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Investigation of Cost Data Management Practices in the U.S. Construction Industry

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Organization and use of data is crucial for a construction company to serve clients in this fast-paced, technology driven world; however, many may not consistently leverage their past bid and completed project data. The purpose of this study was to review and identify present trends and issues in project cost data management processes and to understand what data sharing approaches currently exist within construction companies. The study involved a survey distributed to construction professionals across the United States. A total of 186 survey responses revealed most were trained very little, or not at all, on how to transfer data from estimating software to job cost tracking software. Historical cost data from both successful and unsuccessful bids is typically kept by estimators for use when developing future estimates. This cost data is typically not aggregated into one location, though. Aggregating historical cost data is important and laborious. If data is aggregated, it is done so infrequently and inconsistently. Lastly, many companies do not have a transparent protocol for managing and aggregating data from past projects. The findings of this study are useful for construction practitioners, as well as researchers and construction management educators.

Key Words: Data management, Cost, Estimating, Software, Project management

Introduction and Literature Review

The explosion of revolutionary technologies available to the construction industry has presented opportunities and challenges for companies of all sizes. Some companies have been faster than others to adopt and replace the traditional use of manual processes such as using paper and pencil (Abu Awwad et al., 2020; Pellicer et al., 2012). Nonetheless, leveraging computers and their various software platforms to complete daily tasks is standard in almost every industry today, including construction.

The marketplace for construction cost management software is vast, sometimes difficult to navigate, and ever changing. A simple search engine query into “best construction software” will provide a myriad of options, including established platforms, and new up-and-coming solutions. Interestingly, instead of utilizing newer software to build and manage project cost estimates, contractors continue to use two that have been on the market for over thirty years: Microsoft Excel and Sage Estimating

(Collins & Redden, 2022; JB Knowledge, 2020). Both are considered clunky and static with considerable front-end, manual processing time required to conduct data extraction and/or data transfer with newer project management software. Building Information Modeling (BIM) is considered another data-rich technology that has broadly lagged in leveraging cost data for many contractors (Gholizadeh et al., 2018; Karan and Irizarry, 2015). Abu Awwad et al. (2020) identified multiple human factors, organizational factors, process factors, and external factors to be critical in successful BIM implementation in the United Kingdom construction industry. Many construction companies have not yet moved into maximizing newer technology, such as BIM, for cost control (Smith, 2014). Another shift within the last decade is the profuse use of mobile devices, drones, augmented reality technologies, photography, and video sites for both estimating and project management. As a result, various applications have gained traction to reach various stakeholders through multiple channels. The numerous platforms and applications dedicated to project communication, documentation, cost management and accounting creates a plethora of data (Igwe et al., 2019; Martínez-Rojas et al., 2015).

While the application of data analytics in the construction industry is not new, one main obstacle is that while there is abundant data to leverage, all are in different platforms and in different forms (Philip Chen & Zhang, 2014; Lu et al., 2016). The need to deal with different types of data has caused companies to yearn for practical, efficient, and seamless data management techniques. Huang et al. (2021) asserted the construction industry is facing a "data tsunami" and conducted a metanalysis of challenges of data-driven construction project management in the Big Data context. Bilal et al. (2016) found the "adoption of Big Data technologies in the construction industry remains at a nascent stage and lags the broad uptake of these technologies in other fields."

Historical project data plays a specific, vital role for contractors of all sizes to apply when securing and managing new projects (Adbelaty et al., 2022; Abdelaty et al., 2020; Cheng et al., 2012) Previous work by Abdelaty et al. (2022) developed a data-driven approach from one company's historical bid day data from the past 45 years. The research particularly targeted serving small and medium-size contractors with a framework to leverage historical bid data for use in conceptual estimates. Liu et al. (2012) found historical means proved more advantageous over a multiple linear regression predictive model approach for formulating preliminary engineering budgets for new roadway projects. Cost estimates often require the consideration of historical data on construction costs to accurately estimate costs of future projects. Historical cost data only benefits a company's cost estimation efforts when the data is gathered and organized for future applications.

