

# Study on the Influence of Prefabricated Building on Housing Project Cost and Optimization Strategy

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## Abstract

Compared with traditional cast-in-place buildings, prefabricated buildings have prominent advantages, and this architectural mode is very suitable for the current national conditions of China. However, the high cost of prefabricated buildings seriously restricts its development in China, it is of great significance to deeply study the influencing factors and optimization strategies of the cost of prefabricated buildings. Through literature research and data investigation, this paper identifies the factors affecting the cost of prefabricated buildings in China, and finds that labor cost, mold cost and transportation cost are the main factors. Targeted optimization suggestions are put forward, which aims to change the current situation of high cost of prefabricated residential buildings in China and promoting the sustainable development of prefabricated residential buildings in China.

## Keywords

**Prefabricated Building; Cost Influencing Factors; Cost Control.**

## 1. Introduction

Prefabricated buildings adopt standardized design, factory production and assembly construction[1]. It Prefabricated buildings is a new type of building production mode that transfers a large number of on-site operations in the traditional construction mode to the factory, so as to realize the sustainable development of building products with energy conservation, environmental protection and maximizing the value of the whole life cycle[2]. Compared with traditional cast-in-situ concrete buildings, prefabricated buildings can save energy and reduce emissions, improve building quality and improve building efficiency[3]. As the prefabricated building is a new technology, there are inevitably some problems in the implementation process, such as the shortage of technical talents and the high cost. In order to maximize profits, what kind of project cost management measures have become a difficult problem for cost managers in the construction industry. This paper explores the specific composition of prefabricated buildings in China, finds out three main influencing factors of the construction cost of prefabricated houses, and finally puts forward targeted optimization suggestions, so as to reduce the cost of prefabricated buildings and promote the further development of prefabricated buildings in China.

## 2. Specific Composition of Prefabricated Construction Cost

The cost influencing factors of prefabricated concrete residential buildings include labor, materials, machinery, management and environment[4]. Labor factors include the reduction of the working population and the low technical level of workers[5]; material factors include non standardized production, high transportation cost of components and unsustainability of molds; mechanical factors include many kinds and bulky on-site hoisting machinery, and the mechanical coordination ability is not strong; management factors include immature

construction technology and low management level; environmental factors include few policy support ways and people's disagreement with prefabricated buildings.

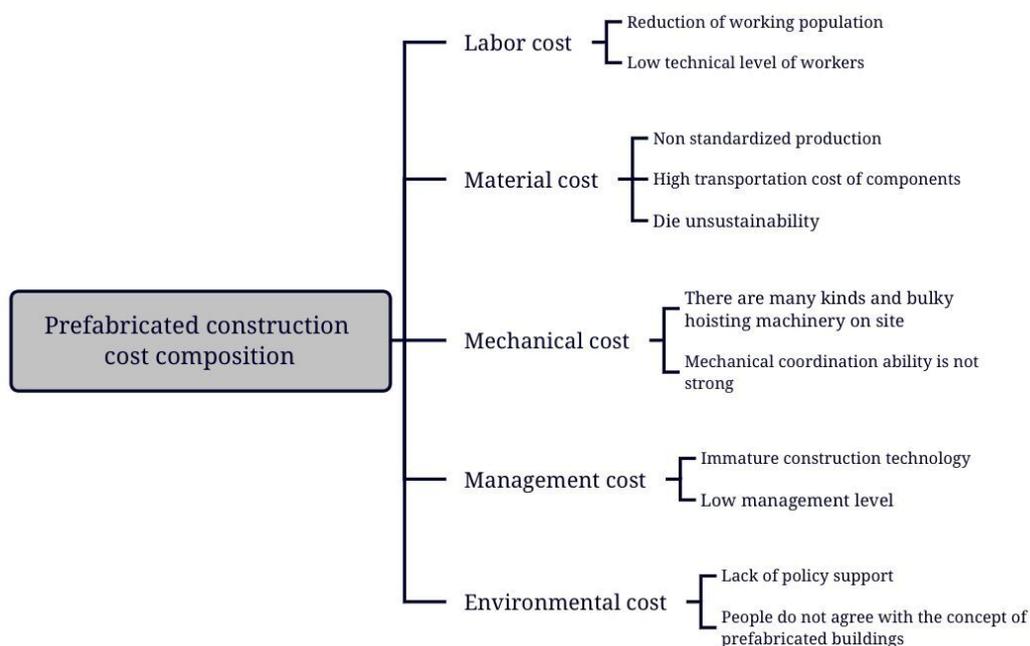


Figure 1. Cost composition of prefabricated construction

### 3. Factors Affecting the Construction Cost of Prefabricated Housing

China issued several opinions of the State Council on Further Strengthening the management of urban planning and construction, the main content of which is to vigorously promote prefabricated buildings, build a national prefabricated building production base, and strive to make the proportion of prefabricated buildings in new buildings reach 30% in about 10 years. In recent years [6], although the development of prefabricated buildings in China has accelerated, the progress of prefabricated construction in China is still slow because construction and construction enterprises do not understand and agree with the technical system of prefabricated construction, and have concerns about the quality and safety of prefabricated buildings. One of the main reasons is that the cost of prefabricated buildings is too high. Through literature research, [7]it can be concluded that the influencing factors of prefabricated building cost are as follows:

