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# Software Subcontracting and the Cost to the Mature Organization

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## Abstract

Software Subcontractor Management, a key process for CMM Level 2 organizations involving the selection and management of software subcontractors, requires the contracting agent to ensure that software developed and delivered by the subcontractor meets quality standards. Toward this goal, the procurer allocates internal (and external) resources to guide and oversee the activities of the subcontractor. While software project cost estimation tools are becoming more precise in their ability to predict the costs associated with software production, few address the costs associated with subcontractor oversight and management.

This paper describes research done to determine the effort expended by organizations in overseeing software subcontracts and the implications for predicting costs of proposed projects.

## Background: CMM and Subcontractor Issues

CMM is a process-improvement framework that describes key elements of effective software processes that may lead an organization from an undisciplined, ad hoc state of software production to a "mature" disciplined state.

CMM defines five levels of organizational maturity:

- Initial (Level 1) - few processes are formalized or defined, software development is chaotic, success relies on heroic efforts.
- Repeatable (Level 2) - processes exist for managing software projects and performance in subsequent projects is predictable based upon recorded experience with similar prior projects.
- Defined (Level 3) - the organization has an integrated set of software processes that are documented and standardized and those processes are applied across the organization. "The Software Process Capability of Level 3 organizations can be

summarized as standard and consistent because both software engineering and management activities are stable and repeatable." [Paulk, M., Curtis, B., Weber, C., & Chrissis, M.B., 1995]

- Managed (Level 4) - the organization maintains a software process database to record, manage, and analyze quantitative data about the organization's processes and projects. Because processes and projects are measured, the organization's performance is quantifiable and predictable.
- Optimizing (Level 5) - "At the Optimizing Level, the entire organization is focused on continuous process improvement." [Paulk, M., Curtis, B., Weber, C., & Chrissis, M.B., 1995] All aspects of software quality are tracked and processes are refined to reduce software defects and rework

An organization involved in software projects assumes one or more roles: developer (all work done in-house), contracting agent (all work done externally by contractors), or both (where the organization is the prime contractor and one or more sub-contractors are used). An organization operating at maturity Level 2 or higher has activities in place that specifically address relationships with subcontractors including: a subcontracting statement of work exists as well as a plan for selecting a subcontractor, a subcontractor is selected based on its ability to perform according to documented procedures, a contracting agreement defines the terms and conditions of the subcontract and is used as the basis for managing the subcontract, the subcontractor documents its software development plan, the plan is approved by the contractor, and the plan is used for tracking subcontractor activities, documented procedures control any changes to a subcontractor's statement of work, periodic management and technical reviews are held with a subcontractor according to selected milestones, a subcontractor maintains software configuration management according to documented procedures, acceptance testing procedures are documented and performed, and subcontractor

performance is evaluated and reviewed with the subcontractor.

## **Project Cost Estimation**

Traditional and evolving estimation methods focus primarily on the technical resources needed for developing a software product although they may include some support resources. Few tools, however, consider the cost of user involvement during the project's life cycle. And, when an organization is contracting for software, the procurement processes and their costs are rarely considered. In general, these costs include the costs incurred by the procuring organization for resources needed before and during the system development lifecycle to acquire, manage, coordinate, control, and support the software project. They consist of the effort expended by management, users, support and other personnel with the necessary skills and expertise, as well as the hardware and software tools to support their efforts. Some of these costs are incurred during the solicitation phase where specific and time-consuming acquisition procedures are required for the evaluation and selection of contractors. Other costs, which may be more significant, are incurred after the contract award. They are related to the management of the contract and the subcontractor, interaction required of users and their managers, domain experts who participate in the development life cycle, deliverable reviews, testing activities, and quality assurance activities. In addition, there are related costs such as travel and user training. Since such costs can be significant, they should be included as part of the cost of subcontracting and should be part of software cost estimation models used to predict project costs.

