Design of Information Consultation System for the Whole Process of Construction Engineering Based on BIM Technology

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Abstract. The existing building engineering information consulting system has the problems of low reliability and poor performance. This paper designs a new whole process information consulting system of building engineering based on BIM technology. Based on the optimization of hardware configuration structure, BIM technology is used to optimize the system software function and operation process, to realize the collection and classification of the whole process of construction engineering information, so as to facilitate the consultation of users. The system performance test results show that the actual consulting function of the system is strong and can meet the needs of the system.

Keywords: BIM technology · Construction engineering · Information consultation

1 Introduction

With the improvement of economic level and continuous progress of production technology, the construction industry and related industries have also been developing rapidly. The change of architectural design thinking and methods, the improvement of various properties of building materials, the emergence of new construction processes and technologies, and the updating and iteration of building systems and equipment have gradually led to the diversification, complexity and integration of architecture in terms of appearance design, internal space and place spirit [1]. The inevitable result is that the difficulty and dimension of management and maintenance of a building after it is completed and put into use will also be greatly increased compared with the past. Therefore, it is necessary for the unit that manages and maintains the building to get rid of the traditional management mode and introduce new management thinking and methods. The whole life cycle of a building can be divided into four stages, namely, the planning and design stage, the construction and construction stage, the operation and use stage and the scrapping and demolition stage. Therefore, it is necessary to get rid of the traditional

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management mode for the units of building management and maintenance, and to carry out building information consultation can improve the quality of building maintenance management.

Reference [2] proposes an integrated consulting system for building information based on cloud BIM. Building information is transmitted between different hierarchical structures of the system. After collection, coding and classification, the whole process of building information is stored in the BIM database, component information is extracted through the cloud platform layer, and the information consulting is completed by the adaptive association rule scheduling method. Reference [3] proposes a building information consulting system based on cloud computing platform, which clusters building information using AP clustering algorithm, stores it in a virtual database after virtualization processing, and transmits the consulting results to the service layer for users to view according to users' consulting needs. Reference [4] proposes a building information integrated consulting system based on MVC mode and mysql. Based on MVC mode, the information consulting service system is designed in combination with MySQL, and an online information consulting service platform for public demand information retrieval is developed by applying machine learning algorithm, Django framework and bootstrap responsive layout. The platform can provide users with a fast information retrieval experience, get visual information feedback, and give certain decision support. Although the above system can complete the information consultation, but there are problems of low reliability.

Aiming at improving the performance of building information consulting system, a new consulting system based on BIM technology is designed. The overall design scheme is as follows:

(1) Collect BIM information of buildings and construct the system framework of engineering information management. According to the characteristics of different stages of construction engineering, BIM information is integrated and interactive stored.
(2) Construct a vector space model, transform the text information into a computable model, calculate the similarity of the text information, and form a complete description of the construction life cycle of the engineering information set.
(3) Based on IFC's BIM data integration structure, the attribute set of building information is classified to realize consultation and sharing of building information.

2 Construction Engineering Whole Process Information Consultation System

2.1 Emergency Structure Configuration of Information Consultation System in the Whole Process of Construction Engineering

For the architectural design and construction stage, take a construction project as an example, test the BIM information integration platform, and study the feasibility and effectiveness of BIM-based engineering information integration and management. Effective information management during the life cycle adds value to the construction and

use of construction projects. Effective information management refers to the effective creation of information, effective management of information and effective sharing of information. BIM is the key to effective information management. This paper introduces the information management of construction engineering, and analyzes the characteristics, information flow, information characteristics and current information management mode of engineering projects. Analyze the meaning of BIM and its modeling techniques. The system framework and integration mechanism of BIM-based engineering information management are proposed as shown in Fig. 1.

