Web-Based Project Management Action Research for Highway Projects Under $10 Million

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ABSTRACT

The Iowa Department of Transportation’s (DOT) desires a web-based project management system (WPMS) for smaller highway project (< $10 million). In 2008, the Iowa DOT was undergoing a construction period that included several complex bridge projects (> $10 million). They sought a WPMS that was able to ease the document management of requests for information (RFIs) and shop drawings for these projects. After having implemented the WPMS solution for complex projects, they are looking for a simpler WPMS that can be implemented in smaller highway projects (under $10 million), with capabilities of expanding its usage to additional Iowa DOT projects. This paper reports on the process of identifying and testing WPMSs for the aforementioned projects.

Action research, an iterative process of continuous improvement, was the methodology used to identify and test WPMSs that met the Iowa DOT’s needs. Through this process the research team, alongside a technical advisory committee (TAC), evaluated the effectiveness of possible WPMS solutions.

This paper describes the process of identifying a WPMS for smaller highway projects. This process involved the development of the workflow for the Iowa DOT’s document management. The workflow that was created corresponded to sign truss projects; this helped the researchers understand the document management of smaller DOT highway projects. Subsequently, several WPMSs were studied and were compared to the workflow. From these, SharePoint was selected as a possible solution for implementation. Currently, further studies and tests are being performed to SharePoint before being pilot tested.

INTRODUCTION

The Iowa Department of Transportation (Iowa DOT) began a phase of complex bridge construction projects in 2008. Having realized that the management of construction documents, such as requests for information (RFIs) and shop drawings, was consuming more time than traditional bridge projects, they approached the research team to help identify and implement a Web-Based Project Management System (WPMS) that could ease the management of such documents. For the first three phases of the project, the research team underwent the task of identifying and implementing different WPMS for complex bridge projects. For the current project phase, the research team was assigned the task to identify a WPMS for smaller highway projects.

The construction industry’s document management is based in traditional communication methods. The communication method and document exchange, in its majority, consists of hard-copy paper documents transmittal and approval. This can result in wasted time and money due to a poor document management and coordination (R. Stewart, et al 2004). Because of this, the information that is being exchanged within the industry can be classified, in some cases, as “difficult-to-access”, outdated, or incomplete (R. Stewart, et al 2004). Web-based project management systems try to mitigate some of the problems caused by this traditional information exchange system and provide additional benefits. The benefits are: coordination with other email or collaborative solutions, decrease of problems related to communication, improvement of the project’s processes, ability to track the project’s process and information through the internet (M. Alshawi, et al 2003), increased coordination between the project team members (M. Alshawi, et al 2003 & Nitithamyong, et al 2004), increase in work speed and document quality, decrease in documentation error, and provide easier and faster access to project information (Nitithamyong, et al 2004).

METHODOLOGY

This research project involved the use of action research. Action research is an iterative approach of identifying a problem or requests that need to be addressed and solved (Susman et al. 1978). It is a continuous learning process where the lessons learned from previous iterations are applied to subsequent project iteration. The steps involved in the action research process are the following:

- Diagnosing: The problems are identified and defined.
- Action Planning: The actions required to solve the problem are determined.
- Action Taking: The plan is implemented.
- Evaluation: The implementation is reviewed and the consequences are measured.
- Specifying Learning: The lessons learned from the evaluation are recorded and used for future iterations. (Susman et al. 1978).

After a cycle is completed, the iteration is completed. The lessons learned from the Specifying Learning are used as part of the Diagnosing stage of the next of iteration. This process is depicted in Figure 1. The action research stages are represented in the cycle and the different iterations are identified in the arrow placed after the Specifying Learning stage.

The first iteration for the smaller highway projects used the lessons learned from the previous iterations performed on the identification and implementation of WPMS for complex bridge projects. Using Susman’s action research approach, several iterations to find a WPMS solution for smaller highway projects, specifically sign truss projects, were performed. Recommendations were presented to the Iowa DOT with the findings and suggested solutions. A Technical Advisory Committee (TAC) was created to provide input and make recommendations during the entire iterative cycles. This TAC is primarily
composed of engineers and information technology (IT) specialists from the Iowa DOT as well as researchers from Iowa State University.

