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Research on Green Building Energy Management Based on BIM and FM

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ABSTRACT

Aiming at the problem of building energy consumption, based on the conceptual model of BIM (Building Information Modelling) and FM (Facility Management) and the concept of green building, this paper expounds the advantages of BIM in energy management and building performance evaluation and optimize from the strategic aspect through FM concept. Research shows that building information modelling (BIM) can play a key role in achieving close cooperation between customers and the construction industry, minimizing building energy consumption and achieving low-carbon and environmental goals.

INTRODUCTION

Energy is the material basis for human survival and the spiritual foundation for human civilization. The rapid development of the world economy cannot be achieved without the supply of energy such as oil and natural gas (Pishdadbozorgi et al. 2018). According to statistics, this resource-driven economic system will rapidly collapse in the second half of the 21st century, and the energy crisis is imminent. As a developing country with a large population base, China's per capita energy consumption is less than half that of the world's per capita energy consumption, and its total energy consumption ranks second (Ilhan & Yaman 2016). At present, through the energy consumption design of new buildings and the energy conservation transformation of existing buildings, the total energy consumption of the building can be reduced compared with the original under the conditions of annual increase of the total building area and moderate improvement of indoor comfort, and the national energy conservation goal, namely, to complete the energy conservation planning of most new buildings and the energy conservation transformation of existing buildings by 2020. The sustainable development of building energy has become a national strategic goal, and building energy management becomes more important. At present, how to realize building energy conservation and emission reduction and reduce energy consumption has become the most important part of building research field, which has important research value.

PAST RESEARCH

Mcglinn et al. (2017) discussed in BIM platform with different design process on the performance of building energy efficiency design and application of simulation software and the method, thus effectively improve the efficiency of building energy efficiency design. BIM technology in our country is mostly applied in the simulation of construction process, through the BIM to the use of all kinds of building materials in the statistics; the quality of the potential risks of the project, safety and cost risk, and the key management to achieve the quality, safety, and cost of the project in accurate control, to ensure quality, time limit for a project, at the same time reduce the cost of construction, improving the efficiency of building.

It is of great practical significance to study the application of BIM and FM technology in green building and comprehensively improve building performance. This paper aims to explore the advantages of BIM and FM technology in the application of building energy management and building performance evaluation and strive to find a set of management mode that is suitable for the combination of BIM and FM in building energy management in China.

BIM AND FM CONCEPT AND ITS MODEL

BIM technology is a 3D digital technology, which uses a common data format throughout the life cycle to create and collect all relevant information of building facilities and establish a comprehensive and coordinated information model as the basis for project decision-making and information sharing resources (Kim & Yu 2016). That is to say, BIM technology building model data into information, make people at every stage of the whole life cycle of construction projects to get access from time to time to the information data related to construction projects, to achieve barrier-free sharing, lossless transmission, for all the decisions in the whole life cycle of construction projects and production activities to provide reliable information. In China, it is expressly stipulated in the "eleventh five-year plan" that building information models should be studied in depth. The ministry of housing and urban-rural development issued the development outline of building information technology in the "twelfth five-year plan" to accelerate the application of building information model and other technologies in engineering, which also indicates that the development and application of BIM technology have reached the government level (Abanda & Byers 2016). BIM technology will lead us into the era of architectural revolution. Based on the urgency of building energy, people have also conducted a lot of research on the application of BIM technology in building energy. A study combined BIM technology with green building and introduced the research route of monitoring platform and energy management (Kim et al. 2017).

BIM is not a particular model or one kind of software, it is based on the engineering staff to collect, store, use a variety of useful information, and analyse the information and management, the formulation, planning, design, construction, operation and maintenance and construction projects finishing process, support and assist the more wisdom and reasonable means of calculation and analysis of process and management (Pishdadbozorgi et al. 2018). The sustainable building model based on BIM is shown in Fig. 1. The application of BIM will generate more useful data and information visualization and simulation, and BIM is considered to have changed the production mode of traditional construction industry.

