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Design of Construction Cost Over Budget Control System Based on BIM Technology

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Abstract. The traditional cost over budget control system gets higher construction cost, and the deviation between budget value and actual value is large. In view of this problem, this paper designs a BIM technology-based construction project cost over budget control system. In terms of system hardware, the front-end acquisition device is optimized to measure the structural parameters of buildings; Optimize the real-time monitoring device of building construction and collect the construction images; Optimize the construction data integrator, integrate the measurement data and image data; In the aspect of system software, the lightweight database is configured according to the functional requirements of data integrator. After preprocessing the collected and monitored image data, the macro and micro influencing factors of construction cost are extracted. Finally, building construction model is established based on BIM Technology, and the influencing factors are displayed and adjusted to make the cost within the budget. The experimental results show that, compared with the traditional system, this system reduces the budget value of construction cost and the deviation between the budget value and the actual value.

Keyword: Project cost · BIM technology · Construction data · Budget value

1 Introduction

At present, there is a deep understanding of the cost management of construction projects in China, and relevant departments have been set up to carry out special project management audit. The intervention of government functional departments can more effectively complete the project management process. A professional cost management team is composed of more professional cost and accounting talents, which is bound by government functional departments, To supervise the process of project cost management, more effective project cost management, but due to the huge amount of project, the number of participating units and individuals is large, the project cost of construction project is still over budget. Therefore, the design of the construction project cost over budget control system and effective project cost control in the whole life cycle can not only save money for the country, but also achieve real-time supervision, timely discover the design risk and construction risk of the project, so that the project cost control runs through the whole life cycle of the project, which is of great significance to the design unit, the construction unit and the construction unit

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construction units, supervision units and other departments of the project management ability also put forward higher requirements.

At present, the theory and practice of project cost management have reached the level of standardization, and a scientific and standardized management system has been established. Through practical cost methods, the benign process from quotation to implementation has been realized. The comprehensive cost control is defined as a set of theories and methods applied to cost management, and enterprises can use the methods of comprehensive cost management Program to manage the whole life cycle cost of all its investments, and manage all kinds of input resources of all strategic assets, including capital, time, human resources and material resources [1, 2]. In the whole life cycle cost management of enterprise strategic assets, we use the comprehensive method to carry out the whole process cost of all the resources invested, get the comprehensive cost management model, and realize the cost management of the whole life cycle of assets. The project life cycle includes four stages: project initiation, plan, implementation and completion.

On the basis of the above theory, this paper designs a BIM technology-based construction project cost over budget control system. An isolation link is added to the data integrator interface to transfer the associated integrated signal of the digital resource from the signal line in and out, and isolate the interference signal to ensure the stability of the communication signal during the associated integration of the digital resource. Configure a lightweight database according to the functional requirements of the data integrator, extract the macro- and micro-influencing factors of the construction project cost, establish a construction model based on BIM technology, display the influencing factors and adjust, so that the cost is within the budget.

2 System Design

2.1 System Hardware Design

Optimize the Front-End Acquisition Device of Construction Data
Through the integrated control equipment, the front-end acquisition device is optimized, and the building structural parameters are measured to provide data support for the control of construction cost exceeding budget. The overall structure of the system is composed of five parts: high voltage energy taking device, special frequency source, repeater, monitoring master station and front-end acquisition device.

The monitoring master station adopts C/S structure and is equipped with an IBM server to analyze and process the construction data. The client of the master station selects the PC and calls the IBM server data in real time to obtain the data of construction funds, time, human resources and material resources. Special frequency injection device is used to inject different frequency signal and communicate with master station directly.

The front-end acquisition device is installed in the construction position, powered by the repeater to detect the construction process and upload the detection data to the repeater. Through the high-voltage energy taking device, it supplies power to the repeater, makes the repeater communicate with the master station, and sends the construction information data to the monitoring master station. The high voltage bushing is used in the structure of the energy taking device, and the device is built in the bushing. The high voltage metallized film capacitor is used to convert the high voltage into the low voltage, so as to realize the zero load start of the control system. The system communication consists of data transmission device and communication network. Two communication modes are selected for the communication network, namely GSM/GPRS communication and RF wireless networking. The frequency range of RF network is 350 kHz−28 GHz, and the transmission rates of GSM and GPRS are 1−65 kb/s and 1−120 KB/s respectively. The repeater uses MCU to control GSM module and GPRS module to communicate with front-end acquisition device and master station respectively. The master station uses GPRS module to receive data.

