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Research on Control Method of Hidden Cost in Construction Engineering

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Abstract

In order to improve the hidden cost control power of construction enterprises and improve the profit rate, on the basis of analyzing the hidden cost composition of construction resources and identifying its control elements, this paper constructs a construction resource based on the complexity and concealment of hidden cost control of construction resources. The construction resource optimization and cost dynamic control model of BIM and genetic algorithm (GA), based on the BIM information model, introduces genetic algorithm to complete the balanced optimization of construction resources, and realizes dynamic management of construction resources and effective control of hidden costs.

Keywords

Hidden Costs; Construction Resources; BIM; GA.

1. Introduction

Because of the inherent concealment, complexity, difficult to quantify and uncontrollable characteristics of hidden cost, although entrepreneurs and scholars have a sufficient understanding of its importance and urgency, the research can only stay on the surface and fail to touch the origin. The results are often general, it is difficult to find the objective basis and quantitative support for hidden cost control, and they have to return to valuation according to experience and response according to interest The low-level and extensive implicit cost control strategy based on habitual decision-making leads to the formality of implicit cost control, the waste of a large number of manpower, material resources, time and funds, and gradually form the "benefit funnel" of construction enterprises.

In related researches in recent years, Thomas C.R and Maurice S.C believe that the hidden cost is the opportunity cost of the enterprise using its own resources [1]. Metallization defines the hidden cost as the cost of organizational structure and management decision-making system in the empirical analysis of British retail enterprises. In financial trading, Roll believes that it is necessary to infer and estimate the effective spread theoretically. He calls the inferred effective spread as the implied spread and regards it as an implicit cost [2]. Deming calls the more indirect costs within the enterprise, such as the inefficiency of the production process, the management costs caused by the inventory backlog, and the uncalculated costs such as equipment downtime as hidden costs [3]. Logothetis refers to intangible costs that cannot be measured in traditional accounting, such as losses caused by customer dissatisfaction and loss of market share, as hidden costs [4]. Campanula first proposed the concept of intangible cost of quality. Point out that most of the cost of loss is "hidden" out of sight, and these costs are often the main factor in the cost of enterprises [5].

In related researches in China, Liu Xing classified "influence cost, information distortion cost, authority failure cost" as hidden costs. And think that the hidden cost has adhesion and potential [6]. Li Limei believes that hidden cost is the waste of educational resources caused by various problems in system, policy, management, etc. It is hidden in the total cost, but it is not

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displayed on the accounting table, and it is separated from financial auditing. costs beyond supervision [7].

According to the summary, both at home and abroad, entrepreneurs, managers and scholars in various fields have some understanding of the impact of hidden cost, but there is no consensus on the concept of hidden cost in previous studies, and there is still no mature and authoritative theory. Generally speaking, the current similar research mainly focuses on the concept discussion stage, lacking theoretical analysis and data support, especially the quantitative methods and control measures for the hidden cost of construction enterprises need to be further studied.

2. Definition of the Concept of Hidden Cost of Construction Projects

By combing the literature and analyzing the connotation of hidden cost, it is found that hidden cost is the opportunity cost of enterprise's own resources and current project management mode[8]. The hidden cost of construction project is the cost loss caused by imperfect project management system, inefficient operation mechanism and unbalanced resource allocation, which can be caused by cost transfer and cost migration[9].

From the perspective of construction resource allocation, this study defines the construction hidden cost in the construction project as: the additional loss caused by the abuse of construction resources (human resources, construction materials, mechanical equipment) due to the untimely information, inaccurate data, unscientific preparation of construction resource allocation plan, unreasonable allocation of construction resources and other reasons in the process of project construction, and finally through cost migration Cost transfer and other methods are reflected in the total cost of the project, which is an additional cost increase.

3. Establishment of Hidden Cost Composition System of Construction Projects

In order to better understand the hidden cost of construction, taking the specific stage from the commencement of construction project to completion acceptance as the research scope, starting from the three production factors of labor, materials and mechanical equipment, this paper establishes three first-class indicators, eight second-class indicators and 19 third-class indicators, as shown in Table 1.

