

Minimizing Construction Project Schedule Delays through Risk Management and Performance Information

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Risk management within construction is becoming an important skill for owners and constructors alike to possess. The challenge is in transferring lessons learned and knowledge to others for the collective benefit of the organization. One thought is that risk management knowledge can be neatly packaged up, documented, and provided to others. Others believe that the project knowledge is useless without the social and organizational culture context from which the knowledge was derived. Performance information can be used to track the impact that risk has on project success factors, on a variety attributes (including cost, schedule delays, and owner satisfaction). In this seven year longitudinal case study, the authors analyzed 199 construction projects and found that the contractor overall schedule delay rate decreased by 87 percent. The authors propose that the owner's structured preplanning and project execution process provided the necessary performance information for the industry to substantively improve their risk management capability and knowledge.

Keywords: Risk Management, Performance Information, Schedule, Preplanning, Project Execution

Introduction

Background and Problem

Risk management is an important skillset for project leaders, regardless of their function within the project delivery process (owner or supplier). Specifically, risk management in construction is seen as being more challenging due to the increasingly complex nature of construction (Davison & Sebastian, 2009). Risk is generally defined as some sort of transaction that could hinder a project's overall success (Hillson, David, 2009; Williams, 1999). Thus, the critical value-adding skill in risk management is actually identifying the issues and mitigating them before project success is impacted (Dikmen, Birgonul, Anac, Tah, & Aouad, 2008). The challenge is not so much finding a supplier or contractor that can do this (from an overall company perspective), but rather, finding people within these companies who possess the skills. A related topic of interest is how this risk management knowledge is transferred, and then used, by other people. Research has identified that post-project analysis is not usually done for a variety of reasons: lack of time or resources, inadequate documentation during project execution, or even personal resistance to reviewing project shortcomings (Gibson, Wang, Cho, & Pappas, 2006; Griffith & Gibson, 2001). Increasing an organization's collective knowledge becomes much more difficult without this closeout process in place.

Research Scope and Variables

The researchers conducted a seven year longitudinal study in the state of Minnesota, in conjunction with a large public university's Capital Planning and Project Management (CPPM) group. CPPM implemented a structured pre-planning, project execution documentation, and closeout process for 199 projects, with 43 different contractors. The primary research question was, "How does contractor capability for risk management, as measured by project schedule deviation, change over an extended period time when a structured pre-planning and project execution process is used by the owner?" This research builds on the work of Perrenoud, Lines, & Sullivan, (2014) by specifically focusing on the schedule risk on year-over-year basis.

Literature Review

Dikmen et al., (2008) propose the concept of corporate risk management, whereby organizations use past project experience to modify and enhance individual employee's aptitude to identify risk, address it, and limit its impact on overall project success. They propose this knowledge should be distributed through one of two means: codification (into some sort of database) and personalization (interpersonal relationships to share experiences and lessons learned). There are, of course, several challenges in attempting to formally develop a structure to share this risk management knowledge:

1. People do not have the time or resources to reflect on their experiences on the project (Von Zedtwitz, 2002).
2. Perception that each project is unique, and therefore the experiences are not transferrable to other different projects.
3. Knowledge is inherently difficult, if not impossible, to share with others. One view is that "knowledge is a resource" that can be neatly packaged, documented, and delivered (Nonaka, 1995). On the other hand, the more contemporary view is that knowledge is a function of the organizational culture, which therefore requires the learner to somehow also experience the social cues of the situation from which the knowledge was derived (Blackler, 1995; Lam, 2000; Tsoukas, 1996; Tsoukas & Vladimirou, 2001).

In particular, Newell, Bresnen, Edelman, Scarbrough, & Swan (2006) support the idea that knowledge is not readily transferrable, and suggest three success factors for the knowledge transfer function. First, actual new knowledge must be created. Attempts to provide information that is already known (either through a past experience or common logic) will reduce the quality of the discussion. Second, the new knowledge must be useful outside of the project or experience from which it was derived. That is, it must be general enough to have application on a myriad of projects. And finally, the new knowledge needs to be simple enough for people to quickly understand and immediately integrate it into their daily job function.

Project performance measurement can be an instrument to measure an entity's (person, contractor, organization, etc.) propensity to identify and minimize risk. Over the past ten years, there has been an increased push to not only measure people's capability to identify and minimize risk, but to also use performance information to increase public transparency and accountability. Fundamentally, performance measurements help an organization align the expected outcomes or deliverables against the expectation (Greene, 2005; Holzer & Schwester, 2011). It also follows that when measurements are established they should relate directly to the organizations' specific objectives (Greene, 2005; Rivlin, 2012).

