

Implementing Project Schedule Metrics to Identify the Impact of Delays Correlated with Contractors

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Schedule management reduces schedule delays while optimizing positive opportunities to the project timeline. The built industry continues to struggle to capture project metrics that will improve supply chain management. The lack of performance metrics on construction projects filters the actual project performance of the project stakeholders. Contractors can easily be blamed for schedule delays because of the nature of construction projects. A large university capital improvement organization recognizes their lack of performance information and begins implementing a performance measurement system in 2005. The university measurements focus on project impacts to cost, schedule, and quality in hopes that additional information will improve risk management processes. This article reviews the schedule impacts that contractors create within projects. Data was collected directly from both contractor and client project managers of 254 construction projects. Actual delays from contractors were found to be a small percentage of the overall project schedule delays. More than half of the delays that contractors produced were found to be correlated to the material suppliers.

Keywords: Risk Management, Contractor Delays, Performance Metrics, Schedule Management

Introduction

Construction organizations have historically struggled to capture performance metrics over an extended period of time (Egan 1998). Due to the high variance between projects, construction organizations have not been able to benefit from long term measurements as they have focused uniquely on short term project data (Love & Holt, 2000). The common short term data of on-time or on-budget percentages provide little assistance to gauge how the company will perform on their next project (Chapman *et al*, 1991). Short term data also provides little assistance for improving processes within an organization (Kaigioglou *et al*, 2001). Long term measurements need to track qualitative measurements, such as: quality, project impacts, social impacts, and human factors (Love & Skitmore, 1996).

Construction companies closely manage project schedules to ensure projects are completed on time. Understanding the organization's ability to manage project schedules is a key metric, both for individual project success and overall organization success. Successful projects that are delivered on time will ensure the profit in which the contractor originally estimated and will allow the owner to effectively utilize the completed facility as planned. Measuring the reasons for delays on projects and the parties responsible for the delays will provide transparency of the common delays that organizations experience on construction projects.

In 2005, a capital program at one of the largest universities in the United States found itself without metrics related to schedule management on their campus projects. The lack of performance information created confusion on what the common project delays were. The

performance of the contractors working on university projects was questioned. This perception of poor contractor performance is common within the build industry (NEDO,1983; HMSO, 1995). During the next several years the university implemented performance metrics on their projects to increase their ability to manage risk with the project schedules. The newly implemented metrics created transparency to delays on the university projects. This article reviews the implementation of the schedule metrics and analyzes the specific delays correlated to the contractor's performance.

Performance Measurement

Performance measurements in the built environment are described as “a quantifiable, simple, and understandable measure that can be used to compare and improve performance” (Pitcher, 2010). Pitt and Tucker (2008) explained the three reasons for measurements as: 1) to ensure the achievement of goals and objectives; 2) to evaluate, control, and improve procedures and processes; and 3) to compare and review the performance of different organizations, teams, and individuals. Metrics have also been found to assist with providing organizations customer ratings, reviews and suggestions (Love & Holt, 2000).

Two limitations are often seen with performance metrics: first, metrics are retrospective, with markets frequently changing, continuous performance metrics are necessary for it to be meaningful to the current climate, as past data might only reflect past markets (Halachmi, 2005; Busco *et al*, 2006); and second, comparable benchmarks are often unavailable to measure company performance, reluctance to release proprietary information forces organizations to place benchmarks from their past metrics or individual goals (Kaplan and Norton, 1992). Because of the nature of construction projects these difficulties were seen with the implementation of the performance metrics on schedule management.

Schedule Management

Project schedule management has been heavily researched and is understood to be highly correlated to successful project management (Globerson and Zwikael, 2002). The effort required from contractors and owners to ensure that projects are completed on schedule is often described as schedule management (PMBOK, 2008). Ineffective time management leads to overruns of the project schedule, known as delays. Schedule delays can become very costly to both owners and contractors. To the owners, delays mean the loss of revenue from the loss of productivity of the facility being constructed. Contractors see financial loss through the extended use of the company's resources on the construction project. Creating greater efficiency with schedule management is beneficial for both the owners and the contractors.

Researchers have placed a great amount of effort into creating greater schedule management efficiency. A large area of time management research focuses on the causation of project delays (Bordoli & Baldwin, 1998). To understand project delays many different methodologies have been used to collect project information. In a review of the past research with schedule delays Doloi *et al*. (2011) found that most studies quantified and identified project schedule delays by gathering schedule data from the project stakeholders. This methodology of research was used in this article to capture the contractor delays.