The integrated control equipment of front-end acquisition device integrates energy taking unit, switch, control unit, detection unit, measurement unit and circuit breaker. Using lightweight and miniaturized high-voltage capacitor, the power is directly taken from the wire as the working power supply of the integrated control equipment. The measurement unit is hung on the building, which is composed of voltage measurement unit, energy acquisition unit and single-chip microcomputer to collect construction data. The technical parameters of the front-end acquisition device are shown in Table 1.

Table 1. Technical parameters of front end acquisition device

Equipment	Parameter	Numerical value
Integrated control equipment	Rated input current	2 mA
	Load	<130 Ω
	Linear range	10–1800%ln
	Rated point ratio difference	<0.2%
	Rated output current	2 mA
	Working temperature	−40–90°C
	Accuracy class	0.1
	Permissible error	<±0.3%
Fault detector	Maximum rated voltage	11 kV
	Accuracy of load current measurement	<±1.5%
	Service voltage level	15–25 kV
	Applicable conductor diameter	10−50 mm
	working temperature	−20–80°C
	Altitude	<2000 m
	Communication distance	>150 m
	Rated frequency	60 Hz
	Sampling resistance	120 Ω

For the circuit breaker of the front-end acquisition device, the common vacuum circuit breaker, model ZW-72, is used. It is equipped with current transformer, isolation knife, solar power supply, feeder automation terminal, intelligent data interface and combined transformer. Due to the large amount of installation work, the structure of the circuit breaker body is modified, the base is extended, the signal processing unit is installed on the base, the energy taking device is installed on the top of the extension section, and the signal processing unit is connected with the front-end acquisition device through the cable. The cable adopts twisted pair cable and is erected along the construction project. This method can ensure that the acquisition device has good anti electromagnetic ability, and ensure that the data acquisition and transmission are not interfered.

The front-end acquisition device adopts multi-channel interface, which enables automatic switching between acquisition channels, including digital signal, analog signal, network signal, GPRS signal, etc., monitors each channel, analyzes the detection data of integrated control equipment and fault judgment device, and converts it into the actual value of construction state [3]. So far, the optimization of the front-end acquisition device of construction data has been completed.

Optimization of Real Time Monitoring Device for Building Construction
Optimize the construction real-time monitoring device, carry out real-time monitoring on the construction project, and collect the construction image. The real-time monitoring device for building construction is composed of three parts: video acquisition device, video server and monitoring terminal. The USB camera is used as the video acquisition device, and the model au4660 is selected. At the front end of the camera, the image clarity ball device is configured to ensure the clarity of the collected image. The hardware of video server is based on SBC2440 embedded platform, embedded with Samsung S3C2440 microprocessor, connected with acquisition equipment and server through USB1.1 bus, and installed in the monitoring site of construction engineering [4]. The monitoring terminal adopts PC, and the overall architecture of the monitoring terminal is shown in Fig. 1.

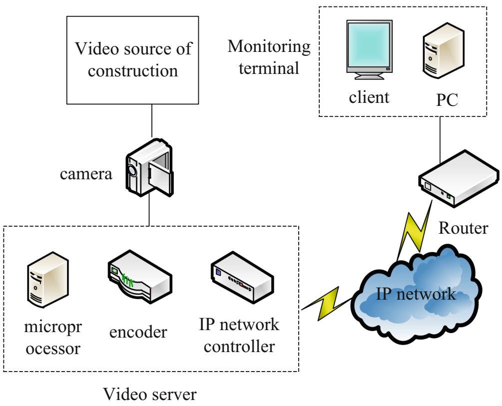

Fig. 1. Overall structure of monitoring terminal

USB camera is used to read the video image information of the construction project, compound the analog video signal, and transmit the digital signal of the video to the video server after a/D conversion. The analog-to-digital converter is set with a precision of 12 bits and a speed of 25 MSPs. The internal analog video switch is configured. The conversion circuit between analog video signal and digital video signal is shown in Fig. 2.

