Whiting-Turner Plangrid Implementation on Oakland Global Logistics Center: A Case Study

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As construction project complexity continues to rise, there will be an increasing importance placed on a company's ability to manage project information. This management is aided by the use of project management information systems (PMIS). These systems are made up of applications that help managers track project progress from start to finish. Whiting-Turner uses the application Plangrid within their PMIS. This paper will explore how Whiting-Turner implements Plangrid on the currently being constructed Oakland Global Logistics Center. In addition, this paper will review the fundamental concepts behind a PMIS, the framework of mobile computing applications, and the features of leading cloud based software. Whiting-Turner's Plangrid implementation for this project has been broken down into use, effectiveness, and areas that Plangrid could further develop. The core uses of Plangrid for this project include: a set of mobile electronic plans that assist in field decision making, a tool for documenting task progress and safety measures, and a means of document encapsulation where RFIs and submittals are linked to plan sheets. Overall, the project team found Plangrid to be effective within their PMIS. However, areas for Plangrid to further develop include: the desktop interface, project party collaboration, and integration with other applications.

Keywords: Plangrid, Whiting-Turner, mobile applications, cloud computing, project management information systems

Introduction

Since the early 2000's the construction industry has seen a massive shift in the way information and communication are handled. The industry has become less and less paper based and has shifted towards software heavy management practices. Due to this increasing demand for software applications that make project management more efficient, the supply of such applications has skyrocketed. Within this skyrocket, cloud computing and mobile computing have proven their effectiveness in the industry. Cloud computing has been defined by the National Institute of Standard and Technology(NIST) as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider protection"(Mell & Grance, 2011). A description of mobile computing is the ability to use technology, not physically connected, in remote locations to communicate through the Internet or a private network. The technology involves a mobile device linked to centrally located information or application software through battery powered, portable, wireless devices. Due to the increasing prevalence and development within both these fields, cloud services are now being aimed at serving these mobile devices. As a result, construction based mobile cloud computing applications have been developed.

Many of the large industry leading construction companies have adapted and incorporated the use of these mobile cloud computing applications. One of these companies, Whiting-Turner Contracting, uses such applications to aid managers and field personnel with documentation, communication, and decision making. Whiting-Turner

Contracting was founded in 1909 and has since established themselves as a leading nationwide general contractor. They have experience in nearly every market segment from healthcare and retail to industrial and data centers. The subject of this exploratory case study is Whiting-Turner's use of Plangrid on the Oakland Global Logistics Center, located at the old Oakland Army Base.

Background

Project Management Information Systems

A progressing affirmation of "agile" thinking and the increase in project complexity has led to the pursuit of tools that deal even more with cooperation, teamwork, and continuous improvement. Attention is shifting towards the need to manage the flow of activities throughout the whole project life cycle, especially those that add value (Alshawi & Ingirige, 2003). The successful management of information is at the core of the Project Manager's job. A coherent flow of information between managers and team members has a significant effect on the completion and profitability of a project. A dissertation, written by Braglia and Frosolini, in the International Journal of Project Management discussed the use and components of a Project Management Information System(PMIS) within an extended enterprise. According to the dissertation, a PMIS involves the use of applications that allow individuals and teams to track projects from their conception to completion. This system provides pertinent tools and information such as (Braglia & Frosolini, 2012): scheduling of resources, budget management, supplier management, time management, task assignments, quality control, documentation, collaborative tools.

