Alternative for Quantifying Field-Overhead Damages

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Abstract: The context of delays significantly affects delay responsibility. Among other things, recoverable damages for a delay should be related to the timing of the corresponding delay and its effect on indirect costs. This paper presents an alternative and integrated approach for quantifying and apportioning delay responsibility. It considers the context of a delay in terms of its timing and the degree of suspension during the course of a project. The proposed approach allocates project-site overhead costs onto schedule activities. It then helps track site overhead damages in a "real-time" manner while schedule-window analysis is employed to analyze the delay. A case study is used to illustrate its application. Results infer that the conventional daily overhead rate-based method can cause double payments because conventional recovery possibly covers parts of field overhead already paid from the original contract. This new approach also enables the application of the comparative negligence doctrine when concurrent delays occur by fairly sharing delay damages between the project parties. Practitioners can employ the proposed approach for reasonably quantifying and apportioning delay damages while researchers may further explore its applications in the industry.

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Introduction

Current practice normally determines a uniform daily overhead rate based on estimates or actual expenses to compensate for increased field overhead (FOH) when compensable delays occur. The rate is either predetermined in contract documents or calculated in delay claims. Among other things, this practice has two major limitations. Specifically, it does not properly consider: (1) the timing of delays; and (2) the degree of suspension (total or partial) in the calculation of the rate.

Because of those limitations we propose an analytical approach that integrates schedule window analysis and activity-specific FOH allocation to fairly apportion delay days and FOH damages between the project parties in an ongoing basis. Delays and suspensions can incur both FOH and home-office overhead (HOOH). The proposed approach helps the project parties quantify FOH damages of delays and suspensions.

Delay Context versus Delay Responsibility

Successful delay claims require proper apportionment of delay responsibility. Unfortunately, apportionment of delay responsibility is an arduous endeavor. Schedule-delay-analysis methods such as as-planned versus as-built, impacted as-planned, collapsed as-built, time-impact analysis, and schedule-window analysis are used to apportion delay days attributable to each project party. Project-site overhead damages, unabsorbed overhead, extended overhead, loss of profits, liquidated damages, and so forth, are potentially recoverable damages for either the contractor or owner. However, current delay-analysis techniques solely focus on “time” criticality of schedule activities. That is, 1-day delay at the i-th day and 1-day delay at the j-th day during the course of work are frequently treated the same.

Our premise is that quantification of delay damages should consider the context of a delay and suspensions, namely its timing and degree of suspension. Degree of suspension means the proportion of work under a contract that is delayed, suspended, or interrupted in a certain period of time, i.e., partial or total suspension. Timing of and the relative importance, in addition to its duration, of a delayed activity can affect delay responsibility and cost. The relationship between project cost items and activities in critical path method schedules should be considered since this can be crucial, especially for evaluating the impact of delays on the work (Overcash and Harris 2005). Different portions of the project need different types of managerial effort, which in turn have different costs (Lankenau 2003). In addition, the ultimate objective of delay-related disputes is to identify who is responsible for the damages. As such, damages incurred at the time of a delay should be estimated timely for recovery. In other words, an overhead rate that is constant over the whole course of contract work is inappropriate. Also, although the compensation based on the daily overhead rate may work for total suspensions, how the compensation is determined based on this rate when the project only suffers partial suspensions is not easy, if not arbitrary. That is, the percentage of the daily overhead rate that the contractor is allowed to recover if only part of the contract work is delayed, suspended, or interrupted is unclear.

Fig. 1 visualizes the issue. The as-planned schedule has four activities A, B, C, and D. Scenarios 1 and 2 exemplify the as-built schedules under nonconcurrent and concurrent delays, respec-
In Scenario 1, there are two 1-week delays by the owner and contractor on Activities A and D, respectively. It is straightforward to divide the 2-week project delays into 1-week compensability and 1-week inexcusability. Given that the time-related overhead level fluctuates, these two 1-week delays cause different overhead damages. Scott and Harris (2004) note that whether the level of overheads during the extended period or that at the time of the delaying event should be paid is controversial. This implies that the timing of delays really matters in apportioning delays and damages.

