Hindawi

*Retraction*

# Retracted: The Establishment and Evaluation Method of Prefabricated Building Construction Quality Evaluation Index System Taking into Account Multimedia Sensor Network Nodes

## Advances in Multimedia

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope

(2) Discrepancies in the description of the research reported

(3) Discrepancies between the availability of data and the research described

(4) Inappropriate citations

(5) Incoherent, meaningless and/or irrelevant content included in the article

(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

## References

[1] Y. Guo, "The Establishment and Evaluation Method of Prefabricated Building Construction Quality Evaluation Index System Taking into Account Multimedia Sensor Network Nodes," *Advances in Multimedia*, vol. 2021, Article ID 9613100, 6 pages, 2021.

*Research Article*

# The Establishment and Evaluation Method of Prefabricated Building Construction Quality Evaluation Index System Taking into Account Multimedia Sensor Network Nodes

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Through in-depth analysis of the characteristics of the quality evaluation stage of prefabricated buildings, the quality evaluation of prefabricated buildings can be divided into three stages: before, during, and after construction. According to the detailed design content of the prefabricated building construction stage, we construct the prefabricated construction quality evaluation index system, use the multimedia sensor network node method to obtain the weight of each evaluation index, comprehensively evaluate the construction quality of the prefabricated building, and finally show through the case analysis results that the multimedia sensor network node method can be of high practical value in the process of prefabricated building construction quality evaluation, and it has improved the domestic prefabricated building construction quality evaluation index system and evaluation quality and has certain reference value.

## 1. Introduction

At present, with the continuous development of the construction industry at home and abroad, various countries regard the quality of prefabricated construction projects as the evaluation standard of the construction industry [1–3]. Compared with previous irrigation buildings, prefabricated buildings have unique advantages in many aspects such as environmental protection, energy saving, green engineering, production cost, and construction speed and can meet the "four sections and one environmental protection" standard as much as possible. Usually in the prefabricated building construction stage, the quality of the project has become an important issue of safety and durability in the construction industry. Therefore, a comprehensive and systematic evaluation is the primary content of construction management. Using multimedia sensor network nodes in the actual three-dimensional building construction quality evaluation index system model can better exert its technical advantages, and it also represents

the trend and status of the performance and significance level of the construction quality evaluation index system. Especially with the introduction of the stable development status of multimedia sensor network node technology, the model's real scene three-dimensional visualization adopts multimedia sensor network nodes, which corresponds to the development of today's era. The focus of the modern industry is the research situation of virtual 3D architecture and virtual reality. Virtual buildings include mathematical modeling, geometric warehouses, textures, and rendering. At the same time, the mathematical modeling and geometric programming of each construction in the building are very challenging. Virtual buildings in large-scale buildings have been widely used in past demonstrations, actual conditions, and real estate demonstrations. Currently, researchers at home and abroad have carried out more research work based on imitating virtual buildings. Using OpenGL in 3D virtual scene, building modeling and simulation in virtual scene can be realized by using OpenGL in the process of assistance, modeling, and simulation [4–6].

Because the evaluation of the construction quality of prefabricated buildings usually contains certain uncertain factors, the previous evaluation results are not very good. Therefore, this article introduces the multimedia sensor network node method into the construction of the prefabricated building construction quality evaluation system. This method can not only effectively solve the error that will occur in the evaluation process of the multimedia sensor network node method but also solve the problem of the multimedia sensor network node method. It is impossible to quickly distinguish the limitations of different standard levels and effectively combine the advantages of the two to conduct an objective assessment.

## 2. Multimedia Sensor Network Design

Based on the basic principles of low cost, scalability, and stability, in order to effectively improve the data processing ability of sensor nodes and quickly obtain multimedia data information [7–9]. The design of multimedia sensor network nodes is mainly divided into 4 parts. (1) The sensor module includes cameras, microphone collection devices, vibration, infrared, and other sensors, which play a role in collecting environmental media information. (2) The collection of various information about the entire environment is realized. (3) The processor module mainly completes the network computing processing, node task management, storage management, power management, communication mechanism, and so on of the collected multimedia information data. (4) Communication transceiver module realizes multinode data transmission and communication through wireless communication. The block diagram of the multimedia wireless sensor node structure is shown in Figure 1. The advantage of this kind of node structure is to realize the free combination of different sensor modules and communication modules and flexibly meet the monitoring requirements of different applications. Based on this structure, a hardware experiment platform is designed.