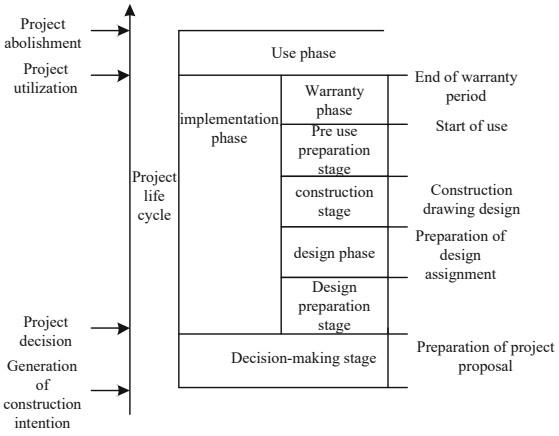

Fig. 1. System framework and integration mechanism of BIM-based engineering information management

DM belongs to the management of the investor and the developer, while FM belongs to the management of the project service life, which may be the owner or the facility management unit entrusted by the owner. Therefore, construction project management is not only the management of the owner, but also involves the management of each participant unit of the construction project, as shown in Fig. 2:

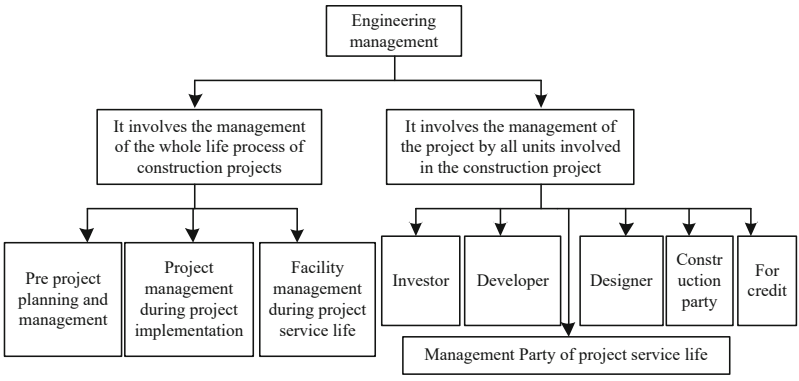

Fig. 2. Construction engineering information management system structure

Considering that many participants will consult information, it is also necessary to consider the information characteristics under different construction periods, as shown in Fig. 3.

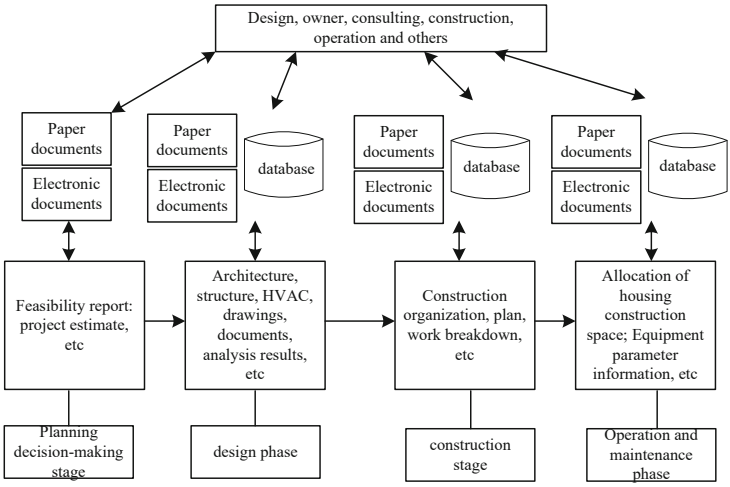

Fig. 3. Hardware structure

In order to process a large number of building data, BIM data sets are constructed to realize operation and maintenance information demand analysis, data function design, data architecture design, database creation and operation and maintenance function module construction [5, 6]. The realization of the BIM data integration platform provides the engineering information and operation and maintenance information required by the building for the integration of the intelligent management system based on BIM.

2.2 System Software Function Optimization

The BIM sub-information model as the core is the phase-oriented and application-oriented BIM information creation method [7]. The BIM database contains information of different stages of construction engineering, which can be integrated and expanded to effectively meet the needs of building information consultation and provide better management services [8]. See Fig. 4 for details:

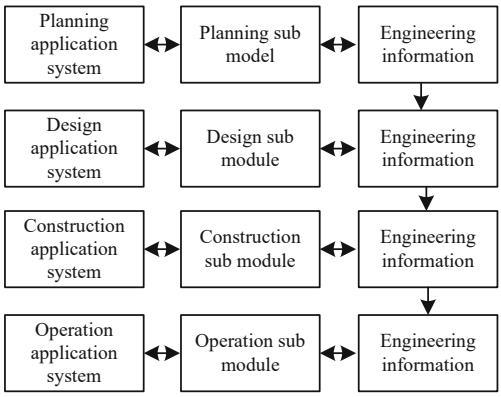

Fig. 4. BIM construction engineering information processing system

After the secondary processing of the BIM as-built model, the optimization of the operation and maintenance model, the creation of the operation and maintenance view, the optimization of the attributes, and the classification of the system, a building information model that is optimized for the operation and maintenance needs is completed. The conversion of the interactive standard format implements a lightweight operation and maintenance model [9]. As shown in the figure, the BIM data lightweight flow Fig. 5:

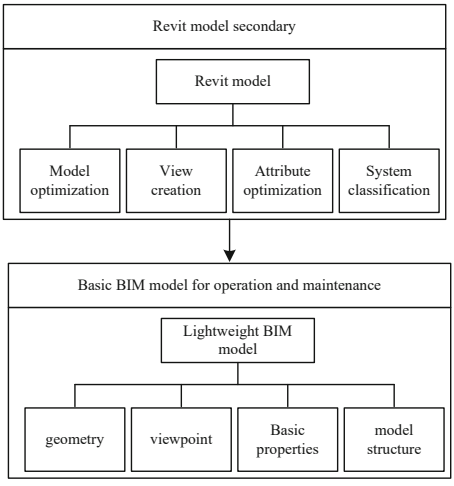

Fig. 5. BIM building information quantitative processing model

The feature items (terms) selected in the text preprocessing stage are collected, and the text information is represented as a structured vector space model (VSM) by using the uniqueness of these terms. Vector space model, also known as "word bag" method, is the most effective and applied method to process text information at present. Its basic idea is to table n text documents into vector d_{nm} in m dimensional vector space, so as to create feature document matrix $V_{m\times n}$, so as to achieve the purpose of modeling and structuring text data. In BIM, the order of feature items appearing in the document is not considered, and only the uniqueness of feature items is guaranteed. The established matrix is as follows:

$$V_{m\times n} = \begin{bmatrix} d_{11} & d_{12} & \cdots & d_{1m} \\ d_{21} & d_{22} & \cdots & d_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ d_{n1} & d_{n2} & \cdots & d_{nm} \end{bmatrix} \tag{1}$$

Through the vector space model, the text information is transformed into a model that can be calculated, and the unstructured information is structured according to the established model, and the inverse document rate statistical calculation of the term frequency is carried out. If the term frequency TF is high in one document and rarely appears in other papers, (that is, the document containing this term has a low frequency of DF in the whole document set), so this term can be considered to have a good distinguishing ability. TF. IDF formula introduces word frequency and inverse document frequency:

$$w(d,t) = V_{m\times n}TF \times IDF \tag{2}$$

$w(d,t)$ is the weight of a term t in document d, TF is the frequency of the term t in a document, and IDF is the local weight of the term t in a document. The formula is:

$$IDF = \sum w(d,t) + \lg\left(\frac{N}{n_1}\right) - t \tag{3}$$

where, N represents the document set, and n represents the number of documents of the term t. . The premise of retrieval and sorting is to analyze the similarity of the text. For text similarity analysis, support vector machine (SVM) or distance formula and cosine formula shown below can be used to calculate the similarity:

$$d = \sqrt{\sum_{i=1}^{N}(p_i - q_i)^2} \tag{4}$$

Among them, p and q are the sub vectors of document vectors p and q in the feature vector dimension [10].

The building classification coding system is shown below.

Table 1. Overall analysis of building information classification system

System category	Name	Classification object	Classification method	Coding mode	Scope of application
Quota system	Valuation form of construction engineering unit	Work item	Line division method	Chapter number	Construction and installation works
	Comprehensive quota of Construction Engineering	Components and design components	Line division method	Chapter number	architectural engineering
Normative system	Quality acceptance standard of Construction Engineering	Mixing of components and work items	Line division method	Nothing	architectural engineering
	Construction technical operation specification	Work item	Line division method	Chapter number	Construction and installation works
Architectural literature	Chinese book classification	Facilities, units, components, etc	Line division method	Subtitle digital hybrid coding	Construction Engineering, civil engineering
Product catalogue	Classification in the valuation table of construction engineering units	Building materials, construction machinery	Line division method	Digital coding	——
	Classification in construction website	Construction products	Line division method	Nothing	——