In Scenario 2, the 2-week delay on activity B and 3-week delay on activity C are concurrent (inexcusable and compensable delays, respectively). Current practice treats concurrent delays as excusable delays. Thus, the contractor will only be granted a time extension and the parties would each bear their own damages. “The contractor is barred from recovering delay damages to the extent that concurrent contractor-caused delays offset owner-caused delays, and the owner is barred from recovery liquidated or actual delay damages to the extent that concurrent owner-caused delays offset contractor-caused delays” (AACEI 2006).

However, a recent trend advocates an equitable apportionment when compensable and inexcusable concurrent delays occur. A party causing less impact of concurrent delays should be permitted to recover damages from the other (Kelleher 2005). This trend also supports a view that sharing burdens between project parties makes expensive changes less excruciating (Kasen and Oblas 1996). Kraiem and Diekmann (1987) call such equitable apportionment a “fair rule.” This rule is rooted in the doctrine of comparative negligence, in contrast to the doctrine of contributory negligence, in tort law. For instance, if two critical activities—“roofing” and “landscaping”—are simultaneously delayed by a contractor and an owner, respectively, it is difficult to accept that their effects on project-indirect costs are similar.

Hughes and Ulwelling (1992) urged that the rule “damages not be apportioned” in concurrent delay situations should be rejected. In practice, a few cases hold that despite the difficulty, the parties should try to segregate damages or costs attributable to each delay cause. James (1991) claims that forfeiture of such damages because of nonapportionability is excessively harsh. Courts often use a jury verdict method to apportion damages to each party (James 1991). This is very subjective and sometimes incorrect, and places the project parties in a passive, reactive position. The parties do not have an effective way to provide and demonstrate fair apportionment in front of the courts. Consequently, the outcome of the jury verdict is what the parties will receive, which is highly speculative and can be grossly inequitable. The project parties should therefore proactively apportion damages in concurrent delays, ideally by employing a logical and systematic approach.

### Field-Overhead Damages

Project delays almost always cause damages—direct and/or indirect costs on a project. When a project suffers a delay while substantial work is in progress, construction-job-site support costs, such as trailers, supervision costs, maintenance, utilities, tools, and equipment, will continue to accumulate until these resources are moved to another job site (Love 2000). The detailed types of delay damages for both owners and contractors can be found elsewhere (e.g., Strogatz et al. 1997). However, the trickiest part of construction cases is how to measure and present evidence on damages (Overcash and Harris 2005).

FOH damages require proper estimation although many practitioners agree that damages of FOH are less complicated than those of HOOH. Determination of daily FOH is not difficult if the contractor maintains reasonably good job-cost records (Zack 2001). Unfortunately, FOH costs that are determined by a stipulated or bid daily rate are potentially unfair. It assumes that all time-related costs are the fault of the owner and a complete extrapolation is foreseeable by the owner (Lankenau 2003). Delay claims need a more accurate approach for calculating FOH damages. The “one-size-fits-all” daily rate is often unreasonable.

### Integrated Approach

The proposed approach starts as early as a project commences. Efforts dedicated to the delay-claims process start at project commencement (Yates and Epstein 2006). From the as-planned schedule and the project’s cost estimate, direct costs, labor costs, and/or labor hours are estimated and/or calculated for each activity in the as-planned schedule. This is because items of the project’s cost estimate may not be schedule activities. The calculation of activity-specific direct costs, labor costs, or labor hours is straightforward and not discussed here. Current practice normally considers indirect costs or overhead at the project and contract level, not the activity level. In contrast, our approach attempts to allocate FOH costs to each schedule activity based on a reasonable basis. Current practice makes delay damages more difficult to derive when a delaying event occurs. Project parties often have more serious disagreement over indirect costs than direct costs.

