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A social network system for sharing construction safety and health knowledge

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ABSTRACT

Construction is one of the largest contributors to national economies and also one of the most accident-prone industries worldwide. Construction site accidents often result in serious injuries or death, cause serious project delays and cost overruns. Prior studies focused on cause and effect relationships of construction accidents, design for construction safety, effectiveness of worker safety programs and government policies. The focus in those studies has been on generation and utilization of safety-related data and information, and not on how to share safety data efficiently among all stakeholders in the construction industry. This paper proposes a Social Network System for Sharing Construction Safety & Health Knowledge (SNSS), which utilizes semantic wiki web and ontology approach for better communication and representation for construction safety information. SNSS was developed on the basis of a safety semantic wiki template (SSWT), which consists of three components: 1) Safety information module (SIM) which uploads common accident and hazard information for sharing; 2) Safety knowledge module (SKM) where the safety information is refined, confirmed and transferred to a repository of safety knowledge; 3) Safety dissemination module (SDM) which allows users to monitor, manage and retrieve safety information and knowledge. SNSS has been tested in a fall accident case study. The study confirms the applicability and benefits of a social network system for enhancing safety communications among all stakeholders of construction projects and organizations behind the construction business.

1. Introduction

Construction is a very intricate and complicated environment that consists of more than twenty trades with different skilled workers involved in construction process. This leads to construction being a high risk industry. The accidents occur repeatedly and inevitably during construction project [4]. In spite of the attention given in the construction site injuries, the incidence rate of industry is reported to be twice comparing with the industrial average [18]. This plague causes many problems related with cost overrun and schedule delay in construction project. Therefore, many studies have been performed to reduce the incident rate, such as construction safety and health monitoring system that integrates internet and database systems for a total automated safety and health management [5], the game technology based visualizing safety assessment for safety and health training [11], and so on. However, according to Fang et al., most of current researchers have been focused on safety training and education as a main channel to improve construction safety rather than to solve the communication problems in sharing and retrieving construction safety information and knowledge [8].

This limitation has required a high demand for online interactive multiuser and information exchange to achieve the sharing and retrieving safety knowledge purpose. The social networking platform allowed its users to connect and communicate with the others, and would help to successfully obtain the construction safety & health sharing purpose. Social network sites are web-based services that allow an individual to construct a profile, articulate a list of other users that they share a connection with, view and traverse their list of connections, exchange information, and communicate with other users within the system [1]. In the construction industry, the integrated classical project management concepts and social network science theory [6] or the use of social network as a strategic tool for managing construction project [14] could greatly improve efficiency of construction project management. Social networking is a potential and powerful tool to engage, motivate user to share, update, and manage information [7], and plays an important role in exchanging resources among partners which have been applied in many diversified areas [10].

This paper proposes a social network system for sharing construction safety & health knowledge (SNSS) that integrates state-of-the-art of information technologies such as semantic wiki and ontology in order to overcome the communicative barrier of safety knowledge sharing. For efficient representation and effective communication of construction safety knowledge, this paper develops three modules in the

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system — information module, knowledge module, and dissemination module — based on safety semantic wiki template (SSWT). The SSWT exploits semantic wiki and construction ontology combination as the platform of SNSS, which provides a convenient and easy environment for construction safety and health information sharing and knowledge exchange. In SSWT, semantic wiki application allows users to add, remove, edit, change content of incident and hazard cases in a cooperative manner without their having any computer science background, while ontology technology plays role as a tool in accident information arrangement and knowledge retrieval. The safety information module (SIM) allows users to upload and gather safety data through the SSWT. In the SIM module, the safety data (dangerous occurrence or hazard & risk) will be transferred to a comprehensive information. The safety information will be conveyed and analyzed in the safety knowledge module (SKM). It is noted that the SKM module will mobilize and utilize domain experts to join in knowledge contribution and refinement phases for achieving the best knowledge. And the whole safety information and knowledge will be manipulated in safety dissemination module (SDM) on a website. It supports users to construct, participate, and explore high-level construction safety and health knowledge easily and conveniently. The proposed SNSS system could be utilized as a beneficial tool for construction safety and health management in the industry.

