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Development Framework of Interactive Electronic Technical Manual for Urban Regeneration

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Abstract: Urban regeneration is a large-scale program that must address challenges such as a significant number of involved projects, diverse participants and their conflicting objectives, and a long life span. In an effort to address these issues, the Interactive Electronic Technical Manual (IETM) is applied to urban regeneration in order to provide a guideline to enhance urban regeneration program management. Through a survey, three major functionalities required in the IETM are identified: process map provision, customized information delivery, and communication ability with other information systems. To achieve these functionalities, the development framework of the IETM and the associated technologies are examined.Its characteristics can be sum up ontology-driven metadata, user-oriented process map composition system and so on. Finally, the usage scenarios of the IETM are discussed.

Keywords: urban regeneration, program management, information system, electronic technical manual

I. INTRODUCTION

Urban regeneration aims at the continuous development and growth of a city through the rehabilitation of existing structures, redevelopment of buildings and sites, or the reuse of urban land (European Commission DGXI, 1996; Yu, 2008). However, urban regeneration does not necessarily mean property-led renewal (Hopkins et al., 1997), but rather represents the systematic development to restorea city's infrastructure when, due to its expansion, it can no longer deal with the growing pressure on its economic, social, and physical resources. Thus, urban regeneration must deal with many complex and uncertain issues, which makes it very difficult to manage. For example, urban regeneration involves many diverse projects and thus, managing these projects as a whole is challenging. This is also why urban regeneration is considered to be a 'program', rather than a 'project', which is comprised of many different projects, or sub-components. In addition, urban regeneration can involve a wide range of stakeholders with multiple and often conflicting objectives.And, as opposed to new urban development,in which the major task is civil work, urban regeneration deals with more complex issues such as eco-system preservation and scenery/nature/historic site protection in conjunction with land development, which generates more conflicts between stakeholders' interests. Furthermore, urban regeneration requires a long life span before its completion, which means that it must experience and adapt to political, economic, cultural, and social changes. All of the aforementioned factors make urban regeneration very challenging to manage.

In order for an urban regeneration program to be successful, one of the major necessities is to facilitate how each program participant identifies and manages his/her procedure, process, and other relevant information regarding his/her tasks. In other words, program participants are exposed to large amounts of data, which are scattered in different places;this hinders participants from finding their own ways to process this data for their tasks (e.g., whom and how to communicate to make a decision for a certain case, and what kind of regulation is to be taken into account). Furthermore, the overwhelming scope of such programs (e.g., the number of participants, budget, program duration, and etc.) also means that it may be likely that most participants will not have sufficient experience with such tasks. Thus, effectively organizing such diverse information and providing a process map is essential for the successful execution of an urban regeneration program.

In an effort to address this issue, the writers proposean intelligent information system (i.e., a process map provider) that assists participants in determining how to appropriately manage their tasks. Specifically, the IETM (Interactive Electronic Technical Manual), a technical manual in a digital format, is explored and applied to an urban regeneration program as a main concept for the aforementioned information system.

The paper proceeds as follows: first, the IETM is briefly introduced; this is followed by how the IETM can be applied to an urban regeneration program.

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Then, the IETM development framework is proposed, which utilizes ontology as the core enabling-technology, and how this framework can be implemented is discussed withexamples. Finally, the usage scenarios of this framework are described.

II. Interactive Electronic Technical Manual(IETM)

A. 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.(Kang et al., 2005) 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) (United States Department of the Army, 1999). 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.

TABLE I
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

B. 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 selectedaccording to the definition of each class, which in turn, provides implementation strategies.

C. 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.

III.IETM For Urban Regeneration

Functional Requirements for urban regeneration program management

In order to identify the functionalities that are most required in the IETM, a survey was conducted with 56representative experts from design (13), general contracting (15), construction management (11), ownership (7), research and development (3), and others (7). Most of these respondents have experience in program management (95%) and over 10 years experience in construction (89%).

