

# Case Study: Implementation of Electronic Documentation on Heavy Civil Construction Projects

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This paper identifies perceived benefits of transitioning to an electronic-based documentation program in a heavy civil subcontractor setting. Electronic documentation has shown to reduce costs through organization, review and retrieval methods. This study provides insight of heavy civil construction managers regarding the efficiency of transitioning to a shared document control system. RFI data among projects utilizing electronic documentation and traditional methods were compared. The RFI turnaround times among six projects that utilized traditional document control methods were compared to the RFI turnaround times of a project utilizing electronic documentation. The data collected from this study suggests that electronic documentation benefits communication amongst members of a project. While the data provided suggests an increase in efficiency, it cannot be concluded that electronic documentation was the sole cause of this.

**Key Words:** Electronic, Documentation, Construction, Project, Management

## Introduction

The projects observed for this case study were (6) in which utilized hardcopy/email/network methods of document control, and one project utilizing electronic document management software. The projects in which hardcopy/email/network methods of documentation were used, will be referred to as projects (1-6) throughout this paper. The remaining project that used electronic means of documentation control will be referred to as project (X) for the remainder of this paper. The company providing data, Company (X), is a heavy civil contractor based in Alameda, CA. Company (X) were subcontractors on all seven projects being studied.

In this paper, Electronic documentation will refer to web-based document sharing, and information gathering tools such as computer software and networks. Electronic documentation allows field workers and managers to view, edit, and share files among members of the project via cloud based applications on tablets and computers. Electronic documentation has the ability to organize documents, store information, and notify all relevant members by email as well as within cloud-based applications when information needs to be reviewed. In theory, the implementation of electronic documentation in the construction industry should reduce costs, reduce project duration, and increase communication between parties.

Electronic document management can reduce time during the RFI process by allowing managers to group and store data, and retrieve data efficiently with the help of tools such as automatic search. Among document management tasks, the RFI process has shown to reduce turnaround time between contractor and architect. The turn-around time referred to in this paper is defined as the amount of work-days in which the RFI was lacking a response from the architect, also referred to as days in architect's court.

The purpose of this paper is to provide evidence to whether electronic documentation increases efficiency on a project as well as what benefits and downfalls of electronic document control are perceived. Additionally, it will determine what benefits of electronic documentation may result on heavy civil projects versus other types of projects. Data analyzed for this study was used to determine whether transitioning to electronic methods of document control is worth the cost and training, as well as what factors contribute to study results.

## Literature Review

Electronic documentation allows members of a construction team to view, edit, and send documents over an online format. This allows for a reduction in “the need for unnecessary travel time and cost overruns.” (Weippert, Kajewski, & Tilley, 2003, p. 4). Allowing members access to the database from any location simplifies distribution of documents and provides efficient means of relaying ongoing project issues. This has been shown useful in cases where managers are overseeing multiple jobs in which they cannot be on site when issues arise. “Debatably, a significant challenge currently facing the construction industry is that of inaccurate and untimely communications amongst project team members, inevitably resulting in costly delays to the progress of any construction project.” (Weippert, Kajewski, & Tilley, 2003, p.3). The data received from respondents shows that efficient communication is key on any project, and electronic documentation as a tool has high potential in reducing expenses and delays of a project. Implementing cloud-based document sharing keeps contractors, architects, engineers, and clients aware of all changes, additions, etc. to the shared document control system.

Bo-Christer Björk explores the prominence of Electronic document control in the industry as well as the perceived benefits of introducing such a system within a company. “What these surveys show very clearly is that Internet connectivity and the general use of email and the world wide web is already very high in our industry. This is clearly a prerequisite for the use of modern EDM systems.” (Björk, 2002, p.4). The transition from old methods to an online control system should be fairly simple, considering many managers currently have skill in technologies which have similar functionality as documentation software. As well as adaptation to new software, transition should be simple due to the construction industry’s younger generation’s technological knowledge, who were likely introduced and instructed on how to efficiently utilize EDM. Electronic documentation’s transition into common industry practice would likely be a simpler process with relevant members being experienced in new software and/or email and networks.

