Study on The IDEF0 Model of EPC Interface Management Based on BIM Platform

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Abstract: In recent years, with further research on engineering-procurement-construction（EPC）project contracting mode, it is found that different participants with different goals are interwoven in an intricate system, forming the interface between various organizations and affecting the project progress. Based on this, the digital integrated system represented by Building Information Modeling（BIM）develops rapidly to solve the problems of interface management in engineering projects. In order to better understand EPC interface management, this paper analyzes the causes of interface problems and constructs EPC project process model through IDEF0 modeling language. Finally, summarizes the critical nodes and their specific contents based on BIM platform, providing reference experience for subsequent research on EPC interface management.

Keywords: Engineering-procurement-construction (EPC), Building Information Modeling (BIM), Interface management, Project management

1 INTRODUCTION

1.1 EPC Project Overview and Advantages

In recent years, with the rapid economic development in our country, it has become particularly important for the stakeholders in the construction industry to further work closely together and break through communication barriers. Therefore, the general contracting mode of EPC projects arises at the historic moment, and is rapidly developed and promoted in the world.

EPC projects contain three important links, namely: Engineering-Procurement-Construction. Among them, in addition to traditional design, engineering also includes the overall planning of the entire project and the specific related work in the construction process; Procurement not only refers to the traditional sense of construction equipment and materials procurement, but also needs to further purchase professional equipment, materials, etc.; Construction includes construction, installation, test testing, etc. Under this general contracting mode, the general contractor signs a general contracting contract with the owner, and is responsible for the engineering, procurement and construction of the entire project in accordance with the relevant provisions in the general contracting contract, and assumes responsibility for the safety, quality, construction period and cost of the project. During the implementation of the project, the general contractor is allowed to subcontract part of the work to the subcontractor within the scope of compliance, but the subcontractor remains responsible to the owner. Figure 1 shows the structure diagram of EPC general contracting mode.

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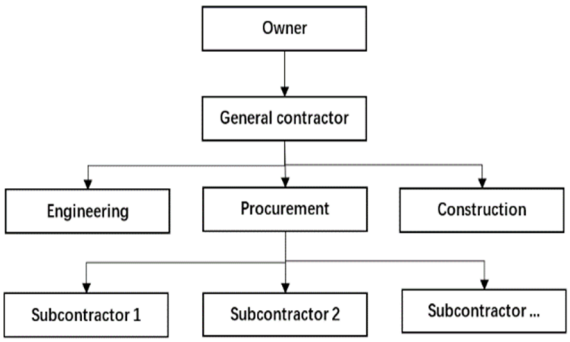

Figure 1: EPC general contracting mode structure diagram

Compared with other engineering modes, the advantages of EPC package mode are as follows [10]:

(1) Clear delineation of work scope and responsibilities. In EPC mode, the owner, as the owner, signs a general contract with the general contractor. The owner does not bear the risk, but mainly transfers the risk to the general contractor. Due to the characteristics of general contracting, once risk problems occur during the implementation of the project, they can be found in time, managed and corrected in a unified manner, and greater hidden dangers can be avoided. This has an important positive effect on achieving the objectives of all stakeholders.

(2) Overall management and close cooperation. According to the characteristics of EPC projects, it can be found that the general contracting mode has changed the previous predicament of each subcontractor contracting independently, which leads to communication obstacles. It organically integrates all stakeholders in the whole project, opening up communication channels, working closely together, unifying management and supervision, greatly reducing unnecessary trouble in communication, increasing work efficiency, and shortening the construction period.

(3) The scale of investment costs will be better controlled. As EPC general contracting mode considers engineering and construction from the perspective of overall planning, it can significantly improve the economy of engineering projects and reduce unnecessary cost input, which is very good in terms of value engineering.

1.2 Overview of BIM Platform

BIM is the abbreviation of Building Information Modelling. Its core is to establish a virtual three-dimensional model of building engineering and use digital technology to provide the model with a complete and consistent building engineering information base with the actual situation. The information base not only contains geometric information, professional attributes and state information of architectural components, but also includes state information of non-component objects (such as space and movement behaviour). With the help of the three-dimensional model containing the information of the construction project, the information integration of the construction project is greatly improved, thus providing a platform for the relevant stakeholders of the construction project to exchange and share the project information.

By using a unified digital information management platform, it can achieve the purpose of breaking the professional barriers at all stages of decision-making, design, construction and operation of construction projects, realize the data synchronization and supervision of all

construction units throughout the life cycle of the building, and provide new ideas for improving the efficiency of engineering projects.

