Prospect and Economic Development Analysis of Prefabricated Building Industry in An Ethnic Minority Area

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Abstract. By comparing the prefabricated building industry with the traditional construction mode, national policies and development planning of the prefabricated building industry were combined to analyze the development advantages and economic benefits of the prefabricated building industry in Yanbian Korean Autonomous Prefecture, Jilin Province, and meanwhile, its development prospects were given, thus providing a reference for the development of prefabricated building industry and economic development in similar ethnic minority areas.

1. Introduction
Prefabricated buildings have sprung up in developed countries like Britain, America, Germany, France and Japan, and the area they cover in these countries has reached over 80%[1]. The high-speed economic development is accompanied by the emergence of building industry in China, with increasingly vigorous development momentum, and the representative modern buildings, such as: National Stadium (Bird’s Nest), China Zun (Beijing CITIC Tower), Shanghai World Financial Center, etc. As a special building pattern emerging in recent years in China’s building industry, prefabricated buildings have been applied in over 30 provinces and cities in China. Featured by green and environmental protection, low carbon, and prominent economic and social benefits, they can not only shorten the construction period but also play a significant role in the implementation of sustainable development strategy. By means of comparing the prefabricated building industry with the traditional construction methods, the national policies and development planning of prefabricated building industry were combined to analyze the development advantages and economic benefits of the prefabricated building industry in Yanbian Korean Autonomous Prefecture, Jilin Province. The productivity of economic aggregate was analyzed from the macroeconomic angle, and the model regarding prefabricated buildings-stimulated economic growth was proposed, with broad economic development prospects.

2. Concept and Construction of Prefabricated Buildings

2.1. Concept of prefabricated buildings
A prefabricated building is constructed by a prefabricated building manufacturer or professional construction unit which assembles partial or all components of the building in accordance with national standards and design drawings. As a whole, a prefabricated building, which integrates prefabricated components, consists of structural system, exterior envelope system, equipment and pipeline system,
and in-built system [2]. First, the corresponding components are fabricated by a manufacturer and then transported to the construction site, followed by five steps—site reservation, yard layout, assembly of hoisting machinery, assembly grouting, and acceptance check upon completion (Figure 1).

![Figure 1. Five Steps of Prefabricated Building](image)

### 2.2. Construction of prefabricated buildings

Due to great demand and increasing components, prefabricated buildings may follow different hoisting sequences, among which the common hoisting sequence is prefabrication of wall body→superimposition of beam and slab→stairway→balcony→air conditioner panel [2]. The hoisting sequence for exterior wall is: The wall body at corner of exterior façade is firstly hoisted, and this exterior wall serves as the positioning control benchmark for the hoisting of other exterior walls. Second, the PCF slab is hoisted after the exterior walls at two sides are hoisted and calibrated. Grouting is the final step. The construction of the prefabricated building example is shown in Figure 2.

![Figure 2. Construction of Prefabricated Building](image)

As shown in Figure 2, the traditional construction process is simplified by following the principal line—hoisting and grouting of prefabricated building components. On this basis, the construction rate is significantly elevated and the labor cost is effectively reduced.

Galaxy green prefabricated building elements can complete 200-300 m² main body construction within just one day under good transportation and hoisting conditions [1]. For example, the overall number of national people infected with COVID-19 presented explosive and exponential growth since its outburst on December 1, 2019, but under the correct guidance of the Central Committee of the CPC and the State Council, Huoshenshan Hospital and Leishenshan Hospital, which covered an area of 75,000 m² and could accommodate 1,500 beds, were constructed within ten days in succession, and this played a significant role in repressing the pandemic and facilitating the rehabilitation of patients. The completion of building facilities at such a large scale was ascribed to the application of PC fabricated buildings, while it would take at least half a year to construct similar facilities using the traditional building pattern. Therefore, in comparison with traditional buildings, the prefabricated buildings are
more effective in coping with emergencies under powerful guarantee of personnel and materials, reaching at least over 10 times of the response rate of traditional building pattern.

3. National Policies and Industrial Development Analysis

3.1. Development requirements and policies for the prefabricated building industry

The prefabricated building-related plans were enacted frequently since 2015, and at the end of 2015, Standard for Assessment of Industrialized Building was released, deciding to comprehensively popularize prefabricated buildings in 2016. On November 14, 2015, the Ministry of Housing and Urban-Rural Development issued Outline for Modernized Development of Building Industry, planning that the proportion of prefabricated buildings in newly constructed buildings would reach over 20% by 2020, and over 50% by 2025. On February 22, 2016, the State Council released Guiding Opinions on Energetically Developing Prefabricated Buildings, requiring to develop prefabricated buildings such as prefabricated concrete structures, steel structures, and modern timber structures according to specific circumstances, and to put efforts to make the proportion of prefabricated buildings in newly constructed buildings reach 30% within about 10 years. On July 5, 2016, the Ministry of Housing and Urban-Rural Development released and published the List of 2016 Science and Technology Demonstration Projects of Ministry of Housing and Urban-Rural Development for Prefabricated Buildings. On September 14, 2016, the State Council held executive meeting of the State Council, and put forward energetically developing prefabricated buildings and promoting the industrial structural adjustment and upgrading. On September 27, 2016, the State Council formulated Guiding Opinions of General Office of the State Council about Energetically Developing Prefabricated Buildings, proposed key areas needing energetic development of prefabricated buildings and steel structures, and confirmed the future proportion of prefabricated buildings in newly constructed buildings and the key cities needing to develop prefabricated buildings.

