Analysis on the restriction factors of the green building scale promotion based on DEMATEL

Hong Wenxia, Jiang Zhenyao, Yang Zhao

Qingdao Technological University, No.2, Changjiang Road, Huangdao District, Qingdao, Shandong Province, China

1181148336@qq.com

Abstract. In order to promote the large-scale development of the green building in our country, DEMATEL method was used to classify influence factors of green building development into three parts, including green building market, green technology and macro economy. Through the DEMATEL model, the interaction mechanism of each part was analyzed. The mutual influence degree of each barrier factor that affects the green building promotion was quantitatively analysed and key factors for the development of green building in China were also finally determined. In addition, some implementation strategies of promoting green building scale development in our country were put forward. This research will show important reference value and practical value for making policies of the green building promotion.

1. Introduction

With the rapid development of China's construction industry, environmental problems have become increasingly prominent and paramount. In the process of construction, large amount of waste water, waste gas and waste residue are discharged into the environment, resulting in serious pollution of air, water and soil and destruction of the ecological environment. Therefore, green building as a new concept of architecture has gradually been recognized and respected by the public. Green building combines the sustainable concept with the field of architecture, which can significantly improve energy efficiency and reduce energy consumption. In our country,green building is defined as the building which can maximize the conservation of resources, protect the environment and reduce pollution in its whole life cycle, and thus providing healthy, suitable and efficient use of space for people and being in harmony with nature. With the rapid development of China's economy, the factors affecting the large-scale promotion of green building are changing all the time. With the aid of DEMATEL method, the mutual influence degree of each obstacle factor was revealed quantitatively, and the key factors restricting the development of green building were also determined, which could simultaneously provide scientific suggestions for urban sustainable development.

2. Analysis of green building scale promotion restricting factors

2.1. Green building market

The amount of green buildings is mainly determined by the market demand. The level of consumers' cognition is the main obstacle of the green building market.

2.1.1. The cognition level of green building (S_1). The government and relevant institutions haven't transformed the qualitative effects into quantitative effects that makes most of the public

consciousness fuzzy, which lead to the green building being difficult to promote and affect the status of green building in the society to a certain extent.

2.1.2. Market requirement of green building (S_2). Consumer demand mainly refers to the purchasing intention and purchasing power for green building. Consumer demand is usually determined by the individual age, education and culture level, income level, personal awareness of consumers.

2.2. Green Technology
The construction of green building is determined by the support of green technology and technical bottlenecks lead to the low degree of green building scale directly.

2.2.1. Application and diffusion level of green technology (S_3). The application of green technology is the integration of development, improvement and promotion process. Also, the cost of green building technology is the common concern of developers, consumers and designers and its application was determined by the exploit investment, application and diffusion of green technology.

2.2.2. Applicability level of green building (S_4). The designer should pay attention to local conditions, instead of implementing blindly "piling products" and "cold spell" policies. It is necessary to consider the regional environment suitability, resource saving and the economic applicability of the technology.

2.2.3. Quality performance level of green building (S_5). The level of quality performance comes from the integration of design, construction and appropriate technology system, which directly relates to the recognition of green building by consumers.

2.3. Macro economy
The development of green building is inseparable from the development of economy. The overall scale of the local economy and the activity of green building market are main factors that developers should take into account.

2.3.1. City GDP (S_6). The total amount of GDP is the measurement standard of local economy. When an area's economy has the development superiority and the development potential, it can provide the foundation for the green building development.

2.3.2. Income level of residents (S_7). Green building consumers must have the willingness to purchase the green buildings. The income levels determine the purchase power of consumers. Digging out the potential demand of consumers for green buildings is an effective measure to promote the development of green building in a large scale.

2.3.3. Attraction of urban residence (S_8). Attraction of urban residence refers to the total amount and quality of residence which meet the needs of urban residents.

2.3.4. Investment amount of green building (S_9). The investment amount of green building can reflect the economic development level and the scale of green building to a certain extent, which should be one of the variables considered by the macroeconomic subsystem.