Activity-specific FOH allocation is the key to quantifying FOH damages on a real-time or ongoing basis. This analytical method classifies FOH into time-related and nontime-related costs. Time-related overhead refers to overhead incurred through and directly connected to the passage of time, e.g., supervision, administration, and utilities. It is associated with delay claims (Harris and Ainsworth 2003). Time-related costs that are not allowed by the contract or regulations must be excluded (Lankenau 2003). Nontime-related overhead includes, but is not limited to, temporary construction, bonds, insurance, and project-office supplies that are one-time expenses.
Accordingly, our allocation method first divided project FOH into time-related and nontime-related overhead cost categories. Each is then allocated to schedule activities in direct proportion of their direct costs, labor costs, labor hours, or whatever cost driver is reasonable. Activity-specific overhead allocation will never be precisely accurate. Next, time-related and nontime-related overheads per time unit (e.g., day, week, and month) for each schedule activity are calculated based on the corresponding activity duration. This enables allocation on the basis of an “as-planned” FOH level throughout the course of the contract.

When a schedule activity is delayed, the activity duration is increased. This duration extension in turn normally increases the FOH cost of the corresponding activity and then that of the project. Although the delayed activity’s nontime-related FOH (FOH\(^n\)) will not change, its value per time duration unit will decrease due to the increase in the activity duration. This is the basis for compensating FOH damages incurred by critical delays, which are drawn from a window analysis.

If a new schedule activity is added to the schedule and extends the project duration, the markup of the corresponding change order already includes the FOH increase. Thus, the above process should not be applied. Otherwise, FOH should be redistributed to update any new schedule activity. Table 1 summarizes the necessary steps of this approach.

The analytical approach proposed herein is based on the following assumptions:

1. When the approach is used for forward pricing or project records are unavailable, the contractor’s cost estimate is reasonable and/or acceptable. Otherwise, FOH calculated in Step 1 should be from actual project-cost records.

2. FOH can be classified and estimated as time-related FOH (FOH\(^t\)) and FOH\(^n\). Only FOH\(^t\) is affected by delays and, hence, recovered (Lankenau 2003; Harris and Ainsworth 2003).

3. The contractor is unable to remobilize their resources in some way as to absorb overhead. Periods of delays are relatively small or in short durations if the as-bid FOH is used in Step 1. These are to ensure that cost extrapolations for calculating FOH damages are plausible. A 10%–25% increase in project duration is reasonable (Lankenau 2003).

4. The project owns float. That is, float is used on a first-come first-served basis.

5. Activity costs are uniform distributions across the duration of the activity.

### Hypothetical Case Study

This case study is a home-construction project, where the as-planned schedule, as-built schedule, and delaying events are adapted from Stumpf (2000). Detailed descriptions are available in Stumpf (2000). The planned project duration was 16 weeks. Fig. 2 illustrates the as-planned schedule, which includes 12 schedule activities. These activities were to build the house and its garage.

Table 2 shows the project-cost estimate. Items are also activities in the as-planned schedule (Fig. 2). The allowable overhead is 20% of total direct costs. Overhead ($54,792) includes $15,000 HOOH and $39,792 FOH. In turn, FOH consists of $19,792 FOH\(^t\) and $20,000 FOH\(^n\). The average daily FOH\(^t\) rate is $1,237 per week ($19,792/16).

Fig. 3 illustrates the as-built schedule. During construction the project is delayed. The actual project duration was 24 weeks, 8 weeks longer than the original plan. Fig. 3 also illustrates the delaying events. Events with (o) are owner-caused delays, and (c) are contractor-caused delays.