This brief literature review has identified that the use of performance measurements can be used to quantify various levels of risk management. These measurements become much more useful on a comparative basis, as each data point provides relative benchmarking information.

Research Methodology and Data Collection

The authors conducted a longitudinal study at a large public university in the state of Minnesota. The authors partnered with the university's Capital Planning and Project Management (CPPM) group in 2005. The primary objective was to help the University minimize claims and litigation, increase project performance, and measure the overall success of their projects (in terms of cost, schedule, and project manager satisfaction). The structured pre-planning and project execution process was initially piloted on smaller specialty trade projects (mechanical and roofing), and then expanded to other larger and more complex projects. The authors measured project performance on a weekly basis once the notice to proceed (NTP) was issued through final payment. The CPPM project manager performed quality control by reviewing the "Weekly Risk Report" to ensure that it contained any risk that he or she was aware of. This report came from a spreadsheet used for data collection, where the contractor documented any changes or deviations to the awarded cost or final completion date. The authors defined these deviations as risk, and were categorized according the risk's source: owner, contractor, designer, or unforeseen. Schedule delay rates were calculated by dividing the sum of each risk category by the project's total duration in calendar days (from NTP to final payment). For example, if a project had a duration of 25 days, and there was a 5 day delay, the change order rate would be 5 days delayed divided by 25 day project duration equals 20 percent schedule delay. Similarly, change order rates were calculated by summing each risk category by the project's award amount in dollars.

The scope of this paper will only focus on the contractor schedule risks. The authors reviewed contractor change order rates, but did not include them in the analysis. The overall contractor change order rate for the entire seven year study was 0.1 percent (and thus did not show significant results in terms of contractor risk management capability). Furthermore, the authors only analyzed the contractor risk categories (as opposed to client, design, or unforeseen risks) assuming that contractors' profit-maximizing motivation will yield the clearest increase in risk management knowledge and capability. All 199 projects were delivered using Design-Bid-Build (DBB), and were 100 percent complete (final payment received).

Results

Figure 1 presents the average contractor schedule delay rate for each fiscal year of the study (solid black line). The black-dotted line shows the number of contractor risks, again as a proportion of the total number of risks over the study's duration. Figure 1 also shows the average project value for each year, as a proportion of the overall project value (diagonal-line shaded bars) and the average number of projects (per fiscal year), as a proportion of the total number of projects (shingle-shaded bars).

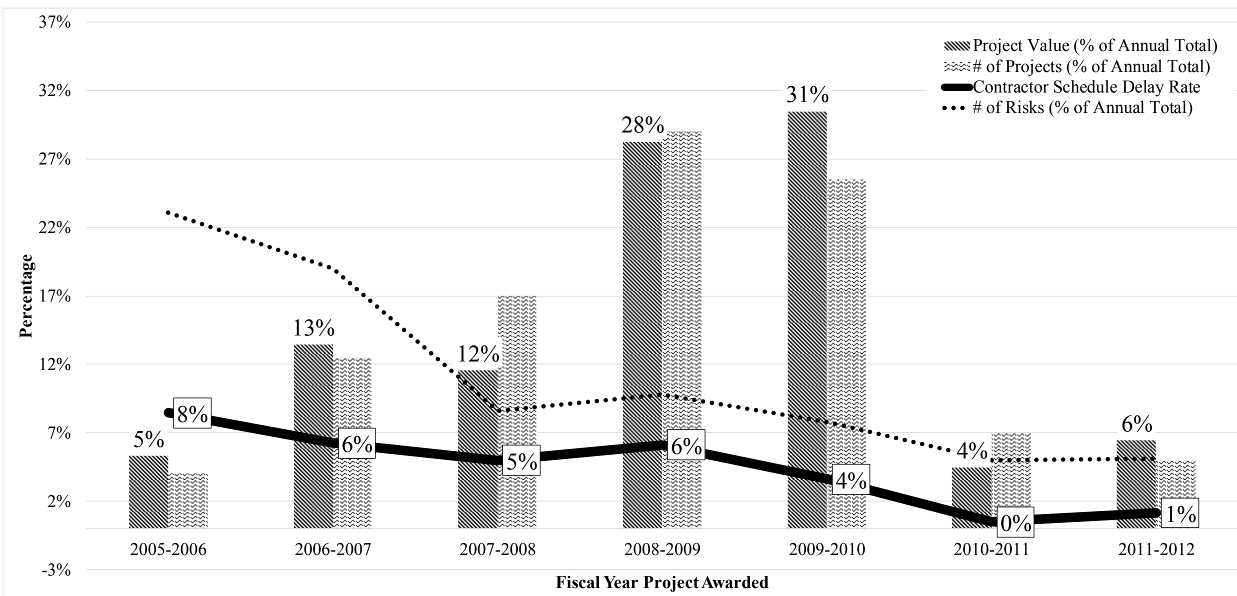

Figure 1: Average Contractor Schedule Delay Rate per Fiscal Year

Next, Figure 2 presents the same contractor schedule delay rates, but provides detail on the amount each specialty trade contributes to the total contractor schedule delay rate for each fiscal year.