3. Summary of DEMATEL model
The full name of DEMATEL method is decision-making and trial evaluation laboratory. The DEMATEL method is a methodology used to screen complex systems and simplify the process of system structure analysis. This method is to make full use of the experts' experience and knowledge to deal with complex social problems, especially for those systems with uncertain elements. This method

can analyze the relationship among various factors quantitatively through the relationship between factors and their strength to simplify complex problems.

The steps of the DEMATEL method are as follows:

(1) Set the system influence factors to $S_1, S_2, S_3, \ldots\ldots, S_m$.

(2) Setting up the direct influence matrix: X (X=$[x_{ij}]_{m \times m}$). $x_{ij} = 0,1,2,3,5$.

(3) Translate the direct influence matrix into normalized influence matrix: Y ($Y = [y_{ij}]_{m \times m}$).

$$Y = \frac{X}{\max\limits_{1 \le i \le m} \sum\limits_{j=1}^{m} x_{ij}}$$

(1)

(4) Calculate the comprehensive influence matrix of system influence factors: T ($T = [t_{ij}]_{m \times m}$).

$$T = Y(I - Y)^{-1}$$

(2)

(5) Calculate the influence degree and influenced degree of each factor.

$$p(i) = \sum_{j=1}^{m} t_{ij}$$

(3)

$$q(i) = \sum_{i=1}^{m} t_{ij}$$

(4)

(6) Calculate the centre degree and reason degree.

$$e(i) = p(i) + q(i)$$

(5)

$$f(i) = p(i) - q(i)$$

(6)

4. Green building scale promotion influence factors DEMATEL analysis

4.1. Data acquisition and process
The relationship among factors was determined by Delphi method. The influence degree, influenced degree, centre degree and reason degree (Table 1.) are calculated on this basis.

4.2. Result interpretation
From Table 1. we can draw some conclusions as follows:

(1)The factors which have more important influence degree are city GDP(S_6), applicability level of green building(S_4), quality performance level of green building(S_5). This result represents that these factors have great influence on other factors. As a result, we should promote the economic development of the city and think about the local conditions and the economic applicability at the same time. Furthermore, improving the level of quality performance of green building and meeting consumer demand for environmental quality and residential suitability requirements are also important.

(2)The factors which are influenced easily include market requirement of green building(S_2), the investment amount of green building(S_9)and the cognition level of green building(S_1). These data represent that these factors are influenced by other factors easily. Improving the public cognitive level is very important to promote the development of green building in a large scale.

(3)The factors which have large centre degree are market requirement of green building(S_2), the investment amount of green building(S_9)and city GDP (S_6). These three factors are the most direct factors hindering the development of green building that should arouse our concern.

(4)The factors which get large reason degree are city GDP (S_6), applicability level of green building(S_4)and income level of residents(S_7). The level of urban economic development is the key factor affecting the promotion of green building, accelerating the development of urban economy is the urgent requirement for green building development.

Table 1. Green building scale promotion restriction factor comprehensive relationship

	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9
Influence degree p(i)	0.2011	0.4077	0.5090	1.1627	0.8658	1.4772	0.6963	0.2107	0.3446
Influenced degree q(i)	1.0589	1.1865	0.8566	0.1066	0.4709	0.0000	0.2381	0.8169	1.1404
Centre degree e(i)	1.2600	1.5942	1.3656	1.2693	1.3367	1.4772	0.9344	1.0276	1.4850
Reason degree f(i)	-0.8578	-0.7788	-0.3476	1.0561	0.3949	1.4772	0.4582	-0.6062	-0.7958

5. Conclusion
According to the DEMATEL model, we can analyze the influence degree, influenced degree, centre degree and reason degree of every factor. Through analysis of the model, city economic development level and the application level of green building proved to be the main factors influencing the development of green building. At present, China is in a period that the urbanization is in the high speed development and the construction industry is about to certainly entering into a booming situation. However, the construction industry of our country is still in an extensive operation stage with high input, high consumption, high pollution but low benefit. This situation has become an important factor affecting the construction of low-carbon economy. Therefore, in order to achieve low-carbon target, the construction industry must transform into green building, reform the traditional production mode, promote green building vigorously and take the road of sustainable development practically. It's our future research direction to design technical path and implementation strategy of the green building promotion according to quantitative analysis method.

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