Research on Green Building Materials Management System Based on BIM

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Abstract - **Green building materials, with advantages in health, environmental protection, and safety, have been widely used in building structures. However, it is necessary to increase the management level and efficiency of green building materials, because construction projects are usually complicated and last for a long time, as well as there are too many interested parties in supply chains. Based on Building Information Modeling (BIM), this paper studies the green building materials management and supply chain system and builds a green building material management evaluation method. It can be found that BIM can deliver supply chain information safely, accurately and fast, reducing the loss of information and management costs. The five-level stepwise evaluation index of green building materials follows the characteristics of purposiveness, operability, simplicity and continuity. This paper provides a theoretical basis for the application of BIM in the green building materials management system. 1. Introduction The low efficiency and high-energy consumption caused by extensive production methods have been the main problems of construction industry sustainable development (Najjar et al., 2017; Ilhan and Yaman, 2016). According to the data, building energy consumption accounts for more than 32% of the total energy consumption of the society. Considering the energy consumption of building materials in the production process, this proportion will exceed 50% (Jrade and Jalaei, 2013). Green building materials reveal a harmonious concept of environment, human and resources, protect the environment, and reduce resource waste without any adverse effects on human life (Ham and Golparvar-Fard, 2015; Lee et al., 2015). Building a resource-conserving and environment-friendly society is closely related to the rational use of green building materials. Compared with traditional construction materials, green building materials are safer and more environmental friendly, without pollution. Green building materials are also more economical and practical than traditional ones (Saldana-Marquez et al., 2018). In recent years, Building Information Modeling (BIM) is regarded as the core technology to promote construction technology and management informationization. From 2005, our country has been adopting BIM in the field of construction, which is the inevitable outcome of the information technology applied in the construction field (Hong et al., 2015; Liao et al., 2012). In order to reduce costs and enhance environmental protection and efficiency of the construction industry, our government strongly encourages the application of BIM in the construction industry (Jiang and Lei, 2014). With the rapid development of green building materials, it is necessary to establish a green building materials management system based on BIM (Al-Ghamdi et al., 2017; Mattoni et al., 2018). Based on BIM, this paper studies the green building materials management and supply chain systems, making contribution to promoting the application of BIM and the green building materials management.**

INTRODUCTION

BIM and green building materials research

BIM, short for Building Information Modeling, includes basic data information of the whole project spanning the whole life cycle of construction. BIM is also regarded as a revolutionary transformation for the development of DOI: 10.3303/CET1866095 Please cite this article as: Ma X., 2018, Research on green building materials management system based on bim, Chemical Engineering Transactions, 66, 565-570 DOI:10.3303/CET1866095 565 construction industry (Jalaei and Jrade, 2015). With characteristics of visibility, coordination, simulation and optimization, BIM can realize the transformation of architectural geometry, attributes and functional information (Yang and Ogunkah, 2013; Ding et al., 2016). As the information sharing platform for project software and professional systems in all project construction, building and operation period, BIM stores, interacts and uses information during the whole life cycle of construction projects (Chen et al., 2011). Figure 1 shows related software of BIM. The core modeling software including BIM program design software, sustainable analysis software, structural analysis

software, visualization software, deepening design software and operations management software, etc. The rapid promotion of BIM accelerates the process of building informatization

From 2008 to 2017, the total output value of China's construction industry has increased more than four-fold, and the proportion of GDP also has continued to increase, as shown in Figure 2. The application of green building materials can be realized with the help of a construction enterprise supply chain information management platform. Information collaborative management guarantees the smooth implementation of supply chain that can reduce information transmission delay and distortion as much as possible in the engineering. There is no information standardization for green building materials of our country. Data interchange cannot achieve the unified standard. There are a lot of types of green building materials with high fluidity. The lack of unified standard of information storage and conversion cannot effectively classify and integrate information resources. With the gradual development of construction, project parties interact and share the application information deeply, which influences the interests of all parties. The cooperation foundation is to realize the maximum interests of the whole project and its own. BIM can enhance information interaction and sharing in the database, and project parties can optimize and complement information in a timely manner, reducing the loss of information and management costs.

