

DEVELOPING ADVANCED EXPERIENCE MANAGEMENT SYSTEM IN CONSTRUCTION PROJECTS USING EXPERIENCE MAPS

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Abstract:

In order to enhance experience management for engineers participating in construction projects, it is helpful to provide engineers the experience exchanging and sharing platform to understand important issues from the previous executed projects during the construction. The proposed experience maps help engineers better to illustrate what they have previously earned experience to “real-life” problems and increase the level of retention of the valued knowledge acquired. This study presents a novel and practical method to capture and represent construction project-based experience by using project-based experience maps approach. Project-based Experience Maps (PBPM) gives users an overview of available and missing experience in core project areas, enabling tacit and explicit experience to be managed appropriately. Integrated with the project management and project-based experience maps approach to experience management in construction, the valued experience source of executed projects may be acquired effectively from the experienced and senior engineers. The multimedia-supported experience management system presents a friendly web-based platform that enables engineers to learn previous available experience during the construction phase of a construction project. Main contribution of this system are as the following; (1) Provide the platform for exchanging the previous knowledge and experience among engineers effectively, and (2) Illustrate what the engineers think about easily in the construction projects. The ConPEM system is then applied in selected cases study of a High-Tech factory building projects in Taiwan to verify our proposed methodology and demonstrate the effectiveness of sharing experience special in the construction phase.

Keywords: Experience management; experience maps; construction project.

1. INTRODUCTION

Experience management is still a very new experience in construction, although knowledge management has become well-established in construction industries. Experience is the life blood for individuals and organizations. As its sub-discipline, Experience Management (EM) deals with collection of processes that govern creation, storage, reuse, evaluation and utilization of experience in a particular situation or problem solving context [2].

Experience and knowledge have a reciprocal relationship: Empiricism emphasizes that knowledge comes from experience, while experience is the knowledge gained from the direct observation or participation in an activity [1]. As previously stated, knowledge and experience are very similar, but during the implementation of a project, the range of each is slightly different. Knowledge management covers a wider area of concern while experience management [5]. In this study, the research content includes experience concerned about the important issues and problem-solutions during project executions.

Many enterprises and organizations in construction are now engaged in experience management (EM) efforts in order to leverage experience both within their organization and externally to their shareholders and customers. In this study, the experience management in construction belongs a part of knowledge management. Furthermore, the experience management focuses the collections and management of important issues and experience acquired from participating engineers. Valuable knowledge and experience can be illustrated in different forms and media, such as in the mind of experts, in operation procedures, and in documents, databases, intranets, etc.; however, experience management in construction aims at effectively and systematically transferring and sharing the experiences among engineers regard to the participating projects. Integrated with multimedia and project-based experience maps approach, the acquisition of experience from engineers enhances experience exchanging and management applied in construction projects. By sharing experience and knowledge, the same and similar experiences in the executing projects do not reinvent the

wheel. In the system, web-based experience exchange environment assist engineers freely to illustrate what they know and have from the participating projects and provide the service of experience sharing and management. In this way, engineers are invited to exchange and share their experience, and construct valued content through their own experience. With the evaluation of the case studies in the Taiwan High-Tech factory building projects, the survey (questionnaire) results show that ConPEM system integrated with project-based experience maps approach is effective in applied experience exchanging and management in construction.

2. PROBLEM STATEMENT

During the construction phase of projects, one of the improvements for construction management is to share experiences amongst engineers, which helps prevent mistakes that past projects have encountered already. Reusing experience also avoids problem-solving from scratch, i.e., already solved problems do not need to be solved over and over again. However, there are no suitable platforms to assist engineers or experts with exchanging and sharing their know-how and experiences when general contractors execute the project. This is a major loss for contractors who do not preserve the know-how and experiences of engineers and experts. When these engineers and experts finish the projects, they usually accumulate the domain knowledge and valued experience with them and share little or nothing experience with others [12]. In the view of experience management, these important issues and experiences of construction engineers and experts are the most valuable because they not only need manpower; they also require major cost and time to be accumulated. According to the questionnaire survey from 18 engineers from participating five high tech factory construction projects specific in the construction phase, the primary problems in experience sharing and exchanging specifically during the construction phase of projects are as following; (1) the efficiency and quality are low special in the experience management in construction just though document-based media; (2) the difficulty to find pervious suitable experience to reuse in other or similar projects; (3) Unofficial discussion and communication in the problem-solved doesn't maintain properly to reuse in the further, and (4) there are usually oral communication in experience exchange by face to face or telephone among engineers. However, there are less suitable platforms to assist engineers with illustrating and sharing their experiences and knowledge when executing the project. Furthermore, reusing experience and knowledge may avoids problem-solving from scratch, i.e., already solved problems do not need to be solved over and over again. Therefore, how to accumulate and utilize the previous experiences and reuse in other or similar projects is a great challenge to contractors.