For a number of years, the construction industry has lagged behind other industries such as manufacturing in the adoption of information management systems (Craig & Summerville, 2006). The adoption of a system called the Supply Chain Event Management (SCEM) paradigm (Stadtler and Kilger, 2002) has been shown to address the need for "agile" thinking through its application in the luxury shipbuilding industry. The SCEM concept has a history of success in the manufacturing industry, however there are many aspects that can be applied to management systems within the construction industry. The SCEM paradigm consists of a Control Tower (CT) application which handles/collects messages and event triggered procedures, a PMIS that plans, schedules, and tracks activities, and a Product Data Management (PDM) that manages designs and documents to ensure the latest version is available. The results of implementing this process within the luxury shipbuilding industry resulted in the following outcomes (Braglia & Frosolini, 2012):

- Reduction of errors and rework,
- Time saving in query and approval process,
- Time saving in real-time control activities,
- Improvement of communications,
- Enhancement in the planning and execution of projects,
- Building of a collaborative environment,

The goal of the SCEM as a management concept is to identify all possible deviations from schedules and respond accordingly before they impact operational efficiency(Braglia & Frosolini, 2012). For this goal to be met information must be up to date and accessible to the extended enterprise. The PMIS, SCEM, and PDM can be viewed as a whole as long as their features are properly blended. The key features of such systems can be summarized as follows (Braglia & Frosolini, 2012) and should be taken into account when analyzing areas in which Plangrid and other cloud computing software can improve:

- Full management of the flow of information,
- Remote access by any actor, allowing safe, effective and efficient data sharing,
- Planning, scheduling, and control capabilities,

- Built-in control systems based on appropriate observation points that can monitor the proper execution of the required activities,

Framework for Mobile Computing in Construction

The shift to the use of mobile computing within the construction industry has lead to the development of various systems and applications to be used in conjunction with these devices. With these developments, a consensus has emerged on the requirements of such a system. First, the on-site construction management system should be capable of site monitoring to understand the current status of the construction project. Second, the system should provide information of work tasks for site engineers to effectively manage resources. Lastly, the system should have the function of real-time information sharing to facilitate efficient interaction among construction participants (Kim, 2013). With these basic requirements established, a system architecture has been developed to improve numerous construction activities such as quality control, safety monitoring, material tracking, and progress monitoring. This mobile computing architecture consists of a three-tier structure: (1) database layer, (2) platform layer, (3) client layer. The database layer encompasses the project information such as: the plans and specs, CAD drawings, cost data, schedules, and work task information. The platform layer consists of the parts necessary for a mobile computing device to be effective such as: wireless capability, GPS technology, closed circuit television (CCTV), and various hardware. The client layer displays the information to the user in various forms depending on information type and user preference (Kim, 2013).

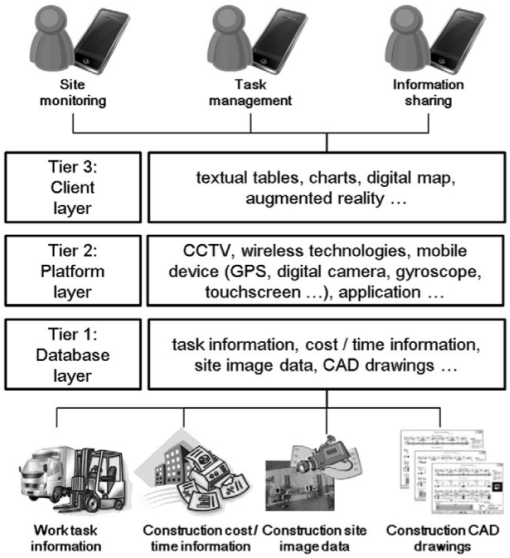

Figure 1: Mobile application framework for construction
Source: Kim, 2013

The site monitoring component of the system architecture allows mobile users to obtain project information from two sources. First, information contained in the database layer can be obtained from a company server or via the cloud. Second, real-time construction site image data, captured by CCTV, can be viewed by selecting a specific camera through the mobile system (Kim, 2013).

The task management component of the system architecture is made effective by breaking it down into two sub-modules: task allocation and task visualization. The task allocation sub-module allows the construction manager to assign tasks to site engineers through the mobile device. The task visualization sub-module utilizes digital map and augmented reality (AR) technology to assist site engineers in confirming task location and keeping track of resources on site (Kim, 2013).

