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Research on the Influencing Factors of Prefabricated Construction Cost Management under EPC Mode

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Abstract

From the perspective of the general contractor, this paper screened out 14 factors affecting the cost of prefabricated buildings under the EPC mode from the four stages of design, component production, component transportation, and construction and installation of prefabricated buildings through literature induction. The cost influencing factors are compared and analyzed, and relevant countermeasures and suggestions are put forward for the above influencing factors.

Keywords

Prefabricated Building; Cost; EPC; Influencing Factors.

1. Introduction

At present, the problem of energy consumption in the construction industry is an urgent problem to be solved. Prefabricated buildings are a new direction for the development of the future construction industry. With its unique advantages of "five festivals and one environmental protection", it is in line with the country's concept of sustainable development of the construction industry, and it is also a way to reduce the energy consumption of the construction industry. The only way to go. Since the construction of prefabricated buildings is a complex systematic project, it is no longer suitable to use the traditional "fragmented" management method of buildings [1]. A systematic management mode suitable for prefabricated buildings should be adopted, and the EPC mode should be adopted. The management of prefabricated buildings is the most suitable contracting mode, which is easy to form a unity of stakeholders, promotes the realization of efficient management coordination and technical system integration, and is conducive to the comprehensive advantages of prefabricated buildings [2]. And my country's policy clearly points out that: focusing on prefabricated buildings, encourage and guide engineering projects with clear construction content and mature technical solutions to give priority to the general contracting model. Therefore, it is an effective way to apply the EPC model to prefabricated buildings, and it is the general trend of the construction industry.

2. Development Status and Existing Problems of Prefabricated Buildings

With the continuous improvement of policies, all parts of my country are actively promoting the development of the prefabricated building industry. In recent years, the scale of new prefabricated buildings in my country has continued to grow, and the prefabricated building industry has a good development trend, as shown in Figure 1 below. my country is also actively using the existing pilot cities as guidance to drive the comprehensive development of prefabricated buildings across the country, with considerable results. The technology of prefabricated buildings is constantly being updated and the system is sound.

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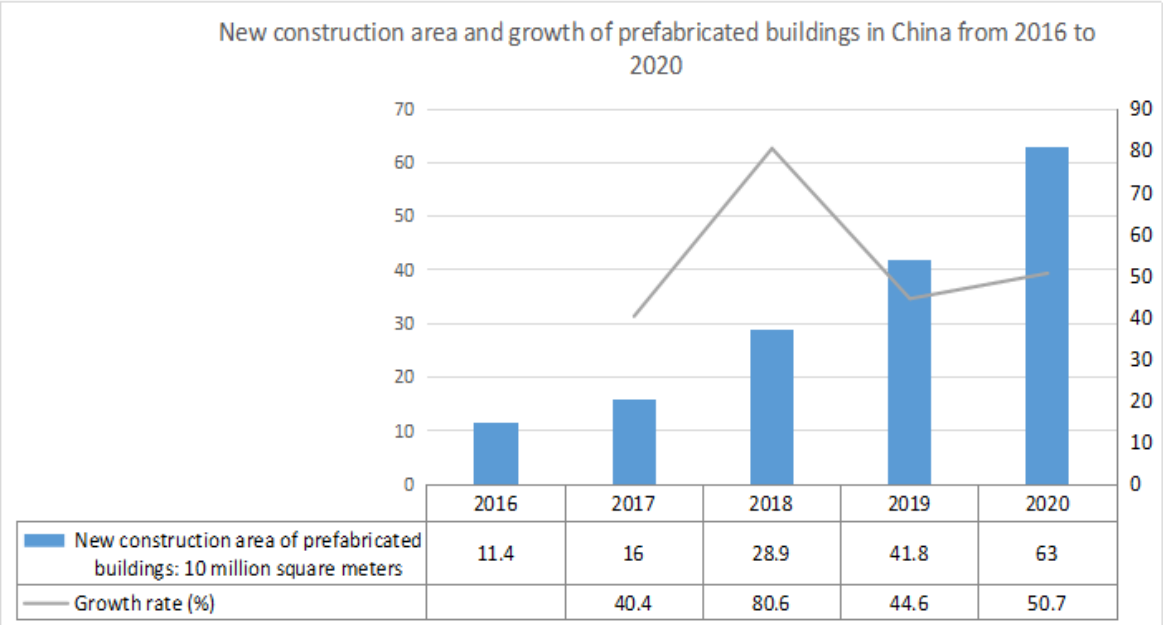

