Research on Total Cost Control Model and Evaluation Method of Prefabricated Buildings

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Abstract: In view of the complicated cost control of prefabricated buildings, imperfect management system and evaluation system, affecting the promotion and use of prefabricated buildings, the key influencing factors of prefabricated building costs are determined according to the whole process, whole life cycle, comprehensive cost management theory and comprehensive evaluation theory, and five sub-systems are established: direct construction cost, quality cost, safety cost, environmental protection cost and construction period cost. It is of great significance to improve the management level of prefabricated buildings by establishing the dynamic simulation model and management evaluation system of the total cost control system and studying the cost and global optimization method of the prefabricated buildings from production to construction.

1. Introduction

The accurate budget, comprehensive control, total quality management and overall optimization of prefabricated construction cost are the new topics facing the industry, and also the new direction of engineering cost control theory. It is necessary to systematically study the cost evaluation and optimization of prefabricated buildings, improve the cost accounting level of prefabricated buildings, and promote the market application.

In the 1950s, prefabricated buildings began to enter China. In recent years, the government attaches great importance to the development of prefabricated buildings [1]. In terms of economic evaluation and simulation of prefabricated buildings, domestic scholars have carried out a lot of studies, which are superior to foreign countries in quantity and depth [2]. Zhao Liang et al. established a comprehensive cost impact assessment system, including design factors, management factors and technical factors, and also took into account policy factors [3]. Li Huishan et al. put forward a cost analysis method [4] : the construction process of prefabricated buildings is divided into four stages: construction design, factory production, logistics transportation and on-site construction, thus dividing the project cost of prefabricated buildings into four parts: design cost, production cost, logistics cost and construction cost, and detailing the cost details. Shi Weiguo put forward some suggestions on project cost control and correction and cycle optimization management. Shi Weiguo [5] also proposed management schemes for project cost accounting, project cost analysis and project cost assessment. The construction cost of the prefabricated building is a dynamic process. A model of the driving factors of the prefabricated building cost is established to simulate the cost generation of the prefabricated building. [6]

In China, there are many researches on the influencing factors and weights of the cost of prefabricated buildings, but few on the cost evaluation of prefabricated buildings. This study establishes a system dynamic simulation model of cost control, proposes an evaluation method for the cost control of prefabricated buildings, and carries out validity and feasibility verification and application, providing theoretical basis and practical reference for the cost control of prefabricated buildings.

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2. Theoretical basis

2.1 Cost management theory

The theory of cost management is the general name of the theory, procedure and method of budgeting and controlling the consumption and use of enterprise resources by using the theory and method of management. The development of cost management, from the cost control in the event to the cost forecast in advance. After years of development, project cost management has formed three theoretical ideas, namely, "whole process cost management", "whole life cycle cost management" and "total cost management".

Whole process cost management: Project cost management runs through the whole process of the project, the project process should be decomposed, and then use technical means and economic methods to measure the cost generated in the process.

Full life cycle cost management: The full life cycle cost management theory was proposed by the US Department of Defense in the 1960s, hoping to reduce the expenditure of support costs by increasing research and development costs, thereby reducing the overall cost expenditure. At present, this kind of thinking is more reflected in the project investment decision and project cost control.

Total cost Management: The total cost management theory was put forward by Mr. R. E. Westeny, former president of the International Total Cost Management Promotion Association. Total cost management refers to "planning and controlling the resources, costs, profitability and risks of a project through professional knowledge and expertise".

Total cost management covers the scope of project construction process cost management, project product life cycle cost management, project comprehensive cost management and so on. Total cost management includes the above two kinds of cost management ideas, is an integrated management concept, in a wider range of cost measurement and control. Total cost management is a formulation that better describes the scope, variety and depth of today's cost management profession and is a cost management approach that suits the actual needs of all industries.

2.2 System simulation theory

According to the purpose of system analysis, system simulation is to establish a simulation model that can describe the structure or behavior process of the system and has a certain logical or quantitative relationship on the basis of analyzing the nature of various elements of the system and their mutual relations, and carry out tests or quantitative analysis accordingly to obtain various information required for correct decision-making.