The real-time information sharing component of the system architecture is primarily used for interactive drawing sharing among project parties. These interactive drawings are shared through a company server or via the cloud and can be accessed using a mobile device (Kim, 2013).

Current Cloud Applications for the Built Environment

The increasing demand for cloud computing has created a large influx of newly created cloud applications aimed at management and the built environment. There are several reasons why cloud computing is seeing such demand. First, it provides flexibility to users by allowing them to pay for cloud space or storage on an "as needed" basis, making it highly economical. Second, the technology is reliable due to the fault-tolerant and highly available services. Last, it is user friendly and enables the adaption of the latest technology while reducing in-house IT staffing (Chong, Wong, & Wang, 2013). In a case study performed in 2013, forty two cloud applications were reviewed and compared. In this case study the applications were divided into three categories: general cloud applications, cloud BIM applications, and cloud project management applications.

The general cloud applications contain basic features such as data storage and file sharing with invited parties. These files can be edited and synchronized to the cloud so that all users have the most up to date versions. Past this basic feature, these general applications contain features including: email, calendars, online storage, document editing, website editing, video chat, and messaging. Generally, companies who use these applications are charged on a per user per month basis (Chong, Wong, & Wang, 2013).

There are two approaches to utilizing BIM in conjunction with cloud computing. The first approach involves products such as BIMx which is a software that is installed and used on a computer. A model designed on BIMx can then be uploaded to the BIMx website where it can be viewed through any web browser or a mobile application. Another application which falls under this first approach is BIMServer. This application allows users to convert any computer to a BIM server, which enables files located on said server to be accessed through any web browser. BIM server is an open source application that can facilitate interoperability from various inputs under a license free file format specification. Essentially, this interoperability allows the software to detect changes in the design files and models. The second approach to utilizing BIM in a cloud setting deals with virtualization of the software entirely. Companies have developed a platform for BIM in the cloud. Due to this platform, users will have the choice of of installing BIM software or using it through a web browser with the virtualized software. This virtualized software has the advantage of running in the cloud even when the computer is switched off (Chong, Wong, & Wang, 2013).

The introduction of cloud computing to project management software allowed for many new developments and potential uses. Thirty-one of these cloud computing project management applications were reviewed and compared. The most common features across the applications reviewed include (Chong, Wong, & Wang, 2013):

- Web browser accessible,
- Mobile access,
- Document upload, storage, and access,
- Prepare and submit reports (daily, weekly, monthly, RFI's),
- Scheduling and budgeting,

Less common or rare features of the applications reviewed include:

- Tender and finance management,
- Drawing viewer and markup (only three applications),
- BIM model integration that allows users to view BIM models,
- Change and contract management,
- Workflow and task management,

- Procurement and inventory management,

Methodology

The objectives of this case study are as follows:

- To report on the manner in which Whiting-Turner personnel use Plangrid within their PMIS for the Oakland Global Logistics Center.
- To report on the effectiveness of Plangrid within the Whiting-Turner PMIS.
- To highlight areas in which Plangrid can improve or further develop.

The methodology selected for the case study is a qualitative data collection approach. This was accomplished by conducting exploratory interviews with the Whiting-Turner personnel on-site. The interviews focused on receiving the following: information on how Plangrid is used to assist in managing the project, feedback on the perceived effectiveness of Plangrid in its current role, and input on desired or possible areas of improvement for Plangrid. These interviews were conducted with both field and management personnel at approximately the 70% complete mark of the project. The results of the exploratory interviews were then analyzed by the researcher to determine similarities and differences in responses. The results of this analysis were then organized into the categories: Plangrid use, Plangrid effectiveness, Plangrid potential areas of development.