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Table 1. Hidden factors of construction hidden cost

Level 1 factor account	Level 2 factor account	Level 3 factor account
Human factors	Construction personnel allocation factors	The technical level of the construction planner is low
	Quality factors of construction personnel	The quality level of construction workers is low The quality level of construction management personnel is low
Construction material factors	Purchase price factors of construction materials	Supplier selection error Poor communication with suppliers
	Mobilization and demobilization factors of construction materials	Unreasonable transportation plan Poor communication with suppliers
	Storage and distribution factors of construction materials	Unreasonable order of construction materials entering and leaving the site Neglect of construction materials Unscientific requisition of construction materials
	Storage and distribution factors of construction materials	Unreasonable purchase plan of mechanical equipment Unreasonable selection of mechanical equipment
Mechanical equipment factors	Selection factors of mechanical equipment	Unreasonable use plan of mechanical equipment Unreasonable travel path arrangement of mechanical equipment in and out of the site
	Mechanical equipment mobilization factors	Unreasonable use plan of mechanical equipment Unreasonable mobilization and demobilization schedule of mechanical equipment Unreasonable travel path arrangement of mechanical equipment in and out of the site
	Use and maintenance factors of mechanical equipment	Unreasonable operation of mechanical equipment Untimely maintenance of mechanical equipment

The construction hidden cost of construction projects varies according to different categories. By combing the motivation and influencing factors, the composition of construction hidden cost is sorted and classified according to the production factors, which is divided into human resources hidden cost, construction material hidden cost and mechanical equipment hidden cost. The system diagram of hidden cost composition of construction resources of construction projects is shown in Table 2.

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Table 2. Hidden cost composition system of construction projects

Level 1 factor account	Level 2 factor account	Level 3 factor account
Hidden cost of human resources	Unreasonable organization cost of human resources	Management cost of work slowdown, work stoppage and accommodation Support cost of work interruption and less work
	Nonstandard operation cost of construction personnel	Use planning error cost Unreasonable cost of labor personnel arrangement in each working face Use planning error cost Unreasonable cost of labor personnel arrangement in each working face
Hidden cost of construction materials	Procurement cost of construction materials	Improper preparation of purchase plan cost Rising cost of construction materials Capital occupation cost
	Construction material supply storage allocation cost	Material shortage guarantee cost Material non-standard receiving cost Material redundancy inventory cost
Hidden cost of mechanical equipment	Unreasonable selection cost of mechanical equipment	Invalid work cost of mechanical equipment Future transfer cost of mechanical equipment
	Mobilization cost of mechanical equipment	Idle cost of mechanical equipment Additional mechanical equipment storage management costs
	Use and maintenance cost of mechanical equipment	Additional mechanical maintenance and maintenance costs Additional rework cost

4. Quantitative Model of Hidden Cost of Construction Project

Based on the in-depth analysis of the constituent indicators and control elements of the hidden cost of construction resources in construction projects, this paper attempts to control these hidden costs by using BIM Technology and GA algorithm. The control process includes four steps.

Step 1: design the structure of construction hidden cost control model. Firstly, it analyzes the degree to which Bim and GA solve the problem of construction resources, and finally determines the structure of construction hidden cost control model.

Step 2: establish BIM construction resource information model. BIM construction resource information model is the basis of the whole model, which is used to realize the correlation between engineering components and progress information, budget information, construction resource consumption information and cost information, finally realize the dynamic query of planned and actual consumption of construction resources at any time, and provide data basis for the balanced optimization of construction resources.

Step 3: establish a construction resource balance and optimization model based on genetic algorithm. Genetic algorithm is mainly used to balance and optimize construction resources based on BIM construction resource information integration platform, so as to effectively control the hidden cost of construction resources.

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Step 4: realize the dynamic control of construction resources and real-time cost monitoring. In the bim5d platform of Guanglianda, the comparative analysis of three calculations of construction resources and the management of material disclosure, as well as the dynamic query of various cost information and timely deviation early warning are realized.

4.1. Structural Design of Construction Hidden Cost Control Model based on BIM

In order to establish the construction hidden cost control model based on BIM more scientifically and reasonably, firstly, the construction resource problems that Bim and GA can solve are analyzed, and then the construction hidden cost control model is designed according to these control elements.

4.1.1. Definition of Construction Hidden Cost Control Model based on BIM

The hidden cost control model of construction based on BIM takes the cost of each construction resource of construction project as the control object, takes the scientific and reasonable balanced allocation scheme of construction resources as the core, uses BIM Technology to realize the integration of construction resource related information such as budget resource information and progress information, and realizes the control model of construction resource planning and management, cost dynamic analysis and management.

