

Construction and Quantitative Analysis of Housing Industrialization Index System

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ABSTRACT

Establishing index system of housing industrialization and pushing development of house industrialization will promote healthy development of house industry in our country. This paper studies the index system of housing industrialization from a new perspective, establishes the institutional index system and technical index system respectively, and sets the value range for the corresponding indicators, so as to achieve the combination of qualitative and quantitative factors. The index system includes some key contents about housing industry development and can truly reflect phase of housing industrialization. It solves the problem that only housing industrialization is mentioned in China, but there is no specific evaluation index system.

Keywords: *Housing industrialization, Index system, Institution, Technology.*

1. INTRODUCTION

At present, the level of housing industrialization in China is low, which is in sharp contrast with the booming housing industry. Establishing index system of housing industrialization and pushing development of house industrialization will promote healthy development of house industry in our country. Therefore, it is of great significance to study the index system of housing industrialization. This paper studies the index system of housing industrialization from a new view, establishes the institutional index system and the technical index system respectively, and sets the value range for the corresponding indicators, so as to achieve the combination of qualitative and quantitative.

2. INSTITUTIONAL INDEX OF HOUSING INDUSTRIALIZATION

The realization of housing industrialization is not only a technical problem, but also needs the support of relevant institution to create a good development environment [1]. Therefore, the development degree of housing industrialization is closely related to these institution indicators, which should be put into the index system of housing industrialization. These indicators are mainly as follows.

2.1. Organization index of housing industrialization

The organization index of housing industrialization includes the integration index of scientific research, production and market, the degree index of from

independent and single development to coordinated development, the index of perfecting the quality control system of housing construction and the index of perfection degree of quality certification system. The following is a detailed description of each index.

2.1.1. The integration index of scientific research, production and market

Scientific research, production and market should be coordinated with each other and the degree of integration can be used as an index to measure housing industrialization.

2.1.2. The index of perfecting the quality control system of housing construction

A perfect housing quality control system will strictly control the production of housing components, which is conducive to the realization of the standardization and serialization goals. Therefore, the perfection of the quality control system of housing construction can be used as an index to measure the housing industrialization.

2.1.3. The index of the perfection degree of the quality certification system

It is a common international practice to implement part certification system and market access system. Therefore, the perfection of the part certification system can be used as an index to measure the housing industrialization.

Table 1. Organization index of housing industrialization

Number	Index	Degree	Score
A1	the integration index of scientific research, production and market	Normal	0.5 – 1
		High	1 – 2.5
		Very high	2.5 – 5
A2	the index of perfecting the quality control system of housing construction	Normal	0.5 – 1
		High	1 – 2.5
		Very high	2.5 – 5
A3	the index of perfection degree of quality certification system	Normal	0.5 – 1
		High	1 – 2.5
		Very high	2.5 – 5

2.2. Policy index of housing industrialization

2.2.1. Financial support policy

The development of housing industry is inseparable from financial support, and the standardization and industrial production of housing components need more financial support. Therefore, whether the government provides corresponding financial support for the development of housing industry is an index to measure the housing industrialization policy.

2.2.2. Special measures for housing projects of government

The demand groups of urban housing are very different. [2] In order to ensure that the low-income

people have the ability to buy houses, the government has implemented the housing project, built a large number of affordable housing, and given some preferential policies to developers, thus ensuring social equity and efficiency, and creating conditions for the smooth implementation of housing industrialization.

2.2.3. Tax reduction and exemption policies for new technologies and new products

In order to attract more enterprises to adopt those components with standardized and large-scale production, the government should provide corresponding policies to guide them. It is one of the main means for the government to give preferential tax policies to enterprises adopting new technologies and new products.

Table 2. Policy index of housing industrialization

Number	Index	Degree	Score
B1	financial support policy	Normal	0.5 – 1
		High	1 – 2.5
		Very high	2.5 – 5
B2	special measures for housing projects of government	Normal	0.5 – 1
		High	1 – 2.5
		Very high	2.5 – 5
B3	tax reduction and exemption policies for new technologies and new products	Normal	0.5 – 1
		High	1 – 2.5
		Very high	2.5 – 5

3. TECHNICAL INDEX OF HOUSING INDUSTRIALIZATION

3.1. Standardization index of housing construction

Housing construction standardization is to use standard design scheme, building system and components in housing design, standardize housing components and products according to certain modulus

standards, form standardized and serialized housing components, reduce randomness in housing design, and simplify construction methods.