Computer simulation theory is a modeling and simulation method based on computer technology. Computer simulation can simulate how real-world or abstract systems behave and interact under different conditions by modeling them.

The essence of project construction cost management is cost control in the construction process, that is, the cost incurred in actual construction is calculated according to certain accounting rules, the cost data is compared with the planned cost or the target cost, the deviation and the cause of the deviation are found out, and the corrective measures are proposed to ensure the consistency of the realistic cost and the target cost.

The traditional cost management theory is faced with two major problems: one is the data lag, the other is the cost deviation is difficult to accurately locate, lack of more data details support.

At present, the research of engineering cost simulation theory mainly uses BIM series software for price calculation. The system dynamics software is used for simulation to make up for the weak overall cost control capability of BIM software [5]. The system dynamics software has a high degree of abstraction, and the cost of each link can be seamlessly connected in the system dynamics software, and the hidden cost can be well displayed and controlled. It is very suitable to establish a mathematical simulation model that reflects the idea of comprehensive cost management.

2.3 Comprehensive evaluation theory

Evaluation can be divided into comprehensive evaluation and single evaluation. Although there is no clear boundary between the two, the comprehensive evaluation is more complex and its indicators are more diversified. The current research has long abandoned the single evaluation of simple statistical methods, and more use of statistical comprehensive evaluation.

In recent decades, comprehensive evaluation research has evolved a variety of research methods, evaluation methods are increasingly complex, mathematical, and widely used. In addition to economic benefit statistics of various industries, it is also widely used in technical method evaluation, quality of life evaluation, social development evaluation, competitiveness evaluation, management ability evaluation and other aspects [10]. In recent decades, the development of evaluation theory is very rapid, and the theoretical system is gradually improved.

Among many evaluation theories, the current mainstream evaluation methods include grey system evaluation method (GS), analytic hierarchy Process (AHP), data envelopment method (DEA), artificial neural network method (ANN), etc. It has been widely used in different fields [5]. The trapezoidal fuzzy analytic hierarchy process adopted in this paper is an evaluation method suitable for the case of incomplete information, which belongs to the relatively advanced research content in the field of evaluation methods.

3. Key factors affecting the overall cost of prefabricated buildings

3.1 Cost composition of prefabricated buildings

The cost composition of prefabricated construction mainly includes the cost generated in the construction process and the indirect cost. The process of prefabricated building construction mainly includes: component design, component production, component transportation, component installation, and related construction costs such as pouring parts, mechanical use costs, material costs, wear costs, labor costs, etc. Indirect costs are necessary to ensure the smooth construction process, including environmental protection costs, safety costs, management costs, communication costs, construction period costs and other indirect costs.

The traditional construction method is on-site support casting, and the prefabricated construction is assembled with predictable components on the site. Traditional construction methods waste steel and cement seriously, water consumption is large, the site environment is poor, prefabricated construction is low resource consumption, the construction site is more tidy and orderly, and the water consumption is less. At present, the comprehensive benefits of prefabricated buildings are higher, and the direct cost and comprehensive cost are lower than that of traditional construction methods.

The cost advantage of prefabricated buildings is not only reflected in the direct construction cost, but also in the aspects of time cost, capital use cost, environmental protection cost and safety cost. Therefore, in addition to the direct economic benefits, the environmental benefits and social benefits generated by prefabricated buildings are significantly higher than the traditional construction methods.

3.2 Screening methods for key influencing factors

There are usually three ways to screen for key influencing factors. One is to propose research hypotheses and define variables through literature and data collection, build theoretical research models, and then sort out and analyze the data, and finally draw research conclusions. The second method is based on literature review and analysis, in-depth interview with experts with actual industry experience, identification of key influencing factors by expert experience, construction of scales, determination of evaluation indicators, design of questionnaires, further establish appropriate mathematical models, demonstrate the basic conclusions, and finally draw research conclusions. The three methods are to first review and analyze the research literature, establish preliminary evaluation indicators, and draw basic conclusions, and then further establish appropriate mathematical models, demonstrate the basic conclusions, and finally draw research conclusions.