The findings of Mohammed, Tilley, and Tucker provide insight on the costs and time associated with the RFI process as well as benefits obtained from utilizing Electronic documentation. The results of the study show that most of the 17 person-hour cycle time for a typical RFI is related to gathering and cross-referencing information. (Mohammed, Tilley & Tucker, 2003, p.1). With the assistance of Electronic Documentation, construction managers are able to quickly cross-reference information using hyperlinks which will provide all relevant information to the user. Reducing the time associated with the RFI process will solve design issues early in the project, reducing waste and lag time.

A construction project progresses with ease when all members communicate effectively. While electronic documentation is becoming more prominent in the construction industry, it is perceived that past methods (e-mail, hard copy) should still be utilized with document control tools in a collaborative manner. When asked if electronic documentation was key on their project, “A convincing 84% of the respondents disagreed somewhat or completely” (Hjelt & Björk, 2007, p.294). Björk and Hjelt’s findings suggest that e-mail is still often used along-side electronic documentation software. Of the population studied, many claimed they were aware of changes to the database due to notifications via e-mail. Implementing new methods is already a difficult enough task for those who have been using past methods their entire career. Electronic documentation is able to integrate new methods while still collaborating with past practices such as email.

Electronic Documentation gives managers the ability to document search based on metadata, text, etc. Construction managers can search within their electronic shared database to extract matching information. This can significantly reduce the time associated with manually organizing/searching for necessary information. Responses of Al Qady and Kandil’s study resulted in the conclusion that electronic documentation “had a positive impact on the perceived effectiveness of classification practices among the respondents” (Al Qady & Kandil, 2013, p.4) With software’s ability to automatically organize data, managers spend less time on tasks related to document retrieval and storage. As well as automatic search, managers are provided with all relevant data when viewing information within their database.

## **Methodology**

Data for this study was collected from two projects in which traditional methods of document control were used, and then compared to data associated with two projects which utilized electronic document sharing software. The data was analyzed based on RFI turnaround time. The comparison was studied to establish whether implementing electronic means of document control resulted in quicker responses to RFIs from the architect. RFI turnaround time gives insight on how efficiently different parties are communicating on a project. Additional data was provided through interviews with industry professionals employed by Company (X). The interviewees consisted of one younger employee, one older employee, and a middle-aged employee. Interviews were conducted in this fashion to establish differing views on electronic documentation of multiple generations. Interviewees were asked how they rank their ability in utilizing electronic documentation, how long it took for them to feel comfortable navigating documentation software, perceived advantages and disadvantages of electronic documentation, and what problems are encountered and how they can be resolved when using electronic documentation.

All projects studied were intended to be similar size however, data was analyzed for projects of differing size. Company (X) does little work in which electronic documentation software is used. Due to this, data from projects of differing size had to be used to provide data for a project utilizing electronic documentation. As well as differing size, the projects studied were all designed by different architects. The architect is responsible for responding to RFI's in a timely manner. Unfortunately, RFI turnaround times can differ heavily depending on the architect of a project. Likewise, the general contractor was not consistent among all projects studied. Data was analyzed to ensure any outliers or external factors did not contribute to the results of this study. The RFI times were compared to determine whether the ability to electronically create, edit, review, and respond results in a reduction in response time from the architect. While the data in this study has multiple variables other than that studied, if the difference in RFI turnaround time is significant, then it can be inferred that electronic documentation impacted the architect's RFI response time. Data from the interviews and RFI's will determine the effectiveness of implementing electronic documentation for Company (X) on jobs where they are a heavy civil subcontractor.