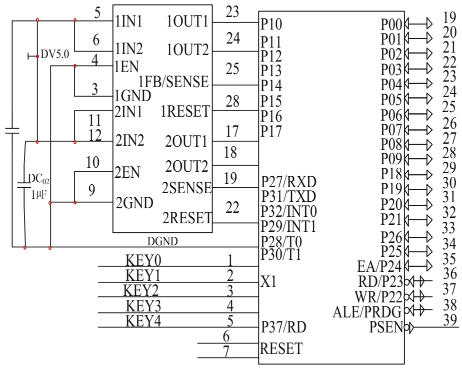

Fig. 2. Conversion circuit of video analog signal and digital signal

In Fig. 2, the left side is the analog-to-digital conversion circuit, and the right side is the composite video processing circuit. Through the composite processing circuit, the chroma and brightness of the video signal are separated, and the parallel YCbCr signal is output. The development board of video server integrates serial interface, SD card storage interface, USB interface, 1.5 mm hard disk interface and IP network interface. The hard disk interface meets the external standard of microprocessor and encoder. S9c1860 is selected as the server chip. The core of the chip is a high-speed buffer structure with tailorability. It can make full use of the hardware resources on the server, and the maximum frequency can reach 540 MHz, which can meet the application requirements of Embedded Server [5]. Run AUS729 encoder on the server to compress the video image to form H.264 video stream in YCbCr format. Through the network layer interface of IP network controller, encapsulate the compressed video stream, convert it into RTP format packet, and send the video stream to the monitoring end through IP network multicast. The monitoring terminal decodes the video stream according to the set format, decodes the H.264 stream into the original image in YCbCr format, and displays the monitoring video of building construction. So far, the optimization of real-time monitoring device for building construction has been completed.

Optimizing Construction Data Integrator

Optimize the construction data integrator, integrate the measurement data and image data. According to the service function of the construction project cost over budget control system, the data integrator of the system is optimized, and the overall construction of the integrator is divided into five modules: core, associated interface, power supply, network function and peripheral circuit. SVB12F762 chip is selected for the integrator, and its configuration should meet the circuit requirements of the integrator. SVB12F762 chip is used for level conversion, so that the integrator bus can maintain high level and weaken the reflected signal when it is idle. The isolation link is added in the data integrator interface to transmit the correlation integration signal of digital resources from the signal line, and isolate the interference signal, so as to ensure the stability of the communication signal in the process of correlation integration of digital resources [6]. The overall framework of its data integrator is shown in Fig. 3.

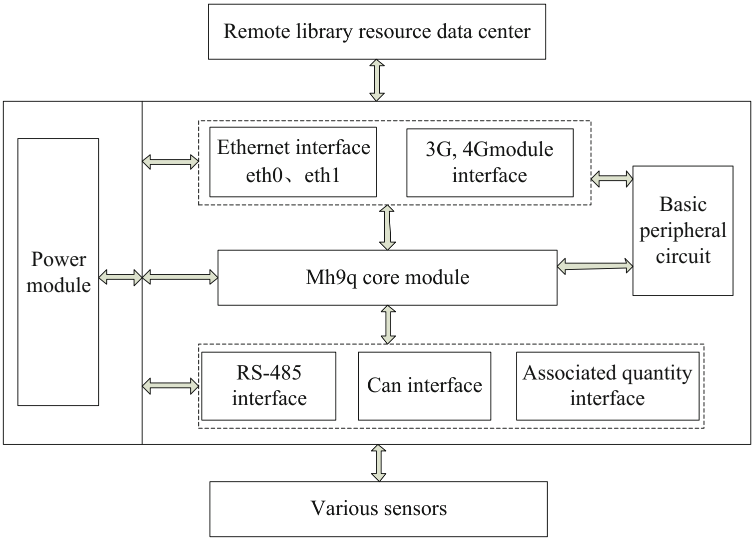

Fig. 3. Framework of data integrator

As shown in Fig. 3, the core module adopts MH9Q core platform produced by Freescale company to build 4 GB eMMC Flash and 2 GB memory to integrate the construction data, integrate it into Cortex-a9 four core processor, and drive the resource data through Ethernet and CAN bus, so as to support the operation of data association and integration. In the optimization of the power module, the data integrator uses 24 VDC power input to make the collector face the industrial general interface. The power module is connected with SVB12F762 chip to convert the transistor logic level signal. The level is directly connected with the input and output interfaces of the core module, and the CAN transceiver of the construction data is added to make it output 5 V power supply with stable voltage, so as to realize the overall optimization of the data integrator. So far, the optimization of construction data integrator is completed, and the hardware design of the system is realized.