This paper mainly collects and collates the factors involved through the literature method; Then, questionnaires were distributed to experts, scholars and practitioners of the prefabricated construction industry, and the questionnaire data were preliminarily collected and sorted out to form a database. Then, principal component analysis is carried out on the collected data to screen the key influencing factors. Finally, the key factors affecting the total cost of prefabricated construction are identified.

3.3 Screening of key factors affecting the overall cost of prefabricated buildings

In order to ensure the objectivity and comprehensiveness of the selection of key influencing factors, this paper first uses the index keyword clustering of the knowledge network for measurement, and then determines the factor field affecting the cost of prefabricated buildings by combining important Chinese and English literatures.

Prefabricated building is not only a construction method, but also a construction process. According to the whole process cost management idea, the cost composition of prefabricated building mainly includes the cost generated in the construction process and the indirect cost. The process of prefabricated building construction mainly includes: component design, component production, component transportation, component installation, and related construction costs such as pouring parts, mechanical use costs, material costs, wear costs, labor costs, etc. Indirect costs are necessary to ensure the smooth construction process, including environmental protection costs, safety costs, management costs, communication costs, construction period costs and other indirect costs.

The construction process of prefabricated buildings is similar to the production process of industrial products. The prefabricated components are designed and transported to the construction site after production. The construction site uses machinery for installation, and the components that cannot be prefabricated are processed by traditional ways such as pouring. The cost incurred in the construction process of prefabricated buildings is an indispensable cost, but the change of indirect cost will have a significant impact on the construction process cost.

4. Total cost simulation and optimization of prefabricated buildings

4.1 Establishment of cost simulation model

The construction process of prefabricated buildings is the assembly and installation of prefabricated components, and various possible problems can be predicted and analyzed through on-site construction simulation. Through simulation, potential conflicts and difficulties can be identified and resolved, time delays and cost increases caused by on-site operational errors can be reduced, and the entire construction process can be optimized.

Virtual reality technology, 3D model display, digital simulation and other methods can be used for on-site construction simulation. Among them, virtual reality technology can establish realistic scenes, so that the construction personnel can simulate the operation; 3D model display can present architectural elements in a virtual environment to help people better understand and coordinate the various parts; The digital simulation can simulate the construction process precisely through mathematical modeling and algorithm analysis. Digital simulation technology can accurately simulate various factors in the construction process of prefabricated buildings and find out the optimal solution. For example, simulation techniques can be used to determine the best choice of materials and costs, and different materials and installation processes can be selected through costing.

Seven sub-system models are established respectively, and the variables inside all sub-system models are in the large system: The model includes five main subsystem models, namely, "construction cost subsystem model", "quality cost subsystem model", "safety cost subsystem model", "environmental cost subsystem model" and "construction cost subsystem model", and two related models constructed according to these five main subsystem models. That is, "engineering cost subsystem model" and "assembly subsystem model".

The system dynamics model established in this paper follows the following assumptions: (1) The project has experienced all aspects such as design, component production, construction and disassembly. The main costs include: design cost, component manufacturing cost, component transportation cost, construction cost, environmental protection cost, safety cost and construction cost throughout the whole process. (2) The component cost is the sum of the costs of all components, and no longer distinguishes the cost of individual components calculated by the complexity of the project or the complexity of the component design. (3) The simulation time is set to 400 days, of which the engineering construction planning time is 240 days. The reason why the total simulation time is larger than the planned construction time is that time is reserved for calculating the delay of the construction period (the final calculation time of the simulation model is 290 days). (4) The time unit of the simulation is "day" and the amount unit of the simulation is "ten thousand yuan".

Using system dynamics software Vensim modeling, a model file is a system. In this system, a system can be decomposed into several sub-systems by using the correlation variables according to the relationship between the main variables. Subsystems are not completely independent, and there are relationships between subsystems.