The application system realizes the integration and sharing of data by extracting and integrating sub models. For example, various document data are mainly generated in the planning stage, which are stored in the form of files. In the design stage, architectural design, structural design, water supply and drainage design, HVAC design are carried out according to the information in the planning stage, resulting in a large amount of geometric data There is a need for collaborative data access between architecture and water supply and drainage and HVAC. These applications generate new information and integrate it into the overall BIM model. The BIM model integrates the engineering

information in the planning stage, design stage and construction stage for the operation and maintenance application system to call. For example, the application system based on BIM can easily extract the building component information, building space information, building equipment information, etc. through the sub model. The application of BIM enables the integration and preservation of engineering information at all stages.

2.3 Realization of Construction Engineering Information Resources

The integration and collaboration of BIM data is the most critical basic technology in the BIM system. Data integration and collaboration and sharing mainly refer to the interaction between data: completion BIM is a complete data modeling. Because of the differences in application goals and application scenarios, BIM data cannot be applied to the operation and maintenance process, and it needs to be realized through the unified format of IFC. Data interaction and transformation are completed by using IFC file parsing and data exchange interface. The software logic function is to ensure that users can easily and quickly create, modify, extract and integrate data; In the early stages of BIM, IFC access program was used to extract a large amount of data from BIM database, as shown in Fig. 6 below:

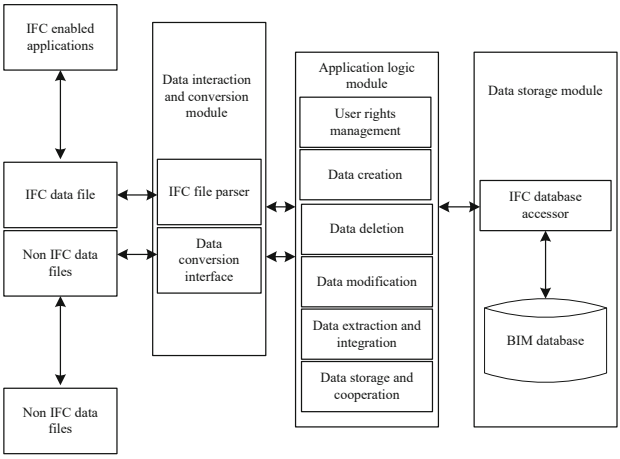

Fig. 6. BIM data integration structure based on IFC

Database is another important carrier of IFC data storage. Different from file based storage, database storage is more suitable for dealing with a complete IFC model with a large amount of data, and provides more powerful information exchange capability for different participants of the project through network-based interface. Databases can be divided into relational databases and object-oriented databases according to their types. Huang Zhongdong and others compared the characteristics of implementation based on relational database and object-oriented database:

Object oriented database has not been widely popularized and applied. Therefore, this section uses relational database to realize the data storage of IFC object model.

Table 2. Comparison of SDAI implementation based on Database

Project	Relational database	Object oriented database
Technology	Mature	Immature
Data mode and interface	Standard	Not standard
Application	Widely	Not extensive
Mode conversion	More complex	More direct
SDAI implementation	Complex	More complex

Attribute set, as the name suggests, is a collection of attributes. The description of things and concepts can be stored in the attribute set through an attribute. Attribute sets provide a flexible way to extend information description. In order to understand the concept of attribute set, this paper classifies the attribute set as follows, as shown in Fig. 7:

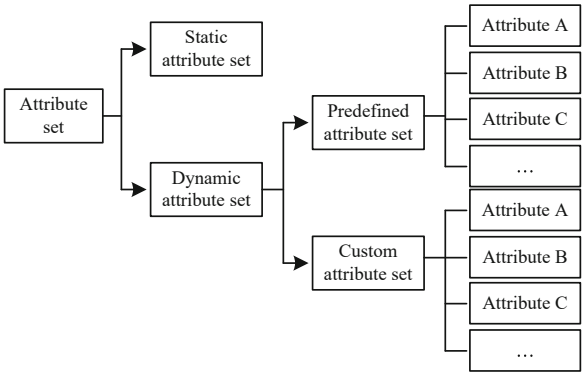

Fig. 7. Classification of information attribute set

The progress error in the S-curve comparison method is linked with the error degree, quantified, and a systematic progress reliability alarm function is established. According to the project progress and the actual situation of the project progress, risks are divided into four levels, and specific risk areas are set with different speed deviation values. In the project implementation stage, if the project progress deviates beyond this range, there will be corresponding alarm information. The prediction scope of project schedule safety risk control is shown in Table 3 below:

Table 3. Construction schedule reliability control warning interval

Progress deviation value t	-3% ~ 3%	3% ~ 4% or - 4% ~ - 3%	4% ~ 5% or - 4% ~ 5%	t > 5% or T < 5%
Deviation level	Low deviation	Low deviation	Moderate deviation	High deviation
Reliable state	High	High	Commonly	Low
Early warning signal	Grey	Brown	Brown	gules

In the reliability management of construction period, because the actual progress of the project does not conform to the plan, it must be predicted according to the actual situation. Therefore, the BIM software must include a prediction function, which can be used to predict according to the current progress and the specific conditions of the construction site, according to the current progress and the specific conditions of the construction site, using the time sequence prediction method. Figure 8 shows the architecture of BIM modeling:

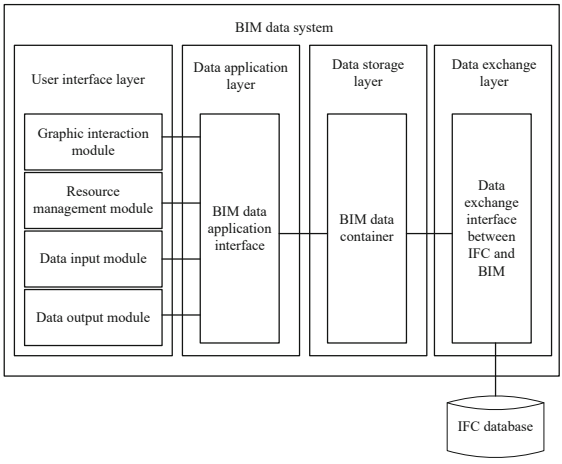

Fig. 8. Structure diagram of BIM model

The first level is the data exchange, which is mainly responsible for receiving and storing data; The second layer is the data storage layer, which is used to classify and store foreign data, and to a certain extent, to achieve the correlation of various data; The third level is the data application level, that is, the application window of BIM model, which can provide users with the ability to query, search and modify relevant project data; The fourth level is the user interface, whose function module is to display the data of BIM model through different charts and pictures according to the needs of customers.

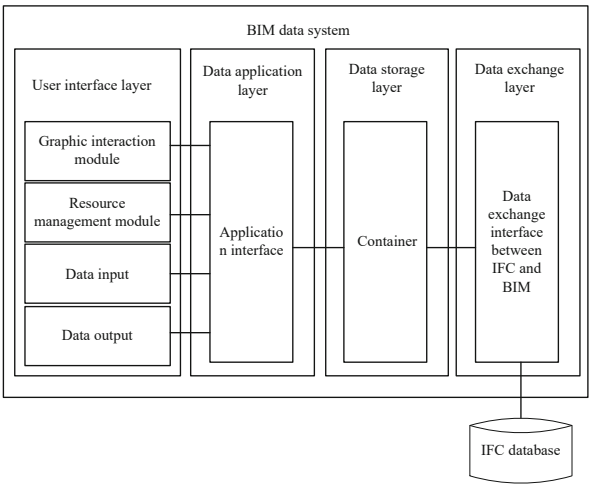

Fig. 9. Structure diagram of BIM model

Based on this, the corresponding project completion time can be calculated when the actual S-shape progress curve of the project is greater than or equal to 100, and the corresponding completion probability, namely progress reliability, can be obtained through computer simulation software simulation. The corresponding project completion time is obtained through computer simulation, so as to obtain the corresponding completion probability, that is, the reliability of the completion time.

3 Analysis of Experimental Results

3.1 Experimental Data

Based on the built BIM database and according to the construction characteristics of construction projects, a project case database of construction projects is formed.

Based on the above 10 construction project cases, the construction information is processed, the original information of the construction project is extracted, and dimensionless processing is carried out to obtain the construction data attributes. The data similarity of construction project cases is as follows:

Test the actual application performance of the consulting system according to the similarity results shown in Table 5.