A window analysis with five window periods apportions the 8-week project delay to 1 week of inexcusable, 2 weeks of excusable, and 5 weeks of compensable delays. Specifically, the five window periods are Weeks 1–4, 5–8, 9–13, 14–17, and 18–21. Among them, the first, the third, and the fifth window periods experienced 3 weeks of compensable delays (Weeks 2, 3, and 4), 2 weeks of concurrent delays (Weeks 11 and 12), 1 week of inexcusable delays (Week 13), and 2 weeks of compensable delays (Weeks 18 and 19), respectively. Periods 2 and 4 did not suffer schedule slippage. The window periods herein are defined based on a suggestion that the beginning of each delay should be the beginning of a window (Finke 1999). The detailed schedule...
analysis of this case can be found elsewhere (Stumpf 2000; Hegazy and Zhang 2005).

After the delay days are apportioned among the parties, the question is how to properly quantify and apportion delay, FOH, and HOOH damages. For HOOH damages, there are a variety of formulas available (Zack 2001; Taam and Singh 2003). FOH damages are, however, calculated based on an average daily FOH rate or the mean of daily overhead costs. As previously discussed, a uniform daily FOH rate fails to take into account the context of delays. To consider the context of delays in quantifying damages, our analytical approach distributes FOH to schedule activities. In this case we presume that the original FOH estimates are reasonable and that actual overhead records are not available. The method also works when actual project costs are well maintained as discussed later.

Table 3 shows the distribution of activity-specific FOH. In this example direct costs are selected as a cost driver. That is, time-related (nontime-related) FOH for a certain activity equals the ratio of the activity’s direct costs and total direct costs times the corresponding project time-related (nontime-related) FOH. In Table 3, Columns 6 and 9 present “as-planned” activity-specific nontime-related and time-related FOHs, respectively. Similarly, Columns 7 and 10 present as-planned activity-specific nontime-related and time-related FOHs per time duration unit, respectively. Column 8 shows “as-built” activity-specific FOH per time duration unit. Because the activity-specific FOH does not change due to delays, its as-built value per time duration unit for delayed activities will be inversely proportional to the ratio of the actual and planned activity durations. In contrast and as previously described, activity-specific FOH per time duration unit would remain unchanged.

Fig. 4 shows the FOH’s over time. They are based on the values in Column 10 (Table 3) and the timing of the activities in the as-planned and as-built schedules (Figs. 2 and 3). In other words, FOH for a certain week equals the sum of FOH per week for all activities performed (either planned or actual) in that week. Obviously, both as-planned and as-built FOH’s fluctuate considerably over the course of the contract. This explains why the uniform daily overhead rate for compensating delay damages is inappropriate. It should be noted that we call these FOH costs as-built because they are distributed to activities based on their timing in the as-built schedule.

Table 4 summarizes the compensable FOH delay damages under the conventional, daily-rate method and the analytical method proposed in this paper. The results are significantly different. Total FOH delay damages for the two methods are $6,185 and $1,548, respectively. It should be noted that in this example liquidated damages are stipulated by the contract and, hence, similar for the two methods if inexcusable delays occur. This demonstrates the value of computing FOH damages by our proposed approach. If a liquidated damages provision does not exist—though this is rarely true—owner’s actual economic losses will replace the liquidated damages in the above analysis.

Discussion

From the analytical approach and the case study presented, some issues need to be discussed.

Estimated FOH versus Actual FOH

The applicability of the proposed method does not depend on the availability of project FOH records. The case study exemplifies the use of the method when project-cost records are not available or verifiable. However, the project parties have to agree on the reasonability of the original estimate, which is a fair assumption since they entered into a contract that was based on that original estimate. In this circumstance the method can quantify FOH damages, if any, in a real-time manner whenever a delaying event...
occurs without waiting for the actual project-cost documentation. For after-the-fact delay analysis, the method may use actual FOH costs instead. The analytical process is the same as presented in Table 1 except that project FOHs in Step 1 obtain data from actual records. Accordingly, an actual FOH level can replace the as-built one on Fig. 4.