3.1.1. Area standard

The area of housing type should be increased appropriately and the allocation of different types is reasonable. The use area of each functional space in the house is shown in the table below.

Table 3. Area standard

Number	Index	Goal	Score
C11	Dining room area	≥8m ²	0.5 – 1
C12	Kitchen area	usable area≥6 m ² , length of console≥3.6 m	0.5 – 1
C13	Living room (Hall) area	usable area≥17m ² , width≥3.9m	0.5 – 1
C14	Double bedroom area	usable area≥14m ² , width≥3.3m	0.5 – 1
C15	Single bedroom area	usable area≥9m ² , width≥3.0m	0.5 – 1

3.1.2. Functional and environmental design standards

The types and spatial layout of housing units are determined by different social family needs, family life cycle evolution and living style changes, which has greater adaptability and flexibility [3]. The layout of housing is reasonable, reflecting the principle of

separation of public and private, dynamic and static, clean and dirty, and living and sleeping. A door bucket should be set to facilitate changing clothes and shoes, storing rain gear and ensuring privacy. Expand the balcony, provide outdoor leisure places, and form a suitable indoor and outdoor transition space. Indoor lighting is sufficient and ventilation is good.

Table 4. Functional and environmental design standards

Number	Index	Score	
C21	The living room (Hall) and bedroom are provided with natural ventilation and lighting, without obvious line of sight interference and daylighting blocking.	0.5 – 1	
C22	No walking through living room (Hall) and bedroom	0.5 – 1	
C23	The net area in the house shall not exceed 1 / 20 of the usable area	0.5 – 1	
C24	The kitchen has natural lighting and ventilation and is located close to the entrance.	0.5 – 1	
C25	Toilet's setting	Set up a toilet with full functions	0.5 – 1

3.1.3. Structural standards

Structural design should pay attention to the safety, durability, rationality and economy of the structure system, and provide conditions for the flexibility and modifiability of residential space [4]. In order to meet the requirements of soil saving, material saving and energy saving, we should actively adopt large bay and large space structural system, popularize and apply the

new building wall materials and adopt new energy-saving enclosure structure. Building safety includes fire prevention, waterproof and anti-corrosion requirements. Attention should be paid to safe evacuation and safety of gas, electrical and water supply and drainage equipment. Security and protection facilities should be set up for security defense, such as infrared monitoring, electronic patrol, intelligent control for home should be installed.

Table 5. Structural standards

Number	Structural standards	Content	Score
C31	Flexibility	Adopt large bay and large space structure system.	1 – 2
C32	Economy	Apply the new building wall materials and use the new energy-saving structure.	1 – 2
C33	Durability	Service life of the structure is 50 years.	0.5 – 1
		Service life of the structure is 100 years.	1.5 – 2

3.2. Industrialization index of component and component production

3.2.1. Series and scale production of components and parts

According to the degree of industrialization, serialization and large-scale can be divided into three development stages. The first stage is the partial use of

prefabricated components, such as a small number of small components, such as floors, door and window lintels, stairs, platforms, etc., while a large number of major projects are still completed on site. In the second stage, most of the residential buildings adopt prefabricated components, such as beams, slabs, columns, piles, large wall panels, roof panels, etc., which are prefabricated in the factory. In the third stage, almost all the houses adopt prefabricated components,

which is the advanced stage of the development of prefabricated buildings. To a large extent, the degree of industrialization of components reflects the level of construction industrialization. Residential construction

industrialization refers to the third stage of development, and the second stage can be called semi industrialization.

Table 6. Series and scale production of components and parts

Number	Industrialization goal	Proportion of industrialization	Score
D1	In the first stage, prefabricated components are used locally.	20~30%	1-2
	In the second stage, most of the prefabricated components are used in residential buildings.	50~70%	3-5
	In the third stage, prefabricated components are almost used in residential buildings.	80%	5-8

3.2.2. Index of set of supply components

components system, equipment components system and supporting components system of communities.

