Interior Art Design Optimization Based on Computer BIM Technology

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Abstract. In the process of interior design optimization, there is a lack of analysis of comfort and energy consumption related factors, a lack of understanding of the knowledge system of low-energy buildings, and a relatively one-sided situation in the improvement and optimization of the scheme, and it is difficult to run through the whole design process. This paper combines a large amount of literature and previous research to systematically study the BIM technology of building information model, the integrated design model of building based on BIM technology, and the optimization of building scheme. The model of this paper finds that the building energy consumption is reduced by 0.18, the natural lighting is improved by 0.154, and the natural pressure Pa hours are increased by 0.03. Overall, the multi-objective optimized building integrated design scheme makes the building consume less energy, and the natural lighting and natural ventilation effects are improved, which reflects the advantages and design effects of building integrated design. The BIM technology in combination with related software has optimized the project management method, and the project objectives can be controlled through the collection of on-site data and prior measures; the comparative analysis of the construction objectives further proves that the optimization of the construction plan with BIM technology has achieved considerable benefits.

Keywords: Building energy saving; BIM technology; Integrated design; Multi-objective optimal design
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1 INTRODUCTION

The rapid development of the construction industry has put forward higher requirements for its technology and management level, and a set of construction modes suitable for it is needed to give full play to the role of design. , operation integration. With the continuous emergence of super high-rise and long-span structures, building structures and building shapes are becoming more and more

complex, various complex surfaces are used more and more in buildings, and more and more complex buildings and super high-rise buildings are appearing in around us [21]. At this time, due to the poor visualization of construction drawings expressed in two-dimensional form, the understanding of the drawings has increased a lot of difficulty, and the communication between designers of architecture, structure, and equipment, and between designers and builders is also difficult. Certain obstacles will arise. Nowadays, the internal competition in various fields of engineering construction is increasingly fierce, and the facade forms of buildings are also different and beautiful. At the same time, the information of each participant of the engineering project is independent of each other, and engineering changes in the process of engineering construction are more commonplace. The traditional CAD software drawing to complete the engineering project has a huge design workload, which can no longer meet the needs of the current engineering construction and development [19].

As a new technology in recent years, building information model has attracted much attention in the industry. Because it can digitally bear the physical and geometric characteristics of building engineering, it can express all kinds of details of the project in an all-round way, making the project management more efficient. Therefore, in view of the actual demand, it is necessary to introduce BIM technology into the traditional construction quality management mode and optimize it appropriately to achieve the quality objectives of the project. At present, the traditional CAD drawing is still the preferred method for engineering design in major design institutes, but with the continuous development of BIM technology, it has been applied to different degrees in professional fields such as architecture, mechanical and electrical, municipal administration, etc [5]. BIM technology has been studied and applied in various aspects of hydraulic engineering, but it is still in the initial exploration stage. BIM technology is based on three-dimensional digital technology, integrating relevant data of engineering projects, and based on this, designing, building and operating management are carried out, providing a visual representation of building structure. The BIM model contains complete information such as geometry, physics and functions of the project, and the staff can directly obtain the required information such as geometry, materials, light source and visual angle from the BIM model [16]. This visualization model can be dynamically updated with the change of BIM design model to ensure the consistency between visualization and design.

This paper takes the quality management mode in the construction stage of construction engineering as the research object. Firstly, based on the relevant literature, this paper summarizes the research status of BIM Technology and quality management mode at home and abroad, defines the definition of construction quality management mode, summarizes and combs the traditional mode, and finds out the defects of the traditional mode. Secondly, it analyzes the relevant theories of BIM Technology and the advantages of BIM Technology in quality management, and introduces two influencing factor analysis theories and multi-level grey comprehensive evaluation model. Since BIM was proposed, it has caused earth shaking changes in the construction industry in some developed countries. As a new tool, BIM has been successfully applied in some large projects [3]. The direct application of information technology in the construction industry is through BIM, which provides a good platform for the designers, constructors and design providers of the project to work together and communicate, avoids the obstacles caused by the construction participants in the communication, and plays a great role in the optimization of project quality, cost, construction period and construction technology [6]. The ultimate purpose of this paper is to improve the project quality, reduce the construction cost and improve the construction efficiency through the optimized quality management mode. Optimizing the quality management mode based on BIM Technology is of great significance for the healthy development of the construction industry. Its innovation lies in:

- In this paper, instead of completely abandoning the traditional model, BIM technology is to be introduced to optimize multiple aspects of the original model such as organization, principles, processes and communication and exchange of quality information. to promote the further improvement of the current quality management model.

- The purpose of this paper is to accumulate data for the application of BIM in construction plan optimization, so that more decision makers can understand the considerable value of BIM technology in the construction stage. The adoption of scientific and reasonable construction plan can improve efficiency, save manpower and reduce energy consumption, and accumulate data to enrich the enterprise quota, promote the digitization of the construction industry and prompt the upgrading of construction enterprise management.

