Obstacle Factors Analysis on Green Building Material Certification from the Perspective of Stakeholders

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Abstract. Green building material certification is an important measure to promote the transformation and upgrading of building materials industry and construction industry. Based on literature study and expert interviews, this paper identifies twenty-four obstacle factors in green building material certification from five respects including institutional, administrate, market, technology and society. Through a questionnaire survey of stakeholders in the building materials industry from different regions and Mann-Whitney U test, it analyzes the differences and reasons of stakeholders' attitudes towards obstacle factors in green building material certification, and puts forward some suggestions on promoting the development of green building materials certification.

1. Introduction
China is undergoing the largest urbanization process in human history, with more than 10 billion building area under construction each year and huge consumption of building materials[1]. Green building materials are the material base of green buildings and play a key role in protecting the ecological environment and promoting sustainable development. However, the certification and extension work of green building materials starts relatively late in China. In 2017, the Ministry of Housing and Urban-Rural Development and the Ministry of Industry and Information Technology successively issued some macroscopic documents such as "Guiding Opinions on Promoting the Work of Standards, Certification and Signs of Green Building Materials Products ", " Implementing Scheme of Certification of Green Building Materials Products" and “Notice on Accelerating Advancing the Certification and Production Application of Green Building Materials Products”. An urgent problem which should be solved presently is how to better implement the assessment and certification of green building materials, guide the green development of the building materials industry, and promote the industrial structure optimization. The application of green building materials involves many participants such as government departments, scientific research institutions, testing institutions, construction side of employer, construction side of contractor, and material suppliers. Different participants have different goals and expectations for the project. There must exist various interest contradictions and conflicts in the interest demand because of its independence, which ultimately affect the promotion and application of green building materials. In the process of promoting green building certification, if the interest demand and corresponding responsibility of the stakeholders cannot be clearly analyzed, it will certainly cause problems in any part of the green building industry chain, which will affect the overall development of the green building industry in China[2].

Therefore, from the perspective of stakeholders, this paper conducts a questionnaire survey of obstacle factors that hinder the assessment and certification of green building materials, and analyzes
the differences in the views of stakeholders on these obstacle factors, which will effectively promote the implementation of the assessment and certification work of green building materials in China.

2. Research design and questionnaire survey

2.1. Overall design
The research process of this paper includes four stages. First, identify the key factors hindering the certification of green building materials in China and design the questionnaire through the method of literature study, expert interviews and so on. Second, select six different places in three kinds of climatic regions including severe cold area, cold area, hot-summer and cold-winter area to conduct research, hand out test papers and collect data. Third, conduct statistical analysis of the collected data with SPSS software and use Mann-Whitney U test to verify the differences in attitudes towards obstacle factors of different stakeholders. Forth, puts forward some suggestions on promoting the development of green building materials certification based on the analysis results.

2.2. Obstacle factor identification
According to the existing research[3-7], combined with the results of expert interviews, twenty-four obstacle factors are identified in the implementation of green building material certification from five respects including institutional, administrate, market, technology and society, as shown in Table 1.

| Category          | Serial number | Obstacle factor                                                                 |
|-------------------|---------------|--------------------------------------------------------------------------------|
| Institutional     | I             | Lack of perfect legal system to promote the assessment and certification of green building materials |
|                   | I2            | Normative standard and technical requirement are not perfect enough               |
|                   | I3            | Insufficient incentive mechanism for the assessment and certification of green building materials |
|                   | I4            | Confusion caused by policy duplication formulated by all levels of departments    |
|                   | I5            | Inadequate supervision of certification by the government                         |
| Administrate      | A             | Department in charge of assessment is not clear                                  |
|                   | A2            | Industry is not systemized enough and the management system is not perfect enough |
|                   | A3            | The system of certification sign is not enough to standardize the market         |
|                   | A4            | Lack of direct stakeholder’s communication network                              |
|                   | A5            | Complicated implementation of the certification                                |
| Market            | M             | Uneven levels of enterprise quality in the market                                |
|                   | M2            | Not paying enough attention to green building materials certification and preference of traditional model |
|                   | M3            | The market recognition of the assessment and certification is not high           |
|                   | M4            | Demand degree of the assessment and certification is not high                    |
| Technology        | T             | Existing technical level is not high                                            |
|                   | T2            | The LCA system of the building materials industry is incomplete and short of data supporting |
|                   | T3            | Lack of professional education and training for assessment and certification    |
|                   | T4            | Lack of association with green building assessment                             |
|                   | T5            | Research and development of green building materials falls behind                |


