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AN ONTOLOGY SCHEME FOR DISCRIMINATING CONSTRUCTION IETM FROM EXISTING INFORMATION SYSTEMS

Jeong, Jinwook[1] and Park, Moonseo[2]

[1] Master Course Student, Department of Architecture, Seoul National University, R.O.Korea
[2] Assistant Professor, Department of Architecture, Seoul National University, R.O.Korea
Correspond to znoogy@snu.ac.kr

ABSTRACT: Today's construction is a large-scale and long life span program, so called Mega-scale project, that every moment constructor faces much of hardships, It is because of a large amount of stakeholders, data and complicated relationship among workers. In order to overcome these problems, IETM(Interactive Electronic Technical Manual) has been introduced to construction industry recently, It is regarded as a useful tool for handling the data, procedures of the construction, but it is similar to existing IT-based information systems, the PMIS(Project Management Information System) and the KMS(Knowledge Management System), without characterizing.

This research is intended to find out IETM's property and to present the Ontology scheme discriminating Construction IETM from existing systems..

Keywords: IETM, PMIS, KMS, Ontology, Information, Management, IT

1. INTRODUCTION

1.1 Research Background

The size of construction project get bigger and more sophisticated every moment. So there is much of information on construction site. Making and using IT-based information systems become important, even mandatory, to all of construction workers to manage the project in effective way. Today, many companies already have built information systems. But, there was low outcome comparing with expectation in same condition of investment. Absence of information system building goal and strategy also caused low efficiency.[1]

Recently, there are more efforts to combine all of data derived from construction field with work process construction workers have to do in accordance with development of IT technology in construction field. PMIS(Project Management Information System) and KMS(Knowledge Management System) are the good examples of those efforts. Project related workers are using these system to produce, store information and communicate with stakeholders. The information is made as a proper form by the suitable WBS(Work Breakdown Structure) in Database then used to be referred by workers and analyzed statistically.

Similar to these systems, IETM(Interactive Electronic Technical Manual) which was used in maintenance and manufacturing field, has introduced to construction field as an information managing tool and has developed continuously. Moreover there is one possible information organizing method. That is the ontology which has been developed and adopted widely to IT-based systems to make contents useful to users.

1.2 Problem Statement

IETM is a process or a procedure manual, offering information as a digital format. It is focused on providing procedures related to administrative and legal works rather than detailed information construction related. Moreover constructional information is more complicated and has many stakeholders compared with manufacturing and maintenance ones. These stakeholders can be professional workers or the public.

Therefore, developers who try to make construction IETM should consider what information IETM deals with and who IETM is intended for. But it is not easy to classify information, offer the information to exact stakeholders on time because construction information is complicated to classify. So there are many stakeholders that the system hardly recognize who is suitable for certain information.

1.3 Research method and Scope

This research is intended to give meaningful properties to construction IETM with ontology method.

To do this, at first, understand IETM's properties and find out properties of PMIS and KMS, then compare properties of IETM with those systems.

Second, determine IETM's properties, then make IETM's information structured and related with ontology method.

This research's scope is to provide a sample of ontologically structured construction information class diagram and usage.

2. INTERACTIVE ELECTRONIC TECHNICAL MANUAL(IETM) [2]

2.1 Definition

An IETM (Interactive Electronic Technical Manual) can be defined as a technical manual that combines any electronic format such as text, image, sound, or video, which can be accessed using a computer-based device. The IETM was developed due to the need to locate crucial information more quickly than in paper format. In this sense, the term 'interactive' signifies the existence of a measure of intelligence which can serve to direct the user of the manual to his/her desired point. The interactive level of IETMs may vary from a simple device instruction manual to high technology devices used for airplane diagnosis.

