The Development of The Lifecycle Function Model By IDEF0 For Construction Projects

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Abstract—The integrated information system is an integral part of the integrated management for construction projects. Based on the analysis of the problems of the current construction project information system and the characteristics of the phases of the construction lifecycle, this paper develops a lifecycle function model for construction projects by the IDEF0 modeling technique that is usually used in the complex industry design. This model could serve as the foundation of developing the all-phase integrated management information system and contribute to the development of the integrated management theory.

Keywords—Construction project; Lifecycle; IDEF0; Integrated management

I. INTRODUCTION

With the rapid development of modern information technology, innovation of management theories and changes of social environment, there are more and more large-scale and complex construction projects. The process of construction project is a construction-aimed one composed by interrelated activities that have commencement and completion dates. The final goal of the process should accord with the preconcerted needs of utility and satisfy the constraints of quality, time, cost and resources required by specifications or owner’s requirements. Compared with general manufacturing industry, construction project calls for high-level resource integration. In fact, because of the difficulties of information integration in information system, it is required to develop an integrated information model for construction projects.

II. EXISTING PROBLEMS OF INTEGRATED INFORMATION SYSTEM

Generally speaking, two basic problems should be considered in the integration of information system. One is how to solve the problems of information exchange between different communication protocols. The other is the content of information, hierarchy and flow that information system needs to integrate. Similarly, these two problems also exist in the integrated management information system for construction projects.

To solve the first problem, one can add hardware or develop an exchange service for communication protocols with the software interface. The function of the exchange service is to transfer information among construction hardware equipments. However, suppliers and customers of integrated systems usually lack consideration of the latter problem which is more significant because the analysis of the content, hierarchy and flow can have influence on decisions of the supervisors and directly determine the final construction performance delivered to owners[1]. With IDEF (ICAM DEFinition method) often used in system modeling[2], the lifecycle function model for construction projects are built and the content and hierarchy of information system integration are analyzed in this paper. Therefore, the information demands are identified and the solution to the second problems is proposed.

III. FEASIBILITY ANALYSIS OF IDEF0 MODELS OF CONSTRUCTION PROJECTS

A. Basic Concept of the IDEF0 Model

An IDEF0 model, usually applied in the complex industrial design, is composed by a number of activities. Each activity has the following properties as shown in Fig. 1[3]:

1) Inputs and outputs representing the information exchange between activities.
2) Controls that constrain the execution of activities depending on runtime value comparison and on activity states.
3) Mechanisms where an action can be defined to perform.
4) Call Arrows used when an activity is needed to call another activity that is already modeled in another IDEF0 model.

Figure 1. Process Model in IDEF0 Notation

The basic idea of IDEF0 modeling technique is a structured analysis, which is used to build the model by decomposition...
from top to bottom strictly. According to the level of decomposition, the activity can represent the whole process, a sub process or an atomic activity. The main function is explained on the top and definitive details are gained through analysis in each level. All models are similarly inside[4], as is shown in Fig. 2.

Figure 2. Decomposition Structure of IDEF0

B. Characteristics of Construction Projects

Construction project is a temporary endeavor, and the uncertainty is prevalent during its lifecycle. Thus, the project execution organization usually divides the projects into some project phases to facilitate more effective management and to build appropriate relationship with the continuous operation of project execution. Each project phase is characterized by the completion of one or more deliverables which are any verifiable items that must be produced to complete the project, such as project feasibility study, detailed design, etc. Deliverables and phases are common and logical parts that assure correct definitions of products.

C. Applicability of IDEF0 in Modeling of Construction Projects

As a very special product, the construction process becomes much complicated. Furthermore, the number of unforeseeable factors increases to a large degree due to the open system. In order to build an integrated system, the information and process of construction projects need fully understanding and the scope and information during the lifecycle should be comprehended[5]. Thus, the whole process of the construction projects can be clearly defined if IDEF0 is used to model construction projects.

Through the application of IDEF0, people can deeply understand the lifecycle of construction projects from initiation, design and construction to operation and realize the integrated management of construction projects.

