

Managing a Project: Techniques Change Requests Handled During Expressway Development: Types and Amounts

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Abstract: Construction modification orders and their resulting cost increases may be an issue for transportation authorities. This subject has both practitioners and scholars interested in discussing. With alternate delivery methods, the management of modification orders is even more crucial because of the difficulties of dealing with this issue. Change orders and project delivery techniques are seldom studied in connection to one another, despite the fact that this is an important problem. It was shown that delivery methods and highway construction modification orders are linked in this study. Only those types of change orders that have been studied in literature and business are included for this study. The research included data from 162 US roadway projects conducted between 2004 and 2015. Supplementing the quantitative data were interviews with representatives of the many agencies involved in the various initiatives studied. The data show that unanticipated conditions have the greatest influence on overall cost rise, followed by agency-directed modification orders. There was evidence that owner agencies taking advantage of an initial contract excess, which is more common in design-build delivery, frequently added value via modification orders directed by the agencies themselves. This study's findings may help agencies and researchers better understand the causes of change orders in various delivery systems and devise effective mitigation techniques.

Introduction

Despite their best efforts, transportation authorities seldom achieve their goal of avoiding post-construction alterations. Scope development for construction projects may be tough due to its complexity and uniqueness. Owners must issue change orders since scope revisions, errors, and unplanned scenarios are inevitable in the vast majority of projects. On average, transportation agencies in the United States face \$4 billion in annual modification requests, according to the most recent US highway construction literature. Scholars have studied change orders from a variety of perspectives because of their importance to both individual projects and the industry

as a whole. Studying the frequency of modification orders and their impact on project costs, for example, has been done before.

Change orders may have a significant impact on the project's performance, but they can also lead to labor-intensive claims or conflicts that harm the programming performance of all stakeholders. A claim requires, at the very least, the development and examination of

Existing Research: Highway Change-Order Categories

- This research drew on five previous studies to help define the change-order categories that have been seen in the transportation sector in the United States. Studying 22 federal projects from 1979–1983, Diekmann and Nelson (1985) found that plan mistakes and omissions, agency-directed adjustments, and unanticipated circumstances were the most common causes of change orders. Bordat et al. (2004) evaluated almost 800 projects from the Indiana DOT, whereas Jacoby (2001) investigated 74 projects from the state DOT. This is consistent with Diekmann and Nelson (1985), however they also included an additional category for less often occurring miscellaneous reasons of change orders. Researchers from the Kentucky Department of Transportation (Kentucky DOT) looked at 610 projects from 2005 to 2008 and found a number of commonalities, as well as a number of plan quantity adjustments, the majority of which applied to unit pricing contracts. While prior studies have used similar language, Additionally, the researchers gathered information on damage claims related to 40 prior DOT projects located in all 50 states prior to 2018. Analysis by Mehany et al. (2018) on the link between change order categories and delivery methods yielded no findings. According to these results, the following is a summary of these findings (notice that these bullets reflect the amount, type, and years of projects evaluated followed by the sorts of modification orders generating cost escalation from greatest impact to the least effect):

- Plans, omissions, and adjustments ordered by agencies on 22 federal projects from 1979 to 1983.
- Plan mistakes and omissions, agency-directed adjustments, unanticipated situations, and other issues plagued 822 Indiana DOT projects between 1996 and 1999.
- Seventy-four pre-2001 state DOT projects had issues due to unanticipated circumstances, adjustments mandated by agencies, and mistakes and omissions in the plans themselves.

- 610 Kentucky Department of Transportation (KDOT) projects, 2005–2008: unexpected conditions, plan quantity modifications, agency-directed alterations, and plan mistakes and omissions.
- unexpected events, plan mistakes, and omissions, agency-directed adjustments, changes in plan quantities and claims for damages are among the 40 projects completed by the DOT prior to 2018. Table 1 presents the category definitions and characteristics discussed in this study based on these research. This study utilises FAR terminology wherever feasible since it focuses on federal highway construction.

Another study on change-order categories was conducted by Creedy, Parikh, and Riley (2005), as well as by Riley and Parikh (2019).

ChangeOrdersandProjectDeliveryMethod

To varying degrees, the government and the contractor share the risk under the most common highway project delivery models: DBB, DB, and CM/GC. Cost overruns and project hazards go hand in hand, as is common knowledge. The risk distribution in a project delivery method leads to a range of modification orders, as seen in the following.

In DBB, the designer or the project is designed in-house by the owner, who then utilises a separate contract to hire a general contractor to complete the work. This means that, regardless of who did the design work (an in-house team or a third party), the agency is responsible for seeing that it gets done. Every inaccuracy, omission, and change in amount represents a possible change order for the bearer of this risk. DBB is more prone to change orders than alternative methods in the highway sector, according to numerous studies.