4.2 Model checking

The system dynamics model is a complex structure-dependent model that needs to be tested from multiple dimensions. In order to prove the vulnerability of the model from all aspects, the feasibility is very low, and comprehensive inspection is neither convenient nor necessary.

Therefore, this paper will test the model from the following three necessary dimensions

Boundary adequacy test: The boundary adequacy test is used to test whether the variables in the model are suitable for placement in the model, and which variables should be introduced into the model but are not introduced. It is a test for the boundary adequacy of model variables. The results show that the boundary of the model is appropriate, and most of the variables in the model are important variables that affect the research objective. The granularity of the model is appropriate, and the model belongs to a medium-sized model with a slightly larger scale, covering important variables and secondary variables that can be measured within the scope of the research object. For example, the influence factors of the refined variables, the model may become a giant model covering nearly 1,000 variables, and even cannot run smoothly. In summary, the model passes the boundary suitability test.

Structural evaluation test: The structural evaluation test is a test used to test whether the model conforms to the system cognition of the relevant description. In short, it is to test whether the model is basically consistent with the objective operation principle of the research object. In the process of modeling, the system dynamics model in this chapter has been modified several times and combined with the opinions of many experts, which can basically ensure that the model structure is consistent with the objective operation principle of the research object. The results show that the model has been reviewed and modified, obtained expert approval, and can be passed.

Parameter estimation test: Each subsystem model in the model has a table description of variable setting and parameter assignment. The system dynamics model established in this paper is a general model of partial theory, not for a specific project simulation, so the parameter setting has a large threshold. Even so, the parameters should be set within common sense. After modification, the parameters of the model in this chapter are within the normal and reasonable range and can pass the parameter estimation test.

4.3 Model simulation result

The simulation results of the submodel show that the construction cost increases slowly in the early stage, rapidly in the middle stage, and lowest in the late stage. This law accords with the basic law of construction engineering. Direct costs and construction costs have maintained a similar trend; During the planned construction period, the incremental indirect cost is fixed and decreases significantly with the end of the planned construction period.

The simulation results of quality cost subsystem model show that quality cost increment always exists during project planning time. Outside the project schedule time, considering that the work related to quality control has been basically completed, the quality cost will not increase, which is consistent with the equation setting of quality cost increment. However, control cost and loss cost always exist in the actual completion period of the project.

The main simulation results of the safety cost subsystem model include safety education cost simulation results and safety cost simulation results. The simulation results of safety education cost show a relatively obvious S-shape, indicating that there is less investment in safety education in the early stage of construction, because this period is mainly the production stage of assembly parts, and there are fewer uncertain factors of safety. In the middle stage of the project, the uncertain factors of safety increase, and the investment in safety education increases. In the final stage of the project, the main body has been completed, only the repair work, so the investment is correspondingly small; The simulation results of safety cost also show an S-shape, but the curve is much more moderate than that of safety education cost, because safety cost is a variable integrated by multiple variables, including safety measures cost and safety loss cost in addition to safety education cost.

The change trend of the total additional cost of environmental protection materials is divided into three stages, and the total additional cost of environmental protection materials is mainly determined by two factors, one is the fluctuation of the market for environmental protection materials, and the other is the table function of the additional cost of environmental protection materials. The additional cost of environmental materials table function is based on past experience and is set for the increase in the demand for comprehensive environmental materials for the construction of prefabricated buildings. This table function can be adjusted according to actual experience and market fluctuations.

4.4 Model optimization

Vensim optimization can be divided into parameter optimization and policy optimization. The optimization method adopted in this paper is policy optimization. The optimization of system dynamics policy is carried out by setting the constraint conditions of exogenous variables.

Through the model policy optimization operation, we can compare the results before and after optimization. The name of the simulation data set before Optimization is Current, and the name of the simulation data set after optimization is optimization. After optimization, the project was completed in 276 days. From the optimization results, the safety cost, construction cost and quality cost have a large space for optimization, while the environmental protection cost has a small space for optimization. The total cost also has a relatively obvious optimization space, and the shape of the optimized cost growth curve is basically consistent with that of the non-optimized one, which indicates that the cost growth has a certain objective law, and the optimization effect becomes more obvious with the passage of time.