Table 4. Sample data of project case base

Case	Engineering characteristic attribute					
	Building type	Value	Overall structure of the building	Value	Completed Area	Number of layers
A	Office	1	Frame	1	6235	7
B	Market	3	Frame	3	5968	5
C	Office	4	Frame	1	6698	8
D	Market	1	Frame	1	13652	15
E	Office	2	Frame	2	7236	3
F	Office	3	Frame	3	6895	6
G	Building complex	1	Frame shear	1	8532	2
H	Building complex	1	Brick	1	10252	8
I	Residence	2	Brick	2	7652	6
J	Office	1	Frame	1	7895	10

Table 5. Similarity between the proposed project and each information

sim1	sim2	sim3	sim5	sim6	sim10
0.9652	0.4895	0.9236	0.6895	0.9182	0.8165

3.2 Consulting System Performance Results

The reliability comparison test results of building information consultation are shown in Fig. 10:

Through application and relevant comparative tests, the differences between the intelligent integrated management of Bim and the system of reference [3] are finally obtained. The application advantages of integrated management based on BIM are obtained by comparing the characteristics of the two systems one by one, as shown in the following table. The table lists four main characteristics, namely: three-dimensional visualization, information integration, information processing and automation, which are subdivided under the four categories. Finally, the advantages of BIM intelligent integrated management after comparison are obtained, as shown in the following table.

Table 6. Comparison of advantages of the two systems

Content	Integrated management	Reference [3] system	Advantages of BIM integration
3D visualization	Full module 3D roaming function	Nothing	Convenient and advanced space browsing
	Internal perspective of facilities and equipment	Impossible	Avoid destructive inspection of equipment
	Comparison between model and real scene	Camera monitoring	Quickly confirm the cause of the fault
Information integration	IPad client input	Paper checklist filling	Paperless and complete information record
	Information transmission within the authority is fully transparent	Information transmission is not public	Improve information collaboration
Information processing	Display after system background processing	Manual processing	Mechanization replaces manpower
	Automatic reminder function	Nothing	Reduce the loss caused by human forgetting
Automation	Radio frequency automatic identification	Rely on workers' experience to find	Accurate and efficient identification of fixed assets
	Automated data collection	Workers report to the management center	Intelligent management

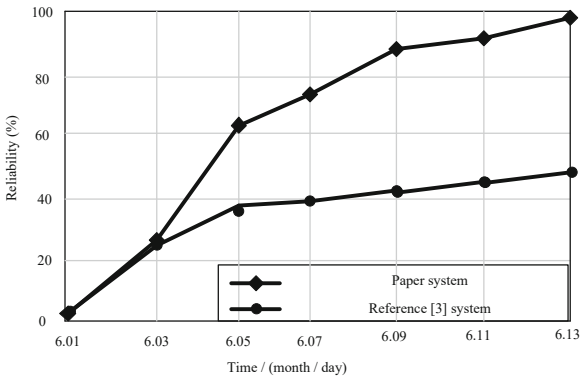

Fig. 10. Comparison of test results

On this basis, through two comparative experiments, it is fully proved that the new BIM information consulting system has obvious advantages. At the same time, we should

also see that the traditional operation and maintenance management also has its merits, For example, “query the amount of information within the specified time” “The comparative test of BIM reveals that the breadth and depth of BIM integrated system need to be improved, and also reflects the problems brought by the mechanization and computer programmability in its application process, which can be made up by the traditional flexible management relying on manpower. Therefore, we should make comprehensive use of the advantages of BIM information consulting and the flexibility advantages of manual flexible management in order to achieve a better management trend of building modernization.

4 Concluding Remarks

Using the characteristics of BIM, it is integrated into the cost management of the project. Through the construction of the project cost management system, the daily management of the project cost and various business processes are simplified without losing accuracy, so as to remove unnecessary obstacles for the communication between various departments. At the same time, clarify the business division of each department and provide scientific work guidance to the project department through information management; Provide necessary data support for enterprises during enterprise upgrading and transformation. However, the consulting system in this study does not verify the performance of the system in the case of a large number of concurrent users. In the subsequent research, we will conduct in-depth research on this performance.

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