To summarize, data has become an important resource for a company in today's world. Given the digital shift society has been making and the continuous growth of data, construction companies desire to be data-driven. The estimating and bidding (i.e. tender) process for each construction company produces a plethora of critical data. The utilization of said data is currently in a state of disarray for many. Choosing a suitable method, or protocol, for efficiently storing, processing, and managing data from numerous sources remains challenging for contractors of all sizes. Previous research is focused on creating or suggesting models for companies to potentially implement to harvest cost data. This research stepped back to examine the overall current position of cost data management in construction firms in the United States.

Research Methodology

The purpose of this study was to review and identify present trends and issues in project cost data management processes and understand what data sharing approaches, particularly from estimating to operations, currently exist within construction companies in the United States. The authors partnered with the American Society of Professional Estimators (ASPE) to conduct this research, as the association has a substantial and experienced membership representing firms across the United States. ASPE is made up of five geographic regions, with over 50 chapters throughout those regions. The exact number of individual members was not provided to the authors by ASPE, but the ASPE website states that the group has over 6,200 members.

The authors first conducted thorough research to identify estimating and project cost management platforms on the current market (Collins and Redden, 2022). The authors then established inquiries regarding the various identified platforms and the management protocols for data derived from those various identified platforms. For this phase of the research, an online survey instrument was developed in Qualtrics by the authors, the contents of which were validated by a group of experienced construction professionals in the ASPE leadership. The survey investigated the following themes regarding data, along with questions on basic demographic information:

1. Process of Transferring Data from Estimating to Operations
2. Storing, Managing and Use of Historical Cost Data

The survey was sent out via email to the ASPE membership once during November of 2019, and twice during December of 2019. Concurrently, the survey was also sent out to members of the Auburn University McWhorter School of Building Science industry advisory committee. Both surveys were closed in January of 2020.

Results and Discussion

The authors received 186 complete survey responses, which included 144 ASPE members, and 42 industry advisory committee members. The respondents had an average of 28 years of construction industry experience and were in 35 of the 50 states. The respondents average over seven estimates/budgets completed each month with an average cost between $1 million and $10 million. A wide range of market segments were represented in the respondents' company portfolios. Table 1 provides a breakdown of respondent firm types. As shown, approximately half of the respondents represented general contracting firms, followed by consulting and specialty contractors/subcontracting firms.

Table 1
Breakdown of company types represented in survey responses

Firm Type	Total Responses
General Contractor	95 (51%)
Consultant	41 (22%)
Specialty Contractor/ Subcontractor	20 (11%)
Owner/ Client	13 (7%)
Design Firm/ Architect	9 (5%)
Unknown	8 (4%)

The Process of Transferring Data from Estimating to Operations

A couple of questions in the survey investigated the process of data transfer from estimating to the project cost control in project management systems which is traditionally known as an operations function in the United States. As stated previously, the literature identified Microsoft Excel and Sage Estimating as the most widely utilized software for creating, managing and/or finalizing project estimates (Collins & Redden, 2022; JB Knowledge, 2020). This study investigated the software used for project cost management after the project award. Interestingly, the responses were scattered amongst various software programs currently available. Respondents frequently deviated from Microsoft Excel in their project cost management software. While some (less than 15%) did report continuing to use Microsoft Excel for project cost management, many respondents confirmed their company shifts, or transfers, the estimate cost data into one of the following: Procore, Trimble ProjectSight, Sage 300, CMiC, and/or Trimble Viewpoint. Proprietary, or a company customized product, was also mentioned by a few respondents.

Table 2 provides a summary of responses regarding how much time is spent transferring estimate data to operations for one project. The survey also inquired about the job title or role within the company who is responsible for conducting the transfer. The duty of transferring data from estimating to the operations is split between Project Managers (48%) and Estimators (33%). Other represented 19% of the responses and included roles identified as accounting personnel such as Chief Financial Officer (CFO), Job Cost Analyst, or Cost Controller. Over half (57%) stated the amount of time currently spent transferring estimate data to operations for a single project is two hours or less.

Table 2
On average, how much time is spent transferring estimate data to operations data for one project?

Less than an hour	26%
1-2 hours	31%
2-4 hours	19%
More than 4 hours	24%

A combination of manual entry and import/export functions of spreadsheets was the most common way of handling the movement of data from estimating to operations. When respondents had an open-ended question to explain their protocol, most protocols place the responsibility on one or a select few employees to do the transfer. 46% of responses acknowledged there are issues with data transfer. The most common issues according to respondents involve (1) inconsistent code costs, (2) knowledge loss in the transfer, (3) human errors, (4) software integration issues, (5) missing or duplicate information, and (6) speed and accuracy of transfer.