It mainly refers to whether it is good or not of the supporting structure components system, interior

Table 7. Index of set of supply components

Number	Index	Score
D21	The supporting structure components system of housing	0.5-2
D22	The interior components system	0.5-2
D23	The equipment components system	0.5-2
D24	The supporting components system of communities	0.5-2

3.3. Cost index

Brick concrete structure needs a large number of solid bricks and has high social and economic costs. Frame structure can save a lot of resources and has the characteristics of low cost, so it is widely used. Due to the lack of scale, the cost of steel structure cannot be greatly reduced in a short time. Therefore, in the initial stage of housing industrialization, frame structure should be the mainstream structure. With the development of housing industrialization, steel structure should gradually become the developing direction.

3.4.1. Indoor environment quality

The main source of indoor air pollution in residential buildings is the building materials used, including inorganic building materials and organic building materials.[5] Therefore, in this paper, the control situation of indoor pollutants is evaluated from three sub items: the radioactive pollution of wall materials and the content of harmful substances in interior decoration materials and the contents of indoor environmental pollutants.

3.4. Environmental protection index

Table 8. Indoor environment quality

Number	Index	Score
E11	Indoor Radon concentration $\leq 200\text{Bq} / \text{m}^3$	0.1-0.4
E12	Indoor Free Formaldehyde concentration $\leq 0.08\text{mg}/\text{m}^3$	0.1-0.4
E13	Indoor Ammonia concentration $\leq 0.2\text{mg}/\text{m}^3$	0.1-0.4
E14	Indoor Benzene concentration $\leq 0.09\text{mg}/\text{m}^3$	0.1-0.4
E15	Indoor total volatile organic compounds (TVOC) concentration $\leq 0.5\text{mg}/\text{m}^3$	0.1-0.4

3.4.2. Water saving index

Reuse of the reclaimed water is the most significant measure of water saving. On the one hand, we call for the shortage of water supply. On the other hand, we use high-quality water for greening, car washing, road

washing and toilet flushing, which can be completely replaced by the reclaimed water. Beijing, Shenzhen, Jinan and other cities have clearly stipulated that reclaimed water facilities must be established in residential quarters with a building area of more than 50000 m². [6] Some cities are building large-scale

reclaimed water supply network. In view of this, in addition to the establishment of reclaimed water

facilities, reclaimed water pipelines can also be installed.

Table 9. Water saving index

Number	Index	Goal	Score
Utilization of reclaimed water	E21	The residential quarters with a building area of more than 50000 m2 or the residential quarters with a recoverable water volume of more than 150m3 / day are equipped with reclaimed water facilities, or backwater utilization facilities, or connected with the urban reclaimed water system.	0.5 – 2
	E22	The residential quarters where the amount of source of reclaimed water or reuse of reclaimed water is too small (less than 50m3 / day), reclaimed water pipeline system and other reclaimed water facilities shall be designed and installed.	0.5 – 2
Water saving apparatus and pipes	E23	Using toilet system ≤ 6 liters	0.5 – 2

3.4.3. Energy consumption index

In 1986, the Ministry of Construction issued the "Civil Building Energy Efficiency Design Standard (jgj26-86)", which aims to save 30% energy on the basis of the heating energy consumption of the local general design from 1980 to 1981. According to the basic goal of "building energy saving technology policy" in "China

Building Technology Policy 1996-2010" compiled by the Ministry of construction, "from 1996 to 2000, the newly residential buildings should achieve 50% energy saving on the basis of the local general energy consumption level from 1980 to 1981; from 2005, the new heating residential buildings should save energy by 30% on the previous basis." This is what we often call three-step energy conservation [7].

Table 10. Energy consumption index

Number	Stage	Energy-saving goal	Score
E3	The first stage	energy saving 30% on the basis of the heating energy consumption of the local general design from 1980 to 1981	0.1 – 0.5
	The second stage	50% energy saving compared with the first stage	0.6 – 1
	The third stage	30% energy saving compared with the second stage	1.1 – 2

4. CONCLUSIONS

This index system includes some key contents for the development of housing industry and the evaluation methods of this index system mainly include subjective evaluation method and objective evaluation method. Subjective evaluation methods such as Delphi method, namely expert evaluation method, are generally applied to those indicators that cannot be quantified. In the process of evaluation, experts in the industry assign values to these indicators according to the actual situation. Objective evaluation method is mainly applied to those indicators that can be quantified and the corresponding score is given according to the target achieved by the index. Finally, add the scores determined by subjective evaluation method and objective evaluation method to get the degree of housing industrialization. This index system put forward by this paper can truly reflect phase of housing industrialization and solve the problem that only housing industrialization is mentioned in China, but there is no specific evaluation index system.

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