As seen in Figure 1, the difficulties in program management are the lack of process guidelines and relevant information (46%), complex processes and related regulation (27%), and the lack of experts in program management (20%). Also, 92% and 96% of experts answered that a functionality to give a clear guide on how to process their work and a functionality to provide structured information, respectively, are needed. Thus, it can be inferred that the overwhelming scope of program management, its involvement in the different

characteristics of stakeholders, and lack of experience, has hindered participants in executing their processes. On the other hand, many of the experts responded that a sort of information system for program management exists (82%). However, a considerable amount of respondents indicated the information system as the factor that least affects the decision making process (40%), which may imply that the current information system is not very helpful for the decision making processes involved in program management. Another notable result is that 94% of the experts responded that the functionality of a check-list for their process management is needed. This can also be interpreted as a lack of confidence in their process management for such a large and complex program.

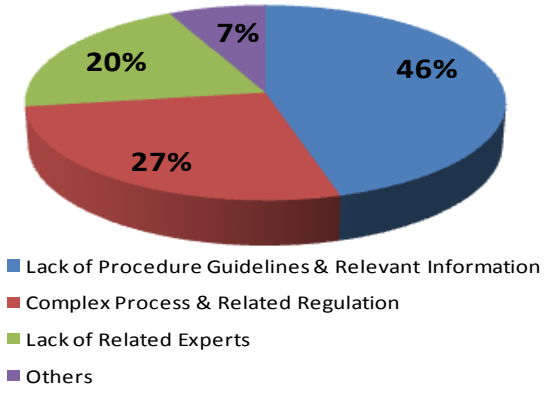

FIGURE I
DIFFICULTIES IN PROGRAM MANAGEMENT

FIGURE II
SURVEY RESULTS OF FUNCTIONAL REQUIREMENTS (EXPERT ONLY, MAXIMUM ANSWERABLE NUMBER IS 3 PER PERSON)

Based on these results, three major requirements are selected for the IETM that will enhance the urban regeneration program: (1) process map provision; (2) customized information deliveries; and (3) communication with other management systems.An elaboration of these requirements follows.

A. Process Map Provision

One of the most significant functionalities required is to provide users with a road map that shows them how they can process their work (e.g., procedure, its related regulation or permit process, and any responsible parties). Taking into account complex processes in program management, supplying information for the work, which a typical Management Information Systems (MIS) does, is not sufficient because the user has to re-process the information to determine how to perform his/her work, which may not guarantee its usefulness in the situation at hand. In this context, providing a process map is regarded as one of the most significant requirements for the urban regeneration program.

B. Customized Information Delivery

As previously discussed, different stakeholders are involved in the urban regeneration program. These stakeholders have different objectives, interests, work types, and etc. Thus, a system that is able to provide customized information by recognizing the user's role in the program would be a great asset. For example, if the program manager accesses the system, how different projects are coordinated would be his/her interest, while how to report the performance of the project to the program manager would be each project manager's interest. This customized delivery is particularly needed because the complexity and large-scale of the program entails that too much information related to its management is available. Thus, it is essential that the system provides only relevant information to the right people, subsequently preventing information overloading.

C. Communication with Other Information Systems

As shown in the survey, most stakeholders in the program maintain their own MIS (82%). In other words, there is no need to develop an independent information system for program management; rather,a functionality that can communicate with other information systems is essential. For example, a user would be interested in detailed information (e.g., phone number for regulation inquiry) after obtaining how to process his/her work. In such a case, the proposed system would collect the necessary information from other independent information systems and provide the user with it. This would also maximize the use of existing information systems, while lessening the burden of developing a completely new information system.

D. IETM Development Strategies for Urban Regeneration

Based on the identified requirements, the proposed IETM targets Class V. In terms of the level of interactivity, the identified requirements clearly call for intelligence that can connect diverse information sources, reason about the right procedure for a user,and provide other relevant information for that user. This can be matched with Class V's intended functionality, the single presentation of multiple information resources (see Table 1), which allows different applications to access other domains' information. In this way, the proposed IETM can create a process map or obtain any needed information by accessing and extracting different domains' information. Additionally,customization can be efficiently performed because one rule can be applied to any situation without worrying about communication.

