



Creative Construction Conference 2015 (CCC2015)

Assessing the influence of automated data analytics on cost and schedule performance

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Abstract

This article assesses the combined influence of information integration and automated data analytics on project performance. To this end, retrospective data on 78 completed projects, with a total installed value of \$8 billion, was collected. The data collection effort characterized, for each project, the level of internal and external information integration. Information integration was assessed as the seamlessly interoperable sharing of data produced from a work function with other functions/stakeholders so that no manual data transfer was required. Also, the level of automated data analytics, understood as the full automation of the data analysis function after input data are entered, was also characterized on a project basis. Then, non-parametric statistical techniques were used to assess the impact of such functions on cost and schedule performance. The statistical analysis was also stratified by project type, e.g. greenfield and brownfield, additions, and modifications or shutdowns. Overall, projects with a sophisticated degree of information integration and automated data analytics can control their projects with more reliable information and in a proactive manner so that informed decisions can be timely made on behalf of the project and the organization.

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Peer-review under responsibility of the organizing committee of the Creative Construction Conference 2015

Keywords: cost; schedule; controls; project performance; information; information integration; automated analytics.

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1. Introduction

Despite advancements in construction technology, project management strategies and information systems the performance of capital projects remains a major issue. The proper control of project cost and schedule performance is of upmost importance in today's ever competitive industry landscape. We found that construction experts has the consensus that an instantaneous, or at least timely, project control capability can be a significant development and will result in substantial benefits to project performance and project stakeholders. Currently the industry believes that the collection of project control data is time consuming, and the availability of timely data lacks when reporting.

The importance of project controls becomes evident after examining construction project drawbacks [1]. Perhaps the construction industry more than others is susceptible to risk due to the complexity, uncertainty, and dynamism [2,3,4]. As a consequence, time and cost deviations are still a common reality in the delivery of capital projects [5].

Timely delivery of information plays a crucial role in achieving project objectives [6,7] because it allows appropriate decision making. Around 50-80% of the problems on construction sites are attributed to missing and delayed information [8,9]. The more delay in identification of discrepancies with project objectives, the more challenging and costly is to apply corrective actions. It is estimated that 12.4% of resources are depleted due to late delivery of information to the decision authority [10], such as defective materials and rework late in the construction phase. This lag in reporting results in inefficient response to the inevitable problems and events that are to occur at almost any project. Thus the main research question in this study aims to find whether information integration and automated analytics have an influence on project performance.

Despite much research and industry effort to improve project control methods and strategies in the last several decades, projects are still experiencing severe performance issues. Research in the field of monitoring and control have ranged from productivity improvements [11,12], forecasting [13,14], automation [15,16,17], and other research areas pertaining to project monitoring and control. Despite these endeavors project managers and contractors are still struggling with effectively tracking and controlling projects [18].

2. Methodology

There is no single tool or technology that allows organizations to fully improve their control practices [19] and there is still a lack of an efficient approach to project control. Such efficient approach should entail data collection, analysis, forecasting, reporting, and corrective actions for all phases of a project, across organizations and stakeholders, so that appropriate, timely, and accurate information is always available when needed. Thus an outreach program seemed the most feasible approach to identify facilitators of appropriate and timely project control practices.

Retrospective data from 78 projects was collected in order to investigate the benefits of information integration and automated data analytics on project performance. For this reason the data collection effort characterized, for each project, the level of internal and external information integration as well as automated data analytics. Information integration was assessed as the information (or data) produced from work functions that are seamlessly interoperable with other functions/stakeholders in manner that no manual data transfer is required. Automated data analytics is described as the complete automation of the data analysis to extract information. The projects were categorized as either with very good or very poor integration and automation capabilities, and later using non-parametric statistical hypothesis testing methods the effect of these capabilities were contrasted with project performance. The statistical analysis was constrained to industrial projects within the owner and contractor organizations.

3. Findings

In order to assess the combined effect of information integration and automation on project performance, we collected retrospective data from 78 projects, with an installed value of \$8 billion. Sixty of these projects were owner projects and eighteen were contractor projects. Most projects are in the light and heavy industrial sector and were located in North America. The majority of projects were delivered through design-bid-build, design-build, engineering-procurement-construction, or parallel primes. The top project business drivers were operability and capacity, as it is often the case in industrial projects. Project priority for half of the reported projects are both cost and schedule, while the other half it is either cost or schedule. On average, about 10 full-time project management team personnel were employed for the project management function. Contract types were mostly cost reimbursable and lump sum for all project phases. Project nature was defined mostly as either grassroots or modernization.

Among many collected metrics, the internal and external integration levels and the level of automated data analytics was measured through a 5-point Likert scale. The three scores of internal and external integration as well as automation were combined in a single metric for the purpose of this study. The projects were separated either with very good or very poor integration and automation capabilities. The cost and schedule deviations for each category or group were compared using a one-way non-parametric Mann-Whitney hypothesis test in order to measure the significance of the cost and schedule performance difference between the two groups.

The 78 projects comprise of grassroots, brownfield, additions, and modernization (turnaround) projects. Indeed, each project type and different combinations of these project types were also stratified and analyzed. Although the results were not determined to be statistically significant, however, there is anecdotal evidence that the seamless communication of information and the ability to generate automated, and hence on-demand, reports could actually result in positive cost and schedule performance impacts. The analysis summary of all projects, as well as grassroots and brownfield projects only is presented in Table 1.

Table 1. Impact of Information Integration and Instantaneous Controls.

Project Type	Cost		Schedule	
	Count (low, high)	Average Performance Impact	Count (low, high)	Average Performance Impact
All	21,14	3.34%	19,15	5.31%
Grassroots and Brownfield	7,7	6.53%	8,8	15.80%

The results show that, on average, the integration and automation of project processes results in improved project cost and schedule performance. For instance, comparing the projects with different levels of information integration and automation result in different cost performance in projects with less sophisticated project functions, to be exact the cost deviation of the higher scored projects is 3.34% lower than that of the poorly scored projects. The reader should notice that there is a stronger positive relationship between integration and automation practices and schedule performance than cost performance.

4. Conclusions

This study assessed the impact of information aspects related to internal and external integration, and to automated analytics on the final performance of capital projects. Even though the results were not statistically significant, it seems clear from the results that such positive impact can be realized. Additional facets of this study actually characterized that even though such information facets are a critical when optimizing the project controls function, the range of aspects to be attained covered, in addition to controls, organizational behavior and advanced information technology aspects. For instance, the work packaging becomes essential in order for project teams to be

able to retrieve the required information through estimating, design, and construction, so that information is available to make informed in reliable decisions. For instance, we documented that decision makers with accurate and timely information are able to benefit projects, portfolios of capital investment projects, and their organizations alike. Currently, a gap in the reporting cycle exists, so that decisions are made on outdated information. Further research efforts should further investigate the impact of information integration and automated analytics by project phase.

Acknowledgements

We want to acknowledge and thank The Construction Industry Institute for the sponsorship and support to all the aspects reported in this article. We also want to thank all the subject matter experts that contributed to this research effort through the data collection, analysis, and validation steps, and specifically the subject matter experts within CII's Research Team 316.

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