

QUANTITATIVE EFFECTS OF PROJECT CHANGE

The Construction Industry Institute
The University of Texas at Austin
3208 Red River
Suite 300
Austin, Texas 78705-2650
(512) 471-4319
FAX (512) 499-8101

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Quantitative Effects of Project Change

**Prepared by
The Construction Industry Institute
Project Change Management Research Team**

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Executive Summary

This publication summarizes research conducted by the CII Change Management Research Team on the quantitative impacts of change . The research concludes that a significant correlation exists between the proportional amount of change on a project and labor productivity, both in design engineering and construction. The decline in overall productivity due to an environment of excessive change can alter the cost/benefit evaluation of potential changes and should be taken into account in project decision making. The research team recommends that project management track the expected amount of change over time as a tool in assisting decisions concerning timing and/or organization of change implementation.

The analysis of the projects submitted for study also shows that projects have a declining ability to recover lost schedule and costs in their later stages. This effect is expressed in a probability profile. A normalized contingency draw-down curve for the projects submitted suggests that many changes occur late in the project life cycle. Analysis of the data indicates that the timing of construction start does have an effect on the amount of change in engineering and in the total cost of changes, but the effect on construction change is negligible.

The research team also studied the amount of change experienced on projects of different types with varying contracting strategies. It is recommended that organizations analyze and retain project data, and also provide information on trends that general management can use as benchmarks to monitor project performance.

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Introduction

Background

A substantial majority of projects in the U.S. construction industry fail to meet their cost and schedule objectives, according to CII research. Change, or rather the inability of the industry to manage change effectively, is a key contributor to the inconsistent results achieved on projects. Although change management is a key factor in project success, and although change is a root cause of much of the litigation plaguing the industry, little quantitative research has been done on the impacts of change on projects. Most of what is understood about the impact of change in the industry today is based on anecdotal information and personal experience. The construction industry needs a basis for quantifying these impacts and understanding key variables in the management of change.

Purpose and Objective of the Study

One of the key principles of change management is the requirement to *evaluate* each potential change. Evaluation implies a clear vision of the probable outcomes of the change. This publication describes some basic quantitative relationships between key project variables so that project managers of both owners and contractors can make better evaluations, and hence better decisions, in the management of change. A clearer view of change impacts will enable project teams to take advantage of beneficial changes when the opportunity arises without inordinate fear of negative impacts. It also will help to discourage changes detrimental to project success through improved cost and schedule analysis. Finally, a clearer view of impacts will result in informed decisions concerning the most efficient way to implement a change, once it has been determined to be necessary to the project mission. **Better vision, better decisions, better outcomes** — this is the objective of this publication.

Study Hypotheses

CII chartered this study, conducted under the supervision of a research team of industry professionals, to develop a basis for quantification of change impacts by testing two basic relationships relating to change:

1. The more change experienced on a project, the greater the negative impact on productivity.
2. Changes that occur late in a project are implemented less efficiently than changes that occur early in the project.

CII felt that by testing and possibly verifying these two relationships, the industry could start to move in a direction of common understanding and would learn important lessons about how change is measured. Although other significant quantitative relationships relate to change, CII felt that much would be learned from focusing on these two basic relationships.

Scope of the Study

The projects studied were submitted by CII member companies. All were executed for private owners—no public projects were submitted. Projects studied included lump sum, unit price and reimbursable contract forms; engineering and construction services; and “design-bid-build” and “design-build” execution. One hundred four projects from 35 CII member companies were submitted. The projects represent over \$8 billion in total installed cost (TIC).

Use of the Results

The results of this study will aid project managers, both owners and contractors, to better understand and evaluate change and to make better decisions concerning change management. Because the results indicate relationships from a broad, total project perspective, they cannot be used to accurately calculate the cost of an individual change or a group of changes. The findings of the study are helpful in benchmarking the amount of change and the expected productivity on a given project against the studied projects. However, many variables affect productivity on a given project other than the amount of change, such as the timing of changes, the rate of changes, the change management system in use, and the type of changes. In evaluating the productivity on an individual project, these other variables, whose effects were not studied in this research, must be taken into account. CII Publication 6-10, *The Impact of Changes on Construction Cost and Schedule* and CII Source Document 66 are good sources of information on the impact of other variables.

Research Team Work on Change Management

The evaluation of cost and time impacts of change is only one aspect of the complex problems currently associated with change management. To address the broader issue of change management as a whole, the research team studied change management policies, terminology, and practices of the CII member companies represented on the team. This effort resulted in the development of CII Special Publication 43-1, *Project Change Management*. This publication provides a comprehensive view of project agreements: how they are structured through various project phases, and how they change. The interplay of key elements of change management is described, and the principles of change management are established in the publication. Special Publication 43-1 also contains recommended best practices for the effective management of change and a prototype change management system.

Research Methodology

Questionnaire Development

Given CII members' interest in the quantitative impacts of change, the research team formulated several hypotheses over the course of several meetings. This, in turn, led to the development of a detailed questionnaire for the data collection effort. This questionnaire included a spreadsheet for information on project changes as they emerged over different points in the project schedule. A preliminary questionnaire was piloted with companies represented on the research team in order to confirm the availability of project data. All data were collected with a confidentiality that screened individual companies and reported only industry averages and trends. The pilot test demonstrated that productivity information could not be gathered on a monthly basis, but only on a cumulative, end-of-project basis because companies do not retain their change related data on a periodic basis. As a result, the hypotheses and the questionnaire were reformulated to meet feasible goals.

Survey Application

The research team disseminated the questionnaire throughout the entire CII membership. Reports on 104 projects from 35 different companies were received (15 contractors volunteered 60 projects and 20 owners volunteered 44 projects). Revamp and renovation projects represented 45 percent of the projects. On 50 percent, design services and construction services were by separate contractors, while the other half were executed design-build. The total installed cost for projects submitted ranged from \$3.2 million to \$1.2 billion. The median size project was \$44 million and the average size project was \$80 million.

Data Analysis

The research team directed the principal investigators on the research project to perform various statistical tests on the data, including student t-tests (to measure significant differences between the means of two samples); linear and non-linear regression fits (to find the best-fit functions); and confidence interval fitting (to