### Table 2. Basic information about respondents

| The nature of the company and its proportion | Government | Scientific research institutions | Suppliers | Assessing and Testing institutions | Constructing side of employer | Constructing side of contractor | Others |
|--------------------------------------------|------------|----------------------------------|-----------|-----------------------------------|-------------------------------|---------------------------------|--------|
|                                           | 10.7%      | 28.6%                            | 21.5%     | 8.3%                              | 9.5%                          | 14.3%                           | 6.0%   |
| The number of years of work and its proportion | 1-5years | 5-10years                        | 10-15years | 15-20years | More than 20 years | 6.0% |
|                                           | 6.0%       | 20.2%                            | 25%       | 14.3%                             | 34.5%                         |                                  |        |
| Educational background and its proportion | Junior college and below | Master's degree and above | 58.3% | 29.8% | 6.0% |
|                                           | 11.9%      |                                  |          |                                  |                               |                                  |        |
| Job title and its proportion               | Primary    | Intermediate                     | Senior    | Others                           |                              |                                  |        |
|                                           | 3.6%       | 21.4%                            | 58.3%     | 16.7%                            | 6.0%                          |                                  |        |

The coefficient of reliability $\alpha$ is 0.869 in this questionnaire, the credibility is very good. Sample data from the survey can be used for further analysis.
3. Survey results analysis

3.1. Ranking of stakeholder’s attitudes towards obstacle factors

The results of the survey on the attitudes of different stakeholders towards obstacle factors are shown in Table 3.

| Category          | Factor | Overall | Government | Scientific research institutions | Suppliers | Assessing and testing institutions | Constructing side of employer | Construction side of contractor | Other |
|-------------------|--------|---------|------------|----------------------------------|-----------|------------------------------------|-------------------------------|--------------------------------|-------|
| Institutional obstacle | I1     | 3.84    | 3.88       | 4.13                             | 3.78      | 3.86                               | 3.25                          | 3.77                          | 3.80  |
|                    | I2     | 3.49    | 3.13       | 3.78                             | 3.61      | 2.86                               | 3.38                          | 3.31                          | 3.80  |
|                    | I3     | 3.96    | 4.11       | 4.00                             | 4.11      | 3.43                               | 3.75                          | 3.85                          | 4.40  |
|                    | I4     | 3.60    | 3.44       | 3.88                             | 4.28      | 2.57                               | 2.86                          | 3.46                          | 3.00  |
|                    | I5     | 3.54    | 3.78       | 3.33                             | 4.06      | 2.86                               | 3.13                          | 3.46                          | 4.25  |
| Administrative obstacle | A1     | 3.27    | 2.78       | 3.13                             | 4.17      | 2.71                               | 3.13                          | 3.46                          | 2.20  |
|                    | A2     | 3.98    | 3.89       | 3.75                             | 4.50      | 3.71                               | 3.63                          | 3.92                          | 4.40  |
|                    | A3     | 3.83    | 3.44       | 4.04                             | 4.47      | 3.57                               | 3.25                          | 3.42                          | 3.60  |
|                    | A4     | 3.46    | 3.00       | 3.70                             | 3.83      | 2.57                               | 3.50                          | 3.15                          | 3.80  |
|                    | A5     | 3.27    | 3.11       | 3.38                             | 3.72      | 2.57                               | 2.75                          | 3.15                          | 3.60  |
| Market obstacle    | M1     | 4.35    | 4.22       | 4.46                             | 4.50      | 4.14                               | 4.13                          | 4.46                          | 3.80  |
|                    | M2     | 3.65    | 3.67       | 3.75                             | 3.83      | 3.43                               | 3.38                          | 3.69                          | 3.20  |
|                    | M3     | 3.80    | 3.44       | 3.96                             | 4.00      | 3.71                               | 3.13                          | 3.77                          | 4.20  |
|                    | M4     | 3.77    | 3.33       | 3.96                             | 4.00      | 4.00                               | 3.50                          | 3.46                          | 3.80  |
| Technology obstacle | T1     | 2.80    | 2.44       | 3.04                             | 2.78      | 3.00                               | 2.75                          | 2.69                          | 2.40  |
|                    | T2     | 3.43    | 3.22       | 3.75                             | 3.22      | 3.57                               | 3.75                          | 3.08                          | 3.20  |
|                    | T3     | 3.41    | 6.56       | 3.70                             | 3.50      | 3.00                               | 3.13                          | 3.08                          | 3.40  |
|                    | T4     | 3.59    | 3.75       | 3.74                             | 3.75      | 3.33                               | 3.14                          | 3.33                          | 3.75  |
|                    | T5     | 3.44    | 3.75       | 3.42                             | 3.56      | 2.57                               | 3.75                          | 3.38                          | 3.50  |
| Society obstacle   | S1     | 3.93    | 3.89       | 4.00                             | 4.33      | 3.57                               | 3.25                          | 3.92                          | 3.80  |
|                    | S2     | 3.70    | 3.63       | 3.88                             | 3.94      | 3.43                               | 3.25                          | 3.62                          | 3.40  |
|                    | S3     | 3.52    | 3.67       | 3.50                             | 3.56      | 3.29                               | 2.88                          | 3.85                          | 3.80  |
|                    | S4     | 3.95    | 3.89       | 4.17                             | 4.11      | 3.57                               | 3.50                          | 4.00                          | 3.60  |
|                    | S5     | 3.88    | 3.33       | 4.08                             | 3.89      | 3.29                               | 3.50                          | 4.38                          | 4.00  |