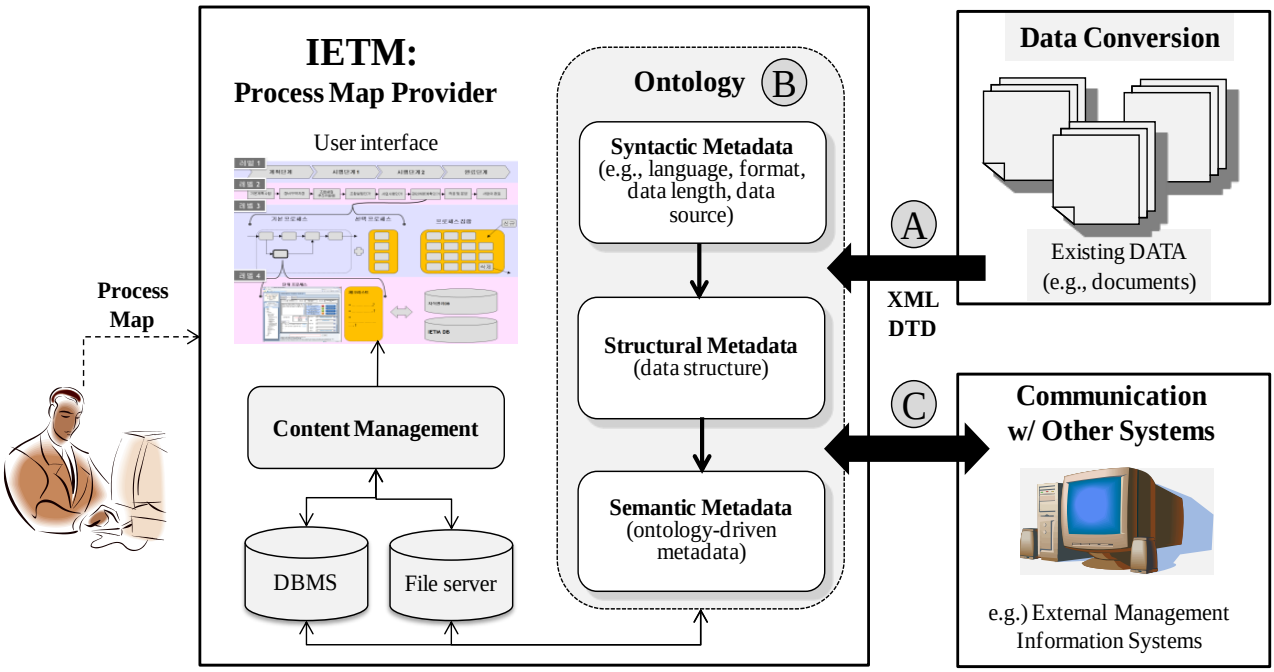

FIGURE III
IETM DEVELOPMENT FRAMEWORK

IV. IETM DEVELOPMENT FRAMEWORK

In order to target Class V, a development framework is proposed as shown in Figure 3. As discussed, in this research, the primary objective of the proposed IETM is to provide a process map. To this end, first, all existing data and documents that contain process information (e.g., data and documents that contain process information (e.g., procedure, regulation, and involved parties) need to be understandable within the IETM, regardless of their format. Thus, all data are converted to the Extensible Markup Language (XML) with its standard Document Type Definition (DTD) exclusively defined for urban regeneration, as denoted by A in Figure 3.