**FIRST ITERATION**

**Diagnosing**

It was established by the TAC to implement the WPMS solution first sign truss projects. The researchers went ahead to establish the required tasks and actions that the solution had to offer for this type of project. For this, the researchers met with the engineers from Traffic and Safety division and Bridges and Structures division from the Iowa DOT, to identify the steps and workflow of the review process for the shop drawings submittals in sign truss projects. The established workflow can be seen in Figure 2. The workflow involves different Iowa DOT departments, depending on the type of shop drawing sent for review. It is important the WPMS solution has the capacity of sending automatic notifications to the corresponding parties involved in the process. The WPMS should also have a log-in requirement, where user access to the site is restricted and a username and password is required to access the page. Also, another requirement to satisfy the workflow is that the WPMS must keep track of the different document versions, especially when the shop drawing has to be resubmitted. Lastly, the WPMS should have the capability to have an approval option or a comment section where the documents can be categorized as “No Exceptions Taken” or “Make Corrections Noted” (documents do not need to be resubmitted) or as “Revise and Resubmit” (were the documents need to go through the workflow process again). These categories are the Iowa DOT’s response and evaluation to the shop drawings submitted by the prime contractors.

![Figure 1. Action research flow](image-url)
Having established the needs and requirements of the WPMS, a plan was developed in order to identify the different existing solutions available. The basic strategy was to find existing online solutions that focused mostly on document management and file sharing. The evaluation criteria in which all the identified WPMS were going to be tested was established. The criteria used for each of the WPMS evaluation are the following:

- project capacity
- storage capacity
- document tracking history
- accessibility
- notification
- approval option
- price
- capacity to recreate the workflow and requirements provided by the Iowa DOT

**Action Taking**

The researchers sought commercial WPMSs that met the requirements established by Iowa DOT engineers. The researchers began identifying solutions with an interface familiar to the end user: the DOT staff and project team members. For this reason, the researchers studied social and professional
connection websites and used these as a backbone for identifying the different WPMS solutions for the sign truss projects.

The WPMS identified were Huddle, Google Applications, TeamWork Live, TeamWork Project Management, and Sosius. Each one of these web-based project management systems were tested by creating different e-mail accounts, representing different parties that are identified in the workflow for the sign truss shop drawing approval process. These emails were set up as different user accounts for each of the solutions being tested. The restrictions on the WPMS were set based on the established workflow and the requirements presented by the Iowa DOT.

**Evaluation**

After all the possible solutions were tested, each of them were compared and evaluated based on the evaluation criteria established in the action planning stage. A matrix was developed to make the comparison of the WPMS easier. Table 1 shows how each solution performed against the evaluation criteria.

<table>
<thead>
<tr>
<th></th>
<th>Huddle</th>
<th>Google Applications</th>
<th>TeamWork Live</th>
<th>TeamWork Project Management</th>
<th>Sosius</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Capacity</strong></td>
<td>25 Projects</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>35 Projects</td>
<td>Unlimited</td>
</tr>
<tr>
<td><strong>Member Capacity</strong></td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>25</td>
<td>Unlimited</td>
<td>Unlimited</td>
</tr>
<tr>
<td><strong>Managers</strong></td>
<td>1</td>
<td>Unlimited</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Storage Capacity (Group)</strong></td>
<td>25 Gb</td>
<td>100 Mb</td>
<td>50 GB</td>
<td>10 Gb</td>
<td>25 Gb</td>
</tr>
<tr>
<td><strong>Storage Capacity (Personal)</strong></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>250 Mb</td>
</tr>
<tr>
<td><strong>Document Tracking History</strong></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Ease of Accessability to the Site</strong></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Document Approval Option</strong></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Email Notification</strong></td>
<td>Yes</td>
<td>Only for folder created</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Calendar Option</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Price</strong></td>
<td>$200/month</td>
<td>Free</td>
<td>$149/month</td>
<td>$49/month</td>
<td>$100/month</td>
</tr>
<tr>
<td><strong>Capacity to Reproduce DOT Workflow</strong></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