Table 1. Factors affecting the cost of prefabricated buildings

Classify	Influencing factor
Labour cost	Reduction of working population
	Insufficient technical level of workers
Mold cost	Mold materials are expensive
	Low mold repetition rate
	High labor cost in mold production
Transportation cos	Horizontal transportation fee
	Vertical transportation fee

#### 3.1. Labor Cost

In recent years, China's multi local housing and Urban Rural Development Commission has issued a document to further standardize the employment age management of construction

enterprises and prohibit the recruitment or use of the following personnel in any form to enter the construction site for construction operations: Workers under the age of 18, men over the age of 60 and women over the age of 50. Male workers over 55 years old and female workers over 45 years old are prohibited from entering the construction site to engage in underground, high altitude, high temperature, especially heavy physical labor or other special work that affects health, high risk and high risk. Since the issuance of this article, the construction labor force across the country has declined sharply. According to the 2021 annual report of the construction industry released by China, the number of employees in China's construction industry has decreased for three consecutive years. At present, the number of employees in China's construction industry is 52.8294 million. The reduction of the working population will inevitably lead to an increase in the cost of employment[8]. On this basis, the talents of prefabricated buildings, such as draftsmen, component production technicians, prefabricated building managers, chief technicians, general managers of prefabricated buildings, prefabricated building technology R & D personnel, prefabricated building designers, prefabricated structure designers, prefabricated building management engineers, are more scarce. The scarcity of talents is bound to increase the labor cost of prefabricated residential buildings[8].

### 3.2. Mold Cost

Due to the short start of prefabricated building in China, the mold design of prefabricated building has not received enough attention, and there is no unified design standard in the industry, so that the mold cost is as high as 15% ~ 42%. The specific reasons for the high cost of molds are as follows:

(1) Mold materials are expensive: Most of the mold materials of PC components are iron or aluminum. At present, the purchase price of iron and steel molds is between 9500 yuan and 13000 yuan per ton, and the price of cast aluminum molds is more expensive. After the completion of the project, the recovery price of scrapped molds is less than 2000 yuan per ton, resulting in excessive loss[10].

(2) Low mold repetition rate: Due to the single characteristics of real estate buildings, it is difficult to achieve uniformity in Chinese buildings. There is no mature unified standard for the disassembly and design of PC components in the same project, which leads to the single applicable project, few turnover times and serious loss of the mold, and can not achieve the purpose of multiple production of a single mold. This is also one of the reasons why the mold cost of prefabricated components remains high[11].

(3) High labor cost of mold production: The main basis of mold design is PC component shape, reinforcement layout, embedded parts location, etc. The mold structure of PC component is complex. Professional technical workers are needed to make the mold structure meet the design requirements of bearing capacity, stiffness, stability and convenient assembly and disassembly. For example, the external wall panel mold needs to adopt the forward or reverse striking process, the angle iron is selected as the side mold for the laminated floor, and the strong rib plate with a spacing of 400-500mm needs to be set on the side mold. These processes require professional die making and welding technicians, which greatly increases the labor cost of die production.

### 3.3. Transportation Cost

(1) Horizontal transportation fee: The standardization of prefabricated components in China is low and there are many specifications and sizes, so they are forced to use bulk transportation[12]. In addition, the prefabrication manufacturers in the market are small in scale and quantity. The production plants of PC components are generally in the suburbs far away from the urban area and far away from the project site. Transportation vehicle billing is

usually related to distance. From the perspective of transportation distance, half a day's round-trip is only available for 50 ~ 100km, and the economic transportation radius of prefabricated components is half a day's round-trip. Backward transportation equipment, transportation mode and transportation efficiency hinder the control of transportation cost.

(2) Vertical transportation cost: Compared with the traditional construction method, the total weight of prefabricated building components requiring vertical transportation is more than times[13]. The more common machinery for vertical transportation is tower crane and truck crane. The selling price and rental cost of machinery of different specifications vary greatly. The machinery that can just meet the hoisting requirements shall be comprehensively analyzed and selected on site. For example, the reinforced concrete structure system generally selects the crane with the maximum lifting weight of 16t, and its one-day rental price is about 2200 yuan. Because vertical transportation is directly combined with on-site installation, the construction of fabricated structure requires not only large lifting capacity of transportation machinery, but also high hoisting accuracy, reliable braking, good slow positioning function and more sensitive operation, which will directly affect the efficiency and cost of vertical transportation.