Early on in the design process, the owner contracts with a construction manager (CM) for advice on construction feasibility and scheduling. As with DBB, the agency is in complete control of the design process. Upon design approval, a price is negotiated with the CM for construction services. As a result, the CM is referred to as the "general contractor" in this context. The agency, like DBB, considers any design change or inaccuracy to be a change order. However, it has been demonstrated that early contractor involvement in the design process improves constructability. Contract change orders and disputes have been found to be reduced by the use of constructability. According to these findings, a more collaborative approach by CM/GC and DB would likewise reduce the size of change outcomes. To put it

another way, collaborating early on in the design phase might conceivably uncover oversights early on, reducing the need for construction alterations. Finally, CM design support services give a layer of quality assurance to the design process, which improves design correctness.

With the DB method of delivery, a single design-builder is responsible for both designing the final product and constructing it. When a design-build company makes a mistake, it usually has to pay for it. One of the most often touted advantages of DB is the transfer of risk. For this reason, modification orders should not be based only on design flaws that are the responsibility of the design-builder. The sole exception to this rule is if the DB request for proposal has mistakes or omissions (RFP).

ResearchMethods

Mehany et al. (2018) found no significant correlation between the kind of claim and the manner of dissemination. Consequently, the authors decided to integrate the findings of literature research, quantitative project performance evaluations, and qualitative agency interviews to fill up this vacuum and complement the lack of statistical data. A more suitable assessment method than quantitative analysis is triangulation, which takes into account both subjective and objective factors, as well as construction management's inherent complexity and irregularity. It has already been used to support results in the construction management literature using triangulation

ProjectPerformanceSurvey

The researchers obtained data from state and federal highway transportation agencies. Data on completed highway building projects was sought by the research team, who hoped to uncover a variety of projects using DBB, DB, and CM/GC techniques. Each project's data was gathered through

data extraction from preexisting agency construction contract cost and schedule data sets, as well as the delivery of a questionnaire to project representatives to gather further empirical evidence on project performance. It's possible to see all the data collected in the final FHWA Project Report however this release focuses on the data that was collected for this particular project. Two-step dissemination of cost data guaranteed the accuracy of the data and encouraged project staff to answer any queries not already answered in the contractual databases. As needed, phone calls were made to fill in any gaps in data and to ensure quality

control.

In all, There were 162 highway projects completed by state DOTs and the FHWA Office of Federal Lands Roadway from 2004 to 2015 included in this research. Authors focused on projects from organisations that have previously used DB and CM/GC delivery methods. They had to be granted within two years of each other, and be of the same kind, location, comparable CM/GC and DB projects in terms of cost and size (within 25% of the award cost). DBB projects accounted for 65 percent of the entire sample, with 21 DBB/LB projects, 56 DBB projects, and 19 CM/GC projects rounding out the top five (12 percent). It is appropriate that this study include as many CM/GC initiatives as it did, considering the overall quantity of these endeavours in the United States. Between 2004 and 2015, just a few CM/GC projects were constructed in the United States. The statistics are shown in Table 2.

Agency Interviews

Interviews with agency personnel were performed to round out the findings from the project data and give the findings additional context. Within each change-order category and each delivery mode, researchers aimed to identify projects that had high and low cost increases. Projects with the most severe costs reductions and costs increases may be used as examples to better comprehend survey findings.

When it came time to interview agency officials from all around the country, twelve projects were picked for further examination. This led to meetings with representatives from Virginia to Florida. To protect the privacy of the participants, the results are presented in the aggregate. The project served as the basis for the study, although the people who were questioned worked for their individual departments of transportation as resident engineers, project managers, or construction managers. It is shown in Table 3 how many agency representatives were interviewed for each of the projects in the table.

Interviews were conducted over the phone using a semi-structured interview process. All interview methods were examined by an institutional review board. After meeting with the agency personnel, the following subjects were discussed:

- It includes a full description of the alteration orders and the reasons behind their demise;
- The reasons for the individual project's agency-ordered modification orders;
- Change orders that provide value and the circumstances that enable them;

- reasons for the individual project's plan mistake or omission changing sequence;
- There is a description of how each change-order category was impacted by the delivery method's risk transference to the contractor.

Table 3 introduces the idea of "initial contract excess," which is determined using this equation:

Results

This section summarises the findings based on the various research methods, including a literature study, surveys, and interviews with agency personnel.

Most Impactful Change-Order Categories

According to Table 4, the most significant contributors to the total cost increase are unexpected occurrences (2%) followed by agency-directed (15%), plan quantity (6%), and plan defects or omissions (6%). Both Jacoby (2001) and the research of Mehany et al. (2018) as well as the findings of Taylor et al. (2017) are in agreement with the findings of this study (2012). Two decades ago, Diekmann and Nelson (1985) and Bordat et al. (1991) have already studied change-order categories, and this paper's conclusions do not correspond with their findings (2004). This discrepancy may be a hint that agencies are better at managing design risk via various ways of delivery. In 1985, Diekmann and Nelson published a paper, and in 2004, Bordat et al. published one, both 34 and 15 years prior to the widespread adoption of DB and CM/GC. Jacoby (2001), Taylor and colleagues (2012), and Mehany et al. (2018) all found comparable results in their own research. This lends credibility to this paper's conclusions.