2.2 System Software Design

Design System Database

According to the functional requirements of data integrator, a lightweight database is configured to store the collected data orderly and record the operation status of construction. DAQ is embedded in the hardware of the daq_status_tb table and data_store_tb table, where daq_status_tb is used to store the running state of construction, data_store_tb is used to store the data of building structure parameters. The specific system database configuration is shown in Table 2.

Table 2. System database configuration

Field name	Field meaning	Field type
start_time	Serial number of data association integration interface	Blob
sensor_num	System operation status	Interger
ID	Ms level, time stamp	Interger
daq_serial	Autoincrement primary key	Interger
Status	Serial number of various sensors	Text
Raw_data	Construction data association and integration serial number	Text
sensor_number	raw data	Interger
store_date	Association type	Blob
daq_type	Integrated data	Text
Process_data	Autoincrement primary key	Interger

Using Mysql database and concurrent operation, we can directly access the data files of construction. In the PHP processing module of the database, the user uses text / htm1; Charset = UTF-8 // sends the access request, then processes the php script, parses the data of book digital resources, reads and writes the data configuration file through login-btn > submit-text2//, receives the information returned by the php script, and finally generates var-export (list1,10) -catch// to present the data to the whole web page, so as to display the data in the database.

At the same time, Ontology semantic web technology is used to realize the digitization of the storage resources in the database, describe the construction data, get the descriptive metadata, and send it to the network as the associated data. According to the code of Cool URIs named by semantic web, the URI of construction data is named. With the help of various description methods provided by FRBR, the associated data vocabulary set is created to describe the semantic ontology of digital resources. The semantic classification standard of Digital Resource Association is shown in Table 3.

Table 3. Classification standard of digital resource association semantics

Semantic name	Subnet type involved	Segmentation criteria
Hierarchy	P-P;K-K;M-M	Genus
Citation relation	P-P;M-M	Entity
Correlation	P-P;K-K;M-M	Whole part
Equivalence relation	P-P;K-K;M-M	synonymous
Attribute relation	P-P;P-K;K-K;M-M	Near meaning
Discuss the relationship	K-K;K-M;M-M	synonym
See relation	P-K;K-K;K-M;M-M	Antisense

According to the content shown in Table 3, the progressive transformation mechanism of construction data association semantics is constructed, and the corresponding subnet type is selected. Then, the associated semantics of construction data is described. With the help of entity extraction mechanism and D2RQ conversion tool, the construction data is transformed into RDF metadata. On this basis, a new semantic descriptive metadata is created [7]. Finally, the publication mode of associated data is selected to expand the construction data, collect the Open API provided by construction engineering, build a network environment with stronger resource correlation and scheduling, and combine services and associated data to connect the control system with internal and external construction data. So far, the design of the system database is completed.

Preprocessing Construction Data

Preprocess the image data collected by acquisition device and monitoring device, remove data noise and reduce memory space. Through weighted mean filtering, the noise of video image is removed, the weight of each pixel is set, and it is judged that the closer the pixel is to the center point, the larger the weight is, and the farther the pixel is to the center point, the smaller the weight is, so as to reduce the blurring of video image [8–10]. Select a fixed size local window, calculate the gray value of each pixel in the window and the average gray value of neighboring pixels, and replace the gray value with the average gray value. The expression of weighted mean filter is as follows

$$f(x,y) = \frac{\sum_{i=0}^{n} R_i(x,y) w_i(x,y)}{\sum_{i=0}^{n} R_i(x,y)} \tag{1}$$

where, (x,y) is the pixel coordinates of the video image, n is the number of center points of the video image, $w_i(x,y)$ is the gray value of the pixel in the neighborhood of the center point of the filter window, $R_i(x,y)$ is the corresponding weight of $w_i(x,y)$, and $f(x,y)$ is the gray value of the center pixel after filtering. The formula (1) is used to improve the digital signal of video image edge and suppress the influence of noise pixels on neighboring pixels. According to the gray value, The h expression of gray image channel is as follows

$$h = \begin{pmatrix} 0.114 & 0.587 & 0.299 \end{pmatrix} \begin{pmatrix} B \\ G \\ U \end{pmatrix} \tag{2}$$

Among them, B, G and U are blue, green and red channels respectively, and 0.114, 0.587 and 0.299 are channel threshold parameters respectively. The expression formula of threshold segmentation is as follows

$$J(x, y) = M(h, Q) \tag{3}$$

Among them, M is Gaussian matrix, Q is channel threshold index of video image, and $J(x, y)$ is the threshold segmentation video image. Through formula (3), the multi-pixel width of the image line is reduced to the unit pixel width, and the structural information of the features is stored in the image to realize the thinning of the video image, so as to recognize the features contained in the image, extract the feature range of the video image, reduce the data structure of the H.264 video stream, and reduce the image data operation efficiency. So far, the pretreatment of construction data is completed.