This paper studies the optimization of interior design based on computer BIM technology, with the following structure.

The first section is the introductory part. This part mainly describes the research background and research significance of the optimization of interior design based on computer BIM technology, and presents the research purpose, method and innovation of this paper. The second section is mainly a review of related literature, summarizing the advantages and shortcomings of it, and presenting the research ideas of this paper. The third section is the methodological part, focusing on the combination of BIM and interior design optimization research design methods. section 4 is the experimental analysis section. This section conducts experimental validation in the data set to analyze the performance of the model. section 5, conclusion and outlook. This part mainly reviews the main contents and results of this paper, summarizes the research conclusions and points out the direction of further research.

2 RELATED WORK

From the actual situation, the research and analysis on the low-energy-consumption design of green buildings has been carried out for a long time. In the 1940s and 1950s, relevant research and analysis were started, which was also the embryonic period of low-energy-consumption design of green buildings. . With the passage of time, the concept of green building has been gradually developed and established. In the case of further development, the environmental pollution has increased and the dependence on energy has increased [4]. As these problems continue to appear, people start to put a lot of energy on buildings and start a lot of research on green buildings.

Mohamed Hamdy proposed to use the multi-objective optimization method to improve and perfect the low emission of buildings and cost management and control in order to obtain a more ideal energy saving effect. The owner visualizes, participates in the analysis, proposes improvement solutions, and proposes new methods to obtain data related to building energy efficiency [9]. Simul EICon provides the basis for decision-making in the architectural design stage, and BIM can accurately provide the parameter information required to improve the architectural design and building performance simulation, and simulate the built environment [14]. Patrick Bynum and Wong Kam-din proposed to use the accurate data of the building information model to simulate the built buildings, provide the owners with an intuitive and real building model, and provide a way for the owners to participate in decision-making, so that the improved scheme can better meet the needs of each party demand [13]. MillsThomas' research mainly focuses on the management of building facilities. He first analyzed the application status and advantages of BIM technology, and then proposed the specific process of BIM information model from successful production to delivery [8]. MadhavNepali proposed a theoretical model of query system based on the data storage function of BIM model. During the construction stage of the project, all personnel of all parties involved in the project can query relevant information through this system, which greatly improves the efficiency of quality management. [7]. NamhunLee's main concern is the application of BIM technology in road and bridge engineering. He first discussed the application status of traditional quality information management and PDCA cycle model in road and bridge engineering, and then tried to build a quality assurance and control method based on PPO model and BIM technology, and concluded that BM technology has great potential in road and bridge engineering quality management. Conclusion [11].

Thomas Shiller's research found that the use of a newly developed carbon heating system for heating can greatly reduce the energy consumption level of residential renovations and achieve twice the economic benefits [15]. Angelique Kelly applied the KPI method to the evaluation of the effect of existing building renovation projects, comprehensively analyzed the design process control problems of the renovation project, and believed that the renovation of the legacy existing buildings has certain application value for the sustainable development of society [1]. N. Delgarm introduced the particle swarm algorithm commonly used in multi-objective optimization into the calculation of building energy consumption to optimize building energy consumption. The single-objective and multi-objective particle swarm algorithm and building energy simulation software are used to solve the problem of building energy consumption and improve the energy-saving performance of buildings [10].

Generally speaking, it is the general trend of the construction industry to optimize the traditional construction quality management mode by using BIM technology, which is of great significance to improve the quality management level of construction projects. The industry should pay more attention to the application of BIM technology in quality management, so that BIM technology can be truly implemented and brought into full play. At present, the construction industry is developing in three mainstream directions: modernization, industrialization and informatization [17]. The informatization of construction industry includes technical information and management informatization. The life cycle management of construction projects is the nucleus of technical informatization, and the resource plan is the nucleus of management informatization. BIM can integrate other technical informatization methods, and at the same time, it carries the information of engineering projects, thus opening a horizontal bridge between technical informatization and management information.

3 METHODOLOGY

3.1 Optimization Principle of Existing Buildings

The principle of economy. The reason why the old building does not overturn the reconstruction, in addition to saving building resources, the most important thing is to consider the construction cost of the building, the demolition and reconstruction of the building will inevitably result in a large amount of wasted building resources, and for buildings located in the city center and other important geographic locations and important influence of the protective buildings are never allowed to demolish and rebuild, so existing buildings for transformation before a comprehensive assessment, mining existing Therefore, before the renovation of existing buildings, a comprehensive assessment should be conducted, and the various resources that can be used in existing buildings should be effectively utilized, and the issue of extending the useful life of old buildings to meet people's needs through partial repair and reinforcement is being promoted by the construction industry [20].