4.1.2. Model Composition and Control Process

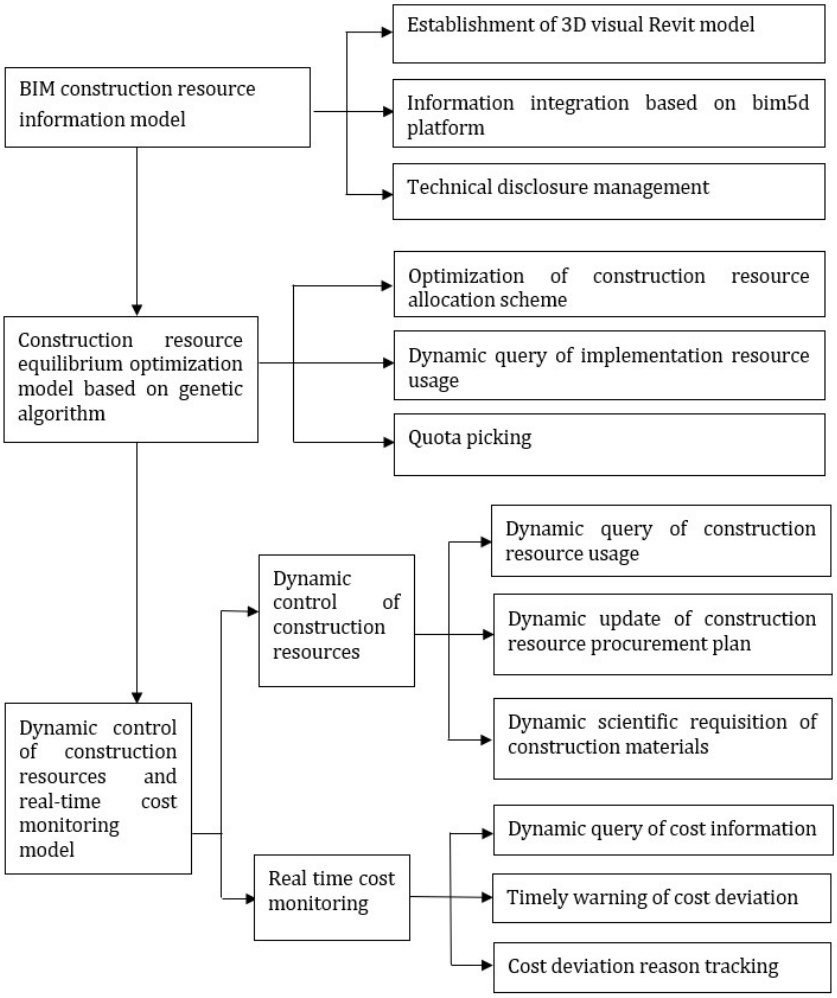

Figure 1. Construction resource optimization and dynamic control model

The unreasonable allocation of construction resources usually involves the whole construction stage. There are many participants from project managers to construction personnel, limited

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management means, and hidden costs exist in varying degrees during the period[10,11]. Therefore, the construction idea of studying the construction hidden cost control model based on BIM is to use more effective BIM Technology and GA algorithm to optimize the allocation of construction resources in each stage of construction project, so as to improve construction efficiency and control hidden cost.

The overall framework of BIM based construction hidden cost control model consists of three sub models: BIM construction resource information model, construction resource balance optimization model based on genetic algorithm, construction resource dynamic control and cost real-time monitoring model. Each sub model has a certain logical relationship and can play the role of implicit cost control of construction resources in different stages. Each sub model is the basis of the next sub model and is independent of each other, forming a systematic and hierarchical control model, as shown in Figure 1.

The specific process of BIM based construction implicit cost control model is as follows:

Firstly, through professional BIM modelers, professional models such as BIM building model, BIM structure model and BIM hydropower model are established, and then various professional models are integrated to form a complete three-dimensional BIM model of construction project. Based on the three-dimensional BIM model, the construction progress and estimated cost information of the project are associated to form a BIM construction resource information model. Then, the construction resource allocation plan is prepared according to the bill of quantities data and construction resource demand data provided by BIM construction resource information model.

