Cloud based Project Management Information System (PMIS) for construction projects

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ABSTRACT

Cloud computing refers to use of virtual servers where users access stored data through an internet connection. It has become an innovative model for delivering IT infrastructure, applications and data management. It shifts the emphasis from static, stand-alone applications to dynamic, shared environments, dynamically allocated among various tasks and accessed via a network. In construction projects, construction managers spend a significant portion of their time gathering project data, assessing production rates, communicating with project participants and tracking project quality. Executing those tasks manually reduces efficiency and can result in less effective project management operations. In order to improve efficiency of information process flow, various types of Project Management Information Systems (PMIS) have been introduced to construction projects. This paper is an attempt to structure the data base through cloud computing and also to develop a Project Management Information System (PMIS) through cloud computing for a power plant project.

Keyword: PMIS, cloud computing, share point, information system, project management.

1. Introduction

The construction industry is fragmented due to the many stakeholders and phases involved in a construction project. This fragmentation has led to well documented problems with communication and information processing and has contributed to the proliferation of adversarial relationships between the parties to a project. This fragmentation is also often seen as one of the major contributors to low productivity in construction. Information Technology (IT) is now routinely used in the construction industry as a tool to reduce some of the problems generated by fragmentation. IT spending in architecture/engineering/construction (A/E/C) firms has increased significantly during the past few years, indicating that A/E/C firms are increasing their interests in IT applications to facilitate construction projects.

The world wide web (www) will be the key to a change in global construction business in the near future and will impact professions, collaboration, and the construction business structure. Its use as a communication medium can help information transfer occur faster and more effectively and enable new opportunities for the development of distributed systems that can cross organization boundaries and provide a unique opportunity for teamwork and workflow automation. A centralized database is an integral part of appropriately formed information involved is working with the most up-to-date information study by Aouad et. al. (1995). Such a system also removes the need for duplication and hence a potential for errors. Web-based
construction information management systems can make use of browsers, data handling devices and other internet technology to create a network for sharing and manipulating corporate information in a way that will assist construction project managers to complete work on time and within budget.

1.1. Components of construction information system:

The evolution of systems using construction information has led to the development of a data model/hierarchy given by Abdelsayed and Navon (1999). This can be used as a basic structure and adapted to incorporate the local needs as well as to form a backbone for any development. The data hierarchy has four main components:
1. Daily site report (DSR)
2. Change order management
3. Project control
4. Correspondence database

The project data held in CIMSs are best stored utilizing a work breakdown structure (WBS) so that storage and retrieval of project data are possible in an organized manner.

1.2. Cloud computing

Cloud is a technical word with varying definitions. According to some, it refers to the use of virtual servers where user’s access stored data through an internet connection. Providing access in this manner is frequently referred to as using cloud-based or web-based services. Others refer to the cloud as including any application that is used outside of a company’s firewall. Moving to the cloud can mean anything from increasing data capacity without having to invest in additional IT infrastructure to licensing a new generation of subscription-based and web-viewable software. The cloud definition often is further expanded to include the use of mobile devices such as smart phones or tablets.

1.3. Cloud computing and the construction industry

Using the cloud in the construction industry has strong appeal because of the constant change of workers and frequent setup of new jobsite locations. Many workers need better access to company data to aid in timely, well-supported decision making and reporting while working in the field. Conversely, the main office balances the need to produce bills, pay invoices, produce financial reports, process payroll, and plan logistics with the need to have offsite workers access and update information to support these functions irrespective of their locations. Traditional client/server software solutions provide users access to this information from designated locations. But cloud technology has opened up new possibilities that allow instant connections to be made beyond these traditional preconfigured office sites. It is now possible with the cloud to tap into back-office information and report functionality from any location in a very secure way wherever one can access the internet. Nitithamyong and Skibniewski (2004, 2006) studied the success and failure factors and also the performance measures of web-based construction project management systems from where they observed that construction companies are uniquely positioned to benefit from the cloud’s ability to provide greater freedom and ease to access information anytime, anywhere from satellite offices, job sites or customer locations that span across the globe. Cloud-based technologies are best suited to connect all critical team members, increase opportunities for team
collaboration, and increase management and owner visibility. Having access to the right information at the right time creates opportunity for enhanced collaboration and co-ordination and also minimizes mistakes which would definitely enhance project profitability. To be the additive needed to produce these results, cloud solutions should ensure that team members can easily find and see the information they need at the time they need it most. And management needs to be absolutely certain and they should ultimately control the people who sees the information provided and can limit or restrict access as needed to protect sensitive data.