Economic indicators mainly reflect the degree of construction cost control, and are also a major indicator for evaluating the quality of the project plan, which runs through the entire process of project development. The direct cost and indirect cost constitute the engineering cost of the construction project, the direct cost includes the direct engineering cost and the measure cost, and the regulation fee and the enterprise agency fee constitute the project indirect cost. Among them, the direct engineering cost in the direct cost accounts for about 75% of the total cost, and the direct engineering cost includes labor cost, material cost and construction machinery usage fee. Therefore, the second-level indicators of economic indicators are: labor costs, material costs, construction machinery usage costs, and other costs.

Calculation formula of labor cost:

$$G = \sum_{m=1}^{5} G_n \tag{1}$$

Environmental protection principle. Choose green building materials according to local conditions. Modern green building design blindly adopts the same energy-saving technology and energy-saving materials, leading to a uniformity in the forms of green building forms, which makes the use of non-native materials more and more in the construction process, resulting in a lot of resource waste and environmental pollution. Green mainly emphasizes adjusting measures to local conditions, so the design should not only consider the selection of local materials, but also the local natural climate, geographical environment, living standards, social customs and other cultural traditions, so as to meet the comprehensive social needs of the building, so that the building can coexist harmoniously with the local cultural, historical and natural environment, and the buildings in different regions show different characteristics and styles.

3.2 Bim Technology Theory

According to the current organizational theory of construction managers, there are three types of organization, namely, functional, linear and matrix; and there are three main basic principles of quality management applied: PDCA cycle principle, three-stage quality management principle and total quality management theory. The organizational approach and the basic principles, etc. together determine the quality objectives and quality management plan. In the construction stage, the four major participants need to regularly check the quality and propose solutions to the quality problems, and finally the construction and supervision units can accept the projects that pass the quality inspection [12]. The above is the traditional construction quality management mode of building engineering construction.

The PDCA cycle is divided into four stages, and each letter represents a stage. Where P stands for planning, D for execution, C for inspection, and A for processing. The four stages are the four stages necessary to improve the quality of the project. These four stages continue to circulate and repeat, and are necessary conditions for quality improvement, as shown in Figure 1.

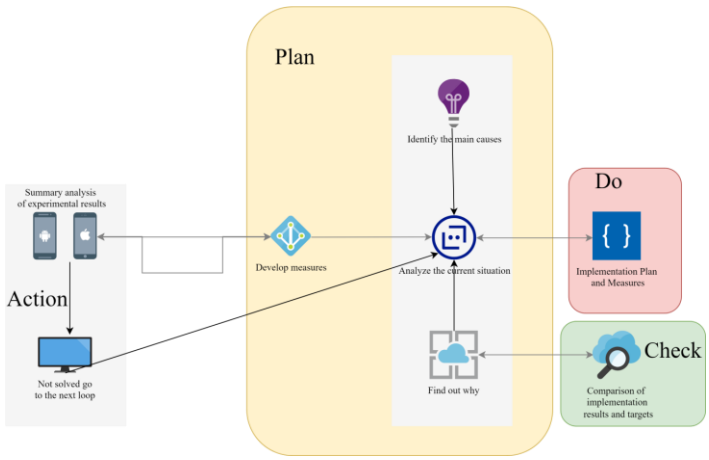

Figure 1: The four phases and eight steps of the PDCA cycle.

Stage P is generally regarded as the stage of quality planning, which needs to define the quality objectives, find out the unresolved problems in the last cycle, analyze the problems, find out the

causes, and finally formulate a detailed quality plan to achieve the objectives or solve the problems. Stage D-after the quality plan is completed in the implementation stage, it needs to be implemented in strict accordance with the quality plan. In the process of quality management, systematic and planned management is needed, and at the same time, scientific and reasonable argumentation is needed to ensure the engineering quality. Stage C-Inspection Stage: During the implementation of the plan, the completion should be inspected regularly. The inspection methods include self-inspection, mutual inspection and inspection by full-time managers. In the inspection process, always compare the gap between the target value and the actual value. If the gap is within the allowable range, you can continue the next stage. If the gap is too large, it is necessary to analyze the reasons and re-establish the construction plan. Stage A-the quality problems found in the inspection stage in the treatment stage need to be analyzed in time, detailed countermeasures should be worked out as soon as possible, and rectification should be carried out to ensure that the quality formation process is within the control of the construction personnel; At the same time, we should thoroughly analyze the causes of the problems and formulate preventive measures to avoid the recurrence of similar problems [18]. If the problem is not completely solved at this stage, it needs to be transferred to the next PDCA cycle.