## 3. Construction of Quality Evaluation Index System for Prefabricated Construction Projects

Compared with traditional modern buildings, prefabricated buildings need to be produced in factories, so the quality inspection of the components needs to be included in the quality evaluation during the construction phase. This article will refer to the traditional concrete construction quality evaluation, aiming at the different characteristics of the work content of each stage of the prefabricated construction project, and according to the principles of systemicity, objectivity, and comprehensiveness, the construction quality evaluation of prefabricated buildings is divided into three stages [10–12].

*3.1. Quality Assessment before Construction.* Preengineering refers to the engineering preparation stage before the project officially starts construction. The engineering preparation is carried out not only before the official start of the project but also through the entire project. The fundamental task of project preparation is to establish all the engineering conditions required for the formal project to ensure the smooth progress of the normal project and to ensure that the quality of the project meets the requirements.

*3.2. Quality Assessment during Construction.* Engineering refers to the actual construction and construction stage of the project. This stage is an important stage of the construction quality of the assembled building. This stage directly affects the quality of the construction. The quality evaluation content in the prefabricated construction project includes whether the connection between the prematerial and the structure meets the design requirements. The strength and shrinkage of concrete or irrigation materials meet the design requirements. The reinforcement connection or anchorage of joints in assembly works shall meet the requirements. The above are the guarantee of the quality and safety of reinforcement sleeve grouting connection or indirect connection. Does the appearance quality inspection of the assembly structure construction meet the requirements? It will lead to the deviation of the dimensions of columns, walls, beams, floors, external wall hanging plates, etc., during the assembly process.

*3.3. Quality Assessment after Construction.* Post-construction refers to the stage of completion acceptance after the completion of the project and construction process. This stage is also an indispensable part of construction quality evaluation. The content of the quality evaluation after the construction of the prefabricated building includes the submission status of the quality acceptance documents of the prefabricated structure project, the quality acceptance status of the sectioned project of the prefabricated structure, the structural entity inspection status of the prefabricated structure, the acceptance status of the construction site, the protection of finished products, etc.

## 4. Multimedia Sensor Network Node Method

The multimedia sensor network node method is a multiguide determination method combining qualitative and quantitative analysis proposed by the famous American operator T.L. Saaty in the 1970s [13–15]. The characteristic of this method is to use less quantitative information to mathematicize the decision-making thinking process on the basis of in-depth analysis of the nature, internal relations, and influencing factors of complex decision-making problems and to provide for complex decision-making problems with multipurpose and multicriteria characteristics. The concept of fuzzy sets was proposed by American automatic control expert Professor Chad in 1965 to express the uncertainty of things. The multimedia sensor network node method is a comprehensive evaluation method based on fuzzy mathematics. This method is based on the subordination theory of fuzzy mathematics to transform qualitative problems into quantitative problems, that is, fuzzy mathematics is used to evaluate the objects constrained by various
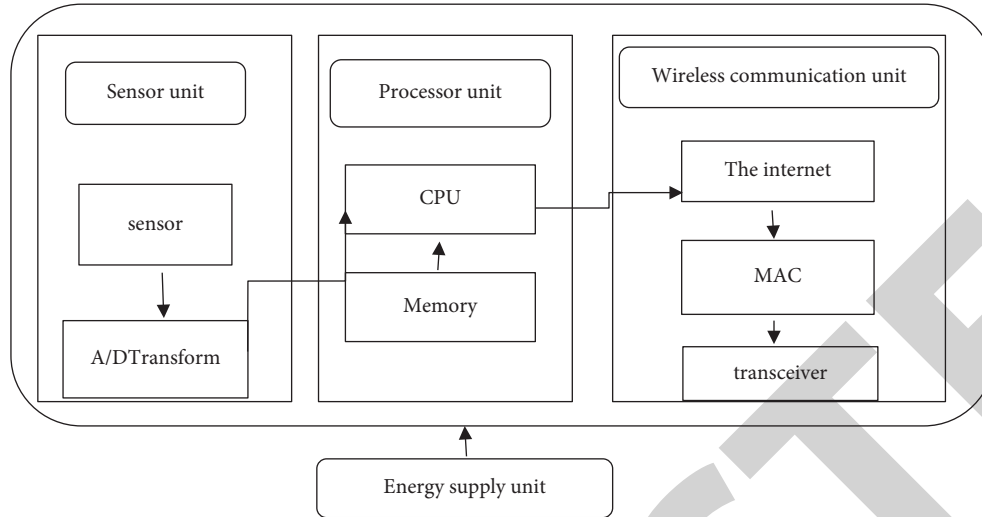
Figure 1: Block diagram of multimedia wireless sensor node structure.

factors. The results are clear and systematic and can better solve unclear and difficult to quantify problems.