The IETM originated in the 1970s when the U.S. Department of Defense (DoD) built its archive of scanned paper documents in order for electronic documentation. This electronic library was built to reduce storage space, to prevent documents from getting lost, and to ease the distribution process of documents. Then, in the 1980s, the basic concept of the IETM was concretized; however, because of the lack of computer software and hardware capabilities, it did not become operational until 1992 when the DoD issued three IETM standards (i.e., Mil-M-87268, Mil-M-87269, and Mil-M-87270). Since then, advances in computer hardware and software, the increase in popularity of new computer-based portable devices (e.g., laptops, mobile phones, iPods, and GPS devices), and the massive global growth of the World Wide Web in both infrastructure and application aspects, have all contributed to a shift from using paper-based documents to the use of electronic documents.

2.2 Classes

IETMs differ in their capabilities and sophistication. Making the undergoing efforts related to the IETM more organized and classified, there are several ways of classifying the IETM. Among them, five classes of IETMs, Class I to Class V, proposed by the US Navy, which are addressed based on the source data format of the given IETM and its functionality, has been generally acknowledged, as shown in Table 1. However, the definitions of these classes are in fairly general terms which overlap and may be insufficient to serve as a basis for contractual use. Nonetheless, these definitions can still provide a valuable idea in a sense that different characteristics and functionalities in each class indicate the level of interactivity, which is one of the most significant design criteria for the IETM. In other words, once how the user will interact with the IETM (i.e., how the user will use the IETM for a targeted application) is determined from requirement analysis, the appropriate class can be selected according to the definition of each class, which in turn, provides implementation strategies.

Table 1. Classes in IETM

Classification	Characteristics	Functionality
Class I	Electronically indexed pages	Access pages by index/header info
Class II	Electronically scrolling documents	Browse through scrolling info
Class III	Linearly structured IETMs	Logical display of data in accordance with content
Class IV	Hierarchically structured IETMs	User selectable cross references and indices
Class V	Integrated data base	Single viewing system for simultaneous access to multiple info sources

2.3 Application

Although the IETM has a military-based origin, its concept has rapidly spread among various businesses. Particularly, it has been applied to the development and maintenance of complex and large-scale manufacturing products such as airplanes, ships, military weapons, and heavy machinery. Also, other sectors that make use of IETMs include virtual training institutes, repair and maintenance service providers, and medical diagnosis institutes. Access to desired data, reusability, updateability, durability, and cost effectiveness are some of the key features of the IETM that have led companies in different areas of expertise to develop their work based on this approach.

3. EXISTING INFORMATION SYSTEMS

3.1 Project Management Information System(PMIS)

PMIS stands for Project Management Information System. This system deals with all of data derived from whole life span of the construction project which contains every plan, job to do, day work output, etc.

PMIS's information domain includes planning, designing, constructing, finishing and maintaining. PMIS allows people, CEO, headquarter, field workers, managers, to get information and share opinions one each other. The workers in the field can have proper information on time easily because PMIS classifies information and processes the information to make it more useful. Besides the processed information can be reproduced and reused when statistical or analyzed information is needed. PMIS's information integrated data management method make information shared easily, then this advantage is helpful for owner and managers to make a decision. And when expecting risks of future project or managing first phase of project, this system offers pre-stored related information to users in a statistical way.

PMIS enables users to handle and store data more easily and exactly when users need to keep or feedback data. This property distinguishes PMIS from similar systems. Through the property, a work can be standardized and shared. In other word, PMIS make project management efficiently, finally, make productivity improved. This is one of the objective of PMIS.

3.2 Knowledge Management System(KMS)

KMS stands for Knowledge Management System.

In time of developing stage, many companies have put high values on economies of scale by expanding their business boundaries. That can be sometimes a understandable management skill though. However, this couldn't be a ultimate solution because financial crisis told us why. Since its introduction in mid 1990s, financial crisis in Korea, knowledge management(KM) has been

considered as a new, optimal way of corporate management style.[3]

KMS deals with the information, experiences, knowledge about schedule management to enable users to use the data systematically. KMS make valuable knowledge of organization alive. It inspire users to share the know-how one each other. This is key property of KMS.