5. Comprehensive cost control evaluation of prefabricated buildings

5.1 Selection of evaluation method

In the field of quantitative analysis, expert scoring is widely used to explore areas that quantitative research cannot cover. However, this method is affected by the subjective factors of the raters, which may lead to some bias in the research results. Aiming at the problem that most of the evaluation indexes of prefabricated building cost control management are qualitative indexes, a new evaluation model based on trapezoidal two-dimensional language power generalized integration operator is proposed in this paper. Among them, the first dimension of the two-dimensional language information is expressed in the form of trapezoidal fuzzy number to express the evaluation information in a more complete, real and effective way to avoid the loss of information. At the same time, the power generalized integration operator can use the mutual support between the index attributes to determine a more reasonable and effective comprehensive weight, and give a lower weight to some unreasonable data (such as extreme values), so as to eliminate the scoring bias of evaluation experts. This evaluation method is also suitable for other quantitative analysis studies using expert scoring method, which minimizes the influence of human factors and improves the accuracy of the research. This paper emphasizes the scientificity and applicability of the proposed method, and puts forward a solution to the limitations of the expert scoring method, which is innovative and practical.

People usually evaluate something by quantitative evaluation and qualitative evaluation in two ways. However, quantitative evaluation usually has limitations, that is, it is easy to cause information loss in the process of information expression or in the process of information operation. With the development of fuzzy mathematics and its application in decision science, fuzzy evaluation information forms such as triangular fuzzy numbers and trapezoidal fuzzy numbers have been widely used. For qualitative evaluation, it can effectively save time and cost. However, the initial use of discrete language terms for evaluation and description, in the expression and processing of information, it is easy to cause information distortion. With the continuous development of evaluation science, new information forms such as two-dimensional language and binary semantics begin to emerge, among which, binary semantics can be used to express and calculate language term information in a continuous way, thus reducing information distortion and making evaluation results more scientific and effective. In this paper, fuzzy information forms such as trapezoidal fuzzy number, two-dimensional language, binary semantics and their combined extension form are used to express and process the evaluation data.

5.2 Weight of key influencing factors

For the determination of index weight, we usually use subjective weighting method, the most commonly used subjective weighting method is the judgment matrix method. However, due to the limited fuzziness of cognition and the incomplete description of data, people's expression of attribute values is often imprecise, and the description of the relationship in ppair comparison is also vague. Therefore, this paper uses language words to describe the judgment data and converts it into triangular fuzzy numbers to avoid more information distortion, so as to better ensure the accuracy and completeness of information. Then the improved fuzzy AHP (FAHP) method is used to determine the index weights.

5.3 Evaluation model

This paper presents an evaluation problem of cost management of prefabricated buildings based on trapezoidal fuzzy two-dimensional language evaluation information. The cost management evaluation of prefabricated buildings includes the following steps: Step 1: Standardize the language evaluation information and convert it into trapezoidal two-dimensional language variables. Step 2: Standardize the trapezoidal two-dimensional language variables. Step 3: Calculate support. Step 4: Calculate two-dimensional language variables with ladder. Step 5: Integrate the second-level index evaluation information under each first-level index through the operator. Step 6: Calculate the combined value of each alternative. Step 7: According to the trapezoidal fuzzy two-dimensional language variable comparison method. Step 8: In descending order, sort the alternatives and then select the most suitable project.

The evaluation method of total cost control for prefabricated building construction is based on the analytic hierarchy process proposed by T. L. Saaty. Based on the above mentioned, the comprehensive cost control evaluation index system of prefabricated building construction includes 5 first-level indexes and 20 second-level indexes.

