, the respondents were asked to list separately the amount of contingency that had been