Based on the results of the overall sample survey, it can be seen that the attitude of all stakeholders towards various obstacles is quite obvious, the average score is above 3 points, the median and mode are roughly equal, not affected by extreme values, indicating the concentration of opinions in the survey sample, which can reflect the attitudes and opinions of various stakeholders to some extent. Variance analysis

This paper used the Mann-Whitney U test method and made pairwise comparisons between the results of the experts in different companies, examining the differences in each stakeholder's perception of the 24 obstacles. If the Sig value is less than 0.05, there is a difference in views between the two parties[9]. It has been tested that there are significant differences in the views of different stakeholders, as in Table 4.
Table 4. The significant differences in attitudes towards obstacles between different stakeholders

|                     | Government | Scientific research institutions | Suppliers | Assessing and testing institutions | Construction side of employer | Construction side of contractor |
|---------------------|------------|----------------------------------|-----------|-----------------------------------|------------------------------|---------------------------------|
| Government          | -          | -                                |           |                                   |                              |                                 |
| Scientific research institutions | A1(0.012) | -                                |           |                                   |                              |                                 |
| Suppliers           | A1(0.012) | -                                |           |                                   |                              |                                 |
| Assessing and testing institutions | I4(0.012) | I4(0.003)                        | A4(0.019) | A1(0.038)                         | A4(0.011)                    |                                 |
| Construction side of employer | M3(0.013) | I4(0.013)                        | M3(0.012) | A3(0.037)                         |                              |                                 |
| Construction side of contractor | A3(0.073) | S2(0.020)                        | A4(0.025) | I5(0.026)                         | A2(0.071)                    | A2(0.011)                       |
|                      |            |                                  |           |                                   | I5(0.023)                    | A5(0.079)                       |

Note: The figures in parentheses represent the significance of the Mann-Whitney U test of the attitude of different stakeholders towards this obstacle factor.

3.1.1. Analysis of differences in Institutional obstacles

From the data above, it can be learned that construction side of employer, construction side of contractor, suppliers and assessing and testing institutions have different opinions on lack of perfect legal system to promote the assessment and certification of green building materials (I1) and confusion caused by policy duplication formulated by all levels of departments (I4). The reason may be that the assessment and certification of green building materials started relatively late in China, and the relevant laws and norms formulated by the government is not comprehensive. Also, policy systems and market mechanisms have not yet been effectively integrated, leading to differences among stakeholders. Construction side of employer, construction side of contractor and assessing and testing institutions have different opinions in inadequate supervision of certification by the government (I5). The interests of these companies are highly correlated with the market regulation, which requires the government to regulate the market.