This kind of data is owned by one person, not sharing one each other. The valued asset of organizations have been disappeared following workers retire or job movement. This means former knowledge of construction field has gone with project's end.

KMS was originated to remove this kind of unreasonableness. In other word, KMS keeps organizational valued knowledge and transmit them one generation to next generation. KMS is aimed to make a knowledge base of schedule management.

KMS provides multi dimensional knowledge map through knowledge base. It manages personal knowledge then sort the knowledge in suitable way. After making database, learning team manages high level knowledge. They stored this sorted knowledge to KMDB. Also they do Q&A service using this DB.

Analyzing system and monitoring system allow users to get more refined knowledge effectively. Finally, learning team make the result of using statistical with user's knowledge mileage system. This rule makes KMS's application more high.

KMS is a good tool for making the knowledge of the organization valued assets, structuring the knowledge and sharing the knowledge.

4. COMPARISON OF THE SYSTEMS BY PROPERTIES

PMIS, KMS, IETM are different systems in many aspects as seen table 2.

PMIS's objective is information sharing. In a life span of construction project, there is much amount of real time data. PMIS is made to manage this data. The user of PMIS is project related people. Due to this reason, the stored data is classified to every users. Also PMIS make the data structured and analyzed. Form this phase the data become information. The view of PMIS is project level. This means one project has a one PMIS. Of course, in an organizational aspect it can be possible that there are milti-project management system or stored information DB. But one project, one PMIS is basic concept of the system.

KMS's objective is knowledge sharing. User of the system make contents and share it one each other. One special administrative team handles whole system and data stored, analyzing and leveling the data every day. After this professionalizing process by special team, the data become authorized knowledge. As process goes on, the knowledge classified as levels. One property of the knowledge is that there's no time limit. This property is totally different from PMIS's data. As long as one organization exist, the KMS's knowledge lasts as an asset of the organization. So the view of data is organization.

Table 2. Comparison of the Systems

Classification	PMIS	KMS	IETM
Objective	Information sharing	Knowledge sharing	Procedure offering
User	Project Stakeholders	Authorized Inner Users	Project Stakeholders /interested public
Kind of Content	Information	Knowledge	Procedure
Stored Data	Active Construction Data and Information	Suggested Knowledge	Legal/Administrative data
Level of data	Occurred Information during the project	Stored Knowledge (No period)	Procedure based on law (No period)
Data Feedback	Feedback	Feedback	No Feedback
View of data	Project	Organization	Program

IETM's objective is process or procedure offering. The users of the system are project stakeholders and the public. In construction project, especially multi project(mega-scale project), there are many process workers to do on time. as worker's job more complicated, there's need for offering process to each worker and alarm the time to do one's job. So IETM has introduced to the industry. IETM deals with legal and administrative data only. There's no data feedback by workers. This means this system aims to give information only. This property is the biggest difference from prior two systems. So IETM is designed more sophisticated because users don't have a chance to correct information(there's no feedback). The ultimate goal of IETM is to provide process information semi-automatically. To do this, the ontology method is the only and best solution.