5.4 Trapezoidal two-dimensional language power generalized integration operator evaluation method

The evaluation method based on trapezoidal two-dimensional linguistic power generalized integration operator is to transform the linguistic information into two-dimensional linguistic information, and express the evaluator's subjective confidence in his evaluation through the second dimension, covering more specific evaluation information. In addition, the first dimension of two-dimensional language information is expressed in the form of trapezoidal fuzzy number, which will make the information covered more complete, more real and effective, and avoid the loss of evaluation information.

Traditional evaluation methods usually ignore the evaluation of the evaluator's subjective conviction, which often leads to the incomplete evaluation information. This study solves this problem by introducing two-dimensional language information, in which dimension II is used to express the evaluator's subjective conviction of the evaluation object, so as to make the evaluation result more detailed and specific. The variable parameters in the power generalized integration operator provide additional flexibility to the evaluation process, allowing the evaluator to adjust the integration process according to the specific situation in order to achieve the best evaluation effect.

In summary, the evaluation method based on trapezoidal two-dimensional language power generalized integration operator not only improves the comprehensiveness and accuracy of the evaluation, but also enhances the ability of the method to adapt to different evaluation scenarios. The innovation of this methodology lies in the fact that it can effectively process and integrate evaluation data containing extreme values without loss of information, which provides a new idea and tool for the field of performance evaluation. This is of great significance for promoting the innovative development of evaluation theory and practice and improving the scientificity and effectiveness of evaluation work.

6. Comprehensive cost simulation and evaluation case study validation

6.1 Application of total cost simulation for prefabricated buildings

The total cost simulation of prefabricated building is the cost simulation of the actual management project with the idea of total cost management, and it is found that there is still room for optimization of cost management, and the simulation model can be optimized.

The following is the basic information of the three projects: (1) P1 project: a project in Baoshan District of Shanghai, the component production units are mainly from Shanghai and Suzhou, the construction unit is S Construction Group, the structure is prefabricated monolithic sandwich insulation shear wall structure. Most of the buildings are middle and high rise, with a garage on the ground floor and supporting rooms. The prefabrication rate of monomer was 45%. The prefabricated components mainly include: prefabricated sandwich insulation wall panels, prefabricated outer wall panels, prefabricated laminated floor panels, prefabricated balconies, prefabricated bay Windows, prefabricated stairs, etc. The construction period of P1 project is 300 days. (2) P2 project: a public rental housing project in Fengtai District, Beijing, built with prefabricated shear wall structure. The outer wall is a sandwich wall composed of outer wall, insulation layer and inner wall. The balcony panel, floor panel and air conditioning panel all adopt the method of superimposed floor panel; The staircase is made of precast concrete. Prefabricated components include stairs, floors, exterior walls, balconies and air conditioning panels. The prefabrication rate is about 35 ~ 40%. The duration of the P2 project is 420 days. (3) P3 project: an affordable housing project in Mentougou, Beijing. The project is a steel structure prefabricated structure, and the main contractor is S Construction Company. The south side of the project is a railway, the east, north and west three sides of the mountain, the construction of the tower crane to complete the vertical transport. Because the construction site is relatively narrow on the hillside, the total contractor has overcome many difficulties, and adopts strict transportation and installation sequence, lifting the components directly from the transport vehicle to the installation location of the components, and lifting with transportation to avoid secondary handling. The duration of the P3 project is 550 days.

6.2 Comparison of total cost simulation and optimization results of prefabricated buildings

IThe comparative simulation of construction cost and direct cost is very similar, because the indirect cost of all three projects is much lower than the direct cost, which makes it not obvious in the construction cost. The comparison of quality cost and control cost per unit time increment is P1 > P2 > P3, and the overall quality cost and control cost of the project are P1 > P2 > P3. The simulation results of security cost comparison show that the security cost of the three projects shows a slightly rapid growth trend during the 50-100 days. This is because at this time it has entered the assembly stage of parts, and the safety cost is increased, which is in line with the objective law of prefabricated buildings. For the safety cost, the comparison results of the three projects are P3 > P2 > P1, and the comparison results of the safety measures cost of the three projects are P2 > P3 > P1. The comparison results of environmental protection cost increment and environmental protection measures cost increment of the three projects are P2 > P1 > P3, but due to the different construction cycle, the comparison result of overall environmental protection cost is P2 > P3 > P1. Duration cost increment or idle cost increment, the comparison simulation results of the three projects are P3 > P2 > P1. The cumulative project cost is P3 > P2 > P1, but from the comparison of cumulative project cost increment, P3 and P2 are close. Comparison of the total cost P3 > P2 > P1. The simulation images of P1 and P2 are close to coincidence, and the simulation data is consistent with the actual situation of the project.