International facility management association (IFMA) defines FM as to maintain the high quality of life and improve the efficiency of the investment business space for the purpose, with the latest technology to the human living environment for effective planning, organizing, and the maintenance and management work; it will be a person's workplace and combine the work task, is a comprehensive industrial and commercial management, building science and engineering technology of comprehensive discipline (Ugliotti et al. 2016). In China, FM research is still in its infancy, and there are many obstacles in its concept promotion and technical exploration. There is a relative shortage of high-quality compound and technical talents in the industry. In view of

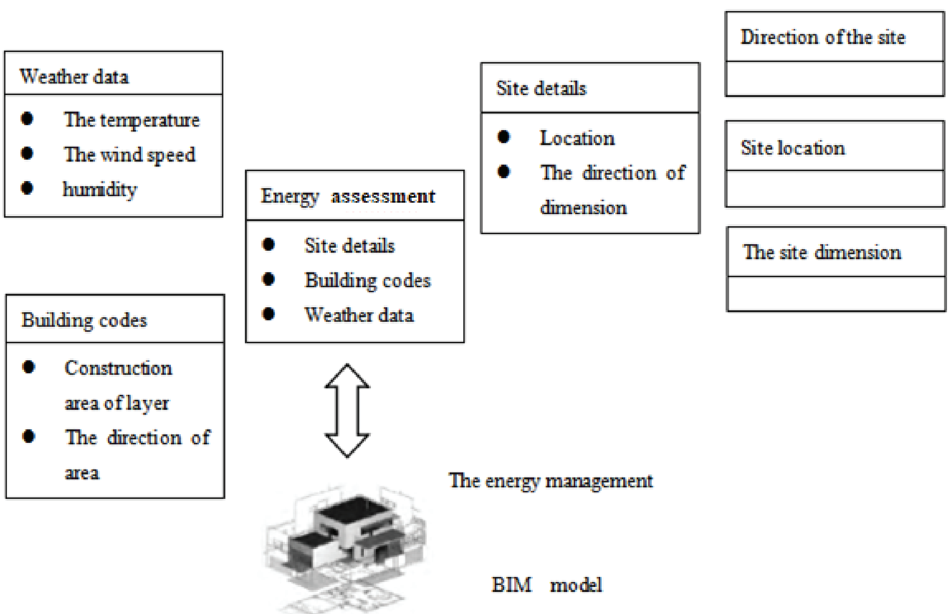

Fig. 1: Green and sustainable building model based on BIM.

this situation, many domestic experts and scholars put forward many constructive suggestions on accelerating the development of FM to ensure that FM plays an active role in building energy management. Royal Australian Institute of Architects (RAIA) proposed in 2007 the role of FM in database and the benefits it can bring in digitization (Nicał &Wodyński 2016). FM is a combination of space, environment and management. FM focuses on energy and facility management, including energy consumption, data statistics, equipment update, etc. (Ilhan & Yaman 2016). It can be applied not only to various types of buildings, but also to various departments and organizations inside buildings, which can help enhance competitiveness, reduce non-core operating costs, increase the value of buildings and maintain their value, thus improving the economic benefits of enterprises (Ahmad et al. 2017). FM covers a lot of management work, such as property management, space management, facilities and equipment management, energy management, etc., as shown in Fig. 2.

Application of BIM and FM technology in green building management

BIM technology helps to process energy management data

The energy management (EM) team operates and maintains energy systems used by many complex building occupants. The information flow process of the energy management life cycle of public buildings is shown in Fig. 3.

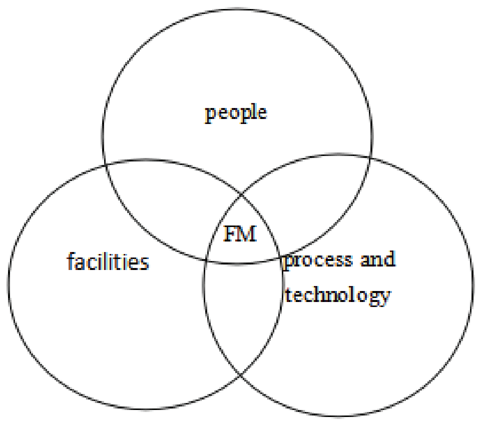

Fig. 2: Integration of a facility management (FM) system.