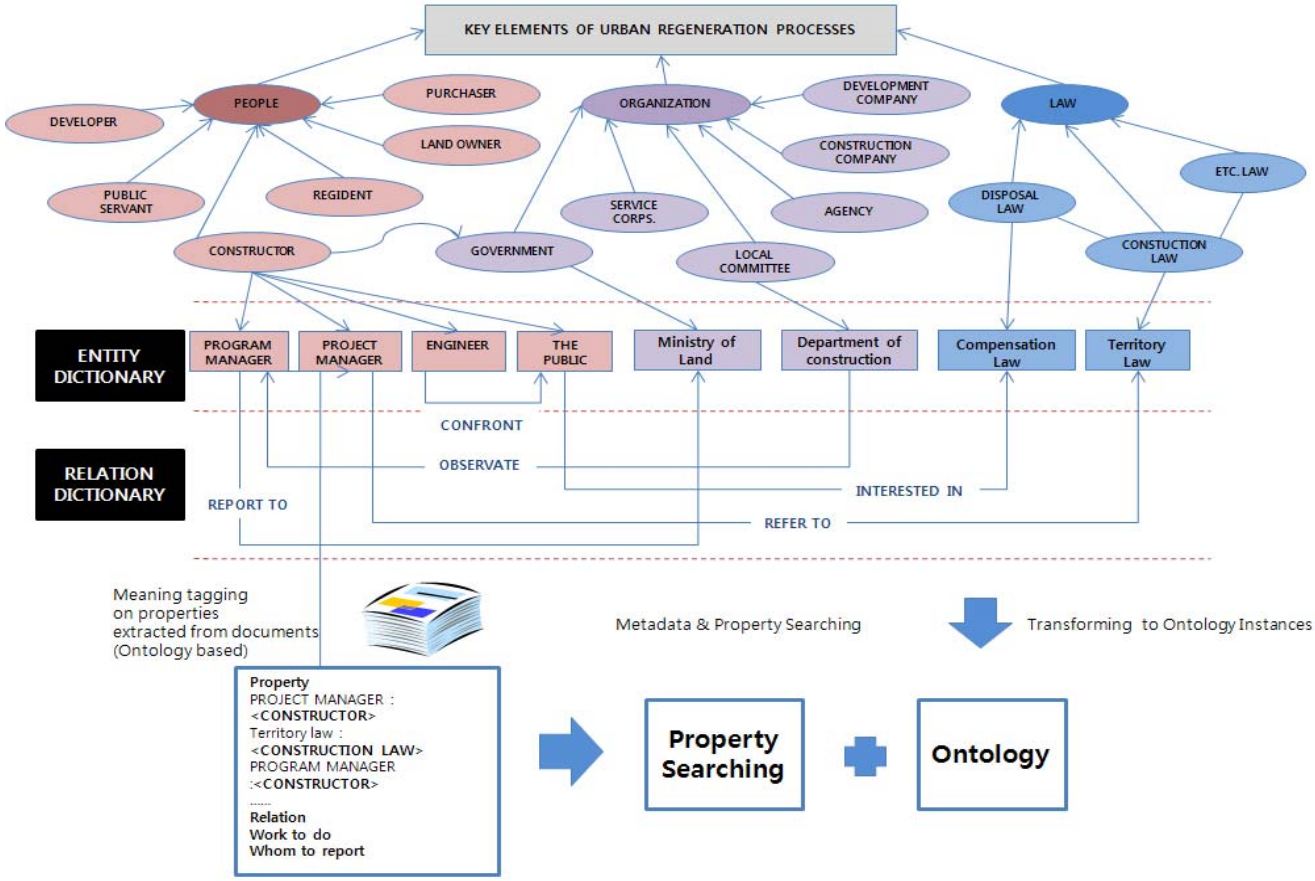

Figure 1. Ontology for Participants in Mega-scale Construction

exchange knowledge(not data) through a set of interoperable ontologies. Each ontology represents the knowledge and processes of a certain domain in the supply chain. [4]

Once data are stored in a structural way, all the process information along with its relationships need to be well-classified, standardized, and structured. This is because information for construction is too broad, complex, and context specific (due to a large number of stakeholders with conflicting interests), which makes it extremely difficult to effectively obtain proper information. In an attempt to address this issue, the development of a formal ontology is proposed.