3. RESEARCH OBJECTIVES

The main purpose for studying this research is to develop a Construction Project-based Experience Sharing (ConPEM) system for engineers in contractors (general contractors and subcontractors), to provide experience exchange and management service in the construction phase of a project for the reuse of domain knowledge and experience. Usually, it is possible for contractor to execute similar projects. Therefore, problems in executing those projects can be considered to refer and learn for other similar projects. Thus the capture, transfer, reuse, and maintain of the construction project knowledge are critical [14]. Experience management in the construction phase of a project is a experience-intensive organizational environment where experience available and reusable has critical importance for engineers [13]. To be competitive, a contractor has to make innovative use of knowledge and experience and accumulate through previous experiences, and share it across the rest of other relative projects. Senior engineers participating in projects act as knowledge workers facilitating the collection and management of experience between current and past projects.

In the article, we focus on the new approaches for managing and reusing past experience special for construction project framework. The research aims to propose new experience flow maps for experience management and develop web-based experience management integrated the approach to service engineers and practitioners can exchange original ideas, experience, knowledge and commands. With the integration of project-based experience maps and construction project management, engineers may acquire the problem-solving and experience directly from senior engineers, reducing the time and cost of training on the on-job. By exchanging and sharing past experience among engineers, the similar and related experience in executing multi-projects can be clear and easy to trace through web-based experience management. Furthermore, the engineers can exchange the experience and experience through experience flow maps regard to the part they participate in the construction project more effectively and easily by senior engineers and knowledge workers.

In order to apply experience management to new or other construction projects, the process and content of acquired experience from the projects need to be collected, illustrated, and then saved effectively in the system. In order to assist participating engineers to illustrate and manage what they own experience in the mind, the approach of project-based experience maps is proposed and assisted to help engineers easily to explore which experience they acquired from past participating projects. Main objectives of this study are as the following; (1) Provide the platform for exchanging the previous knowledge and experience among engineers effectively, and (2) Illustrate what the engineers think about easily in the construction projects. The ConPEM system is then applied in selected cases study

of a High-Tech factory building projects in Taiwan to verify our proposed methodology and demonstrate the effectiveness of sharing experience special in the construction phase.

4. CONSTRUCTION EXPERIENCE MANAGEMENT

Experience is treated as the kind of knowledge based on the execution cases of the critical issues of construction projects in this study. Experience is valuable, stored, specific knowledge acquired by a problem-solving agent in a problem solving situation [2]; experience refers to what people have done and what has happened to them in the past [9]. Experience management deals with collecting, modeling, storing, reusing, evaluating, and maintaining experience.

In construction, experience management is a discipline that promotes an integrated approach to the creation, capture, share, and reuse of a profession's domain knowledge gained from projects [7]. During the construction phase of a project, most project-related problems, solution, experience, and know-how are in the heads of individual engineers and experts [8]. Implicit experience usually is not documented or stored in a system database. To preserve implicit experience as corporation property, how to capture the implicit experience and make it in form of explicit experience is important and necessary in experience management. Problem-solving, know-how, know-what, and innovation are created in the construction phase of any project. By the implementation of experience management, tacit experience can be reused for other projects and speed the improvement of problem-solving in the construction phase. Most experience content in the construction phase of a project can be classified into two broad categories - tacit experience and explicit experience. Tacit experience is personal, context-specific experience that is difficult to formalize, record or articulate; it is stored in the heads of people. Tacit experience is personal knowledge embedded in individual experience and shared and exchanged through direct, face-to-face contact [5]. Explicit experience can be codified and transmitted in a systematic and formal language [5]. It can be found in the documents of organizations, including reports, articles, manuals, patents, pictures, images, video, audio, software, and other forms.

