



CONSTRUCTION INDUSTRY INSTITUTE

QUANTIFYING THE
CUMULATIVE IMPACT OF
CHANGE ORDERS FOR
ELECTRICAL AND
MECHANICAL CONTRACTORS

Construction Industry Institute

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Quantifying the Cumulative Impact of Change Orders for Electrical and Mechanical Contractors

**Prepared by
The Construction Industry Institute
Cumulative Change Order Impact Research Team**

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Executive Summary

Change is inevitable on construction projects, primarily because of the uniqueness of each project and the limited resources of time and money that can be spent on planning, executing, and delivering the project. Change clauses, which authorize the owner to alter work performed by the contractor, are included in most construction contracts and provide a mechanism for equitable adjustment to the contract price and duration. Even so, owners and contractors do not always agree on the adjusted contract price or the time it will take to incorporate the change. What is needed is a method to quantify the impact that the adjustments required by the change will have on the changed and unchanged work.

Owners and our legal system recognize that contractors have a right to an adjustment in contract price for owner changes, including the cost associated with materials, labor, lost profit, and increased overhead due to changes. However, the actions of a contractor can impact a project just as easily as those of an owner. A more complex issue is that of determining the cumulative impact that single or multiple change orders may have over the life of a project.

The Construction Industry Institute (CII) took on this issue by forming the Cumulative Change Order Impacts Research Team. The research team was tasked with investigating the cumulative impact of change orders on electrical and mechanical efficiency.

This research resulted in the development of two models, one to identify if a construction project has been impacted as a result of cumulative change, and the other to predict the probable magnitude of the cumulative impact due to that change. A summary of the research follows, including recommendations for both owners and contractors on the approaches each party could take that would increase the effectiveness of the overall project while focusing on the common goal of project success.

Introduction

Background

The research began with an extensive review of previous literature pertaining to the effect of change orders on projects. Not unexpectedly, that review concurred that change is inevitable on most construction projects due to the uniqueness of each project and the limited resources of time and money that are available for planning, executing, and delivering the project.

Problem Statement

Many courts and administrative boards recognize that there is cumulative impact above and beyond the change itself, however, current construction contracts do not typically include adequate language to enable fair and equitable compensation for the unforeseen impact of cumulative change. Often, the contractor fails to foresee, and the owner fails to acknowledge, the “synergistic effect” of the changes on the work as a whole when pricing individual changes. That is, a change order for one area of the project may likely affect other areas of the project as well as the specific area where the change will actually occur. Consequently, projects that exceed cost or schedule targets are likely to lead to claims. Determining the impacts that changes can have on contract price and time can be arduous due to the interconnected nature of the construction work and the difficulty in isolating factors to quantify them. As a result, it is difficult for owners and contractors to agree on equitable adjustments, especially for cumulative impact.

Research Objectives

The purpose of this research project was to quantify the cumulative impact of change orders on labor efficiency. The research team set out to attain the following four objectives:

1. Investigate how change orders impact labor efficiency over the entire project.
2. Determine and isolate specific measurable characteristics of projects that are impacted by cumulative change.
3. Develop a definition and model of cumulative change impact that can be used by owners and contractors to identify if it has occurred.
4. Develop a method to predict the magnitude of cumulative impact due to project change.

Delta Approach

In order to study the productivity loss associated with change orders, a standard method to calculate the productivity for a project is needed. The method needs to represent the cumulative impact of change including any ripple effects. To do this the researchers have defined the term Delta, which is shown graphically in Figure 1 as the difference between the total actual work-hours expended to complete the project and the estimated work-hours (including the approved change order hours).

