

Process-based Integrated Knowledge Management System Prototype for Plant Projects

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Gas & Oil plant construction projects are increasing recently all over oil-producing countries. An EPC (Engineering, Procurement and Construction) company, which participates in the plant projects, should possess pertinent engineering licenses and EPC management techniques to create high added-value. Nonetheless, there exist various risks involved in the EPC life cycle process due to such characteristics of construction projects as long duration of construction time and complicated processes along with the procured goods or services subjected to various logistics. The objective of this paper is to analyze the overall EPC processes and to develop integrated information and knowledge Management system prototype. Additionally, the principal data for the analysis of the EPC process are derived from personal interviews with experts and specialty contractors of the plant projects. The results of this study would be widely used as a guide for efficient and effective management of overseas gas plant projects.

Keywords—LNG plant, process, life-cycle, information & knowledge management

I. Introduction

(1) Research Background and Purpose

New purchasing orders in gas and oil plant industry are continuously increasing, especially, in the Middle East region. This decrease in business investment stemming from world economy decline has turned to be the driving force for promoting the gas plant project from the perspectives of securing long-term and stable income and economic diversity. Gas and oil plants require various license management and technologies for the manufacturing and handling processes. Additionally, the efficiency of engineering, procurement, construction(EPC), pilot operation and business process management determines the success or failure of the business.

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Moreover, the market for the original technology for the generation of high added-value in the planning and basic engineering design is dominated by a few leading construction companies. Then, the efficiency of the business conducted by minor companies and their possessed technology should be enhanced in order to strengthen their competitive power. Many experts pointed out to focus on the improvement of the life cycle process and efficiency management for this end purpose. This study analyzed the EPC process and the relevant knowledge management technique for the development of integrated information and knowledge management system in the plant projects.

(2) Research Method and Scope

LNG (Liquefied Natural Gas) plant construction projects are increasing recently. The reason for this is the oil producing countries in the Middle East are promoting LNG projects despite its high cost based on the prospect that the oil price will not recover to its level several years ago due to the decreased demand for oil stemming from global financial crisis. This study analyzed the key factors for the development of knowledge management system for LNG plant construction projects from the perspective of EPC (Engineering, procurement, Construction) companies.

This research was conducted in the following sequence.

(1) The preliminary study for the development of knowledge management system for gas and oil plants and analysis of recent trend of gas plants.

(2) The EPC data of major companies in Korea were collected and analyzed in order to derive the standard EPC process of overseas gas plants. Experts from five major companies with excellent overseas construction business records provided the data for the EPC process and its in-house computerized system. These data were used for the analysis of this study.

(3) IDEF0 model was used to process these collected and analyzed input and output information of the business process for the final production of necessary input and output information as well as the documentation in order to derive the major points of each business process stage systematically from management perspective.

(4) Finally, the prototype for the Information and knowledge management system is proposed.

II. Preliminary Studies

A. Literature Review

The research trend for plant construction has generally focused on the current status of Korea and overseas plant construction market and its long-term development through the market prospective. First of all, there is a research on the characteristic analysis of the entrance of construction companies in Korea to overseas construction market (Kim, Jin Wok, et. al. 2007), but it focused on super high-rise building rather than gas and oil plant. The majority of researches in this field are exemplified as follows. Song et. al. (2007) investigated the method for the introduction of technical management of oil and gas plant industry for sharpening the competitive edge. Lee et. al. (2006) examined mid-term and long-term technology development support and analyzed the issues for strengthening competitive power as a strategy through the analysis of current status of overseas plant construction field. In overseas, Chang et. al. (2004) studied on e-procurement for computerization of purchasing/procurement process, but it dealt with general application and implementation and not specific case of plant projects. Additionally, Puschmann et. al. (2005) introduced the concept of e-procurement systems and management of indirect goods supply chain. Thus, most of the research on the management of plant construction projects focused on the development of a management system grafting IT technology to practical construction knowledge and experience for the management of complex overseas plant projects.

B. Trend of Plant Projects

Plant industry refers to facilities industry manufacturing raw material or work-in-progress material and final product for the producer. It is a knowledge-intensive industry with high economic value generation, and it can be regarded as a fusion industry between manufacturing and service industry. The purchasing order for overseas construction amounts to \$47 billion dollars (USD) as of 2008, and it has continually increased since 2003. Plant business amounts to \$26 billion dollars (USD) and accounts for 56% of the total construction purchasing order. It has shown a bullish tendency since 2007. This plant project generally adopts EPC purchasing order method, and the technology competition and the cost for raw material and equipment determines the competitive power. Additionally, this industry is characterized by the project management and comprehensive knowledge management determining the loss and profit as well as the overall success and failure of the business. Many owners and stakeholders in overseas are recently investing actively on PLM (Plant Life-cycle Management), and major domestic companies are also investing on this management since several years ago.