1.3 Project Interface Management

1.3.1 Definition of Project Interface and Interface Management

In the field of engineering, different scholars have different definitions of interface. According to Diao, interface refers to the interaction between enterprises, departments and members, or between machinery, equipment, software and processes in terms of communication and connection of various key elements in order to deal with a certain problem and task [2]. According to Wu Tao, interface is the sum of the contact mechanism between integrated units and the medium, channel and carrier of communication between organizations and the external environment [8].

Regarding the definition of interface management, according to the Building Industry Institute (CII), interface management is defined as "the management of communication, relationships and deliverables between two or more people (e.g., contractors, designers and owners)" [4].

1.3.2 Classification of Interface

Pavitt divides interfaces into three categories: physical, contractual, and organizational [5]. J.lan proposed three types of functional interface, physical interface and organizational interface [3]. Stuckenbruck identified three main interfaces: the personal interface, the organizational interface and the system interface [6].

1.3.3 Causes of The Interface Problems

Clarifying the causes of the interface is helpful for the subsequent research on the key influencing factors of the interface management of EPC projects based on the BIM platform. Using the literature review method, four main reasons are extracted: information reason, goal difference, cultural difference and professional difference [10].

(1) Information reasons

Most of the interface problems in engineering projects are related to "information", which is why it is particularly important for digital information platforms represented by BIM to share data. Due to the problems of accumulation, time difference, loss or deformation of information in the process of transmission, information causes are divided into three categories: information "stickiness", information delay and information distortion and loss.

(2) Differences in goal

Goal variance refers to the differences between interface related participants at different levels, such as personal goals, departmental goals, and organizational goals. The difference in the goals of the interface stakeholders may make the interface participants understand the task differently. When the difference in goals causes serious interface conflicts, all parties to the interface may give up the interests of the collective organization and pursue the maximization of the interests of themselves and their representatives, thus plunging the project organization into a state of chaos.

(3) Differences of cultural

Culture is the concentrated embodiment of personal values, preferences, and other concepts. Differences in cultural backgrounds also diverge people's values, making contact with questions about the behaviour, expression, and language of others. Without adequate communication, it is possible to leave doubts in the hearts of both parties, thereby destroying a good cooperative relationship. Therefore, cultural differences can cause interface barriers.

(4) Differences of major

Business units contain professionals of different specialties, and due to the differences in different professions, members will inevitably have different views on the same task and things, and explain and deal with them according to their professional knowledge. Therefore, in the process of cooperation, people from different professions have different insights and behavioural orientations, which creates conditions for the emergence of interface barriers. Therefore, professional differences will lead to more serious interface conflicts in a short period of time.

The causes of the above four interface barriers are both independent and interactional, which will increase the diversity of interface forms and bring great difficulties to interface management. Exploring the causes of interface barriers or contradictions is the basis of the research on the influencing factors of interface management, and will guide the direction of the subsequent research.

1.4 IDEF0 modelling language

1.4.1 Introduction of IDEF0 modelling language

IDEF0 language is one of the IDEF method groups. It is a method to describe the various elements in a complex system and the interrelationship between the elements in a structured and graphical way of expression. Through the analysis of the logical relationship and content composition of the system, it decomposes the complex system from top to bottom into an active unit with clear logic and simple structure. It has the characteristics of simple operation and easy to understand, so it has strong applicability[9].

1.4.2 Overview of the IDEF0 method

The IDEF0 model is a series of graphics, arrows, and text that describes complex activities by breaking them down step by step. The information represented by the arrows mainly includes input, output, mechanism and control[1].

Input: The arrow on the left side of the box mainly represents the prerequisite for the activity, such as material resources, information resources, etc.

Output: The arrow on the right side of the box, mainly represents the output of the activity after processing and adjustment;

Control: The arrow on the top of the box, mainly represents the activity in the process of completion will be subject to various constraints;

Mechanism: The arrows at the bottom of the box mainly represent the various tools needed to complete the activity, such as the relevant participants and relevant equipment needed. The approximate composition of the IDEF0 model is shown in Figure 2.

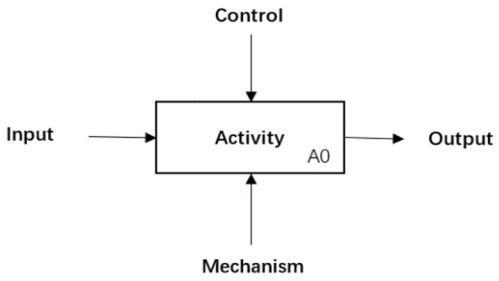

Figure 2: IDEF0 model composition

The IDEF0 model contains multiple levels, among which A-0 is the highest-level graph, which is used to express the connection between the overall activity described and the external environment, and also to determine the boundary of the activity to be described. The next layer is A0 layer, the overall information of this layer is the same as that of A-0 layer, and reflects the overall structure of the activity at the same time. The subsequent model is decomposed layer by layer on this basis. The following figure 3 shows the overall structure of IDEF0 model:

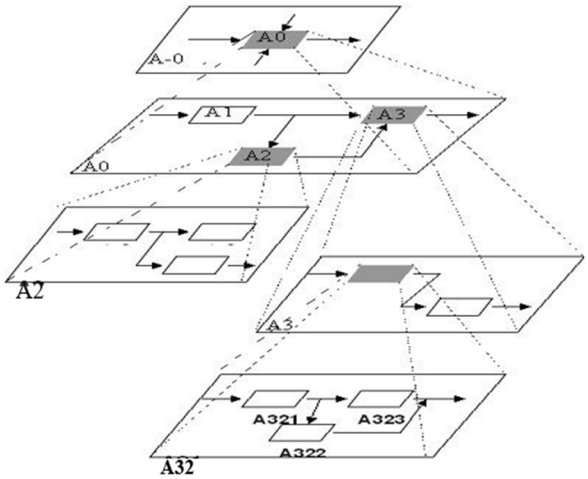

Figure 3: IDEF0 model structure

2 IDEF0 FLOWCHART ESTABLISHMENT

2.1 Process of modelling

At present, there are a small number of projects that achieve interface management by BIM technology in our country. Although a series of policy documents have been issued in our country, such as "Guidance on Promoting the application of building Information model" and

"Guidance on Promoting the Coordinated Development of intelligent Construction and building industrialization", they still cannot well describe the experiences of EPC projects based on BIM platform[7]. This paper uses IDEF0 language to complete the modelling of the project process, with the help of the built model to better identify the influencing factors of EPC interface management.

For the construction of BIM platform based on EPC project interface management process model, this paper mainly builds a preliminary BIM application EPC process model through the collection, analysis and induction of current domestic relevant policy documents and relevant research results.

2.2 IDEF0 model building

2.2.1 BIM applies critical nodes and processes in EPC projects

Key node flow charts are constructed based on the BIM application technology in the engineering, procurement and construction stages of EPC projects. This paper takes steel structure EPC buildings as an example, and the flow chart of BIM application nodes is shown in Figure 4.

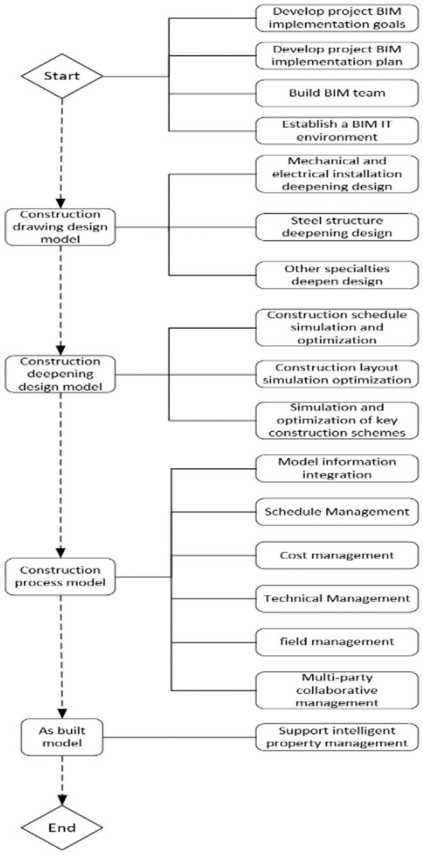

Figure 4: Flowchart of BIM application nodes

2.2.2 Establishing internal and external relationship chart (A-0 chart)

Figure A-0 firstly determines the boundary of the entire project model system and lays A good foundation for the subsequent decomposition. The A-0 figure studied in this paper contains the activity blocks of the entire EPC project. This layer model models the project from the general contractor to the completion of the project as A whole, and takes various information required for the completion of the target as the model elements. A-0 model is shown in Figure 5 below.

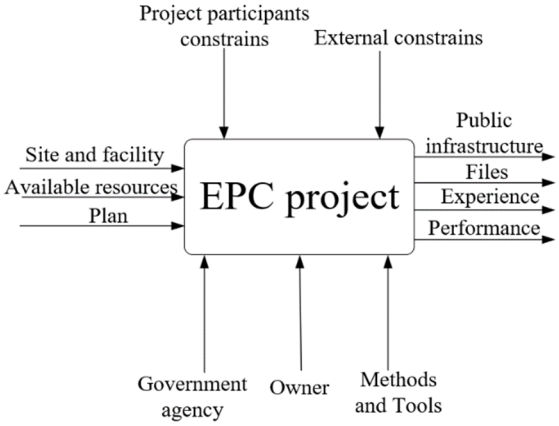

Figure 5: A-0 model

The input factors of EPC general contracting project on layer A-0 include site facilities, available resources and project planning. Output factors include public infrastructure, project documentation, project experience, performance, etc. Institutional factors include government departments, owners, methods and tools. Control factors include participant constraints (such as the management system of participating enterprises) and external factors (such as policies, laws, natural environment, etc.).