## **Results**

### *Interview Results*

During the interview, interviewees were asked a series of questions regarding their perception of electronic documentation in a heavy civil setting. Interviews began with brief introductions in which the employees spoke of their background in the industry as well as with Company (X). The interviewees had differing responses correlating with their age. When asked of their understanding and experience of electronic documentation, they had all heard of its potential and two of the three interviewed claimed they felt confident in their abilities to navigate online document control tools. Of the three interviewed, the younger and middle-aged employees have had more experience utilizing electronic documentation, whereas the oldest interviewee lacked experience. The same two employees also were able to learn new software quickly where the oldest employee required a longer training period.

When asked if electronic documentation has shown a change in efficiency in terms of person-person communication the interviewees all responded by saying that since electronic documentation was more regularly implemented within the construction industry, there has been a decrease in conversation by phone. One respondent claimed that "this can be dangerous for a project because the architect and contractor need to have the same understanding of the contract documents." Electronic document software often has notification tools that allow members to be alerted when documents need to be reviewed, so managers and architects are relying less on verbal notification between parties, creating a less integrated system.

Interviewees were then asked to list advantages and disadvantages of electronic documentation's transition into the industry. Among the responses, the most referenced advantage was electronic documentation's ability to organize data in a way that when referencing, all relevant information is displayed. Organizing data in this way reduces the users time spent on cross-referencing material. A study performed by Mohammed, Tilley, and Tucker provides evidence that most of the time associated with a typical RFI is associated with cross-referencing and gathering past

data. Creating a short-cut for these tasks drastically reduces time spent on an RFI, allowing more time for other tasks. The most referenced disadvantage was the training process. The respondents felt that it is difficult for project managers, superintendents, and engineers to dedicate a portion of their time to learning new software when they are already overwhelmed with other work. Among the interviewees, the youngest felt it would be a quick training process for himself where the older employees would require more training.

As well as gathering and compiling data, electronic documentation “has the ability to automatically organize data and create reports.” The respondents also claimed that they had access to documentation and data corresponding to any point of revision. These footprints provide more information for the user during any point of the RFI process. In terms of transitioning as a company, the respondents felt that it would likely not be possible for electronic documentation to be implemented without the assistance of email. One respondent said that without email alerts he “would have been completely out of the loop.” While the interviews support the utilization of electronic documentation, the respondents felt a major disadvantage was less verbal communication. However, the respondents were convinced that certain architects are less likely to communicate effectively no matter what document control system is in place. They suggest that it could be coincidence that lack of communication correlates with the presence of electronic document management.

While electronic documentation shows much success on a variety of projects, respondents seemed to feel projects in which they are a heavy civil contractor shows less impressive results. The Interviewees were asked if they had used electronic documentation when not a heavy civil contractor. Two of the three respondents claimed to have used it on other projects in which it was more beneficial. Electronic Documentation was perceived as more effective when utilized by a general contractor because when in charge of a project, the general is responsible for organization methods on a larger scale than subcontractors are. When a subcontractor is required to use documentation software in which they have no training, they are less likely to show an increase in productivity on a project.

The last question asked was whether they feel electronic documentation is worth investing the time and cost associated with implementing software and training employees. Of the three interviewees, the oldest felt less inclined to utilize these tools. The other two respondents claimed that there is still a lot of work to be done in order to perfect the tools of electronic documentation, but the potential power of documentation software is shown through current progress of its integration into the construction industry. When asked why electronic documentation isn't fit for the company, the oldest responded “it's not that it won't work well in the industry ever, it's that members used to past methods may not be ready for the transition while younger members would be. The best time for this transition to take place would be when we have less older folks in the office and more young guys with more technological experience.” The data provided suggests that implementing electronic documentation at company (X) has been beneficial in simplifying tasks, and making contract documents less complicated to understand. Past methods are likely to enhance the abilities of electronic documentation, especially among older employees.

### *Data Analysis*

Data was collected and compared among different projects in terms of RFI turnaround time. All 7 projects plotted to graphs comparing total RFIs per project, total turnaround time per project, and the average turnaround time per project.