According to the statistics, the new construction area (10,000m²) of prefabricated buildings in China is shown in Figure 3.

![2016-2019 New Construction Area of Prefabricated Buildings of Nation](image)

Figure 3. New Construction Area of Prefabricated Buildings in China

3.2. Development policies of prefabricated building industry in Shanghai

According to the notice and related policies issued by the Ministry of Housing and Urban-Rural Development, Shanghai General Market Management Station for the Industry of Construction and Building Materials and Shanghai Housing Construction Development Center jointly issued a notice, requiring that the general contracting model should be adopted for the design (reconnaissance), construction and member procurement in Shanghai prefabricated affordable housing projects. For prefabricated housing projects with gross building area of over 30,000 m² and prefabrication rate of over 45%, 100 yuan subsidy would be granted per square meter, and the maximum amount of subsidies for a single project was 10 million yuan. Less than 3% of plot ratio rewards would be granted to projects where the prefabricated buildings were voluntarily implemented and prefabricated thermal-insulating...
sandwich walls were used as the exterior walls of prefabricated buildings. “Two compulsory ratios” were implemented at land source: The area proportion of prefabricated buildings in gross area of supplied lands was not less than 50% in 2015; in 2016, prefabricated buildings were used for all newly constructed civil buildings that met conditions within the outer ring, and the area proportion beyond the outer ring exceeded 50%; the area proportion beyond the outer ring would be increased on basis of 50% year by year since 2017.

3.3. Development policies of prefabricated building industry in Yanbian
Located in Huichun City, Yanbian Prefecture, Jilin Xinyu Yuanda Building Technology Co., Ltd and its production base, the first prefabricated component production base in Yanbian, provide the prefabricated building component resource support for the urbanization progress throughout the prefecture. In addition, the Central Committee of the CPC and State Council have formulated preferential policies to support the urbanization development of ethnic minority areas, e.g. reducing or exempting related taxes for enterprises, relieving their energy use burden, and lowering their financing costs. These policies, which have covered all fields of the urbanization development, are very advantageous for the economic development of high-cost building industry, especially the prefabricated building industry.

4. Development Advantages of Prefabricated Building Industry in Yanbian Prefecture
Located at the junction of three countries: China, Russia and North Korea, Yanbian Prefecture is a front city for foreign trade in Jilin Province, with considerable advantages in economic development policies over other regions. Moreover, it has beautiful scenery, fresh air, and abundant resources. Although the urbanization level is not high, it possesses superior natural environment by virtue of multiple national-level scenic areas like Changbai Mountain, Liuding Mountain, and Fangchuan. In proactive response to preferential policies of the Central Committee of the CPC and provincial government, which are good for the economic development of the autonomous prefecture, the whole prefecture is now energetically developing foreign trade economy by giving full play to its unique advantages, and it has realized annual GDP of 92.758 billion yuan, ranking top three in Jilin Province. Whether the building industry is prosperous decides the development speed and GDP of the autonomous prefecture. From the angles of energy conservation and emission reduction, and protection of natural environment, prefabricated buildings, which are characterized by low energy consumption and high speed, self-evidently show outstanding advantages in green urban development and economic efficiency, and it is extremely urgent to develop PC prefabricated buildings.

4.1. Case analysis
For example, it has taken three years to complete the construction of the Science & Technology Engineering Practice Building in Yanbian University, a total of 160 million yuan have been invested on this building, which covers an area of 30,000m², and the traditional building construction mode is adopted. The prefabricated buildings will be compared with traditional construction mode from seven angles. From the angle of materials saving, the prefabricated buildings can save water by 80%, construction time by 30%, building materials by 20%, labor cost by 47%, and energy consumption by 37%, and moreover, reduce the construction wastes by 58%, noise by 50%, and dust by 80% [3-4].

Table 1. Comparison of Traditional Buildings and Prefabricated Buildings in Construction Mode

| Item                  | Traditional construction mode                                                                 | Construction mode of prefabricated buildings                                                                 |
|-----------------------|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| Construction quality and safety | The potential safety hazards in outdoor working and working at heights are increased.            | Prefabricated production and mechanized installation improve the accuracy of construction and reduce potential safety hazards. |
### Construction period
Long construction period; great influences from natural environment or human factors; for some professional types of work, cross-operation is impossible, and a large quantity of follow-up work remains to be done after the completion of major structural construction.