Positive values of Delta indicate that the actual productivity is less than the planned or estimated productivity. Negative values of Delta are an indication of higher productivity than originally planned or estimated. Delta can be attributed to a contractor's incorrect estimate, a contractor's inefficiency, or the impact of productivity-related factors such as change orders, weather conditions, work interruptions, and rework among other factors. In

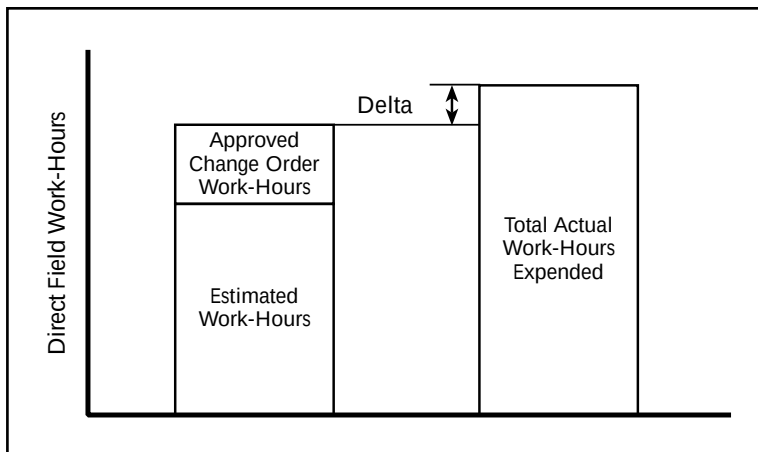


Figure 1. Definition of Delta

order to study the impact of change, the research team solicited projects where change orders were thought to be the main reason for loss of efficiency and not other factors such as inaccurate estimates or weather. The Delta then represents the effect of the change orders on the project. The data were reviewed by the academics and this was confirmed to be the case.

Percent Delta

To be able to compare projects of varying size, it is necessary to scale Delta by the project size, which yields the term Percent Delta (%Delta). %Delta is defined in equation 1.1 as Delta divided by the actual work-hours utilized to complete the project.

The formal mathematical definition of %Delta is as follows:

$$\%Delta = \frac{(\text{Total Act. Direct Labor Hrs.}) - (\text{Est. Hrs.} + \text{Approved Change Order Hrs.})}{\text{Total Act. Direct Labor Hrs.}} \times 100 \quad (1.1)$$

The Delta approach allows for a macro analysis that accounts for the full ripple effect that change orders have on the entire project.

Methodology

The research team consisted of three representatives each from the Electrical Contracting Foundation and the Mechanical Contracting Foundation and six representatives from the Construction Industry Institute. Team members developed a draft questionnaire that would provide data on factors that the team felt could, based on experience, influence change orders during execution of a construction project. A pilot study was then conducted to determine how easily the draft questionnaire could be answered and if the data collected would be useful in achieving the research objectives. After reviewing the data and talking to the participating contractors, the research team developed the final questionnaire.

The first section of the questionnaire contained general background questions about the contractor. The other two sections considered an “on budget” project and an “over budget” project. Contractors were requested to submit projects that were perceived to be over budget as a result of change orders, not factors such as low estimates, unforeseen weather conditions, or poor field planning. The projects were investigated based purely on work-hours and not by cost (dollars) because work-hours are directly comparable. Dollars add complexity for a number of reasons, among them pay scale, premium time differentials, and material costs. In addition to the questionnaire, actual and estimated manpower-loading curves or weekly labor hours were requested for each project along with the change order log, if available.

Is Cumulative Impact Real?

Evolution of Cumulative Impact Principle

Owners and contractors seldom agree on the existence of the cumulative effect of change orders, let alone to what degree they exert a loss of productivity on the so-called unaffected scopes of work. Owners typically require contractors to provide hard evidence that they were affected in areas other than the scope dealing with the change orders. Contractors have found that damages resulting from cumulative impact are difficult to calculate and even more difficult to recover. Many attempts to prove that this phenomenon exists have resulted in litigation. Courts and administrative boards recognize cumulative impact, and a number of court decisions have set the standard in terms of what contractors need to provide in the way of convincing evidence. Sheer magnitude of change does not guarantee that the courts will award damages for impact. The contractor seeking to recover for cumulative impact has the burden of providing the proof of cause and damage. The following examples demonstrate this.

Case Study Examples

In the first example, the Board of Contract Appeals denied the contractor's claim for cumulative impact based on 202 change items because the contractor was unable to show that the change orders caused any disturbance in the work. According to the Board, the contractor could not meet its burden "by merely offering proof of the issuance of the change requests."

In the second example, a contractor was performing modifications to a launch platform. During the project, the contractor sent the owner a large volume of RFIs as a result of various design deficiencies on the project.