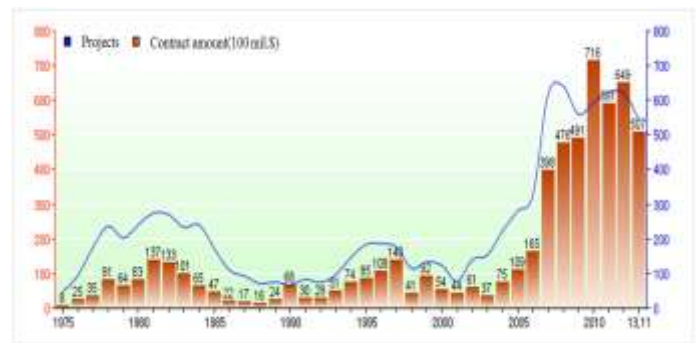


Figure 1. Status of overseas construction contracts

This change is evident due to the fact that, although those owners and stakeholders want to apply the knowledge information extracted past work data to PLM right away during order placement, actual information and knowledge by each department are often lost and segmented, causing serious loss of time and expense. This means that, although the optimization of the business process during total life cycle is important, the management of information and knowledge acquired during each stage of the business is also important.

III. Information & Knowledge Management

A. Trend of the relevant technology and the industry in Korean and overseas

Such techniques as CII and FIATECH (Fully Integrated and Automated Technology) are management techniques for LNG plant and have reached their mature stage of initiating the development of their international open standard through advanced design automation and purchase automation.

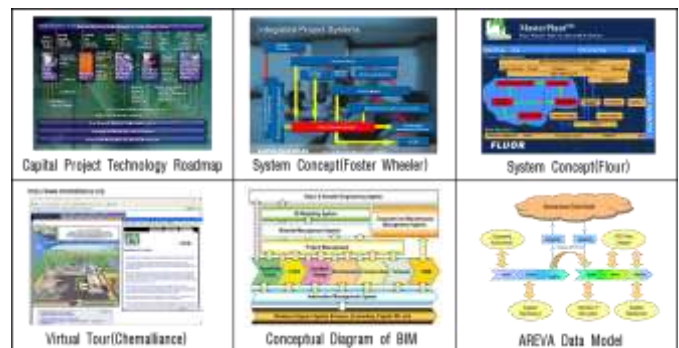


Figure 2. Relevant Trend Analysis

Additionally, NIST (2002) computed the cost of inadequate interoperability of the information shared and used throughout the life cycle to be about \$15.8 billion US dollars for the case of facilities industry. CII is in the process of solving this problem through FIATECH (Fully Integrated and Automated Technology). In other words, the aim is to develop business management foundation and core (essential) technology for the automated and fully integrated environment throughout the entire life cycle of the construction business

including planning, design, engineering, and management stages.

B. Analysis of Business Process

This study classified the life cycle as follows for the analysis of LNG plant business tasks.

- Planning : bidding, quotation, contract
- Design : basic design, detail design (real-time design)
- Purchase and Procurement
- Construction and Pilot Operation

Among these categories, the purchase and procurement stage, which affect the success and failure of the business the most and account for the largest business cost, are used as an example to explain the research progress for the business process analysis. Additionally, there is a characteristic requirement for all architectural construction and, especially, for the plant. It is to procure and deliver the procured goods, i.e. all items in the equipment list and MR list (which are planned in the initial stage of the business) to the construction site pursuant to the procurement requirement of appropriate time, price, place, quantity and quality and in accordance with the field process schedule. Plant construction encompasses unique business process and handling process by the type of the product, and there exist different characteristics for the business process of each domestic leading company by the prioritized plant type. Nonetheless, most companies evenly entered into the subject of this research, i.e. gas and oil plant, and did not manifest a noticeable difference in the result of the business process analysis.

Standard purchase/procurement process refers to the process of analyzing the purchase/procurement process to derive the common tasks from the overall process and changing or adding it at will to make it fit to the characteristics of the particular project.