In the construction preparation stage, the genetic algorithm is used to balance and optimize the construction resources according to the specific construction network plan, obtain the optimal construction resource allocation plan, and carry out the virtual construction before construction according to the plan. If the construction resource allocation plan matches the construction progress, it indicates that the optimization results meet the construction requirements, otherwise the construction resource allocation plan needs to be readjusted.

If the construction cost and actual use of resources deviate from the BIM model dynamically, the construction cost and actual use of resources should be monitored in real time. Once the BIM model deviates from the actual construction progress, the construction cost and actual use of resources should be controlled in time.

4.2. BIM Construction Resource Information Model

The creation of BIM construction resource information model is mainly divided into three parts: the establishment of 3D visual Revit model, information integration based on bim5d platform and technical disclosure management.

4.2.1. Establishment of 3D Visual Revit Model

The three-dimensional BIM model is constructed by using Revit series software. The main reason is that Autodesk Revit series software, as the representative of current 3D modeling software, can realize the integration of professional models such as architectural model, structural model, plumbing and electricity model in 3D state, and form a complete and accurate 3D BIM model. It contains all the attribute information of the construction project, and expresses the spatial relationship between the components. Through the three-dimensional BIM model, the project visualization can be realized, the quantities can be obtained, and reliable data can be provided for the budget estimation.

4.2.2. Information Integration based on Bim5d Platform

5D information platform mainly integrates progress information and budget information on the basis of 3D model, which can realize the information query of any component, time period and specialty. It is the basic data to realize the dynamic query of construction resource

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consumption. In this study, Guanglianda bim5d platform is used to create 5d-bim construction resource information model. The software is used to load the three-dimensional BIM model, construction schedule project file and budget file into bim5d platform to achieve the objectives of construction resource management. Firstly, the bim3d model is associated with various lists to directly obtain the contract budget and cost budget. Secondly, bim3d model is associated with the construction progress information. At present, project software is mainly used to prepare the construction network plan. It can determine the time required for each process according to the logical relationship between each process and the quantities of work and resources invested in each process. By importing the construction schedule project file into the 5D platform, the requirements of dynamic simulation and real-time tracking of the construction process can be realized.

4.2.3. Technical Disclosure Management

When carrying out technical disclosure, the project manager can improve the information communication mode during technical disclosure by using the visual characteristics of three-dimensional BIM model, so as to prevent the construction team from wasting the cost of materials such as "long material section and whole material allowance" and the cost of schedule delay caused by return to work due to the wrong understanding of technical disclosure.

4.3. Construction Resource Balance Optimization Model based on Genetic Algorithm

The construction resource information integration platform based on BIM only achieves the purpose of project management through project information summary. In order to more effectively manage and control the hidden cost of construction resources, we introduce the construction resource optimization algorithm to make up for the defects of Bim in information processing. In the actual project, the unbalanced allocation of construction resources will lead to a certain degree of staff idling, material waste and idle mechanical equipment, resulting in additional hidden costs. Therefore, the balance and optimization of construction resources is the key way to control the hidden cost. The biggest feature of the balanced optimization model of construction resources based on genetic algorithm is that it is based on BIM Technology. Under the condition of relatively fixed construction period, it establishes a mathematical model according to the demand information of construction resources, uses genetic algorithm to solve it, and finally obtains a scientific and effective construction schedule plan. At the same time, it uses BIM construction simulation function to test whether it can meet the construction requirements, The latest plan meeting the requirements is updated to the bim5d information integration platform to generate an implementation resource utilization plan, provide data basis for the realization of quota picking, and complete the feedforward control of the cost in the construction stage of the project.The goal of Balanced Optimization of construction resources is to ensure that all construction resources meet the construction resource demand plan of the project, consider the impact of progress on the allocation of construction resources, and then seek the most reasonable construction schedule plan to minimize the cost of construction resources.

The research selects the unbalanced degree of construction resource allocation, that is, the standard deviation K of daily resource demand within the construction period, as the optimization goal. To optimize resources, it is necessary to use the schedule network diagram. In this study, the double code network diagram will be used to represent the construction project. The symbols and meanings of variables used in the model are shown in Table 3.