## 4.1. Determination of Indicator Weight

### 4.1.1. Constructing a Judgment Matrix.
In general, the three-dimensional visualization of the real scene of a building must maintain the structure of the house and transfer the building from the old site to the new site based on the premise of a complete appearance. Including longitudinal, lateral displacement, rotation, and other angles. The overall transfer is based on the independent individual of the building. After the building is strengthened, it must have its own integrity to overcome the friction of movement and overcome the interference of shaking. Real-life 3D visualization is referred to as panning for short. As the name suggests, it moves while maintaining a level at home. The main step of the three-dimensional visualization of the real scene of the building can be included in the separation from the original location-displacement-connection with the new location. The general process is to cut off the building from the previous foundation and transfer it to the commission structure, set up a mobile device under the transaction structure to form a movable whole, move the building to a predetermined location, and connect with the location. The AHP law requires the evaluator to judge the relative importance of each evaluation element, and these judgments are expressed as a judgment matrix with numerical values. The specific form of constructing the judgment matrix is done by comparing the two evaluation elements through the brain-array method and the expert survey method.

$$B = \begin{pmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{pmatrix}, \tag{1}$$

where $b_{ij}$ represents the variable of judgment matrix $A_k$ and the error of $B_i$ relative to $B_j$ is smaller.

The text uses a ratio of 1 to 9 to evaluate the significance of the numerical value representative meaning: 1 means that it has the same importance compared with two elements. 3 represents the comparison of two elements. 5 represents the comparison of two elements. $B_i$ and $B_j$, are obviously more important than $B_j$; 7 means that compared with two elements, $B_i$ is more important than strong. 9 means that two elements are compared, that is, the number of $Bi$. Between them are 2, 4, 6, and 8, which means that the above represents the intermediate value of adjacent judgment.

### 4.1.2. Calculating the Weight of Each Indicator.
The calculation of index weights can be attributed to the calculation of eigenvectors and eigenroots of the determination matrix. That is, for the judgment matrix $B$, calculate the eigenvalues and eigenvectors that satisfy $BW = \lambda_{max} W$. $\lambda_{max}$ is the largest feature root of $B$, and $W$ is the normalized feature vector corresponding to $\lambda_{max}$. The $W_i$ component of $W$ is the weight corresponding to each indicator. In this article, the square root method is used to calculate the characteristic root. Step (1) calculates the product $M_i$ of each row element of the judgment matrix $B$:

$$M_i = \prod_{j=1}^{n} b_{ij}, \quad (i = 1, 2, \ldots, n). \tag{2}$$

(1) Calculate the $n$-th root $M_i$ of $\overline{W}_i$:

$$\overline{W}_i = \sqrt[n]{M_i}, \quad (i = 1, 2, \ldots, n). \tag{3}$$

(2) Pair vector $\overline{W} = (\overline{W}_1, \overline{W}_2, \ldots, \overline{W}_n)^T$ normalize:

$$W_i = \frac{\overline{W}_i}{\sum_{j=1}^{n} W_j}, \quad (i = 1, 2, \ldots, n), \tag{4}$$

where $\overline{W} = (\overline{W}_1, \overline{W}_2, \ldots, \overline{W}_n)^T$ is the required feature vector.

(3) Calculate the largest characteristic root of the judgment matrix $\lambda_{\max}$:

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{m} \frac{(BM)_i}{W_i}, \tag{5}$$

where $(BW)_i$ represents the $i$-th element of the vector $BW$.

(4) Consistency inspection.

Calculate the consistency index (CI):

$$\text{CI} = \frac{\chi_{\max} - n}{n - 1}. \tag{6}$$

When the judgment matrix is completely consistent, CI = 0.

In addition, the average random consistency index RI of the determination matrix is determined, and the value of RI is shown in Table 1.

Calculate the random consistency ratio (CR) of the judgment matrix and confirm its consistency. In the case of CR = CI/RI ≤ 0.10, the judgment matrix has satisfactory consistency. Otherwise, adjust the judgment matrix until the inspection requirements are met.

### 4.2. Comprehensive Evaluation

*4.2.1. Building a Collection of Construction Quality Comments.* Create the comment set $V = \{v_1, v_2, \ldots, v_n\}$ = {excellent, good, qualified, unqualified} of the evaluation object, that is to say, the evaluation level corresponds to the fuzzy subset according to the evaluation level. According to the evaluation level of the comment set, the comment set $K = \{90, 80, 60, 0\}$ after the class is assigned. Determine the evaluation factor set $U = \{u_1, u_2, \ldots, u_n\}$, where $u_i (i = 1, 2, \ldots, u)$ represents the $i$-th influencing factor of the evaluation object.