The realization of BIM technology depends on various BIM software. More than dozens of BIM softwares have been published. If these softwares are classified, they can be divided into: BIM core modeling software, BIM analysis software, BIM cost software, BIM site management software, etc. Among them, BIM core modeling software is the most important software of BIM technology. A summary of BIM software types is shown in Figure 2.

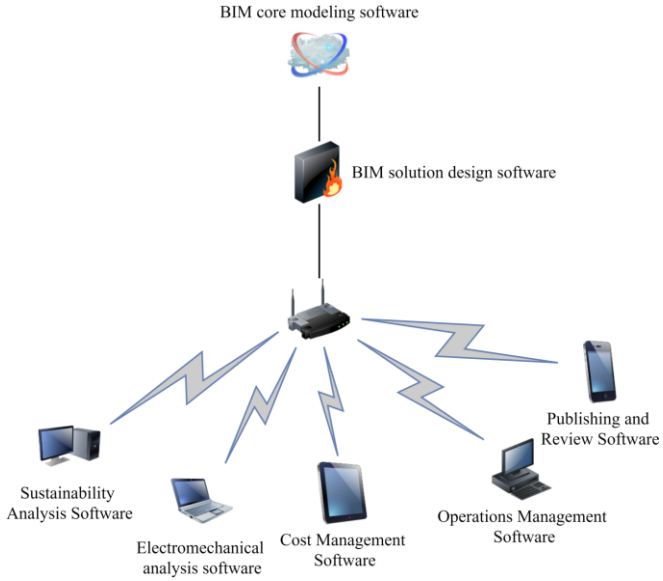

Figure 2: Summary of BIM software types.

Although there are many BIM software, they have their own functions. Managers need to choose BIM software reasonably according to the actual situation of the project in order to ensure the role of BIM Technology.

In the traditional mode, the number of drawings that need to be changed due to design changes is huge, because a small change may involve a large number of drawings, and each one needs to be changed. It is not only a huge amount of work, but also easy to make mistakes. In addition, due

to the poor information communication during the construction process, it is impossible to ensure that all workers construct according to the modified drawings, so it is very inconvenient for managers to deal with design changes in the traditional mode [2]. However, all the components in the BIM model are parameterized and interrelated, and the whole project will be updated after one change, which takes less time and has high accuracy. After the change, it can also be presented with 3D technology, making the change results more intuitive, as shown in Table 1.

	Traditional Model	*BIM-based Management*
Design Changes	*Large volume of work*	*Accurate, efficient and less time-consuming*
Management efficiency	*slower*	*Efficient*
File Storage Method	*Paper Archive*	*Electronic Information Model*
Personnel quality awareness	*Low Awareness*	*High degree of professionalism and quality awareness*
Information Sharing	*More closed*	*High degree of sharing*

Table1: Parameterization of components in BIM model.

A very important application of BIM technology is collision detection, whose function is to find out the collision problems occurred in the design process of each profession through construction simulation and three-dimensional visualization, and to solve them, so as to avoid collision problems before construction, reduce design changes to a large extent, and greatly improve the quality management level of the project.

3.3 Method of Construction Scheme Based on Grey System Theory

Grey forecasting is a loose systematic approach. The grey forecasting technology based on grey system theory can find out the law that works in a certain period when there is not much data, and establish a load forecasting model. The advantage is that it does not require a lot of numbers. The disadvantage is that it is suitable for forecasting exponential growth, and the forecasting results of time series with poor volatility are poor.

Let W be a unified measure transformation, where r_{ij}^{p} is the value of u_{ij}^{p} after changing W:

$$W(u_{ij}^{p}) = r_{ij}^{p} \tag{2}$$

Effect measure changes according to the polarity determined in Step 2.

$$W(y(n), g^{*}) = x(n) \tag{3}$$

Obtained:

$$x(n) = \frac{\min\{ y(n), g^{*}\}}{\max\{ y(n), g^{*}\}} \tag{4}$$

When P is the extreme value target, W is the upper limit effect measure change.

$$r_{ij}^{p} = \frac{u_{ij}^{p}}{u^{p}(\max)} \tag{5}$$

When P is the very small value target, W is the upper limit effect measure change:

$$r_{ij}^{p} = \frac{u^{p}(\min)}{u_{ij}^{p}} \tag{6}$$

Let r_{ij}^{Σ} be a composite effect measure with n objectives.

$$r_{ij}^{\Sigma} = \frac{1}{n}\sum_{p=1}^{n} w_p r_i^{p} \tag{7}$$

Let the difference information space be Δ_{0k} with:

$$\Delta_{0i}(y) = \left| x_0(y) - x_i(y) \right| \tag{8}$$

Grey correlation coefficient is the comparison measure between points. The comparison measure between sequences is called grey correlation degree.