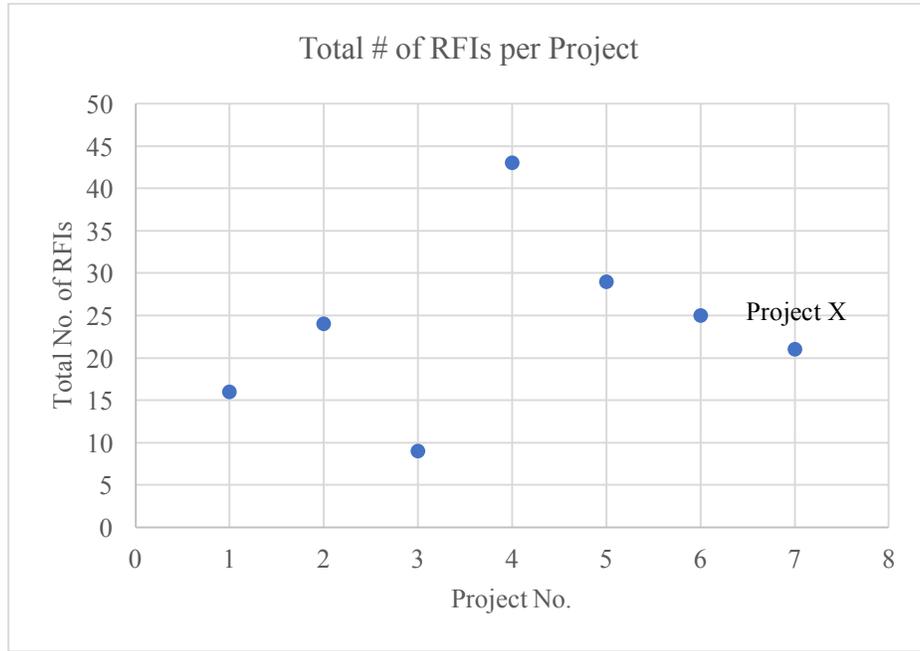


Figure 1: Total Number of RFIs per project

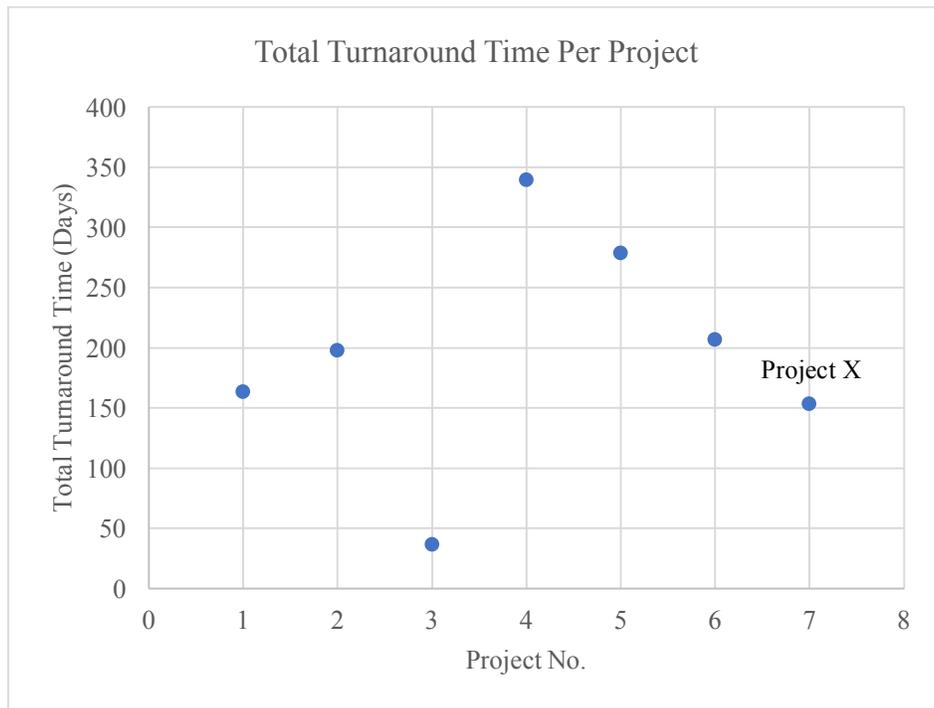


Figure 2: Total Turnaround Time per Project

Comparing projects based on their total RFIs per project provides data to be compared in relation to amount of reliable data. Project X falls in the middle of the graph in terms of total RFIs on the project, which allows the comparison between average turnaround times to be relevant amongst all projects.