Currently, enterprises in the AEC industry have successfully collected and stored explicit information in enterprise databases, but have not always been successful at tacit knowledge retrieval and sharing [17]. A case investigation from the oil and gas industry is adopted to explore the KM activities of eight leading organizations and investigate the opportunities for construction organizations [6]. El-Diraby proposes distributed ontology architecture developed using rigorous knowledge acquisition and ontology development techniques for KM in highway construction [11].

In order to enhance experience acquisition for engineers participating in construction projects, it is helpful to provide engineers with an exchanging platform to search which similar experience available in the previous projects and applied those experiences on the other projects. With the assistance of experience management, the problems and solutions from past projects can be reused and learned with novice and senior engineers (see Fig. 1).

5. PROJECT-BASED EXPERIENCE MAPS

In order to assist engineers extracted what they own experience in their minds from the involve projects, the study propose a new approach project-based experience maps approach integrated with project management in construction. With the assistance of project-based experience maps approach, the experiences in the mind of engineers are illustrated efficiently to generate and organize ideas based on construction project framework. A project-based experience maps is based on organized and associations flow out from a central image in a free-flowing, yet organize and coherent, manner. The above content also will be server as the tool of experience acquisition in the ConPEM system. Furthermore, engineers may edit and conduct most of valued resources to as attachments in the system. Therefore, the ConPEM system not only provides the engineers the experience exchanging environment but also perform engineers a web-based experience acquisition platform from predicating engineers.

Mind Maps diagram the structure of ideas in an associative manner which is more representative of how ideas are stored in the brain [4]. Mind map is better than linear outlining because authors can use flexible thinking and relativity in editing their idea [3]. One can add and subtract a thought or phrase from a mind map easily. Mind Maps is a color-coded outline of main ideas, sub topics and details, printed on different colored branches connected to the center [4]. In the center in a circle, editor will list his main idea, such as problems or commands. Knowledge mapping helps to understand the relationships between knowledge stores and dynamics. Davenport and Prusak note that developing a knowledge map involves locating important knowledge in the organization and then publishing some sort of list or picture that shows where to find it [9]. A knowledge map includes the sources, flows, constraints, and sinks (losses or stopping points) of knowledge within an organization [16]. Well-developed knowledge maps help the users identify intellectual capital, socialize new members, and enhance organizational learning [18]. Knowledge maps have been used for a variety of applications, even for developing a knowledge map of knowledge management software tools [15]. Dynamic knowledge map can assist in the reuse of experts' tacit knowledge [17]. The knowledge map plays important roles in implementing knowledge management. All captured knowledge can be summarized and abstracted through the

knowledge map. The knowledge map also gives a useful blueprint for implementing a knowledge management system. In order to enhance experience management in construction, a research methodology has been proposed and applied in the case study. The proposed methodology called project-based experience maps is specific approach for construction experience management and methodology. Although knowledge and experience map is not new in the knowledge management, the proposed project-based experience maps is new experience and approach specific for construction project management.

6. SYSTEM DEVELOPMENT

This section describes in detail the construction project-based experience management (ConPEM) system. There are three search functions supported in the system. Figure 1 illustrates the system architecture. Different organizations have different needs and cultures and that is the reason why each ConPEM system implementation needs to be tailored to the target organization. We use a methodology to help us understand and setup a ConPEM system for a specific organization. The methodology helps define the content, structure, procedures and tools that will be part of the ConPEM system. The use of this methodology is very important in guiding the work so that the ConPEM system is successful and accepted by the organization. The participation of people from the organization in the application of the methodology is crucial for the success of the ConPEM system implementation because they are the ones who know their culture and problems best. The following is a description of the steps of the methodology to develop a ConPEM system for a particular organization and domain of experiences. It is based on best practices derived from previous ConPEM system projects and has been continuously improved. An important aspect of the methodology is that it serves as a medium for experience transfer internally.