$$r(x_0(y), x_i(y)) = \frac{\delta \max_i \max_y \Delta_{0t}(y)}{\Delta_{0t}(y) + \delta \max_i \max_y \Delta_{0t}(y)} \tag{9}$$

The grey correlation degree can be obtained from the grey correlation coefficient:

$$r(x_0, x_i) = \frac{1}{p}\sum_{y=1}^{p}[x_0(y), x_i(y)] \tag{10}$$

The actual engineering situation cannot be completely consistent with the above assumptions. Therefore, there will be some errors between the solution determined based on the above assumptions and the actual true solution. Generally speaking, the expected duration of PERT network plan calculated by conventional methods is always less than the average value of the actual time of the project, and the standard deviation is greater than the actual standard deviation. Therefore, since the establishment of the network for more than 40 years, many scholars have continuously explored and proposed some improved methods based on the analysis of the shortcomings of PERT methods.

4 RESULT ANALYSIS AND DISCUSSION

The building envelope directly exchanges heat with the outside world, which has a greater impact on the building indoor heat and humidity environment and building energy consumption, and through the preliminary research found that the office building in the summer air conditioning set temperature is lower, so improve the thermal performance of the office building envelope in the premise of ensuring a comfortable indoor thermal environment, to save the summer air conditioning energy consumption and winter heating energy consumption sometimes very important significance, and if the design If not designed properly, it is easy to have condensation on the inner surface of the envelope in winter or overheating in summer.

Low-energy and temperature-appropriate design refers to the active use of sunlight radiation and dominant wind direction to reduce energy consumption to ensure lighting comfort by changing the room use function and physical performance of window and wall enclosure system according to the geographical characteristics of the location. By analyzing the relationship between building

variables and energy consumption indicators under discomfort, the significance between several influencing factors with a high degree of general influence on the building itself is judged.

Using Ecotect green building performance simulation software to carry out month-by-month analysis of the building's annual energy consumption and discomfort hours, the results of the month-by-month discomfort energy consumption calculation are shown in Figure 3.

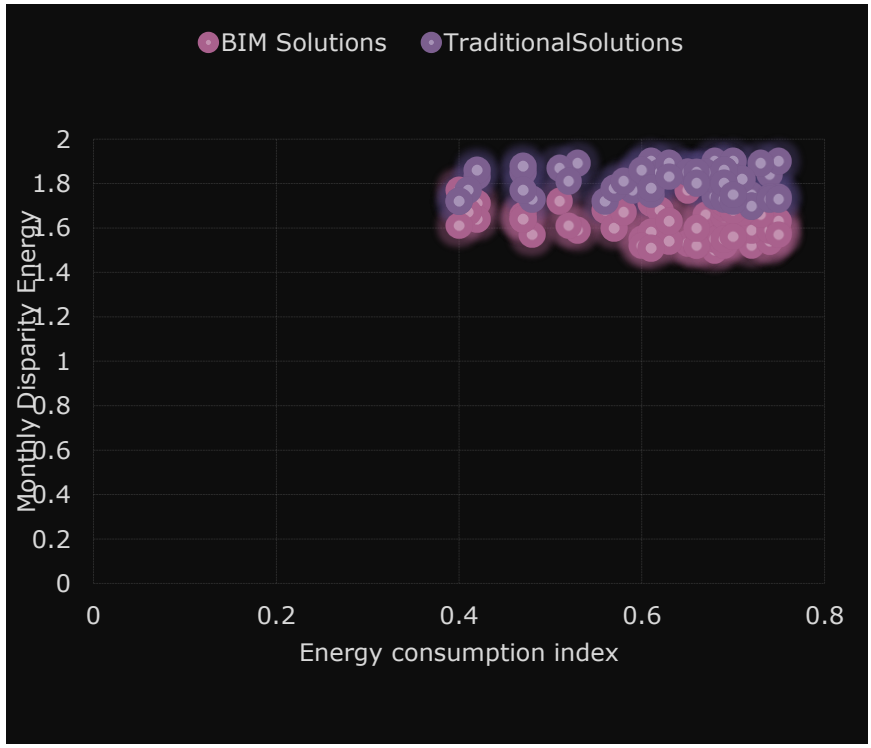

Figure 3: Monthly Disparity Energy Chart.

It can be seen from the analysis that the main design parameters of the building itself that affect building energy consumption in mild areas are window type, window-to-wall ratio and wall type. Therefore, the selection of the envelope structure and its physical coefficients should be considered in the design. Optimize the heat transfer coefficient of the transparent envelope structure, the types of transparent maintenance structural glass commonly used at present, as well as the heat transfer coefficient and shading coefficient.

Although the BIM model contains all the information data of the project, there is still a big gap between the visual expression and the actual building, and the human-computer interaction experience between the user and the model cannot be realized. Experience the scene, experience editing from time to time, and improve the design of the project. Some leading BIM technology companies are gradually integrating BIM technology with VR technology, constantly promoting the development of the architectural design industry, and also improving the competitiveness of enterprises. As shown in Figure 4.