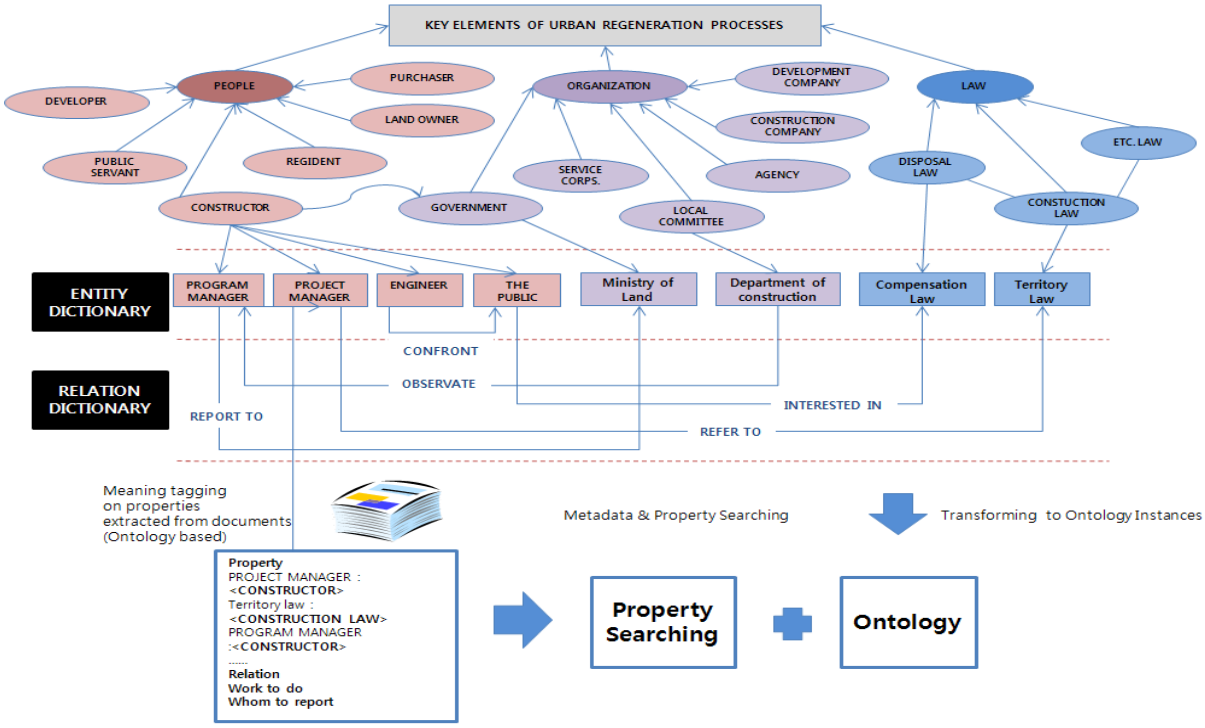

FIGURE IV
ONTOLOGY FOR PARTICIPANTS IN URBAN REGENERATION PROCESS

Next, once data are stored in a structural way, all the process information along with its relationships need to be well-classified, standardized, and structured, as denoted by B in Figure 3. This is because information for urban regeneration 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. 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 [Maedche et al. 2003]. Each ontology can represent the knowledge and processes of a certain domain or discipline. In addition, the integration of such ontology provides a frameworkfor 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 [El-Dirabyet al. 2005]. 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 4 shows an example of the ontology developed for the participants in urban regeneration. In addition, such ontology enables the IETM to connect other information systems as denoted C in Figure 3.

Finally, to function as a process map provider, the IETM enables the design of different process maps for any level of work. To do this, the IETM further classifies the processes—which have already been well-classified, standardized, and structured—by dividing them into a Universal Process (UP) and a Special Process (SP). A UP is the type that can be applied to a typical urban regeneration program, and it would not be changed. In the other words, a UP is more general process which can be basic structure of process composition of urban regeneration procedure. Examples of a UP would be preliminary planning, permit, procurement, and construction. Also, UP structure mainly bases on related regulations or basic program management theories. On the other hand, a SP is customized to each project, and it can be added to or changed by the corresponding authority. SPs would include the detailed procedures, information, and knowledge involved in executing a process. Both UP and SP can have several levels, which follows the previous structure. Particularly, the lowest level is a Process Unit (PU) that has all detailed information on how to execute each task. Combining different PUs will enable to create a procedure customized for the user. In this sense, the IETM is a user-oriented platform with which the user can create the process map. As well, once the process map is created, the IETM functions as the process manual with which the user can obtain relevant information.

V. IETM USAGE SCENARIO

A. Administrator

The administratormanages the proposed IETM and is responsible for understanding the structure of IETM and the characteristics of program management for urban regeneration. His/her biggest task is to create the process map for different types of work and for participants in the program. The administrator also maintains and updates the process map based on any changes received during program execution. Figure 5is ascreenshot that shows how the process map can be created. For example, different levels of processes in a UP and SP can be modified (A in Figure 5) and PUs can be attached to each process (B in Figure 5).