2.2.3 Build the top-level graph (A0 model)

A0 model is the sub-model of A-0 model and the concrete presentation of A-0 model in the project. The A0 model in this paper consists of five functions and their connecting arrow lines. The activity includes five main functions of EPC project from preparation to completion of construction, namely preparation of project, project contracting and contracting, deepening of design, procurement of materials and equipment and construction. Among them, we add the application of BIM platform in the corresponding nodes to realize the digital intelligent management mode of EPC projects. The A0 model and the factor correlation between each function are shown in Figure 6 below.

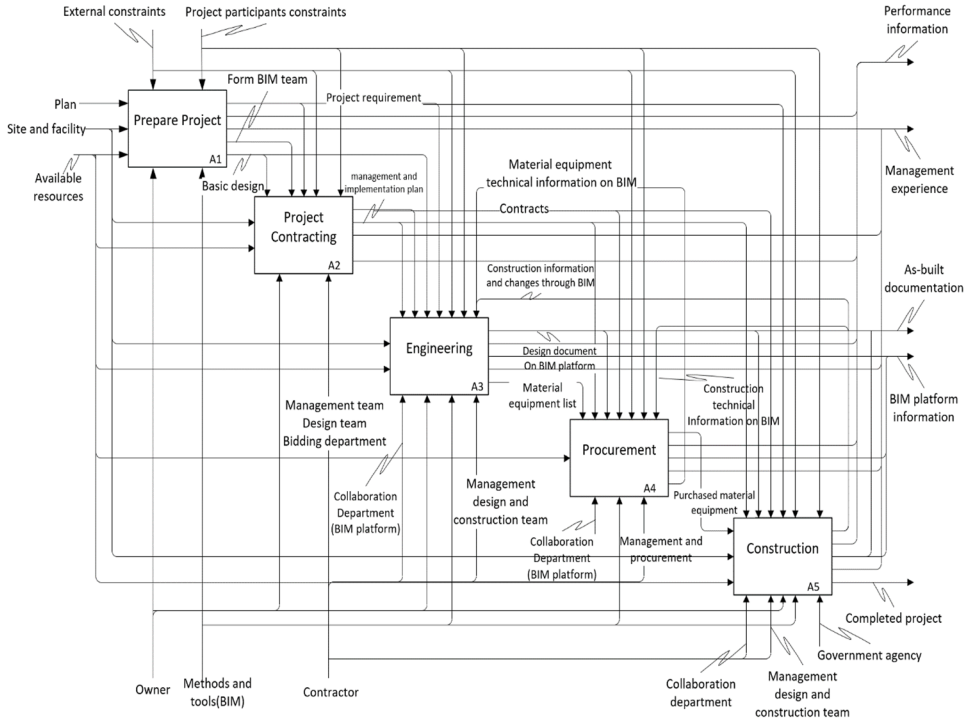

Figure 6: A0 layer IDEF0 model

A1-Prepare Project. Before the start of the EPC project, it is necessary to prepare the basic implementation plan for subsequent work. It is worth noting that component BIM teams are needed at this stage to set up the subsequent BIM working environment and process.

A2-Project Contracting. Project contract bidding includes bidding, bid evaluation and contract signing and other whole links.

A3 - Engineering. The EPC general contractor can give full play to the advantages of the integration of various works, and take the opinions of the construction team, constructability information and purchased material and equipment information into full consideration in the design of the construction drawing. It can achieve the effect of full coordination among different majors with the least work cycle, and shorten the time for the approval of design documents. At the same time, design information and drawings need to be updated synchronously in the BIM platform to facilitate the subsequent information matching and change of parties.

A4 - Procurement. The procurement activities should be carried out under the constraints of the documents in the previous engineering stage. At the same time, it is also necessary to consider the various construction demand information generated by the construction activities, and timely purchase, replace and supplement the materials and equipment that meet the construction requirements.

A5 - Construction. According to the work content of each subcontract and the 3D building model and data information provided on the BIM platform, the subcontractor carries out the

construction of the project, and feedbacks the construction process to the engineering and procurement departments on the platform, so as to continuously optimize and improve the work efficiency.

3 CONCLUTION

In this paper, the EPC general contract project and BIM platform system are briefly introduced. Then, based on the status and difficulties of traditional EPC project interface management, the main causes of interface management problems are classified and discussed. EPC project workflow is built by IDEF0 model, and BIM platform system is incorporated into it, so as to solve interface problems in the project and improve the overall work efficiency of all parties. This model will enable researchers to better understand and analyze EPC projects, which will also contribute to further research on the interface management of EPC projects.

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