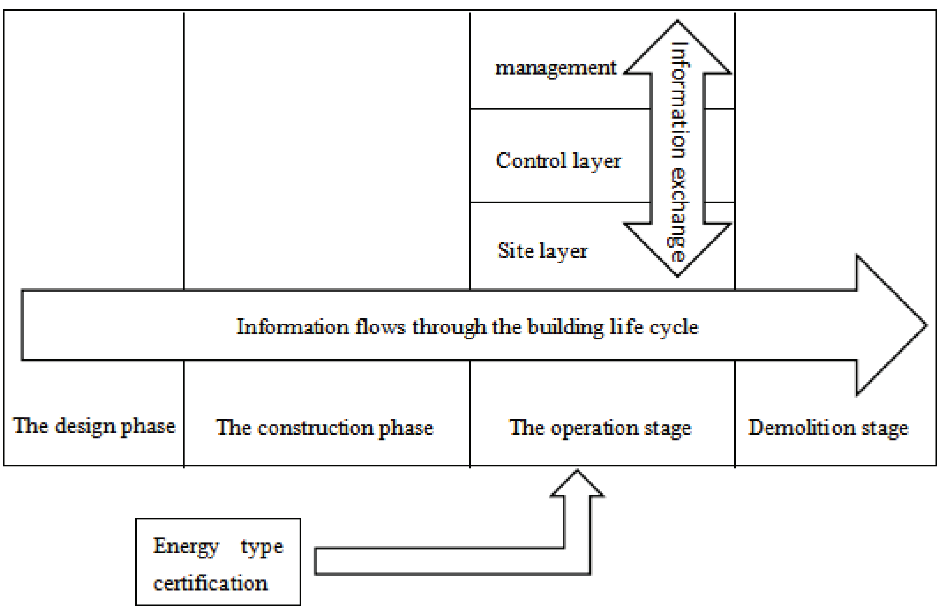

Fig. 3: Flow of information through the building life cycle.

As can be seen from Fig. 3, the realization of green building design and sustainable goals requires a good information flow exchange between the site level, control level and management level. On the basis of information flow exchange, personnel from different disciplines (professionals) use advanced technologies and means to cooperate and optimize coordination in the whole life cycle of design, construction, operation and other construction projects, so as to save energy and reduce emissions. The energy management team uses the building management system (BMS) to store, integrate and analyse data from multiple site sources, including all stages (design, construction and operation, etc.) and location data, such as building specifications, environmental climate, energy consumption, etc. (Kim et al. 2016). The energy management team will supervise the website, synchronously access the data from different site sources and stages, conduct building performance analysis and certification according to the building code and building performance requirements, and feedback to the control layer and management to take corresponding measures to improve the energy performance of the building.

The use of BIM technology can help manage and process BMS data. BIM technology makes the energy efficiency reports generated by BMS easy to understand and analyse. The data storage provided by BIM can be used to analyse different types of data in BMS and is applicable to different decision reports. Table 1 shows the main data types of the BMS types supported by the BIM model.

Some BMS use data management and automatic energy controls (such as those for natural gas, water, oil and solid fuels) and reduce energy consumption by improving building control systems. Currently, there is a lack of BMS integration tools to intecontrol and management functions, which means that the energy team also has to manually handle data transfer between tools. Fig. 4 shows the flow of data flow in building energy management.

From current practice, using BIM in the control layer is a good choice. The BIM model can be used as a collaborative tool to integrate all sites and other data. The collaboration and interactivity of BIM technology can help analyse and eliminate erroneous data processing and improve control

Table 1: Main data types of BMS types supported by the BIM model.