3.1.2. Analysis of differences in administrate obstacles

Differences in administrate obstacles are mainly concentrated on department in charge of assessment is not clear (A1), industry is not systemized enough and the administrate system is not perfect enough(A2) and lack of direct stakeholder’s communication network (A4). The difference of opinion on department in charge of assessment is not clear (A1) is mainly concentrated in the government, suppliers and experts of assessing and testing institutions, the reason may be that there is a cover-up between the supplier and the assessing and testing agency during the green building materials assessing and testing. The difference of opinion on industry is not systemized enough and the administrate system is not perfect enough (A2) is mainly concentrated in construction side of employer, construction side of contractor, and they are the direct users of green building materials. The lower assessment of lack of direct stakeholder’s communication network (A4) is by the scientific research institutions, assessing and testing institutions, construction units and suppliers.
3.1.3. Analysis of differences in market obstacles
The difference in market obstacles mainly lies in that the market recognition of the assessment and certification is not high. Scientific research institutions are not the main participants in the green building materials market and pay less attention to it, so there are certain differences in opinions. China’s green building materials assessment and certification work has just started. As the main participants in the market, construction side of employer and suppliers have a certain demand for certification, but the recognition of certified green building materials products still needs time to test.

3.1.4. Analysis of differences in technology obstacles
Among the technology obstacles, the main reason is that suppliers and construction side of contractor have different views on the lack of association with green building assessment. The reason may be that both the supplier and construction side of contractor are Party B of green building, while China is developing green building in an all-round way. The green building materials assessment and certification are not related to green buildings, which will greatly affect the enthusiasm of suppliers and construction side of contractor.

3.1.5. Analysis of differences in society obstacles
Differences in opinions regarding the lack of implementation of the assessment and certification of green building materials are mainly concentrated in scientific research institutions, construction side of employer and suppliers.
Suppliers and construction side of contractor have different opinions on the insufficient participation of stakeholders in assessment and certification. The two are more enthusiastic about green building materials and are direct participants of green building materials, so they pay more attention to participation in assessment and certification. However, suppliers and construction side of employer have different opinions on insignificant improvement in the reputation and competitiveness of enterprises by certification.

4. Conclusions and Suggestions
This paper mainly conducts statistical analysis on the collected data, and proves that it has a certain reliability. According to the questionnaire, this paper analyzes the differences in attitudes and opinions of stakeholders, as well as the reasons for the differences, and finally analyzes the problems existing in the assessment and certification of the entire green building materials industry. It can be seen that various stakeholders have strong willingness to participate in the assessment and certification of green building materials, but it is still difficult to carry out the assessment and certification work.

China’s green building materials assessment and certification work is still in its infancy. How to formulate effective policies and regulations to guide the healthy development of the industry requires the efforts and support of all parties in the industry. Based on the above analysis, the obstacles to the differences in the opinions of stakeholders and the reasons for the problems have been derived. The suggested solutions are as follows:

1. In terms of institutional obstacles, the key points to be solved are the lack of perfect legal system to promote the assessment and certification of green building materials, confusion caused by policy duplication formulated by all levels of departments and inadequate supervision of certification by the government. To this end, the government should strengthen the construction of the green building materials system, actively study relevant policies, technical standards, laws and regulations, so that enterprises have sufficient driving force to develop and produce green building materials, and have specific operating specifications and technical standards. Clarify the assessment authority and strengthen the government's supervision to guide the development of green building materials assessment and certification, clarify the responsibilities and obligations of stakeholders, and actively promote the development of green building materials assessment and certification.
(2) From the fact that department in charge of assessment is not clear (A1), industry is not systemized enough and the administrate system is not perfect enough (A2), and lack of direct stakeholder’s communication network (A4) is quite different, it can be seen that the green building materials market is not standardized enough. Solving institutional obstacles need government departments to strengthen incentive policies, regulate the industry, strengthen administrate systems, encourage enterprises to use certified green building materials through subsidies and many more.

(3) Through the market obstacles for the market recognition of the assessment and certification is not high (M3) and lack of association with green building assessment (T4), we can see that green building materials certification started late, so the market recognition for green building materials is not very high. Moreover, because of the lack of association with green building evaluation, it has a great impact on the development of green building materials. Therefore, the government should guide the sustainable development of the market, strengthen developers' awareness of using certified green building materials, and strengthen the link between green buildings and green building materials. The requirements for the use of green building materials can be added to the technical standards for green buildings.

(4) Lack of implementation of the assessment and certification of green building materials (S1), insufficient participation of stakeholders in assessment and certification (S2), and insignificant improvement in the reputation and competitiveness of enterprises by certification (S5) are the main social obstacles Factors, indicating that the awareness of stakeholders is very important to promote the development of green building materials assessment and certification. The government should correctly guide all stakeholders in the market, implement the awareness of energy conservation and environmental protection, and standardize the certification market to solve the problem that there are so many green building materials signs and certificates that make people difficult to identify.

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