IV. DEVELOPMENT OF THE LIFECYCLE FUNCTION MODEL FOR CONSTRUCTION PROJECTS BY IDEF0

A. Definition of phases in the Construction Project Lifecycle

The lifecycle of projects refers to the whole process from project conception to project completion. There are four phases in lifecycle of construction projects[6][7]: initiation, design, construction and operation. Each phase can be divided to subprocedures, which are shown in the Fig. 3.

1) Project Initiation Phrase

In this phase of initiation, through the analysis of investment opportunity, feasibility study and project evaluation, varied plans should be carefully compared and the necessity, possibility, time and implement of project investment should be scientifically determined. Although not a huge workload, the phase is crucial to the overall control of project investment.

2) Project Design Phrase

Design includes conceptual design, preliminary design, detailed design, and preparation of contract, etc. This phase is the concretion of strategic decisions, which determines whether the project can be completed successfully and achieve the original goals with high efficiency.

Figure 3. Lifecycle of Construction Projects
3) Project Construction Phrase

The main task of construction is to put the blueprint into reality and achieve the goals of investors. Therefore, the project goal should be high-efficiently accomplished within the limit of the given time, quality and cost. This phase spends the largest amount of manpower, material and money and requires the heaviest workload. As a result, it is the most difficult for the project management.

4) Project Operation Phrase

The phase of operation should comprise but not be limited to test on completion, commissioning, maintenance, post evaluation and dismantlement. Even after the commissioning of the project and the owner’s taking over, project management still can not be ignored in the step of the project maintenance.

As different parts of a whole system, the above phases of the project lifecycle are interrelated as an indivisible integration.

B. Establishing the Lifecycle Function Model for the Construction Project

As is shown in Fig. 4, the lifecycle model of construction project can be divided into four function modules: initiation module, design module, construction module and operation module. The outputs of each function module are the inputs or controls of the next function module. The inputs of the lifecycle are existing projects including the project entity and the past data related to projects. The controls are owner's requirements and pertinent laws and regulations during the operation of all modules. Correlative facilities and human resources are the mechanisms of the model. Product, which is the goal of construction project, is the final outputs. If the design or construction does not meet the anticipated requirements, the project should be redesigned or reconstructed until these standards are satisfied. Only in this way can the next module be inputted.

C. Analysis of the Construction Modules in the Lifecycle Function Model

The specific analysis of the construction module is shown in Fig. 5. The construction module can be divided into five submodules: selection of constructors, preparation of construction methods, civil construction, equipment installation and test on completion and commissioning. The outputs of each submodule are controls or inputs of the next submodule. The original inputs are current facilities. Controls include owner’s requirements and pertinent laws and regulations given in A0 diagram, as well as contract documents and final design scheme produced in the design module. Correlative facilities and human resources are defined as mechanisms. The outputs of this model are the completed projects and relevant information. Civil construction, equipment installation and test on completion and commissioning are three sources of the information of completed project. Unqualified projects in the process of civil construction and equipment installation should be reworked until the projects and information meet the requirement of controls.

The construction module is taken as an example in this paper, and the other modules will not be analyzed due to the similar decomposing procedure based on the analysis of all phases of the construction project lifecycle. It is necessary for these modules to be progressively decomposed in order to build up a feasible and practical lifecycle function model for construction projects.
V. CONCLUSION

A. Contributions to the development of Integrated Management Information System for Construction Projects

Developing the lifecycle function model for construction projects by IDEF0 is a way to explicitly understand the functions, inputs, outputs and relationships of the modules in the project lifecycle. Therefore, the integrated management information system developed based on the model will contribute to the fulfillment of the integrated management of the whole process, omni-bearing and whole staff, and the improvement of the overall management level for construction projects especially large-scale ones, as well as the overall economic and social benefits.

B. Further Research

Though this paper puts up with the method to develop the lifecycle function model for construction project, the model built by IDEF0 above needs to be further embodied and improved to construct the models of information classification and information integration according to characteristics of the different construction projects. Therefore, in the future, the function descriptions of all phases for construction projects should be more specifically clearly identified. On the other hand, due to the defects naturally existing in the IDEF0 model, the effective development of integrated system for complex or mega construction projects should require more than one modeling technique, and thus how to combine the function model developed with other modeling methods and other models is one possible research direction.

REFERENCES