Site details	Building codes	Daily outdoor temperature and humidity information	Instrument details
Name, code, address, contact name, area, area space, volume occupancy, population	Geometry and thermal properties of building components	Meteorological data, temperature and humidity of building external walls	Supplier, MPAN, MPR, target

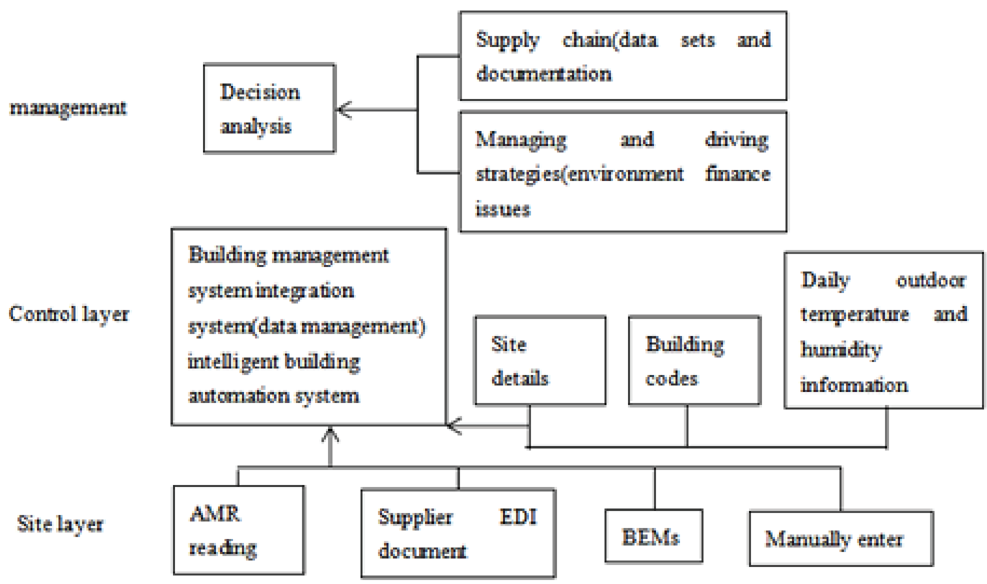

Fig. 4: Operation flow of data flow in energy management of buildings.

results. BIM technology emphasizes information sharing. Through BIM technology, the management team can better transfer and use data flow and improve communication efficiency. It can also solve many typical special problems, such as convenient query and call historical building site data. In addition, BIM technology can improve the value of the BMS system used and better realize energy emission reduction and energy conservation management.

BIM technology assists building performance evaluation

State calculation method (sliding) is defined as the collective negotiation of community and government departments at all levels, through the evaluation method to compute the actual simulation software, at present is mainly used in non-residential construction building performance assessment as shown in Fig. 5. The calculation method by accessing BIM model to extract the information flow of architectural geometry, structure, usage patterns, as well as the related parameters in the Hvac and lighting, transcribed into a spreadsheet format, uploaded to the energy performance analysis program, the energy consumption and energy emissions data calculation, compared with "normal" annual data, and finally form the evaluation results.

The NCM algorithm has steady-state performance, and its advanced performance is also reflected in that it can conduct dynamic evaluation of building performance based on three-dimensional intuitive BIM building model. When the model was applied to shading factor analysis, it was directly imported into DSM (Dynamic Simulation Modelling) program from the BIM system to calculate and analyse.

Application of FM technology in green building management

(1) Strategic approach

Overall planning: formulate the overall objectives of building energy management and the specific objectives of building energy management. Classified management: different guidance will be given to different types of buildings, including energy-saving reconstruction of existing buildings, energy-saving planning of new buildings, and energy-saving work of public buildings and residential buildings. Adjust measures to local conditions: according to different regions, different climate and resource distribution, different levels of economic development to break the strategic approach. Clear priorities: the energy conservation standards for new buildings and pilot projects for energy conservation and renovation of existing buildings will be adopted to gradually spread the scale of energy conservation. Innovation and creation: management system reform, technology innovation, equipment update, etc. Improve efficiency: improve energy efficiency and building energy efficiency.