## **4. Suggestions on Cost Optimization of Prefabricated Buildings**

### **4.1. Suggestions on Labor Cost Optimization**

Prefabricated concrete buildings have more stringent requirements than cast-in-situ buildings in terms of design, production and construction, and the professional requirements of corresponding post talents are also higher. The training of professional workers has become an urgent need. In order to solve this problem, we must establish the talent training mechanism of the whole industrial chain and truly improve the working potential of construction workers from both theory and practice.

(1) For skilled personnel in front-line core posts, centralized rotation training, famous teachers with high apprentices and other methods are adopted to speed up the training of key types of work, key processes and key professional and technical experts. Try out the chief technician system in key posts and special processes, and give full play to the leading role of applied high skilled talents in technology research and innovation.

(2) School enterprise cooperation. School enterprise cooperation can solve the problems of professional personnel training and employment. Students can improve their quality, work technology and work enthusiasm, give full play to their subjective initiative, effectively promote personnel employment and alleviate the shortage of labor force in China by learning relevant courses of prefabricated concrete construction in school and combining with the on-site practice of enterprises.

### **4.2. Suggestions on Die Cost Optimization**

(1) Mold sharing control. Mold sharing is the key to controlling the number of molds. At present, the types of PC components include shear wall, infilled wall, stair, beam, column, etc. We should comprehensively consider the mold sharing of components from the component type - component size - reinforcement form - embedded part point layout, and modify the mold points of some components to achieve mold sharing. Adjustable points include split bolt holes, hoisting embedded parts, diagonal bracing embedded parts, etc. When sharing molds for PC components, drawings should be adjusted reasonably to reduce the amount of tooling rack.

(2) Mold technology innovation. We should increase investment in mold R & D, carry out technological innovation from mold configuration to mold design, compile patents and construction methods, find mold materials with higher economic benefits, and reduce mold costs from a technical point of view. We should continue to strengthen the improvement of demoulding process, the transformation of turnover machine, the development of adjustable

external hanger, the research of scissor board slurry sealing process, the development of stair track demoulding mold, the development of PCF and Pb board integral storage rack, the photothermal curing technology of pre curing kiln, etc.

(3) Establish standardized prefabricated components and supporting mold library. By studying the design and production law of prefabricated components, this paper summarizes the standardized modular design and splitting methods of prefabricated components, and establishes the component standardization library and supporting mold standardization library. Different projects can refer to the component standardization library for component splitting design, and the supporting molds can directly call the molds in the supporting standardized mold library for design and production.

### **4.3. Suggestions on Transportation Cost Optimization**

(1) Reasonably arrange prefabricated component production plants and promote standardized prefabricated components. The closer the construction site is to the prefabricated component production plant, the lower the corresponding transportation cost will be. However, considering the overall social economic benefits and resource allocation, the number of prefabricated component production plants will not increase indefinitely, and the number of new assembly buildings will be much greater than that of prefabricated component production plants. The research shows that the function of a standard prefabricated component factory needs to radiate the range of 30km around, which can not only keep the horizontal transportation cost at a low level, but also make the prefabricated component factory obtain better income.

(2) Develop special transportation machinery and improve the configuration structure. For the characteristics of large-scale and easy damage of prefabricated building components, the traditional transportation vehicles should be improved, the supporting components and methods should be developed, the loading capacity of vehicles should be increased, and vibration isolation, vibration reduction and other protection facilities should be added on the vehicles to avoid the damage of components during transportation, loading and unloading. Appropriate transportation vehicles should be selected according to different types, sizes and quality of prefabricated components.

(3) Reasonably arrange the organization work and improve the technical level. Before the transportation of prefabricated components, the transportation route shall be planned, the transportation route shall be investigated on the spot, focusing on the investigation of roads, bridges, height limit, width limit, load limit, etc., and the transportation route shall be determined through communication with the local traffic management department. Do a good job in the site stacking layout, fully communicate with the site and cooperate with each other. At the same time, scientifically number and place the prefabricated components. While saving the use of the yard, it should be convenient to use and reduce secondary handling.

## **5. Conclusion**

One of the main reasons for the slow development of prefabricated buildings in China is that the cost of prefabricated buildings is much higher than that of traditional buildings, resulting in low investment efficiency and difficult for the market to actively accept and promote. Through the research, we identify that the main influencing factors affecting the cost of prefabricated buildings in China are labor cost, mold cost and transportation cost. This paper puts forward the following targeted improvement suggestions for these three influencing factors: The labor cost can be optimized through school enterprise cooperation, training skilled technicians and improving the technical level of workers; for the mold cost, consider the mold sharing, mold technology innovation and the establishment of standardized prefabricated components and

supporting mold library as much as possible; in view of the transportation cost, we need to reasonably arrange the prefabricated component production plant, promote the standardization of prefabricated components, develop special transportation machinery, improve the configuration structure, and do a good job in organization. Finally, use the above advanced technologies and methods to shorten the cost gap between prefabricated buildings and traditional buildings, so as to ensure the economic and social benefits of prefabricated buildings, and then promote the sustainable development of prefabricated buildings in China.

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