Green building materials' model optimization is divided into single-objective optimization and multi-objective optimization. But the single-objective optimal solution cannot be extended to multi-objective optimal solution, that is, in the field of green building materials it is difficult to achieve the multi-objective optimal solution. Objectives are conflict and obtained at the expense of others. In the current construction field, the singleobjective optimization is usually carried out, and then the multi-objective optimization. Suppose L is the type of green building materials, L= (a,b,c..., n); Km (m∈L) is the number of alternative materials; Dij (i∈L, j∈Km) is the demand of each material; Cij (i∈L, j∈Km) is the price of each material; Pij (i∈L, j∈K m) is the proportion of a specific material In the green building material supply chain information exchanges based on BIM, parties submit different information during the whole life cycle of construction projects. Therefore, it is difficult to guarantee its accuracy and safety, which is the premise of supply chain information security access and exchanges. All parties of the construction project should form a good trust relationship and reduce unnecessary frictions and conflicts, which can greatly reduce costs. Figure 3 is the green building materials supply chain general model. In order to motivate all parties to provide accurate and safe information, corresponding incentive mechanisms should be formulated in constructing the information model that can provide a strong sense of belonging to parties and encourage them to actively take the initiative to provide safe and accurate information, and efficiently complete construction projects with high quality.

In the whole life cycle of construction projects, construction materials involve a lot of information. The traditional materials management is inefficiency and error-prone, while BIM makes the building materials management system informationization. Figure 4 shows the logical structure of green building materials supply chain information flow model based on BIM. BIM central database is the data layer, green building materials basic information model the core layer, aec XML-based network interaction assessment the interactive layer, and design information model, construction information model and operational information model the application layer, which is corresponding to different functional layers, so as to meet the needs of design, construction and the owner. Figure 5 is the information flow for green building materials analysis based on BIM. According to the design information model, the extended analysis data is obtained on the basis of extracted building data combined with the green degree analysis. Then, the materials information model is created and the sustainable analysis is conducted to check whether it is in line with the requirements, in order Government sector Material supply Design unit Equipment supply Owner General contractor Subcontractor Financial Institutions Marketing agency Insurance or guarantee company 567 to choose the green building materials optimal solution. Figure 6 shows the green building materials supply chain information security control. According to the different information needs of members on the supply chain, BIM central database can be partitioned to form information feedback and data calling platforms for users. Green building materials evaluation indexes mainly follow the characteristics of purpose, operability, simplicity and

continuity. Figure 7 is the green building materials management maturity model, which can be divided into initial, repeatable, defined, quantitatively management and optimizing levels, as a stepwise development process. Green building materials evaluation adopts the Delphi method and the evaluation index weight is Design unit Construction unit Owner Comprehensive collision check Green degree analysis Structural analysis Cost estimate Site management Resource management Progress management Construction process simulation Construction safety inspection Facility Management User Management Space management Disaster protection Design information model Construction Information Model Operational Information Model AceXML-based network interaction assessment Basic information model BIM Central Database Functional layer Application layer Interaction layer Core layer Data Layer Building location, scale, orientation Doors, windows, openings Shape, height, plane size Design information model Green building materials analysis Thermal energy analysis Indoor air quality analysis Sustainable analysis indicators Extract building data Extended analysis data Create information model Green degree analysis Meet the requirements Scheme comparison and selection BIM central database N Y User Interface operation Encryption Network platform PIP, Autodesk Buzzsaw, et al. Data calling Authority authentication BIM central database Information feedback Username / password Information feedback Information feedback Username / password Username / password 568 determined according to statistical analysis results. Table 1 is the green building materials supply chain information flow management evaluation index weight. The largest weight is the accuracy and interoperability of information, while the smallest is the richness of data. In the case of a commercial plaza project, it is a tower of 27 floors, which is designed according to the green building theory. After analyzing the green building materials maturity during the whole life cycle of this project, it is determined as five grades (grade 1 is immature and grade 5 is the most mature) as shown in Table 2. The score of green building materials management based on BIM for this construction enterprise in this project is 2.6, which is intermediate. Maturity evaluation indexes for grade 1 include data richness, life cycle and interoperability. Therefore, enterprises should focus on costs of green building materials application based on BIM within the scope of funds and abilities to enhance their core competitive advantages.

Conclusion Based on BIM, this paper studies the green building materials management and supply chain systems and establishes the green building materials management evaluation method. The specific conclusions are as follows: BIM can enhance information interaction and sharing in the database, and project parties can optimize and complement information in a timely manner, reducing the loss of information and management costs. In the green building material supply chain information exchanges based on BIM, all parties of the construction project should form a good trust relationship and reduce unnecessary frictions and conflicts, which can greatly reduce costs. BIM central database is the data layer, green building materials basic information model the core layer, aecXML-based network interaction assessment the interactive layer, and design information model, construction information model and operational information model the application layer, which is corresponding to different functional layers, so as to meet the needs of design, construction and the owner.

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