The interface layer defines administrative and end-user interfaces. The Users can access information through web browsers such as Microsoft Internet Explorer or Netscape Navigator. Administrators can control and manage information via the web browser or using a separate server interface. The access layer provides system security and restricted access, firewall services and system administration functions. The application layer defines various applications for collecting and managing information. These applications offer indexing, full text search, collaborative work and document management functions. The database layer consists of a primary SQL Server 2003 database and a backup database (also based on SQL Server 2003).

7. CASE STUDY

In the following case, the subcontractor that had five year specific in the construction of High-Tech factory building

decides and tries to apply experience management to raise the enterprise competition. For the reuse of experience in other similar projects, the subcontractor hopes to take a good advantage of experience management to acquire the valued experience sources from participating engineers and manage it well to let experience and innovation exchange inside the company. The following cases study is lesson learning concern about the subcontractor applied and practiced experience management.

Experience Acquisition Phase

In the cast study, the senior engineer tries to edit series domain knowledge in the installation of "Clean Room". The experience in "Clean Room" includes the installation process, detailed description, and problem-solution explanations. After the related attached files have been digitized, the senior engineer packages them as experience set for submission. The senior engineer develops the map and discusses with the two experts every week to accelerate the solving of the problem in question. All discussions were summarized and edited in the map by the engineers. The engineer creates the experience map and summarized his experience and domain knowledge in the map to enable the problem's solution to be reused in other and future projects.

Experience Storage Phase

When the submitted experience set is approved, the system will illustrate the process automatically and s an assistant in the EM team attributes knowledge and classifies this experience by placing it in an appropriate position (map units of project map) in the system. In other words, users can find and read related domain knowledge directly just clicking these map units of project map. In the experience storage phase, all information and experience are centralized and stored in the central database to prevent the collection of redundant. All information and experience can be stored in the system by ensuring that data are all electronic and in standard format for each type of file, such as a specific document format, or a drawing format.

Experience Sharing Phase

A new project just start after the High-Tech building project constructed six month ago, a novice engineer with no prior experience meets a problem in the subcontract contract and tries to locate previous experience to help him solve the problem. The novice engineer uses the keyword search to find the four engineers who met similar problems in the previous projects concerned High-Tech building project. The novice engineer finds the experts and retrieves, refers to and studies the knowledge set (including digital video and documentation) supported by these senior engineers. He starts to apply and reuse the knowledge in his own project. Also, the novice engineer gives experienced feedback and offers knowledge that can be reused when others face new problems. Also, another novice engineer

reuses the same knowledge to solve the same problem in other project.

Experience Update Phase

After applying knowledge and information to the other similar projects, the novice engineer solves his problem and finds a new solution in collaboration with some senior engineers. Finally, the novice engineer notes and submits the new suggestion and experience in the map units of project map, associated with the original knowledge. Furthermore, the knowledge is updated later because further feedback and another solution are provided regarding the same problem. After the approval process has been completed, the updated knowledge set is republished in the map units of project map and notice message will be sent to the authorized members.

8. CONCLUSIONS

The application of experience management integrated project-based experience maps approach for construction projects is presented in this article. Furthermore, the paper presents a construction experience-based experience management (ConPEM) system for contractors as an experience exchanging and sharing platform. Construction project-based experience maps the valued experience into project units as effective tool of experience management in construction projects. The development of the ConPEM system employing the integration of web technology is delineated and it has been illustrated through cases study in the High-Tech factor building Project. The ConPEM system is advanced at least in the following aspects: the ConPEM system enables engineers exchange and share previous experience using project-based experience maps by expressing through their ideas and thinks maps. In short, the ConPEM system is able to assist engineers to illustrate their clear experiences and rich experience regard to valued experience in predicating projects. The integration of multimedia-based experience/knowledge and mindmaps approach appear to be a promising way to improve construction experience management during the construction phase of a project. The content of the experience warehouse in the system not only provide the pervious problem-solutions, but also support all area domain knowledge and experience exchanged among project participating engineers. With the evaluation of the case studies in the Taiwan three High-Tech factor building projects, the questionnaire results show that construction project-based experience management system is effective in applied experience management for construction projects.