### Degree of Suspension

This new approach considers the degree of suspension in calculating FOH damages. FOH delay damages are typically paid based on a daily overhead rate when a delay is compensable. However, a daily rate-based indemnification may cover some

### Table 3. Distributed Activity-Specific FOH (in Dollars)

<table>
<thead>
<tr>
<th>Number</th>
<th>Item</th>
<th>Planned</th>
<th>Actual</th>
<th>Direct cost</th>
<th>Total</th>
<th>Plan/week</th>
<th>Actual/week</th>
<th>Total</th>
<th>FOH/week</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Excavation</td>
<td>2</td>
<td>5</td>
<td>12,960</td>
<td>946</td>
<td>473</td>
<td>189</td>
<td>936</td>
<td>468</td>
</tr>
<tr>
<td>2</td>
<td>Foundation</td>
<td>2</td>
<td>2</td>
<td>15,000</td>
<td>1,095</td>
<td>548</td>
<td>548</td>
<td>1,084</td>
<td>542</td>
</tr>
<tr>
<td>3</td>
<td>Joining wall</td>
<td>1</td>
<td>1</td>
<td>18,000</td>
<td>1,314</td>
<td>1,314</td>
<td>1,314</td>
<td>1,300</td>
<td>1,300</td>
</tr>
<tr>
<td>4</td>
<td>House walls</td>
<td>4</td>
<td>7</td>
<td>46,800</td>
<td>3,417</td>
<td>854</td>
<td>488</td>
<td>3,381</td>
<td>845</td>
</tr>
<tr>
<td>5</td>
<td>House roof</td>
<td>3</td>
<td>3</td>
<td>21,600</td>
<td>1,577</td>
<td>526</td>
<td>526</td>
<td>1,560</td>
<td>520</td>
</tr>
<tr>
<td>6</td>
<td>Select finishes</td>
<td>1</td>
<td>7</td>
<td>1,000</td>
<td>73</td>
<td>73</td>
<td>10</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>7</td>
<td>Interior finishes</td>
<td>3</td>
<td>5</td>
<td>100,000</td>
<td>7,300</td>
<td>2,433</td>
<td>1,460</td>
<td>7,224</td>
<td>2,408</td>
</tr>
<tr>
<td>8</td>
<td>Clean up</td>
<td>1</td>
<td>1</td>
<td>2,000</td>
<td>146</td>
<td>146</td>
<td>146</td>
<td>144</td>
<td>144</td>
</tr>
<tr>
<td>9</td>
<td>Fab/del garage doors</td>
<td>6</td>
<td>10</td>
<td>6,000</td>
<td>438</td>
<td>73</td>
<td>44</td>
<td>433</td>
<td>72</td>
</tr>
<tr>
<td>10</td>
<td>Garage walls</td>
<td>3</td>
<td>7</td>
<td>37,800</td>
<td>2,760</td>
<td>920</td>
<td>394</td>
<td>2,731</td>
<td>910</td>
</tr>
<tr>
<td>11</td>
<td>Garage roof</td>
<td>2</td>
<td>2</td>
<td>10,800</td>
<td>788</td>
<td>394</td>
<td>394</td>
<td>780</td>
<td>390</td>
</tr>
<tr>
<td>12</td>
<td>Garage doors</td>
<td>2</td>
<td>6</td>
<td>2,000</td>
<td>146</td>
<td>73</td>
<td>24</td>
<td>144</td>
<td>72</td>
</tr>
<tr>
<td>13</td>
<td>Total direct costs</td>
<td></td>
<td></td>
<td>273,960</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Overhead</td>
<td></td>
<td></td>
<td>54,792</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>HOOH</td>
<td></td>
<td></td>
<td>15,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>FOH</td>
<td></td>
<td></td>
<td>39,792</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>FOH&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>20,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>FOH&lt;sup&gt;f&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>19,792</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 3.** As-built schedule
parts of FOH already paid in the original contract. In other words, an average daily FOH rate for compensating damages potentially causes a "double payment." For instance, Week 19 in the above project was similar to a partial suspension. The schedule analysis indicated that there was a 1-week compensable delay at Week 19. Under the daily-overhead-rate method the contractor was automatically compensated for FOH damages for the whole week. The as-built schedule, however, reflects that activity "interior finishes" was still performed in Week 19 and, hence, its overhead was already included in the as-bid FOH price. As such the daily FOH rate-based compensation in this circumstance is unable to differentiate FOH delay damages from FOH already approved. By allocating FOH to schedule activities and evaluating damages at the activity level, the proposed method can avoid any double-payment problem, especially in the event of a partial suspension.