From these, the one that was chosen for further testing in the next iteration was Huddle, a collaboration and content management solution. Huddle had the most user friendly interface, was the easiest to learn how to use as well of having all the requirements presented in the sign truss workflow. Even though the sign truss shop drawing approval workflow could be recreated in this solution, it lacked the capacity of being fully customizable. This reduces the capability of having other uses and applications in other projects and integration with other communication systems, such as email.
Specifying Learning

From this iteration several lessons learned can be identified:

- Establishing the workflow with the necessary functions and requirements before identifying solutions or alternatives proves to be the most efficient way of selecting a WPMS. The workflow not only establishes the requirements needed but it distinguishes the relationships between the document management and the different parties involved in the project.
- Most of the commercial WPMS solutions available have established tasks, interfaces, and workflows.
- Several commercial WPMS solutions meet the sign truss workflow requirements. Huddle meets these requirements. This WPMS has an already established workflow and allows little to no room of adjusting it in order to provide a customizable solution to the end users. A solution that has the option of allowing the creation of customized workflows could be more beneficial for the Iowa DOT since it can be implemented in other Iowa DOT projects.

SECOND ITERATION

Diagnosing

Using the lessons learned from the first iteration, the researchers sought a solution that was more customizable and allowed for workflows. This enables the research team and the Iowa DOT to implement the WPMS solution effectively, not only on sign truss projects, but if decided in the future, in other types of projects. Also, as established in the first iteration, an automated solution that has the capacity of sending email notifications to the respective party reviewing the shop drawings was still of importance for this iteration.

Action Planning

The researchers will compare Huddle, the WPMS from the first iteration, to Microsoft SharePoint, a web-content management system, based on the requirements of sign truss projects. The evaluation criteria for this iteration are the same as those in the first iteration.

SharePoint can be integrated with other personal content management systems and email services, such as Microsoft Outlook. Also a SharePoint expert can customize workflows in a SharePoint Depending on the Microsoft license, user access can be restricted. If the license owner has the internal license, only users who are in the internal network and have permission can access the SharePoint page. However, with an additional fee, the external license can be acquired and allows external users into the system.

Action Taking

A SharePoint page was developed by the research team using the SharePoint server space provided by the College of Engineering at Iowa State University. Based on of the sign truss shop drawing review process workflow developed in the first iteration, the SharePoint page, the document libraries, and restrictions were established. Since the SharePoint page is limited to users within the University network, the external email accounts developed in the first iterations could not be used. University email accounts were created to be used as project users within the SharePoint page. The researchers then sought a solution to grant external users access to SharePoint or provide them with an option to at least export and import documents to and from, respectively, the SharePoint project page.
Microsoft Outlook and an FTP website were considered as possible solutions. Each of them were evaluated and proposed to the TAC so a decision could be made for the third iteration. Interest was placed in developing an alternate way for external users to access the information within Sharepoint, because the current license that the Iowa DOT holds does not allow granting permission to users outside of their network. Given the scope of this iteration was to only find a customizable solution and compare it to the first iteration, the decision regarding the alternative for external user access is considered as part of the third iteration.

**Evaluation**

As done in the previous iteration, the Microsoft SharePoint page developed was evaluated and compared with Huddle, the first iteration solution. The SharePoint solution was able to provide the opportunity of the development of the exact workflow established in the first iteration in a successful manner. Table 2 summarizes the evaluation process and comparison with Huddle.

**Table 2. Evaluation of second iteration solution and comparison with huddle**

<table>
<thead>
<tr>
<th></th>
<th>Huddle</th>
<th>Microsoft SharePoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Capacity</td>
<td>25 Projects</td>
<td>Depends on server space</td>
</tr>
<tr>
<td>Member Capacity</td>
<td>Unlimited</td>
<td>Unlimited- Approved by Adm.</td>
</tr>
<tr>
<td>Managers</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Storage Capacity (Group)</td>
<td>25 Gb</td>
<td>Depends on server space</td>
</tr>
<tr>
<td>Storage Capacity (Personal)</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Document Tracking History</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Ease of Accessability to the Site</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Document Approval Option</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Email Notification</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Calendar Option</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Price</td>
<td>$200/month</td>
<td>Depends on License</td>
</tr>
<tr>
<td>Capacity to Reproduce DOT Workflow</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