1.4. Project management information system:

The Project Management Information System (PMIS) as defined by the Project Management Institute (PMI), is a standardized set of automated project management tools available within an organization and integrated into a system. But PMI has not specified which tools or technology to use as a PMIS. The Microsoft Share Point can be a used as a customized one. A reliable PMIS should support most, if not all, of the communication and collaboration needs of a project environment. The following is a list of the essential PMIS capabilities:
1. Supports the generation of a project charter, schedule and budget
2. Facilitates communication and feedback
3. Monitor project activities
4. Controls project changes
5. Analyzes and forecasts project performance
6. Circulate project status to relevant stakeholders
7. Provides real-time information essential for initiating, planning, executing, controlling, and closing a project

1.5. Share point

Share Point allows individuals in an organization to easily create and manage their own collaborative solutions. Share Point does not refer to a specific product or technology. Using SharePoint is like using Microsoft Office. It refers to several aspects of collaborative solutions. The key components are:
1. SharePoint Foundation (SF)
2. SharePoint Server (SS)

The main purpose of the Share Point is to empower users with document management and team collaboration tools. Share Point Foundation fulfills this purpose. It is the core “Engine” of Share Point. Without Share Point Foundation, there is no Share Point. Share Point Foundation is available with Windows 2008 Server or later. In this research attempt Windows Server 2008 is used to develop the PMIS.

2. Framework for project management information systems assessments:

Information systems assessment (ISA) issues with quantitative measures have been discussed in a limited number of literatures in the construction industry. As a conceptual starting point, Betts, (1995) proposed a five-level framework for strategic IS from an industry-level perspective. Jung and Gibson (1999) and Stewart and Mohamed (2004) developed two independent comprehensive and detailed IS frameworks' from the industry-level perspective by quantitatively evaluating major factors affecting effective IT utilization in the industry.
Jung and Joo (2011) recently established another comprehensive framework from industry-level IS perception focused on building information modeling (BIM). Scott et al. (2012) developed a web-based information management system for construction industry, but unlike project management information systems (PMIS) of the owners, architects/engineers, and contractors, PMIS should be flexible enough in order to meet the varying CM’s responsibility as the scope of CM contract is very different from project to project. This fact forces CM firms to utilize more commercial off-the-shelf applications than in-house developed systems in terms of IS configurations. Based on these distinct characteristics of CM’s role and responsibilities, this study selected the construction business functions and systems configuration as two fundamental dimensions for PMIS assessment.

2.1. Variable assessment for PMIS:

Construction business function can be defined in many different forms. A good reference is nine areas introduced in the body of knowledge (BOK) defined by Project Management Institute (PMI). The nine areas include —integration, scope, time, cost, quality, human resource, communications, risk, and procurement management. Jung and Gibson (1999) defined fourteen business functions for the construction industry; planning, sales, design, estimating, scheduling, materials management, contracting, cost control, quality management, safety management, human resource management, accounting/financing, general administration, and R&D. Jung and Gibson (1999) developed systems configuration as the second dimension consists of two aspects. One is the method of systems development and acquisition. The information systems are classified into four groups / systems:

1. Developed in-house (proprietary)
2. Purchased as enterprise resource planning (ERP) or application service provider (ASP) packages
3. Utilized as groupware systems
4. Acquired as specialty software such as CAD, CPM, and professional systems.