Apportionment for Concurrent Delays

Analysis of concurrent delays raises various issues. This is because both owners and contractors employ concurrent delays as a strong defense tool against each other (Baram 2000). As previously discussed, the "shield" rule, which grants the contractor time but no money and the owner no liquidated damages in the situation of concurrent delays, should be replaced by equitable apportionments (Hughes and Ulwelling 1992). Kelleher (2005) noted that apportionment analysis may yield fairer results than nonapportionment analysis.

The approach presented here enables such equitable apportionments. FOH delay damages are now calculated at the schedule-activity level. Thus a project party may only be responsible for activities wherein he/she causes critical delays. In other words, he/she may only pay for FOH damages incurred by critical delays on those activities. If, for example, the contractor and the owner caused concurrent delays on Activities B and C, respectively (Scenario 2, Fig. 1), the owner would be responsible for a 2-week time-related FOH increase of activity C while the contractor would be responsible for 2 weeks of liquidated damages. In other circumstances, owners and contractors may cause concurrent delays on the same activities. A 2-week concurrent delay at Weeks 11 and 12 of the case project is an example. This concurrent delay delayed the activity "house walls" and increased project costs by $1690 ($845/week × 2 weeks) of FOH. The parties can equally share this amount of damages. Therefore, the owner would owe the contractor $845 while the contractor would owe the owner 2 weeks of liquidated damages. It should be noted that HOOH damages can be equally shared when concurrent delays truly do exist. Discussion of this issue is beyond the scope of this paper.

Float Ownership

The proposed approach can work in different types of float ownership with some modification. As previously mentioned the proposed approach assumes that the project owns float. In other words, float is used on a first-come first-served basis. The other scenarios are float owned by owner or contractor or shared by these two parties. On the one hand, float ownership defines when an event is considered a delay, the type of delay, and whether damages associated with the delay are assessed to the responsible party. On the other hand, the key concept of our approach is to allocate FOH to specific schedule activities and to assess FOH damages at the activity level. As such, if float ownership helps classify a delay on certain activity, the proposed method is able to calculate if any FOH damages are caused by the corresponding delay. For instance, when float is owned by the contractor, any owner-caused delay on an activity is excusable and compensable regardless of whether it is critical or not. The increased FOH of the corresponding activity due to this delay is damages for which the owner is responsible. Accordingly, Steps 4 and 5 in Table 1 need to be modified to reflect this view of float ownership.

Difficulties in Using the Proposed Method

Some issues may arise when the proposed method is employed. Segregation of FOH and HOOH and proper classification of FOH costs may be problematic. This is because definition of these terms is sometimes different from one contractor to another (Holland and Hobson 1999). Parties may need to write contracts more carefully, specifying the different types of overhead. In addition, some FOH damages, i.e., utilities, may not be reasonably calculated as being directly proportional to the passage of time. These types of FOH should be treated separately if their amounts are considerable. Selecting the right cost driver among labor hours, labor costs, direct costs, and so forth, to allocate FOH into schedule activities is also not simple. Ideally, the parties should agree on the cost driver in advance.