As it can be seen in Table 2, the performance of the two solutions is very similar with the only difference being the price of the solution. From these two, the one selected for further research and study was Microsoft SharePoint. The main decisive element was the ability of creating the customized workflow, document library and folders as well as having the option of implementing Iowa DOT terminology into the system. This WPMS allows the page developer to set all the requirements and page restrictions which can enhance the implementation of this solution to not only sign truss projects, but other Iowa DOT projects.
Specifying Learning

For this iteration, as it was in the first iteration, there were some lessons learned that are worth noting:

- A WPMS that enables the creation of customized workflows instead of a solution with an already established workflow has a better capability of reproducing the specifications of the users and the project. Since the web-page developer or administrator can create different functions and restrictions to meet the project needs, each page can be developed for particular needs.
- The solution selected, Microsoft SharePoint, can cause some difficulties, depending on the license restrictions, when it comes incorporating people outside of the server’s network into the WPMS system. For this reason, a way to mitigate this situation should be addressed in order to provide to all project team members the benefits of a WPMS.

THIRD ITERATION

Diagnosing

Microsoft SharePoint proved to be a good solution for sign truss projects and other small (less than $10 Million) highway construction projects. Some difficulties that have to be overcome involve allowing external project team members access to the SharePoint page. This access allows them to upload and access shop drawings.

Action Planning

One of the main tasks is to meet with TAC to discuss options and identify ways to allow external users to upload and retrieve documents from the Iowa DOT SharePoint page. The easiest way to allow this access would be to acquire the external license. A second option is to develop an FTP site with log-in restrictions that allows external users to upload and access SharePoint. A third option is to develop an email communication system so users could send and receive project documents.

Another main task is to test SharePoint in Iowa DOT sign truss projects, and a final task is to evaluate the effectiveness of SharePoint and identify areas for improvement. Surveys will be used for this evaluation.

Action Taking

This is the current stage of the project. Meetings have been held to identify the best way to allow external users access the documents in SharePoint. Attempts have been made to identify the feasibility of acquiring the external license. Other alternatives have been considered to mitigate the option of not having the external license. The chosen alternative was to develop an FTP website and integrate it with the SharePoint page. This will provide the external users a central place where the project documents, in this case shop drawings, will be stored. The Iowa DOT staff developed a workflow incorporating the effects of the FTP site with the already established sign truss workflow. The workflow in Figure 2 establishes how the FTP and SharePoint page meet the requirements for the shop drawing review process of sign truss projects.
The SharePoint page for sign truss projects is currently under development. Once that it is developed, meetings with the TAC will be held in order to establish the evaluation criteria for the sign truss project SharePoint page and identify sign truss projects that can benefit from the implementation from a WPMS.

After implementation, surveys will be distributed to both DOT staff and external project team members.

CONCLUSION AND LESSONS LEARNED

- Action Research is an effective method to identify, test, and implement a web-based project management system. This method offers a cycle of continuous improvement that allows research and implementation teams to learn from previous iterations. Those lessons learned are applied in further iterations so a more efficient solution can be tested or implemented.
- Establishing a workflow before identifying solutions helped the researchers identify and test the solutions that met the requirements of the Iowa DOT. The workflows allowed the research team to understand the required tasks and actions that were required for this type of project.
- There are different types of commercial solutions available. The WPMS studied and analyzed by the research team can be categorized into two types of WPMS solutions: one with established workflows that allowed some customization and others with fully customizable workflow capabilities.
- Microsoft SharePoint, a WPMS that allows for workflow customization, was chosen as the solution to be implemented in the Iowa DOT sign truss projects because it could replicate the exact sign truss workflow.
- Having a TAC was an important component when identifying specifications needed in the solution to be implemented. The TAC was also important in testing the different solutions. After implementation and evaluation of the final solution by the researchers, the TAC can still perform...
several iterations, either to apply the solution in other types of projects or make adjustments to the solution workflow.

- Identifying the roles and responsibilities of each project team member at the early stages of the project, helps accelerate the development and implementation process of a WPMS solution.

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REFERENCES