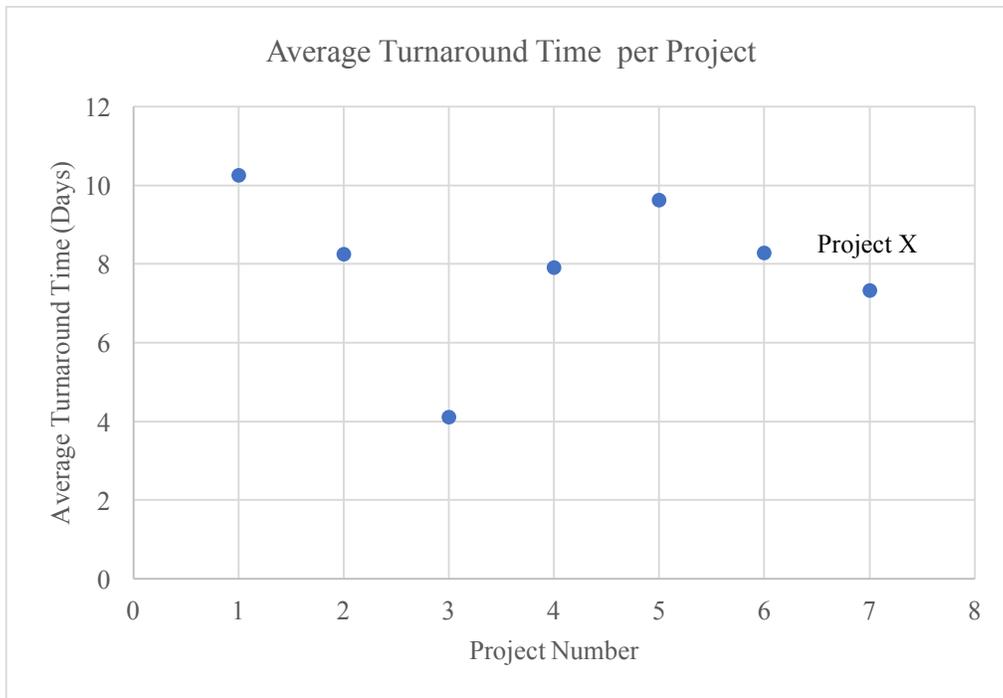


Figure 3: Average turnaround time per project

While data represented from figure 4 suggests that project X was more efficient in response time between architect and contractor, it does not show a significant change in turnaround time. This suggests that while it may have had an effect, the data does not strongly support that electronic documentation was the main factor contributing to shorter turnaround times.

### Conclusion

Unfortunately, the RFI data is not strong enough to determine whether electronic documentation has the ability to increase communication and decrease response time from the architect. There are too many other variables that could have affected the turnaround time on each project. Some of these factors may be members of the project and complexity of the project or RFIs. However, the results of the interviews suggest that electronic documentation can significantly increase productivity on a project. Interviewees felt that implementing electronic documentation allows members to reduce time associated with cross-referencing data and organizing information. Results from this case study can be used to assist heavy civil contractors in determining whether transitioning to electronic means for information control.

### Future Research

Information gathered and analyzed in this paper can be used to continue research on the subject of electronic documentation in a heavy civil construction setting. Future research on this topic could include more in depth research on the cost savings associated with electronic documentation. Research could also include more specific research on different types of software and tools that can be used on construction projects. It is important for this topic to be explored more thoroughly, especially during a time in which electronic forms of document control are becoming more prominent within the industry. Data from this paper as well as future research on the topic can guide contractors during the transition from traditional methods to electronic means of document management.