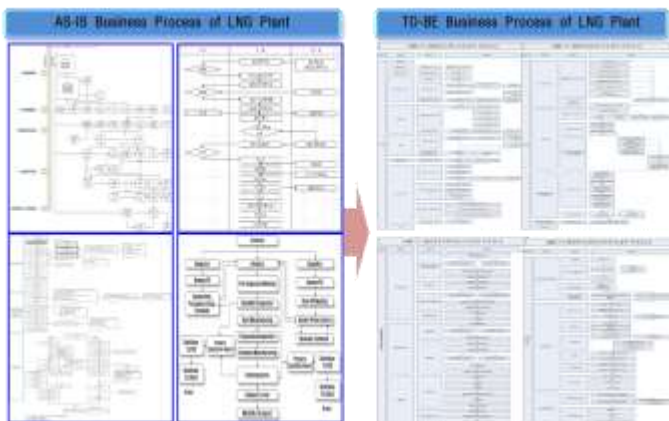


Figure 3. Process Mapping of EPC

Plant projects are mainly classified as engineering, procurement, and construction(EPC). Figure 3 illustrates the entire process for EPC, and the business process are divided into the various stakeholders.

C. Data Modeling using IDEF0

Although the process map appropriate for procurement tasks makes it easier to grasp the overall flow of the business tasks, it has its shortcomings in determining the detail task information required by each important activity (i.e. the contents of input and output documents and major management items). IDEF0 was used to list detail information of each activity to deal with this problem.

Figure 4 illustrates input and output information analysis for detail business activity as shown in figure 3. Purchasing is divided into the four mid-level activities, and these activities are further divided into fourteen low-level activities.

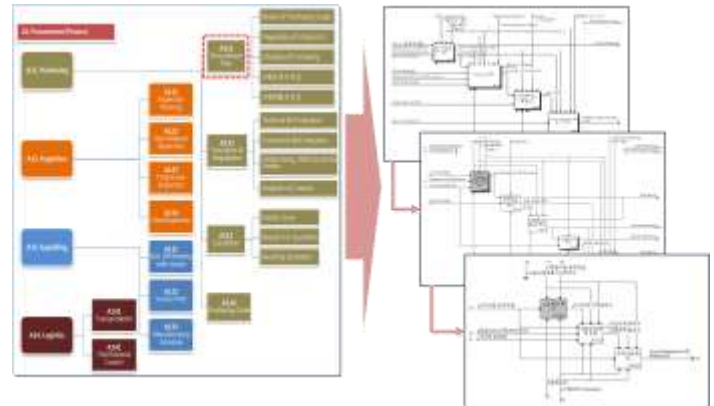


Figure 4. Data Modeling using IDEF method

Thus, the level of activities were gradually lowered (or, detailed) to analyze the knowledge and information throughout the entire life cycle.

IV. Development of Information & Knowledge Management System

A. Development Concept

Plant construction is a complex project performed by a group of experts from various fields. Accordingly, it is important to materialize the information data based on the knowledge and experience acquired for a long time and to make it a knowledge system. The knowledge acquired throughout the life cycle is analyzed and systemized based on the business process to make it a map. Then, this data map is used for building the database by the knowledge type. The accumulated business knowledge can be used in carrying out a project through the server of the plant company connected to anywhere in the world by internet web technology. Figure 5 illustrates a simplified conceptual diagram for plant knowledge management system development.

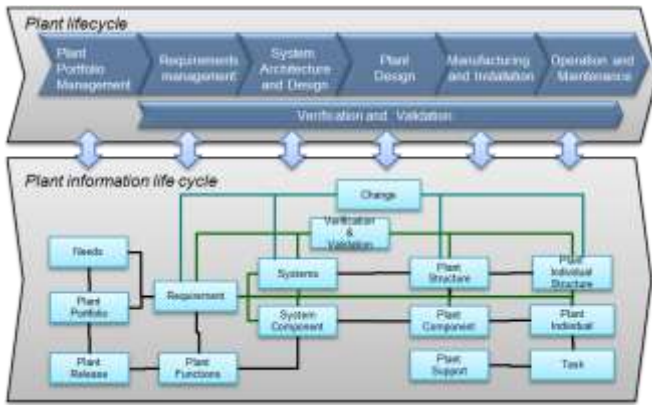


Figure 5. Concept Diagram of Information & Knowledge Management during Lifecycle

B. System Prototype

The information system being developed in this study starts with dealing the general agenda of input and management of overall project information and is classified into the stages of EPC. Then, the first prototype development is completed by building detailed agenda for each category.



Figure 6. Integrated System Prototype Concept

v. Conclusions

This study analyzed the business process of LNG plant throughout its life cycle, and the pertinent knowledge and information were identified for the development of knowledge and information management system to be used anywhere in the world easily. This study aimed at improving the business management ability and knowledge/information management ability, which is one of the weakest area for minor companies participating in LNG projects, so that they can be better equipped for global competitiveness. The study also aims at improving the bidding power for higher added-value field in the long run. Since this is the later stage of our research, the missing parts will be actively supplemented. The study also plans to build a comprehensive knowledge management system throughout the life cycle as its final objective.

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