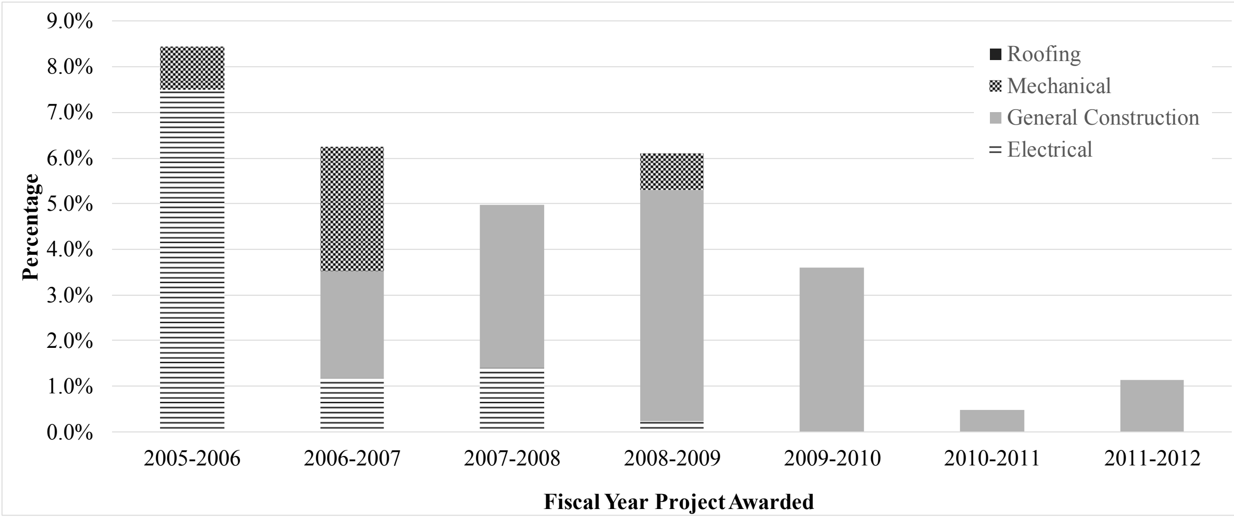

Figure 2: Average Contractor Schedule Delay Rate per Fiscal Year, by Speciality Trade

Table 1 presents a summary of the awarded contractors, and the average number of projects awarded per contractor. This average is calculated by summing the total number of projects a contractor was awarded in a given fiscal year, and dividing it by the total number of projects in that year.

Table 1

Contractor Award Distribution Per Year

Fiscal Year	# of Different Contractors	Average # of Projects Awarded Per Contractor
2006-2007	15	0.6
2007-2008	22	0.8
2008-2009	23	0.9
2009-2010	21	0.8
2010-2011	10	0.4
2011-2012	17	0.6

Finally, the authors analyzed the source of contractor schedule delays. The contractors grouped the source of their schedule delays into Design Oversight (they neglected a certain design or project requirement while preparing their proposal), their subcontractor or supplier (a third party, from the contractor's perspective, did not meet the awarded contractor's schedule requirement), or general issues which do not belong in the two previous categories.