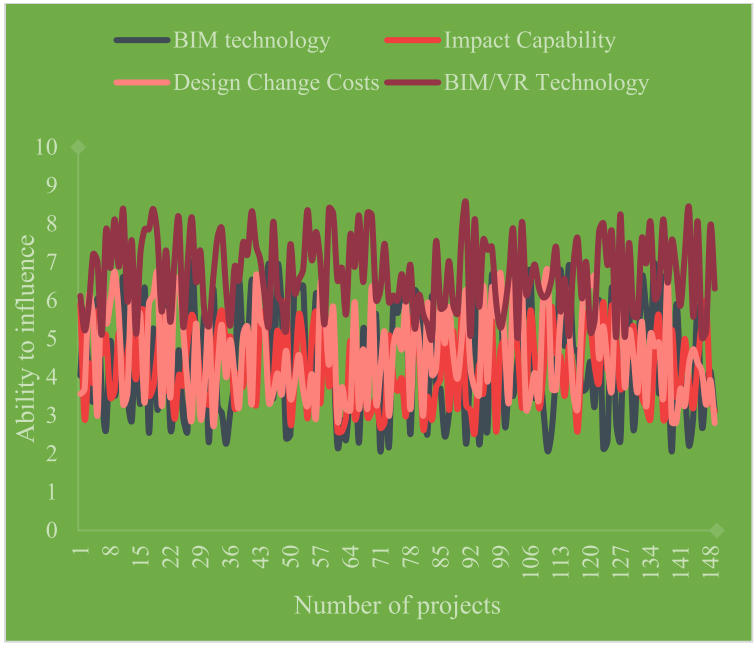

Figure 4: About BIM 、 BIM+VR of Macleamy Curves.

The decision-making in the early design stage has a great influence on the project, and it gradually decreases with the whole process of the project. By the later construction stage and operation and maintenance stage, the influence on the project has become stable. The later the design is advanced, the greater the impact on the project, that is, if the original design scheme of the project is modified in the later stage of the project, it will inevitably cause serious waste of resource cost. Based on the comparison between BIM technology and traditional two-dimensional design methods, it can be seen that the application of BIM technology in the design process of the project will generate a large workload in the early stage, but almost no design changes will occur in the later stage, which effectively improves the design efficiency of the project. Applying BIM+VR technology to the optimization of the design scheme of the renovation project, making use of the owner's personal experience to put forward more targeted opinions on the design scheme of the renovation project, can improve the design efficiency at the initial stage of the scheme design, and has certain application value, especially for the renovation project which requires many units to participate in the design.

Compare the illuminance values of different distance measuring points from the south room to the window, as shown in Figure 5. As the distance from the window increases, the illuminance also decreases. During the 74th experiment, the maximum difference between the near window and the far window is more than 3000lx. Such a large illuminance difference in a short distance is very easy to cause glare.

In summary, the depth of the room will lead to uneven lighting from the room, resulting in glare, so the depth of the office space should not be too large, the light near the window is strong, not easy to carry out office activities, the light intensity at the far window is low, you can arrange the reception and negotiation space, the desk arrangement in the range of 1 ~ 5m from the window is more appropriate.

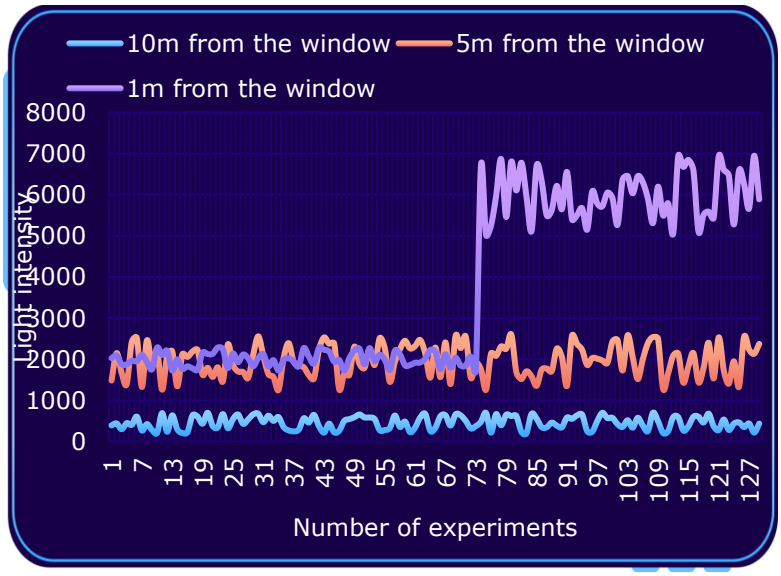

Figure 5: Building from the window at different distances from the measurement point light environment change law comparison.