2.2. Construction information classification system

A construction information classification system (CICS) might have a framework that consists of facility items or operational items. But it is desirable for a CICS to have a framework that consists of all items from facility to construction operation if it is considered that a CICS can be used in all phases through a project. At this point the existing systems are difficult to use as a CICS for construction management.

3. Case study

The project for the case study has been taken from an ongoing infrastructure project, located in Nasik, Maharashtra, India. IndiaBulls Power Ltd. is developing a 1,335 MW coal-fired thermal power project in Nashik, Maharashtra through its subsidiary IRL. Nashik Power Project will consist of five units of 135 MW each and two units of 330 MW each, with a combined capacity of 1,335 MW. The Nashik Power Project is situated at the Sinnar SEZ in Nashik, Maharashtra. The Company expects that five units of 135 MW will be commissioned by September 2012 and two units of 330 MW will be commissioned by February 2013. The Nashik Power Project was envisaged to be developed with two super-critical units of 660 MW each aggregating to a total capacity of 1,320 MW. However, the configuration of the
Nashik Power Project has since been revised as mentioned above and the total capacity of the project has increased to 1,335 MW. The project has an estimated development cost of approximately Rs. 60,480.00 million.

4. Creating a Share Point for the project

Part 1: After selecting the PMIS structure for the project next step is to create the PMIS. In this attempt, PMIS built in Share Point will be a sub-site, so this will be the approach used for the case study. The following are the basic steps in creating a Share Point 2010 sub-site from an existing Share Point.

Open the SharePoint 2010 Central Administration from Windows Explorer.

Part 2: Once the site has been created then the basic site settings using the “Site Settings” page can be done.

Part 3: Adding announcement list:

In part 1 and part 2, the foundation of a Share Point 2010 PMIS is created. This step is to add the basic Share Point components which are known as Share Point lists. The Lists are used to store and organize information in Share Point. In this section, relevant information is added that can be used to provide relevant project announcement.

1. On the homepage, click “Lists” and then click “Create”.
2. The “Create” page will be displayed. In the “Lists” section, click “Announcement”
3. Click More Options
4. In both the Name and Description fields, enter the text “Project Announcements” and in the “Display” this list on the “Quick Launch” section select “Yes”. “Yes” is the default selection.
5. Click “Create”. The “Project Announcements” list is created to store relevant information that is to announce or broadcast to site members.

4.1. Adding the PMIS component

Adding the PMIS components should be the next step to decide which features are necessary for the PMIS. At a basic level, PMIS components should allow the project team to:

1. Centralize project information
2. Facilitate project communication and collaboration
3. Automate project process

The essential PMIS components that need to be considered to develop a PMIS for the project case study are presented in table 1.

<table>
<thead>
<tr>
<th>PMIS component</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Calendar</td>
<td>Stores common project events such as meeting, deadlines and resource availability</td>
</tr>
<tr>
<td>Project Tasks</td>
<td>Stores project task information, assignments, and status</td>
</tr>
<tr>
<td>Project Risks</td>
<td>Stores project risk information, priority and status</td>
</tr>
<tr>
<td>Project Contacts</td>
<td>Stores common projects contacts</td>
</tr>
<tr>
<td>Project Resources</td>
<td>Stores resource information, skill sets and rates</td>
</tr>
<tr>
<td>Project Documents</td>
<td>Stores relevant project documents, templates, checklists and reports</td>
</tr>
<tr>
<td>Change request system</td>
<td>Stores change request information, decisions, and actions</td>
</tr>
<tr>
<td>Project announcements</td>
<td>Stores relevant project announcements</td>
</tr>
<tr>
<td>Project Milestones</td>
<td>Stores project milestone information with baseline dates and actual dates</td>
</tr>
</tbody>
</table>
4.2. Adding stakeholders to PMIS

A good two-way communication between all project stakeholders is a key to project success. Solid project communication forestalls surprises, prevents duplication of efforts, and helps the project manager and the team reveal omissions and misallocation of resources early enough to permit corrections. The project manager has to ensure that only relevant project information goes out to the appropriate stakeholders. The members of the executive management team on their project are less interested in the detailed project information, but they are interested in having the following updates:
1. Milestone-level project status
2. High-level budget information
3. Overall project health
To ensure the executive management receive that information in a timely fashion, on the other end of the spectrum, the project team is more likely to be interested in the project details specific to what they are working on, as well as what affects them. Again, to ensure they receive timely and relevant project information the “Stakeholders” are added to the PMIS.