2. Literature review

2.1. Safety data, information, and knowledge

Before entering more deeply into a discussion about this research, several terminologies, which include construction safety data, information and knowledge need to be understood to make the paper more clear. According to Wikipedia, data are values of qualitative or quantitative variables, belonging to a set of items [24]. Information is a message or collection of messages in an ordered sequence that consists of symbols, or it is the meaning that can be interpreted from such a message or collection of messages, while knowledge is a familiarity with someone or something, which can include information, facts, description, or skills acquired through experience or education [26,27]. Data is the lowest level of abstraction, information is the next level, and finally, knowledge is the highest level among all three. From the point of view of three definitions above, construction safety data in this paper are accident and hazard & risk records or reports while safety information is considered as the description of accident process, which consists of hazard phenomenon, accident result, etc. Construction safety knowledge is acquired by domain experts based on safety information analysis through a social network platform.

2.2. Communication in construction safety & health

The construction industry is considered to be a distinctly unique and highly fragmented environment where lack of safety knowledge is a critical reason for high accident rate causing cost and time overruns [22]. The effective safety knowledge and information exchange is becoming more important to reduce dangerous occurrence of accidents as well as hazards and risk in the construction industry [13]. However, it is difficult to solve this problem due to nonstandard knowledge, and vague, ambiguous, and inconsistent safety standard and regulation [8] or the subjective nature and ad-hoc nature of construction knowledge [29]. In other words, the lack of construction safety information exchange and knowledge sharing is a main reason that causes on-site accidents and thus low construction productivity. So, in order to achieve better safety performance, an enhanced safety and health communication system is necessary to identify and analyze safety hazards and risk, incident information, and to develop proactive accident prevention method in construction process.

2.3. Semantic wiki website

Unlike some content management system, semantic wiki websites offer sharable environment that allows visitors to easily add, remove, edit, and change available content in a collaborative manner without using any complex commands or learning programming language [15]. West and West have found in their review that wiki could support the dynamic online communication where wiki customers could write, discuss, comment, edit and evaluate information [23]. Furthermore, the wiki system is used for many different purposes such as database for research and writing, information management, collaborative tool for documents needed to update frequently due to the free expandable collection of interlink web pages or storing and modifying information functions [20]. Buffa et al. proposed a system, called Sweet Wiki that combines general wiki advantages and semantic web technology [3]. The Sweet Wiki not only formalizes and reuses information based on semantic searching and navigation but also supports knowledge relationships between searching keywords and the results through semantic tagging. Obviously, semantic wiki technique would be an excellent tool in information sharing and knowledge exchange.

2.4. Ontology application

An ontology is a representation model which defines concepts, attributes, and relations with explicit specifications that could solve the problems of ambiguity in knowledge sharing and reuse [19]. According to Rezgui, ontology plays a critical role in proposing knowledge environment and providing a semantic reference to ensure relevance, accuracy, and complete information [17]. Lima et al. suggested e-COGNOS that applied ontology as the main feature of the platform providing a formal representation of knowledge domain with an effective means [12]. Reusable ontology is more important for information integration, knowledge-level interoperation, and knowledge base development [9]. Tudorache and Noy developed Protégé system as an open-source platform that provides a growing user community with a suite of tools to construct domain system and knowledge based applications with ontologies [21]. The Protégé system enables users not only to establish and populate hierarchical ontologies but also to build a new ontology class. In summary, ontology is a potential and powerful technology to facilitate knowledge sharing, reusing and also knowledge acquisition.

2.5. Need for an integration semantic wiki and ontology with social network

The social network provides the conduit for users to engagingly share their knowledge and experiences on their term, and communicate with others. However, social network seems chaotic due to no predefined index, no knowledge managers, and no structure. This causes some problems related with data repository and knowledge management. Previous literature review indicates that semantic wiki and ontology can potentially play a key role to facilitate a hierarchical view of information and knowledge management. Therefore, the integration of semantic wiki and ontology with social network would bring a powerful and strong tool in sharing, retrieving and reusing information as well as managing knowledge. To do this, the next section will propose a social network system which utilizes state-of-the-art semantic wiki and ontology for better communication and representation for construction safety information & knowledge.

3. Social network system for sharing construction safety & health knowledge

The main purpose of developing a social network system is to enhance information sharing and knowledge exchange through social communication. The key benefit of social network system does not require the authority expert as an intermediary, so it allows users to