Contractor Delays

The variety found within construction project scopes account for the difficulties of identifying and eliminating the defects from the supply chain. Unlike manufacturing, construction workers seldom, if ever, replicate identical products more than once. However, common characteristics are found on construction projects and past research has identified many of the common schedule delays seen on construction projects (Kumaraswamy & Chan, 1998). Common schedule delays on projects include: owner interference, delayed decisions, project financials, ineffective planning, subcontractor delays, labor productivity, and inadequate contractor performance. Although owner interference greatly impacts construction schedules, owners expect contractors to perform at high levels and to minimize any contractor related delay. The common practices found with liquated damages on construction projects demonstrate the low tolerance owners have with contractor delays. Because of this high expectation, contractors focus on minimizing the risk in which they might impact the schedule. Researchers have identified the main reasons that contractors delay project schedules (Doloi *et al*, 2011, Kumaraswamy & Chan, 1998), they include:

- Contractors finance difficulties
- Conflicts with subcontractors schedules
- Construction errors causing rework
- Other parties creating conflict with the contractor
- Poor site management
- Poor communication and coordination
- Ineffective planning and scheduling
- Improper construction methods
- Delays from subcontractors
- Frequent changes with subcontractors

A 2002 study found that the different stakeholders involved with construction projects often disagree with which party creates the greatest risk to the schedule; owners and consultants blame the contractors and contractors blame the consultants and owners (Odeh & Battaineh, 2002). Without project metrics, finger pointing will always result from the non transparency, this is the situation that the organization included in this research was in.

Methodology

In 2005, the capital program at the University of Minnesota had no system in place to track and document challenges they were facing in cost and schedule growth within their capital construction projects, which also prevented the identification of opportunities to improve performance in these areas. Capital Planning and Project Management (CPPM) is the department responsible for all construction projects on the two main universities campuses. CPPM consists of a director, senior project managers, project managers, and support level staff that are responsible to ensure that all construction projects are delivered effectively. Without a comprehensive metric system, the quality of the organizations performance was created by perception and opinion alone, this consequentially left management skeptical of contractor's

performance. CPPM looked for ways in which they could begin capturing project time management metrics to better understand performance and minimize project delays. During 2005, CPPM implemented metrics on the performance of construction projects on its campus. The implementation of metrics is described extensively in past research (Sullivan *et al*, 2007).

To capture the individual project metrics CPPM introduced the “Weekly Risk Report” (WRR). CPPM required that contractor project managers maintained the weekly report to capture any event that delayed their project. The contractor managed the WRR and captured any risk on the project that delayed the project schedule, each delay was categorized in the WRR to identify who and what caused the issue. The development of the WRR has been described in further detail in past research (Sullivan *et al*, 2006) but, the main purposes of the WRR are to:

1. Provide basic project information;
2. Track the projects schedule;
3. Track all project risks on the project and how they are managed;
4. Track deviations to the schedule and cost;
5. Track who and what caused deviations;
6. Assign a level of project severity from the projects impacts for executives;
7. Capture the client’s satisfaction ratings of contractor’s ability to manage risk.

The WRR captured any deviation to the vendors planned schedule. The desire of the report was for the contractor to identify potential risks and provide solutions to minimize the risks. If a risk wasn't minimized and the project schedule was impacted than it was recorded with an explanation of the schedule delay. Each delay that occurred on the project was labeled with the party responsible for the delay, these project stakeholders included:

1. Client – department within the university
2. CPPM – client project management representative
3. Contractor - vendor selected to construct project
4. Design – consultant for design and engineer of the project
5. Unforeseen – any delay that was not foreseeable and could not be assigned to a stakeholder

The client project representative evaluated and confirmed the data collected on the WRR each week. On completion of the project the WRR summarized the risks that impacted the project schedule and identified the amount, the severity, the causation, and who was responsible for the project delay. The data captured project delays whether the actual completion date was completed on time or not. The university started implementing the WRR on select construction projects in 2005. The number of WRRs used on construction projects increased annually, until 2008 when the university required that a WRR was used on all construction projects. By the year 2012, 254 weekly risk reports had been implemented on construction projects at the university (Perrenoud & Sullivan, 2012).

Research Analysis

The results of the metrics captured in the WRR were gathered and analyzed for trends and common occurrences at the University of Minnesota. Information relating specifically to project schedule delays is analyzed in this section including an in depth analysis of the delays that contractors created.

Overall Schedule Delays

Weekly Risk Reports were collected on 254 projects at the university from 2005 to 2012. The 254 projects included both new construction and renovation projects on the university campuses. The total awarded cost for these projects was \$222,964,090 and the total number of days scheduled for these projects was 26,183 days. Each project captured the number of days in the planned schedule and the number of day the planned schedule was delayed. Sixty nine percent of the projects experienced a delay in the project schedule, in total 174 projects had delays. Overall the projects were delayed by 8,567 days, a 32.7% delay rate. A breakdown of the project delays categorized by project stakeholders can be seen in Table 1.