Mining Video Frame of Construction Project

Using big data tag technology, mining construction video frames in the preprocessed image data. According to the extracted image contrast, structure information and brightness, the video image is compared, and the similarity of the preprocessed image is calculated:

$$\begin{cases} j(a, b) = (2u_a u_b) / \left(u_a^2 + u_b^2\right) \\ p(a, b) = (2s_a s_b) / \left(s_a^2 + s_b^2\right) \\ g(a, b) = (2s_{ab}) / (s_a s_b) \end{cases} \tag{4}$$

Among them, a is the preprocessed video image, b is the contrast video frame, $j(a, b)$, $p(a, b)$ and $g(a, b)$ are the brightness similarity, contrast similarity and structure similarity of the video frame, u_a and u_b are the average brightness values of a and b frames, s_a and s_b are the standard deviation of a and b frames, and s_{ab} is the covariance of two frames. Then the final similarity Z of the video frame is:

$$Z = [j(a, b)]^m [p(a, b)]^n [g(a, b)]^O \tag{5}$$

Among them, m, n and O are the importance proportion of the three modules. In the H.264 video stream, the video frame with high final similarity is selected as the associated data in the massive video data. Using the big data label technology, the data label is established, and the associated image data is clustered to label each cluster of data. According to the tags of all the data, it is classified and stored in the tag library, and the source of video frames is analyzed. The alarm information of tag library is shown in Table 4.

Table 4. Label library alarm information table

Data type	Listing	Space	Data description
User number	varchar	yes	Construction time
User name	varchar	yes	Construction address
Logon times	varchar	no	Construction number
describe	char	no	describe
Last logon time	varchar		Linkage intercom
Alarm number	datetime	yes	construction stage
Alarm name	varchar	yes	Construction structure
Alarm level	varchar	yes	construction technology
Alarm status	datetime	yes	Construction time
Occurrence time	varchar	no	Construction funds
End time	datetime	yes	Construction manpower
Alarm event	datetime	no	Construction material resources
Linkage intercom	char	no	Construction status
Remarks	varchar	no	Completion time of construction

For the newly added construction video images, the video frames are allocated to the most similar clusters, which are also transmitted to the tag library to search for data tags. In the massive monitoring video image data, the construction video frames are mined out, and after exceeding the budget control, the video frames are labeled with invalid Tags. So far, the excavation of construction video frame is completed.

Extraction of Macro Influencing Factors of Construction Cost
In the excavation of construction video frame, the influencing factors of project cost exceeding budget are extracted. The Macro Influencing Factors of cost are summarized as follows:

1. The total length of the building, when the length of the building is long, the expansion joint needs to be set. The length of the frame structure is more than 55mm, and the length of the shear wall structure is more than 45mm. The shrinkage stress and temperature stress inside the concrete of the super long structure are relatively large, so the amount of reinforcement will naturally increase, and it is also unfavorable to the earthquake resistance of the structure, In the case of no expansion joint, expansion post cast strip is usually set with a width of 2 mm, and additional reinforcement is set in the strip, which will also increase the amount of steel used;
2. For buildings with large plane aspect ratio and large plane aspect ratio, due to the large difference of dynamic characteristics in the two principal axis directions, under the horizontal earthquake, the stress of components in the two directions is not uniform, and the structural torsion coefficient is large, which leads to the increase of component reinforcement;