A cost driver-based FOH allocation may be another source of unbalanced bids. For instance, a contractor may inflate direct

Table 4. FOH Delay Damages (in Dollars)

<table>
<thead>
<tr>
<th>Window (week)</th>
<th>Daily FOH rate</th>
<th>Analytical method</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (1–4)</td>
<td>1,237 × 3 = 3,711</td>
<td>468 + 468 + 468 = 1,404</td>
<td>3-week compensable delays</td>
</tr>
<tr>
<td>2 (5–8)</td>
<td>0</td>
<td>0</td>
<td>No delay</td>
</tr>
<tr>
<td>3 (9–13)</td>
<td>0</td>
<td>0</td>
<td>1-week liquidated damages</td>
</tr>
<tr>
<td>4 (14–17)</td>
<td>0</td>
<td>0</td>
<td>No delay</td>
</tr>
<tr>
<td>5 (18–21)</td>
<td>1,237 × 2 = 2,474</td>
<td>72 + 72 = 144</td>
<td>2-week compensable delays</td>
</tr>
<tr>
<td>Total FOH damages</td>
<td>6,185</td>
<td>1,548</td>
<td></td>
</tr>
</tbody>
</table>

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costs, labor costs, and/or labor hours for certain activities that will likely be delayed by his/her owner. Current strategies for preventing unbalanced bids also work in this situation.

Conclusions

This research argues that apportionment of delay responsibility according to the context of delays is very essential. In addition, calculation of FOH damages based on a daily rate is far from reasonable. A “one-size-fits-all” method undermines the relative importance of delayed activities and the fluctuating nature of overhead levels during the course of contract work. Double payment—or conceivably underpayment—of FOH may occur if a project suffers a suspension. It also indirectly hinders the application of the fair rule or the comparative negligence doctrine to apportionment for concurrent delays.

The analytical approach proposed in this paper takes into account the timing of delays and the degree of suspensions in quantifying FOH damages. It realistically allocates FOH into schedule activities. FOH delay damages, if any and/or allowable, are calculated based on activity-specific FOH. When being integrated with schedule-window analysis, the proposed approach is able to produce a reasonable damage computation in a real-time manner. For that reason this approach can be used very effectively in the forward-pricing practice and the negotiation of delay compensation. Finally, it can also be a practical and systematic approach that enables equitable apportionments for concurrent delays. When the proposed method is applied to the case-study project, its result differed noticeably from that of the daily rate method. The case study illustrates that the daily-rate-based method may cause double payments since the recovery probably covers some parts of FOH already included in the as-bid price.

This new approach is useful for both practitioners and researchers. It facilitates systematic apportionment analysis in delay claims. Practitioners are more proactive in measuring and presenting delay damages. Researchers should benefit from exploring insights into its application and implementation in the real world. Finally, further research seeks to develop a proper and realistic approach for fairly calculating delay damages of HOOH.

Notation

The following symbols are used in this paper:

\[ CD_i = \text{cost driver value for activity } i; \]
\[ D_i = \text{duration of activity } i; \]
\[ \text{FOH}^n = \text{nontime-related FOH}; \]
\[ \text{FOH}_i = \text{nontime-related FOH for activity } i; \]
\[ \text{ FOH'} = \text{time-related FOH}; \]
\[ \text{FOH}_i' = \text{time-related FOH for activity } i; \]
\[ \text{FOH}_t = \text{total compensable FOH damages}; \]
\[ iD = \text{critically delayed activity } i; \]
\[ iDo = \text{owner-caused critically delayed activity } i; \]
\[ u\text{FOH}_i' = \text{nontime-related FOH for activity } i \text{ per time unit}; \]
\[ u\text{FOH}_{iD} = \text{time-related FOH for critically delayed activity } i \text{ per time unit}; \]
\[ u\text{FOH}_{iDo} = \text{time-related FOH for owner-caused critically delayed activity } i \text{ per time unit}; \]
\[ W_j = j\text{th window period or window } j. \]