Table 1

Overall schedule delay rate

	Original Schedule Delay Rate	Number of Projects that had a Delay	Percent of Projects that had a Delay
Overall	32.7%	174	69%
Client	11.6%	93	37%
CPPM	9.9%	80	31%
Contractor	3.0%	41	16%
Designer	3.2%	39	15%
Unforeseen	5.0%	54	21%

As Table 1 points out the majority of the delays came from the client and the client project management team. Frequent scope changes and delayed action tasks accounted for a large portion of the delays that impacted the construction projects. The greatest risk to the contractor completing the project on the planned schedule was the client themselves. As the contractors on these projects were not included with the planning and designing of the project, there was very little the contractor could do to minimize the majority of the delays. Table 2 breaks down the number of days delayed by each stake holder. In total the contractor delays accounted for 788 days, 9 percent of the days delayed. The next section will analyze these 788 delays to find the major causes of the contractor delays.

Table 2

<i>Stakeholders delays</i>		
Stakeholder Schedule Delays	Days	Percent of Days Delayed
Client Delays	3047	35.6%
CPPM Delays	2603	30.4%
Contractor Delays	788	9.2%
Design Delays	825	9.6%
Unforeseen Delays	1304	15.2%
Total Schedule Delays	8567	100%

Contractor Schedule Delays

Of the 788 days that the contractor delayed project schedules, the researcher found that more than half of the delays were due to the manufacturers and the suppliers responsible to produce and deliver the construction materials. Manufacturers accounted for 56 percent of the delays that were reported on the WRR for the contractors. Table 3 is a complete breakdown of the contractor delays.

Table 3

<i>Contractor delay breakdown</i>					
Contractor Delay Attributes	Delays	Days Delayed	Delay %	Delay %	Delay %
<u>Contractor delay source</u>	26	344	44%		
Construction documents oversight	7	70		20%	
Equipment ordered late	4	78		23%	
Work related errors	15	196		57%	
Scheduling conflicts	4	42			21%
Installed incorrectly	6	102			52%
Soil not compacted	1	5			3%
Damages occurred in construction	3	16			8%
Forgot to install equipment	1	31			16%
<u>Manufacturer delay source</u>	18	444	56%		
Shortage of materials	2	92		20%	
Delivery of materials delayed	11	215		49%	
The manufacture was delayed	2	37			17%
Manufacture delivered late	9	179			83%
Incorrect material delivered	6	137		31%	
Delivery lost	1	36			26%
Missing pieces	2	10			10%
Incorrect size delivered	1	15			15%
Wrong equipment delivered	2	49			49%
Total	44	772	100%		

Actual delays created by the contractors were broken down into three subcategories: construction document oversight, equipment ordered late, and work related errors. Project management errors accounted for the majority of the contractor errors. Work related errors occurred when the construction processes broke down and the delay was specifically the contractors fault. Ordering equipment late also resulted in several delays to construction. These types of management errors are risks that contractors should have the ability to minimize.

Manufacturers and suppliers created the biggest impact to the projects when they either delivered supplies late or they delivered incorrect materials. With 56 percent of construction delays coming from the manufacturers, it is important that contractors work with effective and proven companies that will be able to deliver their product on time and correctly. Although the manufacturers delays only occurred 18 times compared to the 26 contractor related delays, the 18 delays had a larger impact on the schedule, highlighting the severity of the manufacturer delays. Manufacturer delays might be less likely to occur, but the severity of their impact was the greatest. The most severe manufacturer delays occurred when deliveries were lost, wrong equipment was delivered, incorrect sizes were delivered, or when the delivery was delayed.

Conclusion

In conclusion, the University of Minnesota was able to establish and collect performance measurements on 254 of its construction projects by gathering Weekly Risk Reports. The WRR is a simple tool managed by the contractor to assist risk management communication, produce accountability to the project teams, and provide performance metrics to the client. The university gained the ability to understand the needs of their projects with regards to managing the schedule. They have used these metrics to improve annually and to assist individual project managers to alleviate common delays they might experience on projects.

The researcher analyzed the performance of the project schedules from the data collected in the 254 WRRs and presented the findings in this paper. Against the common perception that contractors create large project delays, contractors were found to only have a slight impact on schedule performance, only accounted for 3.0 percent of the delay rate. The majority of the delays came from within the university and their project management group. The contractor has very little ability to manage and minimize these delays from the clients, such as: scope changes, delayed decisions, and lack of planning. But, the delays that the contractors should have minimized were presented in Table 3. Within these contractor delays the manufacturer and suppliers accounted for the largest portion of their delays. Because of the risk that suppliers create to the project schedule it is critical that contractors work with effective suppliers to ensure that they don't hinder the contractors' performance. In the end, the metrics provided transparency of the project delays and created accountability of the different stakeholders to ensure they minimize project delays.

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