(2) Strategic measures

National strategic demand: the overall strategic direction of the planning includes the analysis, formulation and implementation of strategies and sub-strategies. For example, the "sustainable development" and "energy conservation and emission reduction" strategies formulated by the state are conducive to the promotion and implementation of building energy conservation. Public demand: public demand is the basis of policy making and the embodiment of national policies

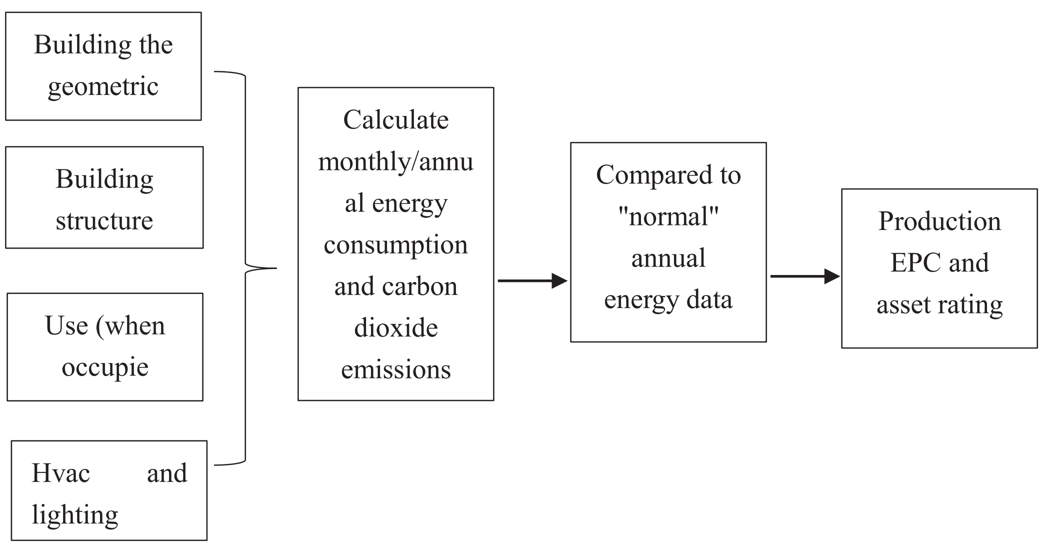

Fig. 5: National calculation method.

at the grassroots level. Local demand: between national strategy and people's demand, local demand can carry out energy conservation work in a targeted way, which not only has reasonable planning and overall arrangement, but also has the micro foundation of people. In order to carry out building energy conservation work in various regions, it is necessary to combine regional climate, resource distribution and economic development, and adapt measures to local conditions, so as to select the economic system and technical methods in line with China's national conditions. Only in this way can energy saving work be effective. The whole process control strategy is an important link of building energy conservation work, which mainly includes four stages: research, planning, implementation and post-evaluation, forming a whole set of energy conservation process.

CONCLUSION

In public building management, various information will be generated in different stages of the building life cycle, and different management teams will also create and use a large amount of architectural information in the design, construction and operation stages. It is crucial to aggregate the vast amounts of information that are often scattered across different energy operations and maintenance systems. BIM model and BMS system can effectively solve the problem of data dispersion.

The practice shows that the BIM technology and energy management system (EMS), can be in 3 d models in real-time running status and intuitively show the whole building energy consumption information, help management find large public buildings energy consumption problem and call the police, energy-saving renovation suggestions are given, so that the user is more accurate and efficient for safety control, analysis of energy consumption, energy transformation, energy performance evaluation, such as energy management decision-making to provide the reference for managers.

The introduction of BIM technology, according to its visual function, information integration, simulation technology and other characteristics, starting from the design stage of building energy management, focusing on the control of design errors, inadequate research, data mismatch and other congenital problems. Secondly, FM concept will be brought into the later construction energy management to optimize from the aspects of strategic principles and measures.

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