5. AN ONTOLOGY EXAMPLE for IETM

The advancement of semantic web and enterprise modeling provides for more collaborative e-business supply chains. Different from the traditional web, the semantic web aims to exchange "meanings" in addition to "hypertext" this allows people(and machines) to

From an information technology perspective, ontology can be defined as a formal, explicit specification of a shared conceptualization. In other words, it is a representation of a domain that provides explicit definitions for the concepts within that domain, along with their relationships and constraints, in a format that is machine-readable and agreed upon by a group of people who intend to use the ontology for the purpose of knowledge exchange [5] Each ontology can represent the knowledge and processes of a certain domain or discipline. In addition, the integration of such ontologies provides a framework for representing, sharing, and managing domain knowledge through a system of concept hierarchies (taxonomy), associative relations (in order to link concepts across hierarchies), and axioms, which facilitates reasoning in a semantic manner [6]. Thus, the development of this formal ontology can greatly contribute to process management, serving to link all participants' work process manuals and maintain the efficiency of the IETM, while facilitating an update of changes from diverse sources. Also, this ontology enables customized information delivery because all relevant information with regard to participants' roles is well-structured. Figure 1 shows an example of the ontology developed for the participants. Each participant stands for lower level entity's role and relationship. Through this class diagram the system knows how the information is structured. If there is need for adopting search engine, this job is the most useful. The system classified users and information simultaneously. Figure 2 is an example of user interface. It shows more classified information offering when users do search on the system. This is totally different from former systems.

Assume that there is person who even doesn't know what to do. If the system's information was related by ontology method, he/she can find what he/she's going to do easily and exactly. He/she typed a word "resident", the system shows possible information like below. Possible event, processes are shown at once. Then related law and stakeholders, documents and object(even linkage to other possible data) will be shown below. At last the system recommends all format and type of possible information to users. PMIS and KMS can be linked automatically once administrative is done.

Users can choose what they need. Also they can see whole structure of information and information map.