It is very difficult to minimise change orders due to the fact that they are widespread across all delivery modalities. In comparison to other categories, they may have a greater effect due to the difficulty of mitigating them. "If we hadn't started the project, I don't see how we could have found out about the problem" said one official. The high frequency of unanticipated conditions, however, is attributed by one representative to the fact that the preconstruction period is typically rushed by agencies, decreasing the time for soil borings and therefore raising the possible dangers.

Change orders issued by the client's agency come in second place in terms of impact on the projects examined in this research. According to the literature, this result may also indicate that agencies aren't doing enough pre-planning or speeding the scope development process. A

database of agency-ordered change orders, however, found that half of the projects had original contract surplus savings larger than the value of their change orders. Agency-directed adjustments are frequently a good thing, according to the results of interviews. That's what one employee said, adding that they were looking at "things we can do to improve the project in the region" with "more money."

The combined projects in this analysis had the least effect from plan revisions and plan mistakes and omissions. Alternate project delivery techniques may help agencies achieve their theoretical aim of reducing these kinds of modification orders, as seen by this finding. The impact of DB on shifting design risks to the design builder is well-known among agencies. There is little room for mistakes and omissions modification orders when the design-builder is responsible for drawing up the blueprints, according to a DB spokesperson. The effect of CM/GC on design quality is also recognised by agencies (since early contractor engagement may lead to better design). In the words of another spokesperson According to the DOT, "CM/GC allows them to conduct a comprehensive site inspection that optimises the design and minimises dangers, eventually reducing errors and omissions modification orders."

Delivery Methods' Impact on Change-Order Categories

Agency-Directed Change Orders

Per Table 4, First and second place went to DB/BV projects, with DB/LB and DBB rounding out the top three. According to the current analysis, DB was found to have the largest number of agency-ordered changes, surveys, and interviews. There was no unanimity after comparing DBB and CM/GC results. DB's lack of design completeness at the proposal stage or a hasty RFP preparation has been observed to lead to agency-directed modification orders. According to the results of the interviews, agencies that spend their initial contract excess have a greater incidence of agency-directed modification orders in DB than other delivery approaches. 'We had more money to spend,' said one participant. We considered what we might do to make the project better in the neighbourhood. For our brainstorming session, Some 16 or 20 suggestions were generated by the group. According to five out of eight project managers, their agency-ordered modifications were value-added and integrated due of the budgetary constraints. Over time, modification orders issued by agencies resulted cost overruns in the remaining 39 of the 57 DB projects. As a result, it's safe to assume that most of the DB initiatives had to deal with

change orders. Instead, there might be four representatives from each delivery option on the project, claimed that they had to deal with negative agency-directed modification requests. The reasons for their failures were typically more complex than a single agency blunder. According to DBB: "The budget is based on the initial bid amount rather than the projected cost. It's the initial offer amount, not the buyout, that we take into account" DBB projects, Because the scope is better understood at the time of bid due to the usage of 100 percent drawings, the award savings are lower, according to experts. Engineers' estimates often rise by 3 percent or 6 percent, depending on the DBB or DB; this was shown in earlier studies. At the time of procurement, DBB projects are more likely to have a more full scope than other projects. It seems to reason that change orders that provide value should be prioritised above DB changes. As far as the research goes, Revisions requested by the government account for the lowest percentage of CM/changes. GC's The scope and cost of the project have been agreed upon by both the owner and the contractor. "To put it another way, CM/GC provided us with the opportunity to examine several options and work together with the contractor to find an optimal solution for the project," a company official noted. There are several advantages to adopting construction management and general contracting (CM/GC) instead of conventional CM/GC. A CM/GC agency, such as DB, has the same opportunity to spend the original contract surplus. As a result, agency officials hypothesized that CM/GC was more sensitive than DBB to agency orders being modified. There was "a large volume of owner-directed change orders" in a CM/GC project that had a "objective was always to extend project limits as far north as we could, with the purpose of spending all the money provided to date".

Unforeseen Conditions Change Orders

DBB, DB/LB, DB/BV, and C/GC were the most affected by the unexpected change orders on the projects analysed in this study. Researchers have shown that DBB is more susceptible than DB or CM/GC to last-minute modification requests, as evidenced by their surveys and interviews. Participants agreed that any unplanned circumstance arising after contract execution inside DBB is the agency's financial responsibility. Both sources of information and interviewees had no idea that DB and CM/GC would have unexpected modification orders.

Conclusions and Limitations

It was shown that four common kinds of change orders are affected by the manner of delivery

used for a project, as well as the amount of time and money spent on the project. Total cost rise was driven most significantly by unexpected changes in circumstances (2.0 percent), Agency-directed (1.5 percent), plan quantity (0.6 percent), and planning faults or omissions (0.6 percent) are the next three most common differences. According to Taylor et al. (2012) and Mehany et al. (2013), two more recent studies, plan mistakes and omissions are not the most damaging, but rather the most common (2018). We may infer that agencies are transferring the risk of design flaws and omissions to contractors by employing alternative delivery methods.

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