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Table 3. Symbols and meanings of construction resource balance optimization model

Symbol	meaning
V	Unbalanced degree of construction resources
σk	Standard deviation of the k-th construction resource imbalance
ωk	Importance coefficient of the k-th construction resource
T	Total project duration (unit: day)
Rk	Average daily demand of K construction resources
Rjk	Demand of operation J for the k-th construction resource
$Rijk$	Demand for k-th construction resources of process J on day I
ESj	Earliest start time of operation J
LSj	Latest start time of process J
TSj	Actual start time of operation J
Dj	Duration of process J
j − 1	Indicates the immediately preceding operation of operation J

If the average daily demand of K construction resources is R and k, $R_k = \frac{1}{T}\sum_{i=1}^{T} R_{jk}$, During the construction period, the imbalance degree of the k-th construction resource allocation is expressed by the standard deviation, $\sigma_k = \sqrt{\frac{1}{T}\sum_{i=1}^{T}(R_{ijk} - R_k^2)}$. In view of the characteristics of various types of construction resources and different degrees of importance to construction projects, when solving the resource balance optimization model, it is necessary to transform the multi resource optimization problem into a single resource optimization problem. This study adopts the commonly used linear weighted sum method, and sets the weight coefficient of various resources as ωk. The weight coefficient can be determined by expert scoring method and fuzzy analytic hierarchy process. And because the units of construction resources are often not unified, it is necessary to deal with them dimensionless. Considering that the ultimate goal of the study is to reduce the hidden cost of construction resources, and the cost of construction resources is the most important factor affecting the reduction of hidden cost, in order to simplify the calculation, this study uses the cost of required resources to express the demand of resources. At this time, the cost of various resources has represented its importance, so its weight coefficientωk is considered equal.

For the cost data acquisition of construction resources, our acquisition method is through the bim5d information platform. The real-time query function can obtain the construction resource cost of any construction resource at any time, which makes the data acquisition more timely and efficient, and improves the accuracy of the data. Therefore, the construction resource balance optimization model aiming at minimizing the imbalance of construction resource allocation is as follows:

$$\text{Min}V = \sum \omega k \sigma k \tag{1}$$

$$ESj \leq TSj \leq LSj \tag{2}$$

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$$STj-1+Dj-1\leq ESj \tag{3}$$

$$ST0=0 \tag{4}$$

$$STj\in \text{int+}, j=1,2,3,\cdots,n \tag{5}$$

Wherein, equation (1) is the objective function, indicating that the imbalance of construction resources is the lowest; Equation (2) is a time constraint, which means that the actual start time T of process J shall not be less than its earliest start time E and not exceed the actual latest start time L; In the construction network plan, the value range of process J start time depends on the start time of the immediately preceding process. Therefore, equation (3) indicates that the earliest start time should be greater than the actual end time of the immediately preceding work; Equation (4) indicates that the construction project starts from 0; Equation (5) indicates that the actual start time of process J is a non negative integer.

The research adopts MATLAB programming to achieve genetic algorithm to solve the model, and the steps are as follows:

Step 1: coding scheme design.

The floating-point coding method is used to solve the balance and optimization problem of construction resources. Due to the logical relationship between the construction processes of the project, arbitrary arrangement will not only disrupt the logical structure between the processes, but also lead to the generation of infeasible solutions. The advantage of floating-point coding method is that the coding length of each individual is equal to the number of decision variables, which can encode the chromosome by using the list of all processes of the project. Therefore, this study uses the floating-point coding method to encode the chromosome by using the list of all processes of the project, and takes the actual start time of each process as a gene value.

Step 2: initial population selection.

The start time TSJ of operation J is generated randomly under the condition of ensuring the logical relationship of each operation. For the resource equilibrium optimization problem with fixed construction period, the initialization direction should be reversed from the last process to the first process. If the set of work immediately after operation J is BJ, the gene value of operation J is:

$$gj=ESj+\text{random}(\min\{gk|k\in Bj\}-Dj-ESj) \tag{6}$$

Equation (6) represents the random value of the initial start time of each process J. this initial population method can completely avoid the generation of plans and arrangements that do not meet the process time constraints.

Step 3: fitness function design.

The optimal construction resource balance optimization scheme is to minimize the objective function, so the design of the fitness function must meet the condition that it is inversely proportional to the value of the objective function. In order to make the fitness function as simple as possible, the ranking function is selected in MATLAB to indicate that the smaller the value of the objective function corresponding to the individual, the higher the fitness of the individual. The specific fitness function expression is as follows:

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$$FitV = \text{ranking}(ObjV) \tag{7}$$

Step 4: select operator design.