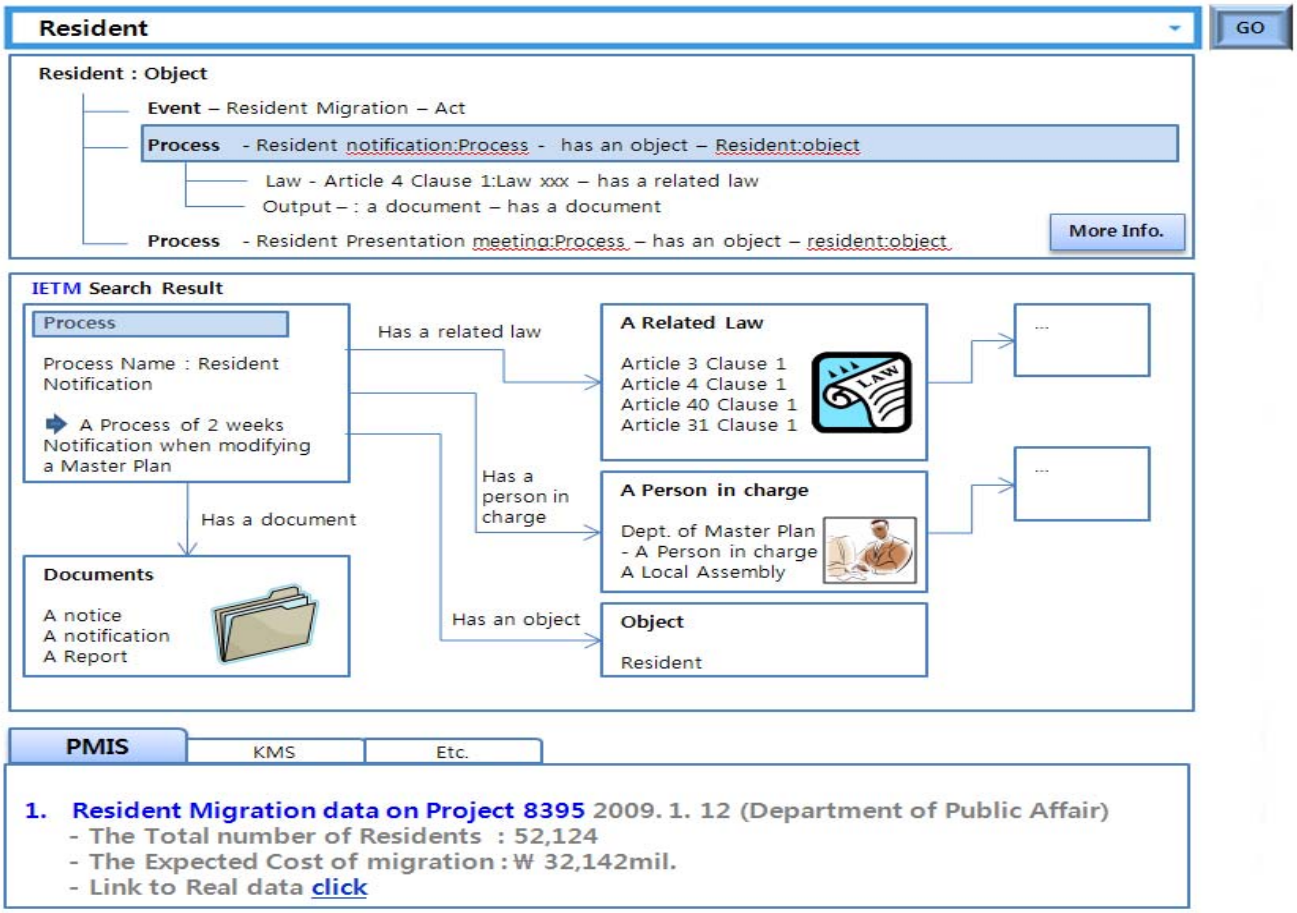

Figure 2. The Ontology Usage for Search Function

6. CONCLUSIONS

This research dealt with construction IETM's mandatory properties through reviewing and comparing with present existing IT-based information systems(PMIS, KMS).

Construction IETM's basic concept is to offer work processes and procedures to related workers and stakeholders. In other word, IETM's basic goal is to be non-papered map provider. This means the IETM should be totally different concept from present information systems which aim to give integrated information to users.

To be different system, developers of IETM should classify data, information, knowledge and processes and procedures. In the short term IETM only deals with processes and procedures. It is because there are many information systems which already dealt with whole part of information. So that IETM is IETM, developers ought to prevent IETM's information from circulating. This feedback makes IETM similar to PMIS and KMS. Also in the long term, IETM makes inner information well organized and structured in accordance with semantic technology. Processes and procedures include complex users, stakeholders and in/outputs. Ontology is one of promising semantic technology. Once the information is organized by ontology. Users can easily get the information and knowledge without wasting time and efforts.

The properties of IETM enables the IETM to be an unique and useful tool for giving processes and procedures to each user. This kind of new concepts makes IT-based construction system more useful and efficient tool for field workers.

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REFERENCES

[1] Junhyung Lee., "IT System Roadmapping Method for General Contractors", p. 1, 2009.

[2] Jungho Yu et al., "Development Framework of Interactive Electronic Technical Manual for Urban Regeneration", pp 2-3. , 2009.

[3] Jong-keon Baik et al, "Implementing Knowledge Managenent(KM) for a competitive engancement in Construction Company", Architectural Institute of Korea, Vol. 19(3), p. 1, 2003.

[4] El-Diraby, T. E., Lima, C., and Feis, B. (2005) Domain Taxonomy for Construction Concepts: Toward a Formal Ontology for Construction Knowledge. Journal of Computing in Civil Engineering, ASCE, Reston, VA., 19(4), 394-406..

[5] Maedche, A., Motik, B., Stojanovic, L., Studer, R., and Volz, R. (2003) Ontologies for Enterprise Knowledge Management. IEEE Intelligent Systems, 18(1), 26-33..

[6] El-Diraby, T. E., Lima, C., and Feis, B. (2005) Domain Taxonomy for Construction Concepts: Toward a Formal Ontology for Construction Knowledge. Journal of Computing in Civil Engineering, ASCE, Reston, VA., 19(4), 394-406.