After optimization, the completion time of P1 project is 274 days, 26 days earlier than the original project; The P2 project was completed in 378 days, 42 days earlier than the original project. The P3 project was completed in 482 days, 68 days earlier than the original project. The final results show that P1 has the smallest optimization space, P2 has the second, and P3 has the largest optimization space.

6.3 Evaluation and suggestion on overall cost control of prefabricated building construction

Cost control strategy based on evaluation results, according to the evaluation results of the prefabricated building cost evaluation system, we can develop the corresponding cost control strategy. For the projects with poor economic performance, the cost can be reduced by optimizing the design and production process and strengthening supply chain management. For projects with poor performance in social indicators, social benefits can be improved by strengthening community participation and job training. For projects with poor environmental performance, energy consumption and emissions can be reduced through the use of environmentally friendly materials and energy-saving technologies.

Development of cost control strategies based on evaluation results. According to the evaluation results of the cost evaluation system of prefabricated buildings, we can develop corresponding cost control strategies. For the projects with poor economic performance, the cost can be reduced by optimizing the design and production process and strengthening supply chain management. For projects with poor performance in social indicators, social benefits can be improved by strengthening community participation and job training. For projects with poor environmental performance, energy consumption and emissions can be reduced through the use of environmentally friendly materials and energy-saving technologies.

Production management innovation strategies, at the production stage, can improve production efficiency and quality stability by introducing intelligent manufacturing and automation technologies. At the same time, it can also reduce scrap rates and rework costs by strengthening quality control and inspection in the production process. In addition, production and inventory costs can be reduced by optimizing production planning and inventory management.

Supply chain management optimization suggests that in supply chain management, the procurement cost can be reduced and the overall efficiency of the supply chain can be improved by strengthening the cooperation with suppliers. For example, it is possible to establish long-term cooperation with suppliers and sign long-term contracts; Can work with suppliers on technology development and innovation; It can strengthen the quality management and inspection of suppliers.

In this study, several experts were selected as the main investigation objects, and these experts were all insiders who had participated in (or understood) the project. Questionnaire survey method was adopted to obtain the project cost control management evaluation data, and then through effective questionnaire statistical analysis and summary, the cost control management evaluation data of prefabricated construction projects were obtained.

6. Conclusion

The 20 indexes selected by the prefabricated construction cost control management evaluation system have certain breadth and reliability, and have good applicability.

The total cost management of prefabricated buildings can be divided into five sub-system models of construction cost, quality cost, safety cost, environmental protection cost and construction period cost, as well as two auxiliary subsystems, seven systems are interrelated, and ultimately constitute the overall system of total cost management.

The evaluation method based on trapezoidal two-dimensional language power generalized integration operator can process the evaluation information more accurately, and is closer to the real decision-making environment, which is suitable for the cost control management evaluation of prefabricated buildings.

Cost components and key links: Cost control in the design phase is particularly critical, which directly determines the cost base of subsequent production, transportation and installation. Through standardized design, modular design and fine design, design changes and rework costs can be significantly reduced, laying a solid foundation for the cost control of subsequent links.

Case analysis and verification: Through the case analysis of actual prefabricated construction projects, the effectiveness of the cost control strategy and evaluation system proposed in this paper is verified. The case study shows that the cost-effectiveness and social value of prefabricated buildings can be significantly improved by implementing comprehensive cost control and adopting scientific evaluation system.

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