For the individual selection mode, the improved roulette mode is adopted. The improvement is that two individuals must be selected by roulette every time, and the one with high fitness is the selected object. In this way, it is easier to select individuals with higher fitness. The expression is as follows:

$$P(V) = \frac{f(v)}{\sum f(v)} \tag{8}$$

Step 5: crossover operator design.

Single point crossover operator is adopted. Since the actual start time of process J is affected by its immediate process, the cross operation may produce individuals that do not meet the time constraints. Therefore, each individual should be inspected after the cross operation and unreasonable individuals should be adjusted. The inspection and adjustment process is still in the reverse order from back to front. The inspection formula is as follows:

$$gj \leq \min\{gk | k \in Bj\} - Dj \tag{1-9}$$

When the individual's gene value meets the test conditions in formula (9), the individual is reasonable. Otherwise, the individual needs to be re assigned, and the random assignment method in formula (6) is adopted.

Step 6: mutation operator design.

The basic bit variation was used. Because the variable time difference of some processes is 0, it is impossible to simply select a gene at random for mutation operation. Therefore, for the mutation operator, on the basis of random selection by roulette, its gene value must be assigned according to the initialization formula (6), so as to ensure that each randomly generated gene is within its corresponding variable TDOA range, and then randomly select a gene position from the newly generated chromosome to replace the corresponding gene position of the chromosome to be mutated after cross processing. In this way, it can avoid that the start time randomly generated by an operation does not meet the logical relationship of the operation, resulting in an infeasible solution.

Through the above construction resource balance optimization process, the optimized overall construction schedule of the construction project can be obtained, and the implementation construction resource allocation plan can be obtained. Then the BIM construction simulation function is used to analyze the optimization results. The virtual construction based on BIM Technology adds the virtual simulation technology on the basis of the basic construction model. The construction process simulation is a real-time, realistic and interactive virtual of the construction plan, so as to evaluate and optimize the construction scheme, construction resource plan, construction period arrangement, etc. It mainly tests whether the construction resource allocation plan matches the construction progress and meets the construction requirements, so as to find problems as soon as possible and reduce the hidden cost of construction caused by construction changes.

Finally, the final optimization results are updated to the 5dbim information model to realize the dynamic query of resource use plan. The construction manager can query the daily, weekly and monthly resource demand plans of any process, and use this as the basis to allocate

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construction personnel, purchase engineering materials and limit picking, mobilization and maintenance of mechanical equipment, so as to control the hidden cost caused by unreasonable preparation of resource demand plan.

4.4. Dynamic Control of Construction Resources and Real-time Cost Monitoring Model

The dynamic management and control of construction resources is to dynamically grasp the use of construction resources, dynamically update the procurement plan of construction resources and realize the dynamic and scientific utilization of construction materials during the construction process.

In bim5d model, each component is associated with its related progress information and budget information, so the required quantities can be quickly counted from the scope and time of the engineering model. In the construction preparation stage, according to the WBS process classification and detailed project content, the accurate data such as planned consumption and cost of human, material and machine resources of each process within a certain time range can be queried in bim5d platform. In the actual construction process, BIM model can dynamically collect the expected use of resources in the planned progress, the expected use of resources in the actual progress, and the actual resource consumption, draw the comparison curve of construction resources, and continuously analyze and study the three indicators. The hidden cost caused by insufficient resource supply can be avoided. When the actual consumption of a certain construction resource exceeds the expected demand of the actual progress, the model will give an early warning in time. At the same time, for the specific consumption of construction resources, the material procurement personnel can prepare the material procurement plan according to the exported statistical table of construction resources, so as to reduce the hidden cost in the procurement process.

The construction period of construction projects is long, and the procurement of construction resources is a continuous work. Using bim5d platform, the weekly procurement plan of construction resources can be generated according to the actual situation of the project, and the price information of construction resources will continue to rise and fall during the construction process. Therefore, when purchasing construction resources, we should not only pay attention to the procurement volume, but also pay attention to the price changes in real time, and update it to bim5d platform in time. In this way, the construction personnel can scientifically and reasonably arrange the weekly resource procurement according to these information.