Furthermore, the administrator's role is in line with the role of a Project Information Officer proposed by Froese (2005). Froese has argued that great effectiveness and efficiency in construction management, expected from a wide range of new computer-based tools, should be accompanied by enhancements in information management. Thus, the role of the Project Information Officer is to create, or signifyprocess composition and take responsibility for information management. This idea is extremely suitable for the management of an urban regeneration program due to the complexity of information management involved in such a large-scale program. Thus, an administrator is considered as the Program Information Officer in urban regeneration. Particularly, taking into account the functionalities required in the IETM (e.g., creating a process map), the role of an administrator is essential.

B. Users

Userswill utilize the process map created by the administrator. However, they can also create or customize their own maps as can the administrator. In this way, their specific expertise and learning can be used for their process map and simultaneously shared with other users who will benefit from this knowledge.

The user can be a manager (e.g., program or project), field personnel, and others such as owners or the public. They may have a different usage scenario of the IETM. For example, the primary interest of the project manager is to identify the relationships between different processes and their sequences so that they can manage these processes; this information can be obtained from navigating the process mp in the IETM. In addition, if a project manageris dealing with conflict, he/she can obtaindiverse information about conflict management as shown in Figure 6. On the other hand, the field personnel actually execute each task. In their case,they look for the

procedure and other related information (e.g., specifications and checklist) for their tasks. Similarly, others (e.g. the public) can also obtain necessary information, as long as they have access privileges which reflect their role and responsibilities.