Figure 1. New construction area and growth of prefabricated buildings in China from 2016 to 2020

However, there are still problems in my country's prefabricated buildings due to insufficient popularity, which leads to low enterprise recognition, imperfect industrial chain management, large initial cost investment, resulting in high production and construction costs, backward technology, low degree of specialization, imperfect industry norms, and management models. The problems of incompatibility and other aspects have led to high risks in the implementation process of prefabricated construction projects in my country. However, there is still a lot of room for improvement of prefabricated buildings in my country, and the cost advantage of prefabricated buildings compared with cast-in-place buildings is low. In prefabricated buildings, the high construction cost of concrete structure buildings is a more prominent problem for prefabricated concrete buildings compared with other structural forms of buildings, which hinders the development of prefabricated buildings.

As a general project contracting mode mainly implemented at home and abroad, the EPC model can exert its advantages when applied to the construction of prefabricated buildings. Therefore, from the perspective of general contractors, this paper will study prefabricated concrete buildings (hereinafter referred to as prefabricated buildings), identify, analyze and evaluate the influencing factors of its cost, and find out the influence factors of prefabricated buildings under the EPC mode. The main influencing factors of cost, so as to propose measures for the main influencing factors in a targeted manner.

3. Determination of Influencing Factors

Many scholars have put forward their own views on the influencing factors of the cost control of prefabricated buildings under the EPC mode. The method of literature and data analysis in this paper selects 10 representative documents with the theme of the cost of prefabricated buildings under the EPC mode. The main factors affecting the prefabricated construction cost of the general contractor are summarized, as shown in Table 1.

In the EPC mode, the general contractor's prefabricated construction cost refers to the cost of completing a project, that is, the total cost of the project from design to on-site assembly completion, including the cost of production and transportation. . Factors affecting the construction cost of prefabricated buildings:

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3.1. Design Stage

In the design stage, a design unit with a high professional level is required. The prefabricated component manufacturer will open the mold according to the requirements of the design unit, such as the drawings and design dimensions of the component. This process is basically a little careless. big. This part mainly affects the cost of the following factors:

3.1.1. Prefabrication Rate(A1)

The prefabrication rate is the volume ratio of the prefabricated concrete consumption in both the main structure and the enclosure structure above the outdoor floor of the prefabricated building to the total concrete consumption in the corresponding part. Within a certain range, the greater the prefabrication rate of the building monomer, the higher the cost of the prefabricated building. However, a reasonable prefabrication rate will even reduce the incremental construction cost. Therefore, determining a reasonable prefabrication rate has a great impact on the cost.

3.1.2. Rationality of Splitting Prefabricated Components(A2)

It is to split the main components of the building according to the overall drawings of the prefabricated building. If the size of the prefabricated components after design and disassembly is relatively large, the number and connection parts will be relatively reduced. Although the construction efficiency is improved, problems such as increased cost may be caused during the production and transportation of prefabricated components. During the installation and construction process, due to the large size, it is easy to cause safety hazards such as component fracture and overturning; if the size of the prefabricated components after design and splitting is small, the required formwork during the production process will increase, and the installation and construction efficiency will also be affected. , which increases the cost of prefabricated construction. Therefore, the rationality of splitting prefabricated components is an important factor affecting the cost of prefabricated buildings.

3.1.3. Standardization Degree of Component Design(A3)

Standardized design is an indispensable part of engineering construction standardization. Standardized design can not only ensure quality problems and progress, but also reduce material consumption, reduce uncertain engineering costs, and improve economic benefits.

3.1.4. Overall Design Level(A4)

The overall design of prefabricated buildings includes the initial scheme design to the detailed design of construction drawings, all of which affect the production, transportation, installation and other links of components. Therefore, professional designers are required to coordinate all aspects in addition to the concept of prefabricated industrial design. , so as to reduce the overall construction cost of prefabricated buildings.