Figure 1 provides a summary of responses regarding what the amount of training the survey respondents received as part of the role in the preconstruction area of their construction business. Most estimators (over 66%) were trained very little, or not at all, on how to transfer data from estimating software to job cost tracking software.

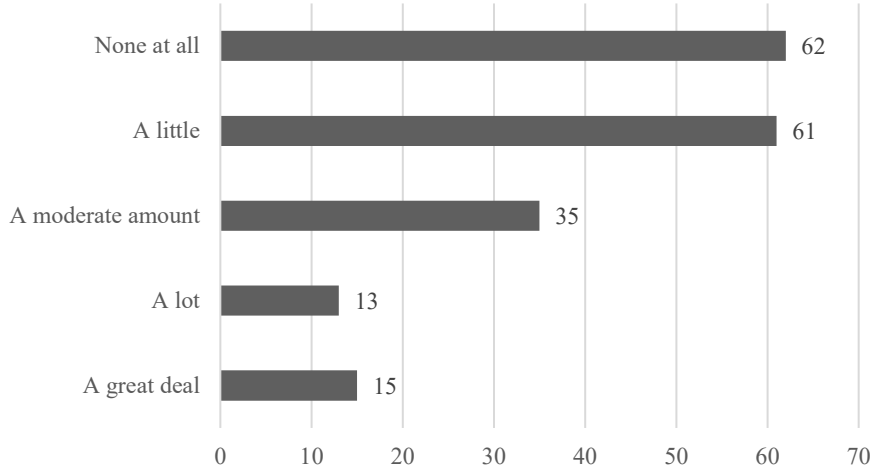

Figure 1. Survey Responses Regarding Amount of Training Received on Data Transfer from Estimates to Job Cost

Storing, Managing and Utilizing Historical Cost Data

Table 3 provides a summary of responses regarding the choice to store historical cost data. Historical cost data from both successful and unsuccessful bids is typically kept by estimators for use when developing future estimates. Survey respondents were able to Out of the 186 total respondents, 118 (63%) answered all project data is retained for completed projects, and 101 (54%) answered the data on bid but not awarded projects, noted as Bid Only Projects (not awarded), is also kept. Thirty-four respondents (18%) reported not keeping project estimate data for Bid Only Projects which would be projects the company bid but did not move to building the project.

Table 3

Survey Responses Regarding Preserving Historical Costs Data

	Completed Projects	Bid Only Projects (Not Awarded)
Yes, all project data is kept	118	101
Yes, but data only on some projects is kept	54	51
No, project data is not kept	14	34
Total	186	186

One respondent offered further explanation by adding in an optional text entry box for this question, "While all project data (won and lost) is archived, only select projects are aggregated and used to generate historic data. Projects are selected based on complexity, detail of estimate, and project sector. Actual cost data is also tracked on all current and completed work."

Table 4 provides a summary of responses regarding the location(s) a company stores historical cost data. Choices in the survey for this question included local computer hard drive, accounting software

platform, estimating software platform, server accessible to estimating staff only, server accessible to all company employees, and "the cloud." Respondents were asked to check all that apply for storage location of historical cost data. Multiple choice selection per survey respondent was common for this question. The most common location for storing the company historical cost data is on a server. Software platforms, both estimating and accounting platforms, were the least utilized locations for storing historical cost data.

Table 4

Survey Responses Regarding Storage Location(s) of Historical Cost Data

	Completed Projects	Bid Only Projects (Not Awarded)
Accounting software platform	35	5
"The Cloud"	46	37
Estimating software platform	22	20
Server accessible to all company employees	54	47
Server accessible to estimating staff only	47	57
Local computer hard drive	41	35

Respondents were asked, "Does your company have a protocol for managing and aggregating data from past projects?" Many companies do not have a protocol for managing and aggregating data from past projects, but some do, and some are working to develop one. One hundred eighty-one (181) respondents answered the question, "Does your company aggregate data from past projects into one location?" A total of 124 responded (68%) that this data is not aggregated into one location while the other 32% said their company does aggregate data into one location. Multiple respondents added further explanation in an optional text entry box offered with this question and stated, "no set protocol; differs between offices and market sectors."