4.3. Project communication plan

Creating the project communications plan is an important step in sound project planning. This plan facilitates effective and efficient communications with all project stakeholders, describing how project communications will occur while project work is being done. The communications plan in this PMIS includes the following elements:
1. Communication objectives
2. Targeted project stakeholders
3. Key communications format and content
4. Communication methods and frequency

4.4. Project reporting using share point

4.4.1. Schedule

The project manager is concerned with—making sure that the project is not running behind, and that the expected end date is still possible given what has been happening on the project to date. To ensure a project is on schedule, the progress of projects by frequently comparing the planned schedule to what is actually happening.

4.4.2. Change

Clients change the project scope. To track changes in the project is to track changes by establishing a change control process for my projects. Any type of change that comes in goes through a change request, which is then evaluated by change control board. After a decision regarding the requested change has been made, the change will be scheduled for implementation

4.4.3. Tracking Project Tasks
A common tool used in project management is the Gantt chart. The table has a listing of project tasks and information about those tasks. The calendar displays the schedule of the task, symbolizing the task duration across the calendar using a bar. In addition, the Gantt chart is used to monitor actual task progress.

Share Point comes with a “Project Tasks” list. By default, this list displays a Gantt chart and a customized table view. Share Point’s “Project Tasks” list the following parameters that can be shared and used to:
1. Define project tasks, assignments, start date, and due date
2. Specify task priority
3. Indicate task status
4. Track percentage completion
5. Display project task information in a Gantt chart view

The “Project Tasks” list is a very simple task-tracking tool. It can only use manual scheduling and does not allow to:

1. Define task dependencies (F-S, S-S, F-F, S-F)
2. Save a schedule baseline
3. Reschedule a slipped task automatically
4. Track anything besides % complete, but it may configure it to track actuals
5. Synchronize with other project management tools, such as Microsoft Project 2010

Taking full advantage of the Project Tasks list requires adding custom columns to meet the project task-tracking needs.

4.5. Updating the schedule and tracking risks

Updating the project schedule and tracking the risks are other important functions carried out by Share Point PMIS; some of the steps involved are as shown below:

1. Updating the Project Tasks List
2. Populating and Updating the Project Tasks List
3. Controlling Changes with Workflow

Change control refers to a set of procedures defining the steps on how project changes are requested, evaluated, and addressed. These changes typically relate to project scope, budget, or schedule. This procedure is based on effective processes, and the human based interactions are known as workflows. Automating workflows among the people who participate in a process can improve how that process functions, thereby increasing its efficiency and lowering its error rate.

4.6. Creating a change control system with three-state workflow

The steps for creating a change control system with three-state workflow are as shown in the following steps:
1. Creating a Custom List
2. Customizing the Three-State Workflow

3. Testing the Workflow

To test the workflow that has just been created, one has to “Submit”, “Review”, and “Approve” the “Change Request” button. The following steps need to be followed:

1. Enter and submit a new “Change Request”
2. Access the “Change Request” Tasks list to view the assignment
3. View the new task by clicking the “Task title”. The details of the task will be displayed
4. To set the change request from the initial state (Proposed) to the middle state (In Review), click “Edit Item” and set the Status to “In Progress”.