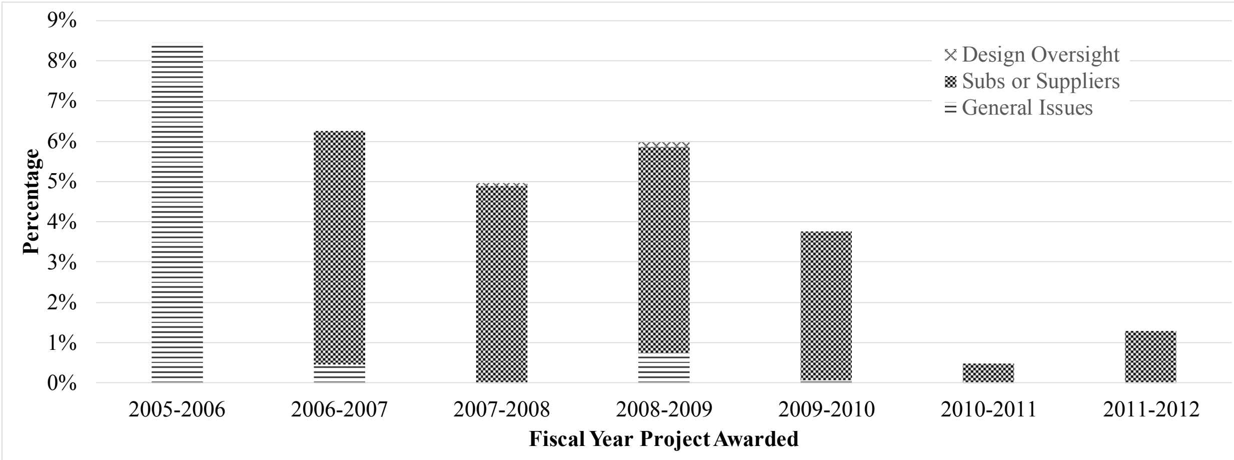

Figure 3: Average Contractor Schedule Delay Rate per Fiscal Year, by Source of Delay

Discussion and Limitations

Figure 1 shows that that the average contractor schedule delay rate has been steadily decreasing overall, in spite of increasing project volume (both in terms of dollar value and the number of projects). The average schedule delay rate decreased 87 percent from FY 2005-2006 to FY 2011-2012. If the schedule delay rate corresponded with the project volume, a potential explanation might be that volume affects overall schedule performance. However, the data shows quite the opposite: contractors have become more efficient year over year and have minimized schedule delays, regardless of their workload. Furthermore, contractors appear to not only minimized the overall delays (in terms of calendar days), but have also minimized the frequency of schedule delay events.

With Figure 2, the reader may observe that while the general contractor contributes the highest amount of schedule delays, each trade also decreased their relative contribution each fiscal year to the overall schedule delay rate. Table 1 provides further evidence that while overall industry participation corresponds with project volume each fiscal year, schedule delays have continued to decrease. A potential explanation is that the preplanning and project execution structure created by the owner has allowed the industry to collectively increase their overall performance through distribution and collaboration of each company's individual risk management knowledge.

25 percent of the projects in 2005-06 were electrical work, but most of the risks are attributed to the electrical projects. There were fewer electrical projects in the subsequent years, but still less delay for the electrical work in the later years. The cumulative delay rate (of all risks together) has the most explanatory power, and shows the overall improvement across all trades. With regard to general construction, there are more participants due to the increasing volume of work (see Figure 2). Though the University had the preplanning structure in place, the new contractors still had a learning curve, which may have increased the change order rate during that timeframe.

The strongest evidence indicating the construction industry (participating at this university on these projects) has improved their capability is shown in Figure 3. As discussed in the literature review, risk is an event (which may be outside the control of the contractor) that may negatively impact a project's success. Subcontractor or supplier risks may be of little importance to an owner – a delay is a delay, regardless of who caused it. However, granulation of project risk down to the level of schedule delay source is highly beneficial for industry. It tells the contractors where they need to direct resources in an effort minimize risk. This exemplifies the appropriate use of performance metrics to increase overall project success. Thus, the transfer of risk management knowledge is facilitated through the existence of performance metrics.

The chief limitation of this study is its reliance on the accuracy of the self-reported performance information. The authors have minimized this potential shortcoming by educating the CPPM project managers to perform quality assurance of the reports, and by also instituting a closeout survey process on the actual project performance. However, considering the data with respect to project volume, specialty trade contribution of risk, and schedule delay source helps to validate the trend of decreasing schedule delay rates. The reader is also reminded that this study was carried out over a period of seven years within a single owner organization, whose personnel largely remained the same. The authors do not necessarily expect the same results at other organizations without the sustained structure required by the University.

Conclusions and Recommendations

The ability to transfer risk management knowledge (or general knowledge for that matter) has two different concepts: it can be neatly packaged and given to other people (through a risk database, for example) or it is only possible through consideration of the social and organizational context from which the knowledge was initially derived. Performance measurements help an organization quantify its overall success and can be used to specifically monitor risk. The research presented appears to indicate that an owner's sustained use of a preplanning and project execution structure has helped the industry improve its risk management capability. The subject University in this study saw contractor-related schedule delays decrease by 87 percent over a seven year period. The authors propose that the preplanning structure and associated performance measures helped the industry improve its risk management capability.

Further research should be conducted on any impact to the owner organization, or their satisfaction relative to the industry's overall performance. Additional study should also be conducted on the organizational culture changes within the construction entities and their perception on risk management. Research on individual contractor performance overtime at the University may also yield additional insight.

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