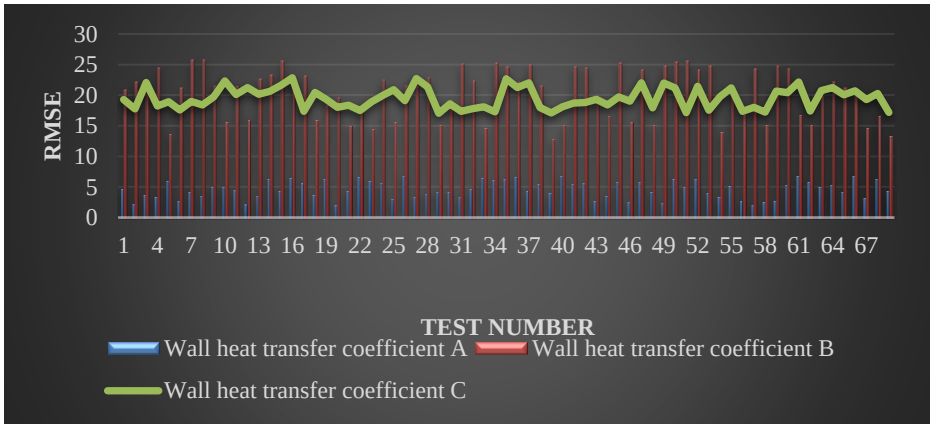

Figure 6: RMSE of the heat transfer coefficient of the wall.

It can be seen from the above table that the most significant factor of building energy consumption in thermal environment is the window heat transfer coefficient, then the window-to-wall ratio, and finally the roof heat transfer coefficient. Architecturally, the comfort level of the built environment is largely influenced by the openings and materials of the transparent envelope.

The photometric design under the architectural light environment refers to making full use of the natural lighting conditions in the area by changing the use function of the building itself, the architectural form, and the size of the transparent envelope under the natural lighting conditions of the building, so as to achieve indoor natural lighting and comfort. with the purpose of reducing the

lighting load. That is to say, by making more use of natural light and reducing the use of lights, so as to achieve energy saving as much as possible, as shown in Figure 7.

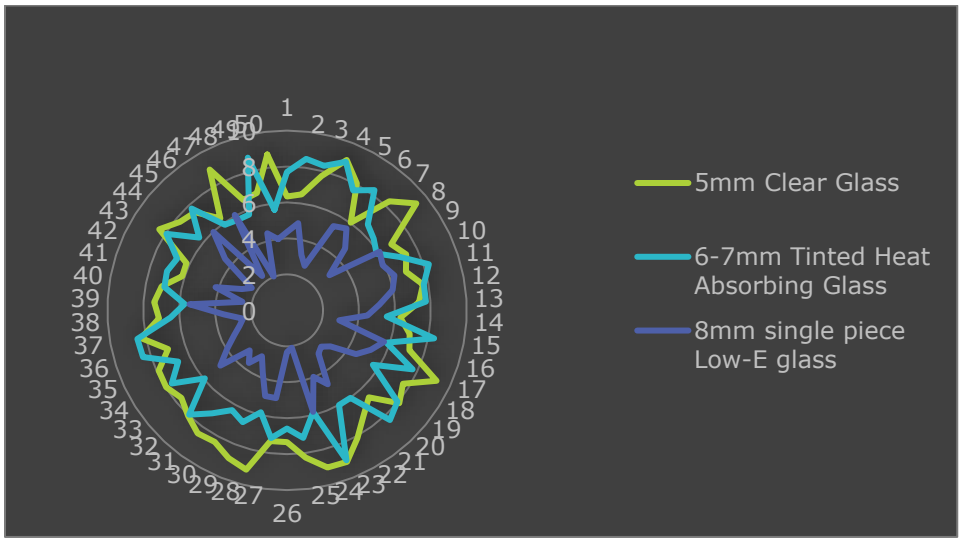

Figure 7: Common glass physical parameters.

Low-E glass and insulating glass have small heat transfer coefficient and good energy-saving effect, so they should be preferred. As for the choice of glass color, colored glass will affect the light transmittance of glass, so it should be selected according to the function of building room. Therefore, in mild areas, the thermal comfort in winter is mainly considered, and the heat transfer coefficient of the outer envelope structure is mainly considered in the design, with special attention to the types and heat transfer coefficients of windows. Double-layer insulating glass should be used more often.

Bartlett test is to verify whether the original variables are independent or not, and the results show significance. When < 0.02, it means that the variables are related and the original data is valid. The results of KMO test and bartlett spherical test of this questionnaire are shown in Table 2.