5. Click Save.
6. Return to the “Change Request” list. The “Change Request” workflow should have been automatically updated the status to “In Progress”. At this point; the workflow has been assigned another task to the person responsible for dealing with the middle state.
7. Return to the “Change Request” Tasks list. A “New Task” has been created and assigned
8. To set the “Change Request” from the middle state (In Progress) to the final state (Completed), select the “New Task” to view its details, click “Edit Item”, and set the Status to “Completed”.
9. Click Save.
10. Return to the “Change Request” list. The change request workflow should have automatically updated the status to “Approved”.

4.7. Integrating project management tools

4.7.1. Integrating Microsoft Project into SharePoint

Proper use of Microsoft Project can be leveraged with SharePoint. Project managers can use Microsoft Project to create project schedules, generate staffing plans, and track project progress. Microsoft Project comes in two editions: Microsoft Project Standard and Microsoft Project Professional. The key difference is that Microsoft Project Professional interacts with Microsoft Project Server.

4.7.2. Store Microsoft Project files in a document library

As with any other document type, you can benefit from applying the version control, check-in/check-out, and content approval capabilities of a document library to the Microsoft Project files. I have found that using version control is a great way to keep track of project baseline information in Microsoft Project, should there be a change in scope or schedule.

4.7.3. Using Microsoft Project

1. Launch Microsoft Project.
2. Select File → Open.
3. Open the file

A project manager will be tracking the project schedule using the Microsoft Project schedule that is created. The resources will be entering their status updates from the “Project Tasks” list created earlier.
4. Select task 2, then click Task → Mark on Track → Update Tasks.
5. In the % complete field, enter 100% and click OK.
Notice that the Actual Start and Actual Finish columns are populated

6. Click File → Save & Send → —Sync with Tasks Listl. Enter the URL of the PMIS and Select Project Tasks
7. Click Sync.
8. Click OK to all dialog boxes until synchronization is completed.
9. From the browser, go to the “Project Tasks” list in SharePoint and update any tasks fields.
10. Return to the project schedule in Microsoft Project.
11. Click File → Save & Send →Sync.

4.8. Project closing

Analyzing how a project went and considering the lessons learned should be the last essential step in the project management process. This step allows the project team to assess how the project actually went compared to what was planned. You can also evaluate how effective the PMIS was by looking at the following:

a. How well did the PMIS facilitate project communications and collaboration?
b. Which components in the PMIS provided great benefit? Anything missing?
c. How well was the PMIS adopted and used by the stakeholders?
d. Can a similar PMIS be utilized for future projects?

4.9. Creating a PMIS template

Carry out these tasks in preparation for saving the SharePoint site as a template:
1. Customize the look and feel of the site.
2. Identify all of the required functionalities:
   a. Lists
   b. Document libraries
   c. Web parts
3. Add the necessary lists and/or web parts.
4. Address navigational requirements:
   a. Quick Launch
   b. Top link bar
   c. Hyperlinks
5. To save the site as a site template, click Site Actions → Site Settings. In the Site Action section, click —Save site as template.

Once the site is saved as a template, it will be available as a site template selection when a new site is created under the “Blank & Custom” category. It is a good practice to archive the SharePoint PMIS once the project is finished. A common way to archive a PMIS is simply to back up the SharePoint site by running a backup command on the SharePoint server, or by using SharePoint Designer.

5. Conclusion

In project driven engineering industries multiple external parties collaborate in designing, building and maintaining projects. Project participants heavily rely on sharing and exchanging information that is kept in documents. SharePoint provides a collaborative document environment where all project participants can easily upload, share, manage and
exchange their project documentation and can collaborate on drawings, designs and office documents. New capabilities for subcontractors are such that, the subcontractors have real-time access to new information and tools, including budget status, change orders, compliance information, and payroll apps. As a result, they can get paid faster and no longer need to wait for a printed report or pick up the phone whenever they have a question. Also, the project owners no longer need to wait for monthly reports. The real-time visibility into their investments, including schedule status, budget status, and progress photos, will realize significant cost savings through reduced rework and improved document distribution.

6. References


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