Case Study

The Oakland Global Logistics Center is a warehouse that Whiting-Turner is currently constructing for the owner Prologis. The project is located in the old Oakland Army Port. The site required deep dynamic compaction to meet the geotechnical requirements due to the bay mud subgrade. The warehouse is approximately 250,000 SF and is a tilt-up concrete panel shell. The Whiting-Turner personnel for this project include two superintendents, one project engineer, and one project manager. The standard Whiting-Turner project management information system was implemented for this project, the applications involved include: CMiC (cost control), Primavera P6 (scheduling), Newforma (document management), and Plangrid (task management). The focus of this case study is to explore the use, effectiveness, and potential areas of development for Plangrid within this standard project information management system.

Results and Analysis

The information presented below reflects the results of interviews with Whiting-Turner personnel on the Oakland Global Logistics Center, located at the old Oakland Army Base. The information will be provided in an objective manner that aims to present the thoughts of the personnel interviewed.

Plangrid Use

This portion of the interview contained questions that aimed at determining how Plangrid is used and incorporated within the Whiting-Turner project management system. The results are as follows:

Mobility and Convenience: All members of the Whiting-Turner team reported that having a mobile set of plans in a handheld format is very useful. The team commented on the convenience and confidence that comes with being able to download and ensure that you have the most up to date set of plans prior to going out into the field. This mobility was said to be convenient for walking the site with the owner as it allows for easy access to plans at any location or point during the walk. There was consensus that the mobility and convenience aspect is most taken advantage of by the field side (superintendents) of the project team. This is due to the superintendent's need for quick access to up to date plans in order to make appropriate real time decisions. These program aspects are the result of the mobile cloud computing foundation that Plangrid has developed their application interface around.

Communication: All interviewees indicated that Plangrid has played a role in aiding communication within the project team. However, it was not as useful in communication with subcontractors onsite due to none of them having the software (further analyzation provided in "Plangrid Effectiveness" section). Communication is aided by the ability to markup the documents with notes, icons, and hyperlinks and then sync these changes to the cloud so all members have access. The cloud aspect also proves useful when new personnel are assigned to a project because it gives them the opportunity to download the latest set of plans remotely. This allows the new team member to familiarize themselves with the current state of the project before showing up to the site.

Tools: The project team reported the ways in which they use Plangrid's tools to assist in project management and documentation. The following are the most common tools/features used:

1. *Markup, dimensioning, and scaling tools:* These tools used for field verification, getting rough dimensions, certain takeoffs, and general marking up. The takeoffs performed are usually counts and not lengths or square footage due to the limitations of Plangrid in this area.
2. *Camera tool:* The camera tool allows users to take pictures within the application using their mobile device. This ability allows the camera tool to be used in conjunction with several other tools. Team members use the camera tool to assist in creating punchlist items, RFIs, and to document inspections. The photos are logged with the time and date they were taken, this allows the field team to document activities such as safety inspections of potential site hazards. Another aspect of this tool that the team found useful was that a series of photos can be stored within a single icon, reducing the clutter of icons on the sheet.
3. *Punchlist tool:* This will be used as the project comes closer to finishing. The team finds this to be one of the more useful tools due to it's ability to use labeled icons to keep track of unfinished items. Photos are attached using camera tool. The sheet with the punchlist items can then be uploaded to the cloud so all team members are aware of the unfinished items.
4. *RFI creation:* This tool is used primarily by the superintendents on this project. It allows them to create an RFI within the application while out in the field. Photos can be taken and attached using the camera tool. The RFIs created can then be assigned to the architect/responsible party or exported and sent via email. On this project the RFIs were sent via email due to the design team not being on Plangrid.
5. Hyperlink tool: This tool is used to create clickable hyperlinks on the plan sheets. These hyperlinks allow for items such as RFIs, submittals, and other plan sheets to be quickly viewed. In order for this tool to be used, the hyperlinked documents must be uploaded to the project cloud via the Plangrid website. On this project, the management team is responsible for uploading these documents.