3. Vertical aspect ratio, for high-rise buildings, the overturning moment of the structure with large aspect ratio is larger, which leads to the poor overall stability of the structure. In order to ensure the overall stability of the structure and control the lateral displacement of the structure, it is necessary to increase the lateral force resisting members or improve the stiffness of the lateral force resisting members, which will increase the amount of concrete and reinforcement, thus increasing the cost;
4. The buildings with regular and uniform facade shape and vertical shape have no sudden change in stiffness, even stress and small steel consumption. If there is vertical irregularity, such as cantilever structure, the calculation reinforcement will be increased in stress, and the requirements for seismic structure will be higher, so as to increase the cost;
5. Plane shape: the simpler the plane shape of a building is, the better the stress is, the less the steel consumption is. Irregular plane shape not only increases the steel consumption, but also has a great impact on the seismic performance of the structure;
6. The reasonable layout of column net and the size of column net can reduce the stress of components and the steel consumption;
7. Different types of buildings, such as villas, multi-storey buildings, small high-rise buildings, high-rise buildings and super high-rise buildings, all have different design and construction specifications. For example, the design specifications of small high-rise buildings and super high-rise buildings are different, which are reflected in the aspects of earthquake resistance, wind resistance, fire prevention and pressure increase;
8. Floor height, on the premise of meeting the building function, appropriately reducing the floor height will reduce the project cost. For every 10 cm decrease in floor height, the project cost will be reduced by about 1%, and the wall materials will be saved by about 10%;
9. Lateral force resisting system, because the horizontal force in high-rise structure has a great influence on the structure, so lateral force resisting system becomes an important part of high-rise structure system. The amount of structural materials used to bear vertical load in unit building area is linearly proportional to the number of floors of the building. When the floor load is determined, the reinforcement of the floor structure is certain, which has almost no relationship with the number of floors of the structure. The material consumption of vertical load-bearing components such as walls and columns increases linearly with the number of floors of the building. The structural material consumption for resisting lateral force increases in a quadratic curve according to the number of floors of the building. Is the selection of lateral force resisting system economical and reasonable, Directly affect the amount of structural materials [11].

So far, the extraction of macro factors affecting the construction cost has been completed.

Extraction of Micro Influencing Factors of Construction Cost

In the mining video frame, the micro influencing factors of project cost exceeding budget are extracted as follows:

1. Generally speaking, for the residence with more than 8 floors, the shear wall structure adopts more structural forms. When the shear wall layout is reasonable and the limb length is appropriate, most of the reinforcement of the section can be arranged according to the structure. According to the technical specification for concrete structure of high rise buildings, the seismic grade of short limb shear wall with the wall length of 5–8 times, Therefore, in the plane layout, the number of short pier walls should be reduced as much as possible, and the amount of structural reinforcement should be reduced accordingly;
2. In the plane layout of shear wall structure, the windows at the corner should be reduced as much as possible, and the shear wall at the corner should be retained to control the torsion of the whole building. The more the wall limb at the corner is weakened, the more the amount of concrete needed for other components is, and the corresponding reinforcement of beams and walls will also be increased;
3. The torsion effect of the structure can be reduced if the position of the lateral force resisting member and the center of stiffness coincide with or close to the center of mass. By reasonably arranging the lateral force resisting member, the torsion can be effectively adjusted, so as to reduce the steel consumption;
4. In the layout of beams, slabs, columns, walls and other components, the reasonable stress and direct force transmission should be considered to make the transfer path of floor load as simple as possible, avoid the unclear force transmission of multi-level beams, and then meet the requirements of normal use. For the case of partition wall on the slab, the load of partition wall can be changed into uniform load on the floor, and the method of adding reinforcement at the bottom of the slab is adopted instead of setting beams to increase the cost;
5. The section size of the wall and column should be reasonably determined in the structural design. The wall and column are compression bending members, and the actual reinforcement amount is generally in accordance with the structural requirements. On the premise of meeting the specification, the axial compression ratio of the column should not be too small, and the section size of the column is too large, which not only affects the use of indoor space, but also increases the foundation size and cost;
6. The reinforced part of the shear wall, the first and second shear walls are divided into the bottom reinforced part and the non reinforced part. The reinforced part is reinforced according to the constraint edge member, and the non reinforced part is reinforced according to the structural edge member. The reinforcement amount of the nodes in the bottom reinforced area and the edge member is much larger than that of the non reinforced part, so the structural design should be in accordance with the specification, Strictly distinguish the seismic grade and shear wall position, so as to avoid unnecessary waste;
7. On the premise of meeting the structural design, the selection of high-grade reinforcement scheme can not only reduce the project cost, but also increase the building safety reserve and concrete structure strength, especially for high-rise and important buildings;

8. On the premise of meeting the requirements of the code, reducing the weight of the structure, reducing the number of shear walls, controlling the stiffness of the structure, thinning the shear wall, changing the windowsill wall into brick, opening the long wall, and designing the large bay can achieve good benefits.
9. The choice of foundation form is not only related to the direct engineering cost of buildings, but also affects the foundation pit maintenance.

So far, the extraction of micro influencing factors of construction cost is completed.