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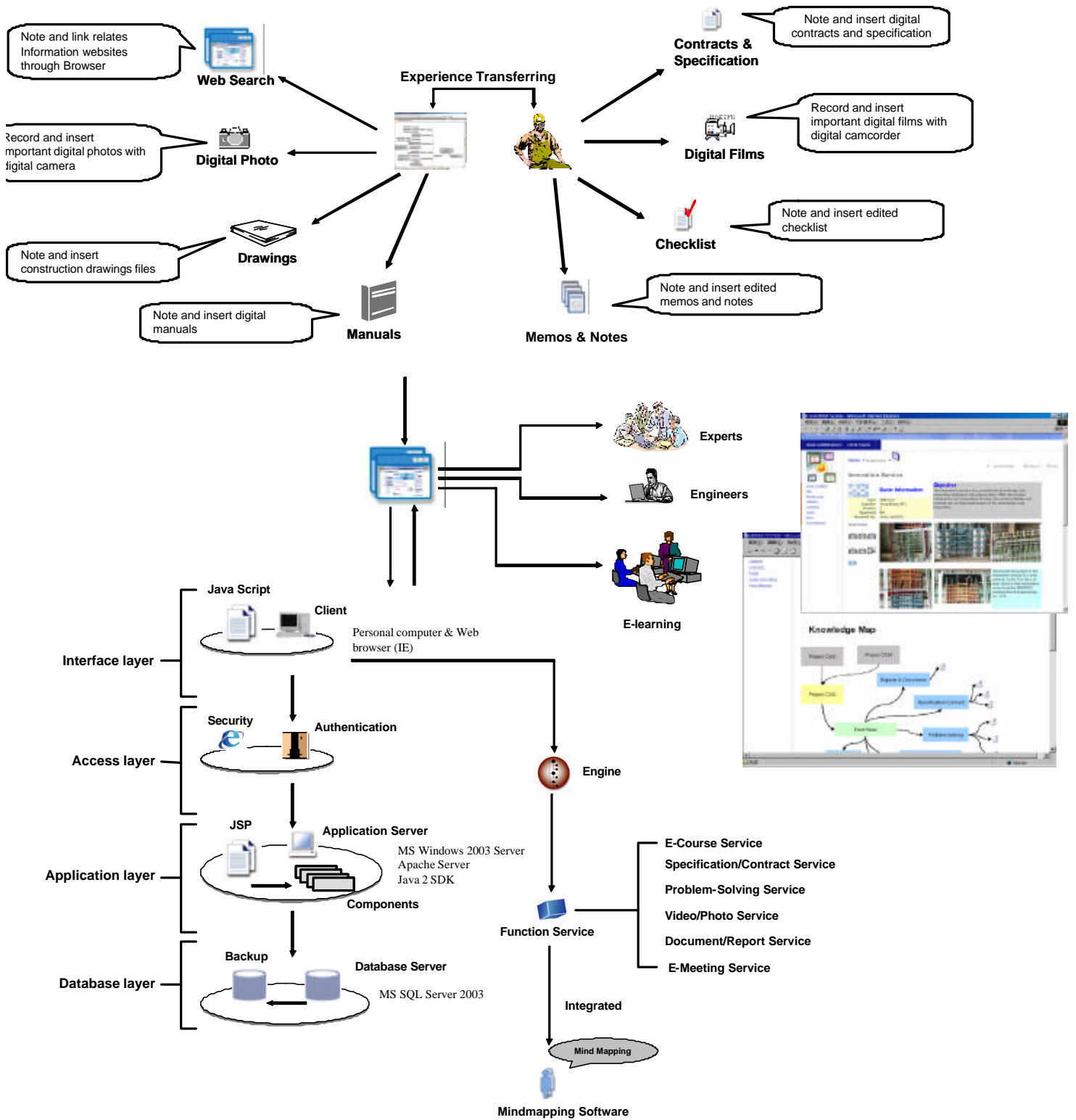


Fig. 1. System architecture.