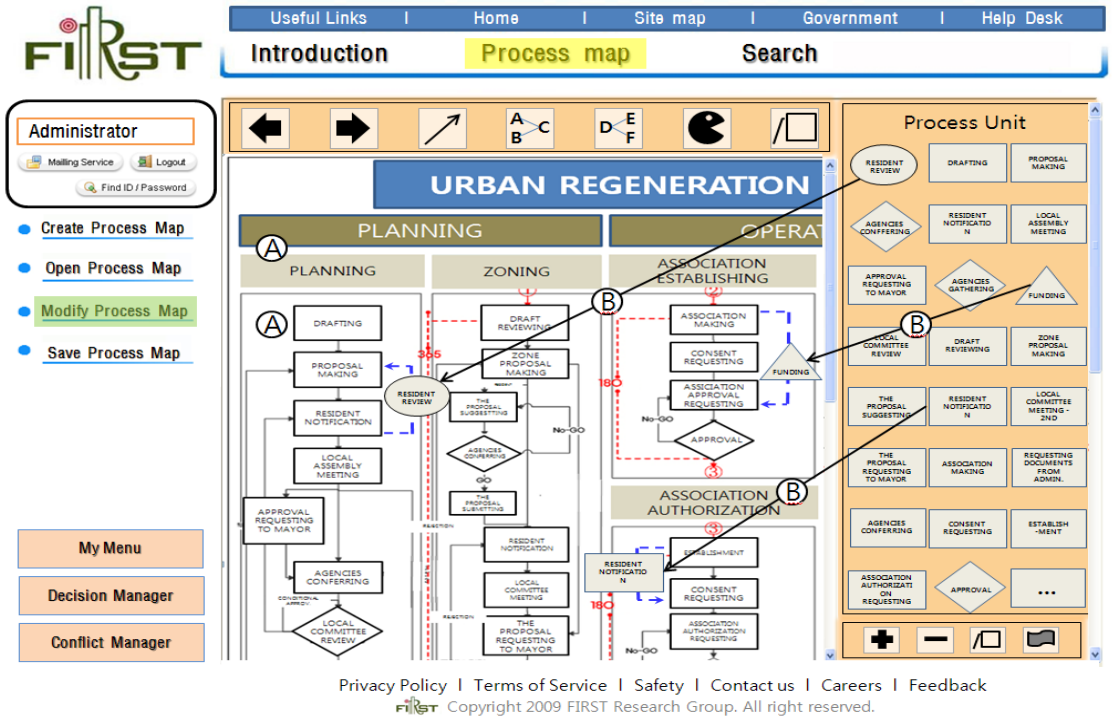

FIGURE V
IETM USAGE SCENARIO FOR THE ADMINISTRATOR

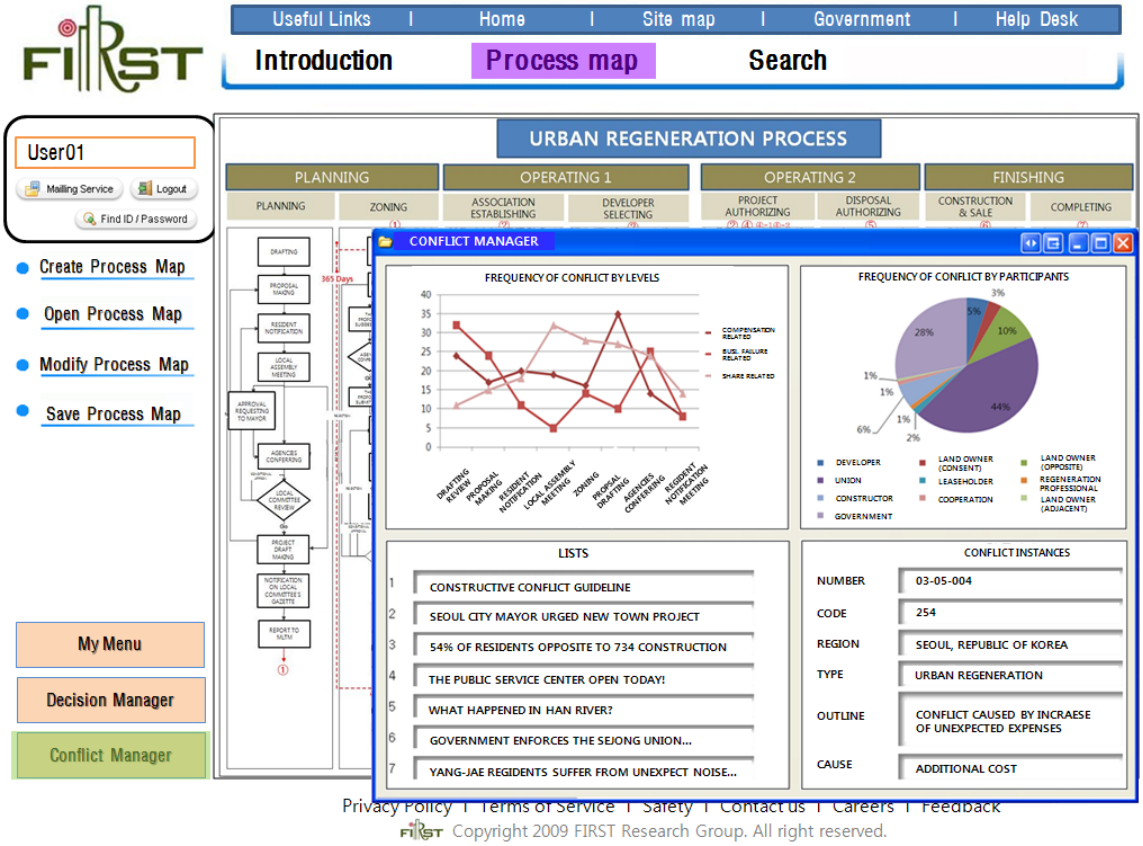

FIGURE VI
IETM USAGE SCENARIO FOR THE USER

VI. CONCLUSION

In order to deal with the challenges involved in managing urban regeneration programs, such as a significant number of projects, diverse participants with conflicting objectives, and a long life span, an enhanced IETM is suggested in this study. To extract functional requirements, this study conducts a survey and interviews of workers and experts in construction field. As a result, the IETM, which can guide users in how to execute theirwork, is applied with the functionalities of process map provision, customized information delivery, and communication with other information systems. The system also has a potential to play a role a higher level of information management system of urban regeneration programs between other project level information systems through the way of interactivity.

However, although the proposed IETM exhibits great potential for the effective management of urban regeneration, it still needs to be validated through case studies. Currently, its prototype, which is under development, will consequently be tested in an actual urban regeneration program. Through this process, the IETM will be corrected and enchanted. Based on those developments, the IETM is expected to be more effective supporting tool on program management.

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