Control of Construction Cost Exceeding Budget Based on BIM Technology
The BIM Technology is used to establish the building model, and the macro and micro factors are displayed through the model to control the over budget of the construction cost. In the process of construction, CAD drawings are imported into 3D-BIM modeling software to create real component information to avoid drawing recognition errors due to the long time of drawing review. Then, a visual model is generated by adding the corresponding coordinate information artificially. When managing the construction progress, the collected construction data are added to obtain the four-dimensional model of the construction project. For the civil engineering and installation part, the technical department uses the MagiCAD software to complete the modeling of the mechanical and electrical part, and the software engaged in the calculation work is used for the cost budget part. Through the construction network provided by BIM software, it helps CAD drawings express the building space intuitively, making the construction progress more visible and easy to track the progress of the Project. Meanwhile, the project schedule prepared by project software reflects the space and time information in the construction, and facilitates the control of the construction period [12, 13].

This study applies BIM Technology to the field management. Through the model and field simulation, we can know the possible events in the construction site in advance. The accurate database provided by BIM Technology model created by the project is used to track the site, so as to achieve the effect of dynamic management of the factors affecting the project cost.

At this point, the cost of construction project based on BIM Technology is over budget control, and the software design of the system is realized. Combined with hardware design and software design, the design of the construction cost over budget control system based on BIM Technology is completed.

3 Experiment and Analysis

In order to verify the reliability of the BIM technology-based construction project cost over budget control system, the traditional construction project cost over budget control system is selected as the contrast, and the budget value and the deviation between the budget value and the actual value of the construction project under the control of the two groups of systems are compared.

3.1 Summary of Construction Engineering

The construction project is an office building project with a building height of 22.5 m and a building area of 9210.47 m^2, The building base area is 1490.57 M 2, The building has two floors underground and 13 floors above ground. The second floor is the underground garage, and the first floor is the basement. Office and technical buildings are located on the 13th floor above ground. The second floor underground is a fire compartment. The first floor underground has two fire compartments. The first floor and the second floor are one fire compartment. One fire compartment is set on the third floor to the thirteenth floor. The structural type of the building is frame structure, the seismic grade is grade 3, the seismic structural measures are grade 2, and the structural safety grade is grade 2. The seismic fortification category is class B, the design grade of foundation is class C, the environmental category of concrete structure is class 2b, the environmental category of indoor concrete structure is class I, and the environmental category of toilet is class 2a. The BIM model of the design system is shown in Fig. 4.

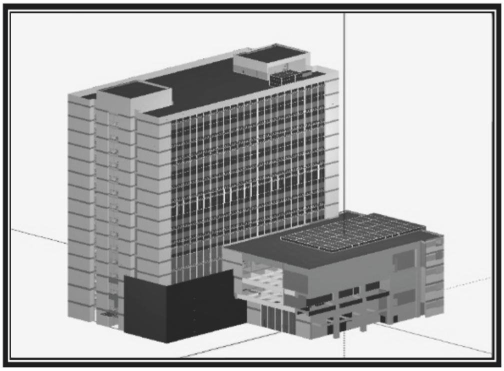

Fig. 4. Building BIM model

3.2 Experimental Result

The two groups of systems are used to control the construction project cost exceeding the budget, and the budget value of the construction project cost under the control of the two groups of systems is compared. The results are shown in Table 5.

Table 5. Comparison results of construction project cost budget (10000 yuan)

	Construction stage	This paper system	Traditional system
Underground	1st floor	8392.40	8976.20
	2nd floor	8251.50	8816.40
On the ground	1st floor	7936.20	8826.10
	2nd floor	8142.40	8991.90
	3 layers	8028.30	8718.60
	4th floor	7826.10	8834.50
	5 floors	7935.90	8971.40
	6th floor	8092.70	8816.30
	7th floor	8271.20	8782.90
	8th floor	8172.60	8826.20
	9th floor	8204.40	8803.40
	10th floor	7906.90	8714.50
	11th floor	7836.40	8829.10
	12th floor	8152.60	8902.30
	13th floor	8071.40	8816.40

It can be seen from Table 5 that the construction cost of the system budget in this paper is significantly lower than that of the traditional system. In this paper, the total budget value of the system construction project cost is 1212.21 million yuan, and the total budget value of the traditional system construction project cost is 1326.262 million yuan. Compared with the traditional system, the total budget value of the construction project cost of this system is reduced by 114.052 million yuan, which proves that it saves more construction cost.