TABLE 1: Values of RI for different orders.

| Order | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|-------|------|------|------|------|------|------|------|------|------|
| RI | 0.00 | 0.00 | 0.57 | 0.91 | 1.13 | 1.25 | 1.31 | 1.41 | 1.44 |

*4.2.2. Constructing the Membership Matrix R.* If a single element of the $i$-th element is set, the $i$-th factor indicates the membership attribute of the $j$-th annotation. Evaluate all the factors of $U$ one by one to form $U. \times V$'s correlation matrix $R$: $r_i = (r_{i1}, r_{i2}, \ldots, r_{im}) \, r_{ij}$.

$$R = (r_{ij})_{n \times m} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix}. \tag{7}$$

*4.2.3. Fuzzy Comprehensive Evaluation.* Finally, in the fuzzy comprehensive evaluation model, the weighted group $W$ and the fuzzy decision matrix $R$ obtained by the AFP method are constructed.

$$B = W \times R = (w_1, w_2, \ldots, w_n) \times \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} \tag{8}$$

$$= (b_1, b_2, \ldots, b_m),$$

where due to the fuzzy comprehensive evaluation index of $b_i$, the standard evaluation result $B' = (b'_1, b'_2, \ldots, b'_m)$ can be obtained after standardization.

Finally, the comprehensive evaluation value $D = B' \times K^T$ can be calculated.

## 5. Examples and Result Analysis

This article takes a building with an area of 96346 m$^2$ leased by the government of a city, including a basement, as an example. The building adopts an assembled frame structure construction method. The design unit and component unit used are of foreign companies, and the construction unit is a building in our country. According to the detailed analysis, we can know the relevant inspection and other related materials of the assembled construction project. The multimedia sensor network node method is used to comprehensively evaluate the indicators at all levels. The industry experts and experts at all levels are used to score the indicator system in Table 1. This choice finally obtains the following judgment matrix:

$$A - B = \begin{bmatrix} 2 & 2 & 5 \\ 1/2 & 1 & 3 \\ 1/5 & 1/3 & 1 \end{bmatrix},$$

$$B_1 - C = \begin{bmatrix} 1 & 1/5 & 1/7 & 1/4 & 1/6 & 1/3 & 1/2 \\ 5 & 1 & 1/3 & 3 & 1/2 & 2 & 4 \\ 7 & 3 & 1 & 5 & 2 & 4 & 6 \\ 4 & 1/3 & 1/5 & 1 & 1/4 & 3 & 5 \\ 6 & 2 & 1/2 & 4 & 1 & 3 & 5 \\ 3 & 1/2 & 1/4 & 1/3 & 1/3 & 1 & 2 \\ 2 & 1/4 & 1/6 & 1/5 & 1/5 & 1/2 & 1 \end{bmatrix},$$

$$B_2 - C = \begin{bmatrix} 1 & 2 & 3 & 4 & 7 & 6 & 5 \\ 1/2 & 1 & 2 & 3 & 6 & 7 & 5 \\ 1/3 & 1/2 & 1 & 2 & 4 & 5 & 3 \\ 1/4 & 1/3 & 1/2 & 1 & 3 & 4 & 2 \\ 1/7 & 1/6 & 1/4 & 1/3 & 1 & 2 & 1/2 \\ 1/6 & 1/7 & 1/5 & 1/4 & 1/2 & 1 & 1/2 \\ 1/5 & 1/5 & 1/3 & 1/2 & 2 & 2 & 1 \end{bmatrix}, \quad (9)$$

$$B_3 - C = \begin{bmatrix} 1 & 1/7 & 1/5 & 1/4 & 1/2 \\ 7 & 1 & 2 & 3 & 6 \\ 5 & 1/2 & 1 & 2 & 4 \\ 4 & 1/3 & 1/2 & 1 & 4 \\ 2 & 1/6 & 1/4 & 1/4 & 1 \end{bmatrix}.$$

### 5.1. Calculating the Index Weight Value of Each Level.
The above square root method is used to calculate the weight of each indicator, and after normalization, the consistency check results are as follows:

$$W_A = (0.582, 0.309, 0.109),$$
$$W_{B1} = (0.031, 0.159, 0.351, 0.104, 0.241, 0.073, 0.042),$$
$$W_{B2} = (0.347, 0.258, 0.157, 0.103, 0.042, 0.032, 0.061),$$
$$W_{B3} = (0.047, 0.442, 0.266, 0.178, 0.067),$$

$$(10)$$

where $W_A$ represents the comprehensive weight of each engineering stage; $W_{B1}$ represents the weight of each index before construction; $W_{B2}$ shows the weight of each index in the project; and $W_{B3}$ represents the weight of each index after construction. Check the consistency of the weighted values of the above indicators, and the results are shown in Table 2.