Based on the BIM model, it can also realize the dynamic and scientific collection of construction materials. It is easy to falsely support and claim construction materials in the distribution process, and BIM can generate an accurate use plan of construction materials, which greatly improves the accuracy of the material requisition and effectively prevents the hidden cost caused by non-standard collection.

In the process of traditional construction project cost control, "over budget" is a common phenomenon. Therefore, the hidden cost of construction resources can be effectively avoided by real-time monitoring the cost information of construction resources, timely warning and adjustment in case of cost deviation, and tracking the causes of cost deviation afterwards. Cost real-time monitoring first realizes the dynamic query of various cost information at any time through the fast and accurate calculation ability of BIM construction resource information model. In the bim5d platform of Guanglianda, users can obtain the budget cost at any time node, and can also compare the bid winning price, budget cost and actual cost of the project through the function of "three calculation and comparison of resources" of bim5d platform. At the same time, users can intuitively compare the consumption of each of the three elements of labor, materials and mechanical equipment. Therefore, by automatically comparing the budget cost

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and actual consumption cost at any time node, the cost deviation is obtained, and the causes of the cost deviation are tracked and analyzed to provide direction and basis for the construction manager to control the cost.

5. Control Measures for Hidden Costs of Construction Projects

5.1. Control of Hidden Cost of Human Resources

To effectively control the hidden cost of human resources, we need to start from three dimensions, including reasonable human resources allocation plan, scientific organization setting and perfect human resources management system.

5.1.1. Reasonable Human Resource Allocation Plan

Preparation of labor allocation plan. Before preparing the labor allocation plan, it is necessary to accurately calculate the project quantities and construction progress, and then determine the labor demand according to the quantities and labor quota standards. At the same time, it is necessary to meet the principle of simplification and efficiency, optimize the staffing, maintain the balanced input of labor, and avoid increasing additional labor costs.

Carefully select labor subcontractors. The labor subcontractor is in the front line of construction, and its quality will directly affect the project quality, cost, schedule control and the brand reputation of the construction enterprise. Therefore, we should constantly improve the bidding management system of labor subcontractors. For the selection of labor subcontractors, we should comprehensively consider a number of factors, including whether they meet the qualification conditions, whether they have good performance and social reputation, whether they have a certain ability to resist capital risks, and whether they are reasonable in terms of construction progress, quality and price. After determining the labor subcontractor, strengthen the contract management of the labor subcontractor, reasonably arrange the number of construction workers and types of work according to the schedule and quantities, and make early preparations for temporary rush.

5.1.2. Scientific Organizational Structure

The organization form is lean and efficient. When selecting the project organization form, we should comprehensively consider the construction characteristics and contents of the project, strive for lean and efficient staffing, strictly control the number of middle and lower level managers, and avoid the hidden costs caused by overstaffing and low efficiency[12].

Strictly implement the system of division of labor and responsibility. Set up jobs in strict accordance with the organizational structure, prepare specific job responsibilities, and then give corresponding responsibilities and rights according to the specific job responsibilities.

Enhance internal communication and cooperation. All departments of the project shall strengthen contact to ensure the timely transmission of information, and pay attention to the communication and exchange of technical dimensions. During the handover of each process, there shall be not only written technical disclosure, but also necessary communication and exchange, so that the problems can be solved in time and avoid unnecessary losses during the implementation of the project.

5.1.3. Perfect Human Resource Management System

Improve the professional training mechanism for construction personnel. The quality level of construction personnel in construction enterprises, especially for construction managers, often seriously affects the whole process of the whole project[13]. Therefore, a scientific and targeted construction professional training management mechanism should be established to improve the professional skills and comprehensive quality of workers and managers, so as to ensure the construction efficiency and quality and avoid the hidden cost caused by rework.

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Strengthen the on-site management of labor subcontracting personnel. The labor subcontractors on the construction site are also the focus of human resources management. The technical management of subcontractors should be strengthened, and the technical disclosure and pre operation training should be paid attention to. The on-site guidance, supervision and coordination shall be strengthened, and the rectification measures and rewards and punishments shall be pointed out in time in case of illegal operations.

5.2. Control of Hidden Cost of Construction Materials

The countermeasures and suggestions for the hidden cost control of construction materials are mainly divided into two aspects: reasonable construction material procurement system and strict on-site management of construction materials.