## **Project Cost Research**

This paper addresses the improvement of cost estimation processes for forecasting and controlling development costs by procuring organizations. The goal of the supporting research was to improve the process of cost estimation by revealing the hidden costs of software development for a contracting organization. This research involved identifying such costs, measuring them relative to the project cost and determining the consequences to the organization for failing to recognize the hidden costs. At a minimum, failure to plan for contracting costs introduces risks to projects and greater costs in the long term to mitigate the risks.

Ordinarily, when an organization awards a contract for software development, it considers its only cost to be the contract value. In trying to discern the magnitude of hidden costs in contracting, a study of over two dozen contracted software projects was done. The goal of the study was to contribute to the refinement of the available software estimation models by examining the procuring

organization user and management costs that ordinarily are not factored into the total system cost.

Another goal of the research was to encourage the collection of data about contracting costs within an organization so that databases of completed projects can be used to forecast costs for future projects.

In surveying companies about their contracted software project costs, a questionnaire was prepared and distributed. In some cases, the target-organization returned the completed survey, in other cases, face-to-face interviews were carried out using the questionnaire as an interview instrument.

The strategy used to discern and evaluate hidden contracting costs included the following:

- Determine whether the contracting organization has processes in place for estimating resources for software projects.
- Determine whether expended resources on contracted projects were estimated, planned, and tracked.
- Determine whether historical data is collected on contracted project costs.
- Determine whether historical data about software contracts is used in economic analysis of projects.
- Determine whether contracting organizations track expenditures according to project lifecycle phase.
- Determine which organizational resources actually participate in contracting.
- Determine the effort expended by the contracting organizations on the projects surveyed.
- Determine characteristics of contracted projects in terms of size and complexity.
- Determine the cost drivers that influenced hidden costs.
- Determine impact on the organization of hidden contracting costs.

Care was taken to locate the individual or individuals in the organizations who understood all aspects of the contracted project and the details of the organization's efforts in procuring, tracking, and completing the contract.

## **Results of Survey**

Despite advances in organizations' understanding of quality software production practices, such as those developed at Carnegie Mellon's Software Engineering Institute, many organizations are slow to embrace recent proven practices. For example, a majority of the respondents did not know at which CMM level their organization was operating or whether a maturity assessment had even been performed in their

organization. The respondents' organizations represented a broad range of companies and government agencies, leading us to believe that the adoption of software quality precepts is slower than proponents would like to believe.

The contracts studied had project costs ranging from \$30K to \$50M. Cost estimation methods varied widely ranging from "No estimation method" to the use of "Lines of Code." The most common project estimation technique was "Experience." Regardless of the estimating technique used, all of the projects studied had project cost and schedule over-runs.

One of the goals of the research was to discover the magnitude of the investment in resources needed to assign a contract and to carry out contract oversight. The majority of organizations did not include their contract management and oversight costs as part of their project estimation costs or as part of any budgeting process related to the contracted project. Nor were user resources included in the estimating process.

A number of questions in the survey addressed planning and scheduling of resources related to a project prior to deployment. The results of these questions showed that organizations expose themselves to a broad range of risks that logically lead to schedule and cost overruns. A majority of the organizations and projects did not incorporate contract management or user resource allocation as elements of pre-planning or on-going project management. It is, therefore, no surprise that when an analysis of hidden costs was carried out, approximately 35% was attributable to management and 50% to users in a labor-category analysis. Finally, when hidden costs were analyzed as a percent of project cost, they were quite substantial. The mean value of the hidden costs were 190% of the total development costs of the projects.

## Conclusion

The results of this research are significant to contracting organizations. The results show that hidden costs are incurred, the costs are significant, and they are not managed. Failure to plan and schedule critical resources such as users, project managers, domain experts, management software, and other resources may pose a risk to a contracting organization and to the project itself. Organizations that understand the inherent costs of contracting software are better positioned to estimate costs of future projects and also improve decision making processes associated with software contract oversight. Mature organizations have insight into all aspects of software development whether in-house or contracted. Hidden costs of contracting software are significant and may contribute to both schedule and cost overruns for a software project.

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