Table 6. Comparison results of project cost budget deviation (%)

	Construction stage	This paper system	Traditional system
Underground	1st floor	0.09	0.26
	2nd floor	0.08	0.29
On the ground	1st floor	0.08	0.25
	2nd floor	0.07	0.19
	3 layers	0.06	0.25
	4th floor	0.09	0.28
	5 floors	0.05	0.22
	6th floor	0.08	0.25
	7th floor	0.06	0.24
	8th floor	0.08	0.12
	9th floor	0.12	0.29
	10th floor	0.11	0.21
	11th floor	0.06	0.18
	12th floor	0.07	0.22
	13th floor	0.10	0.23

On this basis, the deviation between the budget value and the actual value of the project cost obtained by the two systems is compared. The experimental results are shown in Table 6.

It can be seen from Table 6 that the construction cost obtained from the system budget in this paper is closer to the actual value. The average deviation of the construction project cost of the system budget in this paper is 0.08%, and that of the traditional system budget is 0.23%. Compared with the traditional system, this system budget construction cost deviation, reduced by 0.15%, the budget value is more accurate and reliable. The main reason is that the method in this paper adds an isolation link to the data integrator interface, transmits the associated integrated signal of the digital resource from the signal line, and isolates the interference signal to ensure the stability of the communication signal during the associated integration of the digital resource.

4 Conclusion

This study gives full play to the modeling advantages of BIM Technology, reduces the budget value of construction cost, and reduces the deviation between the budget value and the actual value. However, there are still some deficiencies in this study. It takes a lot of time to establish BIM model for engineering quantity calculation. In the future research, it will simplify the calculation process of reinforcement and civil engineering, and further improve the control accuracy of construction cost over budget.

Fund Projects

1. Guangxi Vocational Education Teaching Reform Research Project in 2020 “Research and Practice on the Practice Teaching System of “Three Courses and Four Abilities” in Higher Vocational Architecture Majors with Progressive Ability” (GXGZJG2020B122)
2. In 2020, Guangxi Gao School's young and middle-aged teachers’ scientific research ability improvement project “Research and Practice of Prefabricated Buildings Based on BIM Technology in Underdeveloped Areas” (2020KY45013).

References

1. Lei, C.: Analysis and control measures of overbudgeting of construction cost. Shanxi Architecture **45**(3), 221–222 (2019)
2. He, S., Zhuo, L.: Study on the causes and control of landscape engineering costs beyond the budget. Urbanism Architecture **16**(15), 185–186 (2019)
3. Yu, N.: Reasons for over budget of construction project cost and control countermeasures. Build. Techn. Dev. **46**(7), 100–101 (2019)
4. Chen, L., Liang, K.: Cause Analysis and control method exploration of project settlement cost exceeding bbudget. Equipment Manufacturing Technol. (10), 113–114+149 (2019)
5. Yuan, Y.: Analysis of the causes and control measures of construction project over budget. Value Eng. **39**(6), 16–17 (2020)

6. Cao, W.: Causes and control methods of construction cost over budget. Const. Design Project (13), 252–254 (2020)
7. Liu, S., Liu, D., Muhammad, K., Ding, W.: Effective Template Update Mechanism in Visual Tracking with Background Clutter. Neurocomputing (2020). https://doi.org/10.1016/j.neucom.2019.12.143
8. Li, J.: Analysis of the causes and control strategies of overbudget of construction cost. Const. Design Project (12), 245–246 (2019)
9. Liu, S., Li, Z., Zhang, Y., Cheng, X.: Introduction of key problems in long-distance learning and training. Mob. Networks Appl. **24**(1), 1–4 (2018). https://doi.org/10.1007/s11036-018-1136-6
10. Ma, X., Liu, D.: 3D reconstruction simulation of BIM building based on perspective augmented reality. Comput. Simul. **37**(3), 229–233 (2020)
11. Wang, D.: Analysis of the causes and control measures of construction project cost exceeding budget. Manage. Technol. SME (8), 86–88 (2020)
12. Liu, S., Liu, D., Srivastava, G., Połap, D., Woźniak, M.: Overview and methods of correlation filter algorithms in object tracking. Complex Intell. Syst. **7**(4), 1895–1917 (2020). https://doi.org/10.1007/s40747-020-00161-4
13. Yue, L.: Application of BIM technology in installation budget. Eng. Cost Manage. (5), 50–56 (2019)