3.2. Production Stage

The cost of the production stage refers to the cost incurred in the production and processing of the prefabricated components by the prefabrication plant. The cost in this stage is mainly affected by the following factors:

3.2.1. Production Process(B1)

At present, the common production processes of prefabricated components of prefabricated buildings include platform method, long-line pedestal method and unit assembly line method. The platform method is suitable for the production of non-standardized special-shaped components. Although the process method has strong adaptability to the product and flexible production process, the production efficiency of this process is not high. The long-line pedestal method is suitable for uniform specifications of prefabricated components, and the production efficiency is relatively high. The unit assembly line method is suitable for the production of

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large-scale standardized prefabricated components. The advantages of this process are high efficiency, the adaptability of the production process can be adjusted, and the quality of the components is reliable. The production process of prefabricated components has different effects on production efficiency and on the construction cost of prefabricated buildings.

3.2.2. Comprehensive Strength of Prefabricated Component Factories(B2)

The comprehensive strength of the prefabricated component factory mainly includes the scale, the degree of modernization of production capacity, the degree of standardization of production technology, and the technical level of production workers. If the comprehensive strength of prefabricated component manufacturers is low, the cost of prefabricated components will increase, which in turn will affect the cost of prefabricated buildings.

3.2.3. Usage of Mold(B3)

Component production molds are usually divided into special-purpose and general-purpose molds according to the way they are used. Dedicated moulds are suitable for the production of specific prefabricated components, and the mould re-use rate is low. The general mold is suitable for the production of standardized prefabricated components, and the quality of the components can be easily guaranteed. The mold reuse rate is high, and the cost of mold opening is reduced. Therefore, the reuse rate of the mold affects the cost of prefabricated construction.

3.3. Transportation Stage

The cost of the transportation stage refers to the sum of the transportation cost of the prefabricated components from the prefabricated factory to the site, the cost of the protection component and the cost of secondary transportation. The cost at this stage is mainly affected by the following factors:

3.3.1. Transportation Plan(C1)

According to the characteristics of the prefabricated components and the conditions of the transportation road, select the appropriate transportation vehicles, loading and unloading machinery, and the protection measures for the prefabricated components during transportation, and then formulate a transportation plan. For example, when installing the first batch of components, the optimal transportation plan should be formulated. Due to the storage of components and related management costs incurred by the storage of hoisting prefabricated components at the construction site, the cost of the transportation stage will be increased.

3.3.2. Transportation Distance (C2)

The transportation distance is an important part of the freight. If the transportation distance is too long, the cost of amortization to the sales of prefabricated components will also increase. It is necessary to consider the distance between the project location and the location of the prefabricated factory. 300 kilometers can be round-trip on the same day, and more than 300 kilometers cannot be round-trip on the same day, so different transportation distances have a great impact on transportation costs.

3.3.3. Secondary Handling (C3)

When the prefabricated components are transported out of the factory, the construction site is small or the organization and coordination of the construction unit are insufficient, resulting in the prefabricated components that cannot reach the destination directly after entering the site during the transportation process, and are stored in a warehouse some distance from the construction site, requiring rickshaws or rickshaws. The truck is transported twice or multiple times, resulting in additional transportation costs.

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3.4. Construction and Installation Stage

The cost of the construction and installation stage refers to the sum of all the costs incurred during the hoisting of the prefabricated components according to the construction plan. The main factors affecting the cost at this stage are as follows:

3.4.1. Construction Organization Design(D1)

The rationality of construction organization design is to ensure the realization of construction project management objectives and the effective control of construction costs. The construction organization plan is an important part of the construction organization design. The quality of the preparation of this part will affect whether the construction unit can effectively use the limited resources to complete the project on time and with high quality. progress, information communication rate, resource allocation rate, quality, cost, etc.

3.4.2. The Level of Project Management Personnel(D2)

The high level of project management personnel is to ensure that the construction site operations of the prefabricated building are carried out in a reasonable, orderly and standardized manner, and it is also a manifestation of the executive power of the management personnel, so that the construction can be carried out reasonably within the construction period. If the management level of the project management personnel is insufficient, there will be unreasonable deployment of construction workers, disorderly stacking of prefabricated components, and inconsistency between the entry of materials and the needs of the construction site, which will cause waste of resources and increase the number of people, materials, construction cost of the machine.

3.4.3. Maturity of Node Connection Technology(D3)

The prefabricated building node connection technology is to connect prefabricated reinforced concrete components in a safe and reliable way. The node connection technology is a crucial core technology in the construction technology of prefabricated buildings, which directly affects the construction quality of prefabricated concrete buildings. Therefore, the maturity of the node connection technology of prefabricated buildings affects the construction quality and efficiency, thereby affecting the cost of the construction stage.