5.2.1. Reasonable Construction Material Procurement System

Preparation of construction material procurement plan. Before the construction of the project, the procurement plan of construction materials shall be prepared according to the architectural drawings, construction progress, construction scheme and consumption of construction materials, so as to lay the foundation for the timely supply of materials in the construction process.

Procurement management of construction materials. In the actual material procurement process, the procurement of bulk materials must be subject to public bidding. The comprehensive strength such as the supplier's reputation and supply capacity, as well as the economy of material price, transportation cost and storage cost shall be comprehensively considered, and the unit with high quality and low price shall be selected as the bid winner.

5.2.2. Strict On-site Management of Construction Materials

Management of mobilization and demobilization of construction materials. When the construction materials enter and leave the site, the time and sequence of entering and leaving the site shall be reasonably arranged in strict accordance with the resource supply plan to avoid material loss caused by entering the site too early or too late. When entering the site, it is necessary to carefully check the quantity, number, production batch number, variety, model, quality and other aspects of materials[14]. In case of any problem, it shall be returned immediately to ensure that the construction materials meet the requirements of the material plan, and the material entry records shall be made.

Standardize the requisition of construction materials. Material quota requisition shall be implemented. The construction material manager shall sign and issue the material requisition in strict accordance with the use plan of construction materials, and the material requisition must be signed and approved by the construction technician to prevent the loss of construction materials caused by fraudulent support and requisition.

Strengthen material supervision and waste management. During the use of construction materials, the use of materials shall be strictly supervised. Materials requiring on-site processing such as reinforcement and formwork shall be processed in strict accordance with the processing table to prevent material waste caused by improper processing. At the same time, the secondary utilization of waste materials should be strengthened, and the quantity and price of waste materials disposed should be recorded to prevent the loss of enterprise benefits.

5.3. Control of Hidden Cost of Mechanical Equipment

Similar to construction materials, the countermeasures and suggestions for mechanical equipment are also put forward from two aspects: reasonable mechanical equipment procurement system and standardized on-site management of mechanical equipment.

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5.3.1. Reasonable Mechanical Equipment Procurement System

Preparation of mechanical equipment procurement plan. Before the project construction, the manager with professional mechanical knowledge shall complete the preparation of mechanical equipment purchase list and construction machinery mobilization plan according to the actual construction requirements. For the selection of mechanical equipment, the size of construction scale, the characteristics of construction technology and working time shall be comprehensively considered. Mechanical equipment with strong universality shall be selected as far as possible to expand the application scope of equipment and improve the use efficiency of mechanical equipment.

Mechanical equipment procurement management. When purchasing machinery and equipment, we should choose to purchase or lease according to the demand of machinery and equipment during the project construction and combined with the actual market situation, so as to control the increase of cost and avoid the idle of machinery and equipment. For the purchase of large quantities or large-scale equipment, the bidding system must be adopted, and the capital cost calculation must be strictly carried out to control the purchase cost of mechanical equipment.

5.3.2. Standardized On-site Management of Mechanical Equipment

Management of mechanical equipment in and out of the site. When the mechanical equipment enters the site, it must be registered in detail, and the name, manufacturer, model and other basic information must be indicated. The instructions, maintenance and maintenance books of the mechanical equipment should also be properly kept for emergency needs. Mechanical equipment shall be placed in strict accordance with the layout plan of the construction site to avoid secondary handling costs and maximize the use efficiency of mechanical equipment.

Standardize the operation of mechanical equipment. Mechanical equipment operators shall work with certificates and carry out construction operations according to the specified operation procedures. Operators shall be assessed regularly to avoid additional costs caused by non-standard operation. At the same time, ensure the safety of mechanical equipment operators in the operation process, and do not work fatigue.

6. Conclusion

The hidden cost control model of construction engineering based on BIM can provide strong information and data support for the construction resource control in the construction stage, and change the post control into pre and in-process control. Through the introduction of GA for resource balance optimization, the best start time of each construction process can be accurately calculated, the optimal allocation of construction resources can be realized, and unnecessary costs of manpower, materials and mechanical equipment can be saved. Through the construction of construction resource optimization and dynamic control model combined with BIM Technology and genetic algorithm, the implicit cost control of construction resources is more scientific and reliable.

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