The frequency of updating the aggregated data was also investigated. Of the 186 validated survey responses, 110 responded to the question, "How often is this aggregated data updated?" Figure 2 provides a summary of responses regarding how often the aggregated data is updated. Fifty-three percent (53%) state any aggregated data is updated yearly or even less frequently (rarely and never), while only 39% (or 43 respondents) state aggregated data is updated on a quarterly or monthly basis.

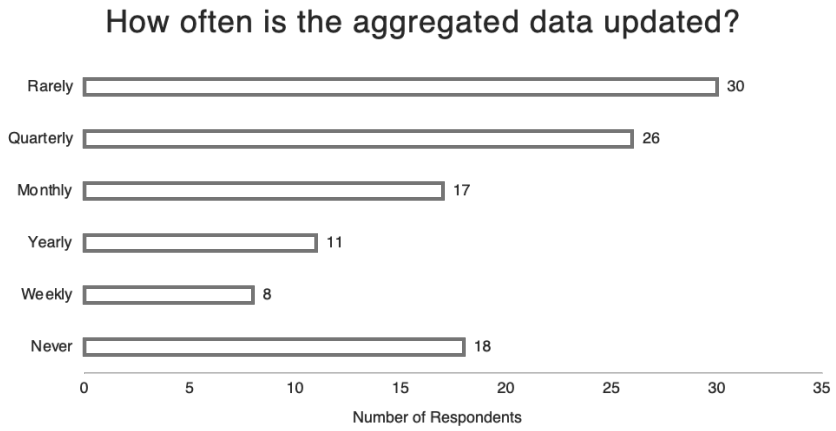

Figure 2. Survey Responses Regarding Frequency of Aggregated Data Updates

Lastly, the question was asked of each individual survey participant regarding their own use of past project data. The survey question was written as follows: "Do you personally use data from past projects when developing estimates for new projects?" Fifty percent (50%) of respondents stated only sometimes/selectively, while 44% said they always use data from past projects, and 6% stated they never use data from past projects when developing estimates for new projects.

Conclusions, Limitations, and Future Research

With all the advance of various technologies, one major challenge for contractors is the strategy for organization, management and administration of project cost continues to be complicated and cumbersome. The purpose of this study was to review and identify present trends and issues in project cost data management processes and understand what data sharing approaches, particularly from estimating to operations, currently exist within construction companies in the United States. Individuals associated with ASPE and the school's industry advisory council were surveyed.

Less than 15% of respondents report continuing to use the same software utilized in the estimating and bidding phase which is most commonly Microsoft Excel. Most respondents confirmed their company shifts, or transfers, the estimate data into one of the following: Procore, Trimble ProjectSight, Sage 300, CMiC, and/or Trimble Viewpoint. A few companies have a proprietary or a company customized product for cost control and management in the operations phase of project. This shift in software, or data transfer, can cause issues in producing a seamless, coherent data exchange and lacks in the ability for quick, critical data sharing.

Historical cost data from both successful and unsuccessful bids is typically kept by estimators for use when developing future estimates. Although, construction firms tend to lean on manual project estimate data retrieval processes and ad-hoc decision making from senior-level roles in the company, such as Chief Estimators and Project Executives, for when and what information is aggregated for historical cost data reference. Another significant finding of this study is that when companies do collate their bid project and completed project cost data, the frequency in updating the aggregated data location is subpar at best. More than half of respondents (53%) do not have procedures in place to update the aggregated database in a timely manner to leverage that data in their work consistently.

This causes irregularity and confusion in the information for the broader employee base since it is unknown what factors are elected in such analysis (Adbelaty et al., 2022).

The results described are limited to the pool of voluntary respondents associated with ASPE and the school's industry advisory council. Similar results may or may not be found if a different sample was used. Future research should continue to assess where construction companies can improve their data management and data analytic processes. Performing even finer grain analytics across construction departments seems virtually impossible for some currently, which is the key to effectiveness, accuracy, and high return-on-investment (ROI) for the company. Researchers through this study have a broad base understanding of the current issues and trends in data management, particularly from the preconstruction lens to transferring into the project management lens. Next steps may include finding easy and effective solutions for companies of all sizes to improve the "data tsunami" as Huang et al. (2021) stated that construction companies currently are confronting today.

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