Prefabricated members are predetermined, with few field formwork and cast-in-place operation; building component and walls on all storeys can be manufactured in factory, while only hoisting, grouting, etc. require to be done on the construction site.

### Waste generation and pollution
Consideration generation of construction wastes, which, if not effectively disposed, will impose permanent environmental harms, such as dust, light pollution, and noise.

Production in factory can realize effective disposal of wastes, and remarkably reduce noise pollution, dust pollution, etc.

### Labor productivity
Low

Building components or walls are produced in factory, along with high levels of mechanization and intelligence in the field construction, and significantly high production efficiency.

### Constructor
Too many constructors, with poor specialty; high turnover rate, and great management difficulty.

Few constructors, with excellent specialty, and greatly reduced management difficulty.

### Quality of finished construction products
Restricted by the technical level of field constructors.

Building components, walls, etc. are manufactured in factory with machinery based on drawings, along with high accuracy, controllable hoisting process, favorable technical level of workers, and high construction quality.

### Diversity of building forms
Restricted by the technical level in the form erecting and construction process.

Building components are produced by factory in advance, steel membranes and so on are predetermined, construction models are varied and hoisted on the construction site, and theoretically speaking, any finished construction work can be produced in a combined way.

Besides, as all prefabricated parts are produced in factory and the hoisting operation is implemented on the construction site, the level of mechanization is high in the prefabricated construction, which effectively reduces wet operations on the site, such as concrete mixing and pouring, mixing of masonry mortar and wall building, mortar mixing and plastering, etc. Moreover, the construction period can be shortened by a large margin as the prefabricated construction because of minor weather effect.

### 4.2. Economic development model for prefabricated buildings in Yanbian

The direct cause and root cause should be analyzed in order to establish the economic growth model from the macroeconomic angle.

#### 4.2.1. Productivity of economic aggregate.
Assume that the economic aggregate production function is\(^5\):\[ Y = A F (N, K) \]

Where gross output depends on labor A, capital K, and technical level A. (+) means that the relationships of the dependent variable Y with the independent variables A, N, and K are changed in the same direction. This is the aggregate production function that describes the ability of an economy to produce products and labor services.

According to the microeconomics law of constant returns, if the above production function satisfies constant returns to scale (CRTS), namely, the production scale of prefabricated building components is unchanged, then the output can be enlarged by a certain proportion by expanding the input ratio.

\[ xY = AF (xN, xK), x = 1/N \]
Y/N=AF (1, K/N)

Where Y/N is defined as the productivity which denotes the working efficiency of each prefabricated component production worker and field hoisting worker. Therefore, the productivity depends on per capita capital K/N and represents the variable A, that is, technical condition. Economic growth is the yield increase, so when the three variables—production efficiency Y/N of prefabricated building worker, technical level A in prefabricated construction, and input of capital K—tend to be stable, economic growth can be realized if only one parameter presents positive change.

The prefabricated building industry in Yanbian Prefecture is still in initial phase, so the emphasis should be laid on improving the production efficiency Y/N of prefabricated building worker, input of capital K, technical level A in prefabricated construction, etc., thus effectively stimulating the economic growth.

4.2.2. Economic growth model.

The economic growth model and the relationships among root cause, direct cause, and various factors are displayed in Figure 4.

![Figure 4. Relationships of Economic Growth Model with Factors](image)

It is policies and systems, culture, and geographical environment of Yanbian Prefecture that are the root causes deciding whether prefabricated buildings can stimulate the economic growth. The positive economic growth of Yanbian Prefecture can be realized only by enlarging the investment on prefabricated buildings, enhancing the technological development, and cultivating the corresponding talents specialized in prefabricated buildings while the three factors are simultaneously satisfied. From the current situation, Yanbian Prefecture has already possessed prefabricated building component production bases, with professional practitioners and increasingly mature prefabricated building technologies. Furthermore, it has carried out national economic preferential policies for ethnic minority areas, showing outstanding advantages in government investment.

5. Conclusions

(1) The concept and construction of prefabricated buildings were introduced in this study, the national policies and development of prefabricated building industry were analyzed, and this construction mode was compared with the traditional construction mode from five aspects. It is proved that the prefabricated building industry integrates the merits of low energy consumption, low pollution, high construction speed, and prominent economic and social benefits, so its popularization becomes extremely urgent.

(2) By analyzing the regional advantages and characteristics of one of ethnic minority areas, Yanbian Korean Autonomous Prefecture, from macroeconomic angle, the economic benefits of prefabricated buildings were figured out, and an economic development model was established, thus providing a reference for the economic development of prefabricated buildings in similar ethnic minority areas.

(3) As a direction indicator stimulating the future economic aggregate growth in Yanbian Korean Autonomous Prefecture, prefabricated buildings are of very broad development prospect.
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