Plangrid Effectiveness

This portion of the interview contained questions aimed at gathering feedback on the effectiveness of Plangrid within the Whiting-Turner project management system. The results are as follows:

There is a consensus within the project team that, overall, Plangrid is an effective application within their information management system. All members believe that Plangrid has found its niche as an intuitive mobile cloud computing application. They believe that it is most effective due to its ease of navigation on a mobile device and the "push to master" feature. This feature uploads and overrides the last version of a given document, leaving the most current one in place for members to access. While Plangrid's interface is sufficient for mobile use, the team members all believed that it could improve its desktop interface to include more tools. The members do not believe that Plangrid should start to expand towards an all inclusive project management interface, such as Procore. The effectiveness of this program within the project as a whole was hampered by the fact that none of the subcontractors on-site utilized Plangrid. This limited communication to within the Whiting-Turner team.

Plangrid Potential Areas for Development

This portion of the interview contained questions aimed at determining areas in which Plangrid could improve to become a better component of the Whiting-Turner project management system. The results are as follows:

1. *Desktop Interface:* As stated previously, all team members believe that the desktop interface could be further developed. The desktop interface currently mirrors the interface for the mobile application. The team stated that when they are at their desktop and need to create RFIs or do takeoffs they use Bluebeam instead of Plangrid. They find that Bluebeam has a much larger variety of tools and is more accurate and useful for tasks such as takeoff. User friendly features such as being able to snap to edges/corners and pan while calibrating are lacking in Plangrid. While the simplicity of tools offered within Plangrid is well suited for their mobile interface, there is definitely a desire for more advanced tools on the desktop interface. Developing this area will be needed for Plangrid to be a competitive software while users are at their desks.
2. *Collaboration:* The effectiveness of Plangrid is most optimized when all parties involved with a project are using the software. On this project, none of the subcontractors or designers had Plangrid licenses. The Whiting-Turner team believes that, overall, Plangrid is being used more by general contractors as opposed to other contract parties. Plangrid currently charges users monthly on a per license and per sheet basis. The consensus among the team is that the cost could be a deterrent for these subcontractors and designers. This can be addressed both by Plangrid and Whiting-Turner. Plangrid can adjust their marketing, pricing, or packaging to become more appealing to these parties. Whiting-Turner can stress the importance of having Plangrid licenses or stipulate the need for them when requesting bids from subcontractors. Once Plangrid becomes more prevalent with subcontractors and designers, the Whiting-Turner team believes that collaboration can be further increased by the incorporation of more RFI and submittal capability within the application. They believe there is an opportunity for Plangrid to take on the role of Newforma, their current document management software.
3. *Integration:* The project teams believes there is an opportunity for Plangrid to integrate information from other management applications into the user interface. The field side of team believes this could come in the form of linking the schedule (Primavera P6) so that start, finish, and duration values can be linked to assigned tasks within Plangrid. This would increase ease of information sharing/access between the field side and management side, as well as allowing for better decision making in the field.

Conclusions and Future Research

As mobile cloud based software continues to evolve, it is important that companies evaluate their current project information management systems. Through evaluation, companies can determine the role and value that this

software brings to their projects. This case study with Whiting-Turner at the Oakland Global Logistics Center highlighted the use, effectiveness, and areas of improvement for Plangrid within their current project information management system. The project team members find the markup, punchlist, RFI, camera, and hyperlink tools to be the most useful for this project. Overall, the team finds the software to be effective as a mobile cloud computing application and should continue to corner this area of the market. While the software excels at user friendly mobile plan viewing, areas that can be further developed include: the desktop interface, collaboration tools, and integration with other management applications. There are clear information communication benefits to be gained if all contract parties use Plangrid in future projects. Further research on subjects of project management information systems and mobile cloud computing applications will be needed as the market is large and continually evolving. Tools such as BIM and augmented reality are becoming more advanced and easier to use with these mobile applications. Research on the effects of these new tools and how they can be coupled with existing applications could lead to promising results.

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