Projects		*Numerical value*
KMO sampling suitability quantity		*0.191*
Bartlett's sphericity test	*Approximate cardinality*	*114.514*
	Degree of freedom	*810*
	Significance	*0.001*

Table 2: KMO values and Bartlett's sphericity test results.

It can be seen from the above table that the kmo value of the data collected in this survey is greater than 0.1, and the significance value of Bartlett's spherical test is less than 0.02. The data are valid and suitable for factor analysis.

In the temperature frequency calculation method, it is assumed that the heat gain caused by solar radiation transmitted to the indoor through the transparent enclosure and the unstable heat transfer transmitted to the indoor through the roof and wall are linear with the outdoor temperature,

which makes the simplified calculation result very different from the software simulation calculation result. The building function room load caused by radiation is composed of two parts, one is transmitted through the wall roof system, and the other is the heat transfer measured by the window system, in which the window system accounts for the largest proportion of the total solar radiation load. The solar radiation intensity results of various building orientations are shown in Figure 8.

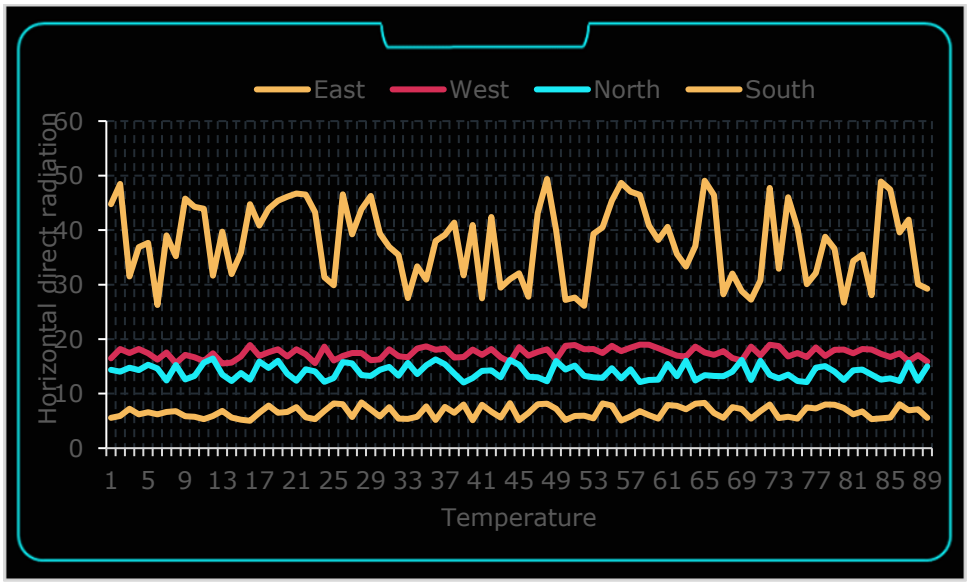

Figure 8: Solar radiation intensity of various building orientations.

The initial design plan has a building energy consumption of 4176kw-h/m2, a lighting coefficient of 1.14%, and 4396 natural pressure hours, compared with the optimized plan, it is found that the building energy consumption is reduced by 0.18, natural lighting is increased by 0.154, and natural pressure hours are increased by 0.03. Overall, the multi-objective optimized building integrated design plan makes the building consume less energy, and natural lighting and natural ventilation are improved. In general, the multi-objective optimized building integrated design solution results in lower energy consumption, improved natural lighting and natural ventilation, which reflects the advantages and design effects of building integrated design.

5 CONCLUSIONS

This paper summarizes the application status of BIM technology in design by analyzing the statistical data of articles on green buildings, energy saving, low energy consumption, and the application of BIM technology in engineering practice. The characteristics of green and low-energy buildings are summarized, and the parameters affecting energy-saving design are summarized from the external natural regional environment and the internal physical characteristics of the building, including regional climate characteristics, building layout, orientation, building shape, transparent and opaque outer protection. structure. And the model in this paper finds that the building energy consumption is reduced by 0.18, the natural lighting is increased by 0.154, and the natural pressure Pa time is increased by 0.03. In general, the multi-objective optimized building integrated design scheme makes the building consume less energy, and the natural lighting and natural ventilation effects are

improved, reflecting the advantages and design effects of the building integrated design. Green and low energy consumption design is a complex optimization process, and genetic algorithm is suitable for this complex optimization process. This paper only uses this algorithm to carry out a brief optimization design in the program design stage, but in other stages and research depth, objective function formula and other aspects More in-depth theoretical and practical research should also be carried out. In terms of the algorithm, this paper only uses some basic theories. In the future, it is still necessary to use the algorithm for more in-depth exploration and practice, discuss the rationality and process of its use in the design stage, and find an improved algorithm suitable for use in each design stage.

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