3.4.4. Qualifications of Construction Companies(D4)

Table 1. Literature analysis of factors affecting the cost of prefabricated buildings under EPC mode

Representative literature	Design stage				Production stage			Transportation stage			Construction and installation stage			
	A1	A2	A3	A4	B1	B2	B3	C1	C2	C3	D1	D2	D3	D4
ZHOU[3]	√	√	√		√	√	√	√	√	√	√	√	√	
ZHAO[4]	√	√		√	√	√	√	√	√	√		√	√	√
ZOU[5]	√		√	√	√	√		√	√		√		√	√
WANG[6]			√	√	√	√		√	√	√	√	√	√	
ZHU[7]	√	√	√		√	√	√	√	√	√	√	√		√
YAO[8]	√	√	√		√	√		√	√		√	√		
JIA[9]		√		√	√	√			√	√				
LI[10]	√	√	√			√	√	√	√		√	√	√	
ZHANG[11]	√		√		√	√		√	√		√		√	
LI[12]	√		√	√	√	√	√	√	√			√	√	√
Total	8/10	6/10	8/10	5/10	9/10	10/10	5/10	9/10	10/10	5/10	7/10	7/10	7/10	4/10

The qualification ability of a construction enterprise is a comprehensive quality ability that reflects the organization and coordination ability, technical level, personnel quality, financial status, degree of construction machinery, construction capacity and other aspects of the enterprise. If the professional quality of the operators in the comprehensive quality ability of

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the construction enterprise is insufficient, it will lead to quality problems such as insufficient control of the installation accuracy of the prefabricated components, rework will occur, and the cost of the construction stage will be increased.

4. Make Recommendations based on Cost Influencing Factors

4.1. In the Design Phase

The leading role of design should be brought into full play and the technical level of designers should be improved. When meeting the requirements of the prefabricated building design scheme, when the prefabrication rate of the prefabricated building is required to be in the range of 30% to 50%, a prefabricated scheme with a lower prefabrication rate should be selected to ensure that EPC project general contractor engineering cost is the lowest. At the same time, BIM technology can be applied to complete the construction of the component information model library and the "family" of prefabricated components required by the prefabricated construction project in the EPC mode, which can standardize the design of prefabricated components and reduce the overall design and production costs. Keep abreast of site conditions, reasonably split prefabricated components, follow the principles of less type and modularization; improve the enterprise technical standard system, and determine reasonable component size and weight.

4.2. In the Production Phase

As the main components of prefabricated buildings, controlling the quality of the production stage is a key stage of quality control. Improve the comprehensive strength of the prefabrication plant, improve the component production process, improve the level of intelligence and mechanization, use assembly line production, improve production efficiency, and reduce labor costs. Control the material cost of prefabricated components and components, strengthen research on new technologies and materials for prefabricated components, and improve various properties and production fineness of prefabricated components to reduce the cost increment of prefabricated components.

4.3. In the Transport Phase

In the transportation stage, the advance amount should be reasonably reserved according to the use requirements, and the most suitable transportation route should be reasonably planned to ensure the arrival at the construction site as planned, so as to avoid weather, road obstruction, etc. affecting the delivery time and save time and cost. According to the characteristics of the components, the component loading plan is designed, the appropriate vehicle is selected, the components installed first are placed on the outermost or the top, and the prefabricated components are numbered to improve the space utilization rate of the vehicle.

4.4. In the Construction Phase

The project manager should, in accordance with the requirements of the organization plan for the installation and construction of prefabricated building components, strengthen the provision of the relevant number of management personnel, enhance the management ability of the project department, improve the management level, reasonably allocate the working hours of the installation personnel, reduce material loss, and rationally use machinery.Key positions such as technical person in charge, on-site safety officer, and quality officer should be fully equipped.

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5. Conclusion

Although prefabricated buildings have significant advantages compared with traditional cast-in-place systems, the cost of prefabricated buildings is higher than that of cast-in-place monoliths, and the enthusiasm of all participants is not high, which is one of the main factors restricting the development of prefabricated buildings. Therefore, this paper mainly focuses on the determination of the factors affecting the cost of prefabricated buildings under the EPC mode by literature and data analysis, so as to find the main factors that affect the cost of prefabricated buildings in the EPC mode, and put forward targeted suggestions for cost-influencing factors. To achieve the purpose of reducing the construction cost of prefabricated buildings, improve project income, and promote the development of prefabricated buildings.

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