It can be seen from Table 2 that the consistency ratio of each evaluation index (CR < 0.10) indicates that the determination matrix is in good agreement.

### 5.2. Constructing the Membership Matrix.
We invited 10 experts to rate the prefabricated construction quality

TABLE 2: Consistency test results of each judgment matrix.

| Evaluation index | A | B1 | B2 | B3 |
|---|---|---|---|---|
| $\lambda_{max}$ | 3.0002 | 7.4338 | 7.1882 | 5.1112 |
| CI | 0.0002 | 0.0722 | 0.0315 | 0.0275 |
| CR | 0.0003 | 0.0547 | 0.0238 | 0.0308 |

evaluation indicators for many times. The ambiguous relationship matrix is as follows:

$$R_{B1} = \begin{bmatrix} 0.54 & 0.34 & 0.11 & 0.01 \\ 0.38 & 0.49 & 0.12 & 0.01 \\ 0.57 & 0.32 & 0.11 & 0 \\ 0.53 & 0.33 & 0.14 & 0 \\ 0.46 & 0.37 & 0.13 & 0 \\ 0.34 & 0.36 & 0.27 & 0.03 \\ 0.40 & 0.37 & 0.21 & 0.02 \end{bmatrix},$$

$$R_{B2} = \begin{bmatrix} 0.49 & 0.28 & 0.19 & 0.04 \\ 0.43 & 0.33 & 0.22 & 0.02 \\ 0.64 & 0.27 & 0.09 & 0 \\ 0.55 & 0.28 & 0.16 & 0.01 \\ 0.49 & 0.37 & 0.13 & 0.01 \\ 0.58 & 0.34 & 0.08 & 0 \\ 0.50 & 0.39 & 0.09 & 0.02 \end{bmatrix}, \quad (11)$$

$$R_{B3} = \begin{bmatrix} 0.53 & 0.27 & 0.18 & 0.02 \\ 0.56 & 0.36 & 0.08 & 0 \\ 0.47 & 0.29 & 0.21 & 0.03 \\ 0.61 & 0.31 & 0.08 & 0 \\ 0.36 & 0.37 & 0.24 & 0.03 \end{bmatrix},$$

where $R_{B1}$ shows the fuzzy relationship matrix generated by 10 experts evaluating the 7 secondary indicators in the preconstruction quality evaluation $B1$ indicator; $R_{B2}$ shows the fuzzy relationship matrix of the results of the evaluation of 7 two indicators of the quality evaluation $B2$ by 10 experts in the project; and $R_{B3}$ shows the fuzzy relationship matrix obtained by 10 experts by evaluating 5 secondary indicators in the $B3$ indicators of quality evaluation after construction.

### 5.3. The Single Factor Selected for Fuzzy Comprehensive Evaluation

$$B_1 = W_{B1} \times R_{B1} = (0.4848, 0.3661, 0.1355, 0.0140),$$
$$B_2 = W_{B2} \times R_{B2} = (0.5077, 0.3037, 0.1668, 0.0217), \quad (12)$$
$$B_3 = W_{B3} \times R_{B3} = (0.5302, 0.3289, 0.1300, 0.0109),$$

where $B_1$, $B_2$, and $B_3$, respectively, represent the fuzzy evaluation matrices of 3 first-level indicators and $R$ represents the fuzzy relationship matrix of the overall assembly construction quality evaluation index system.

Then, we conduct a comprehensive assessment:

$$B = W_A \times R = (0.4968, 0.3428, 0.1446, 0.0160),$$
$$D = B \times K = 80.81, \tag{13}$$

where $D$ represents the overall comprehensive evaluation score of the assembly type construction quality evaluation index system.

Similarly, we calculate the evaluation scores of each first-level index and set them as follows: $D_{B1}$ before construction = 81.56, $D_{B2}$ during construction = 81.83, and $D_{B2}$ after construction = 80.00.

According to the above calculation, the comprehensive evaluation point of the construction quality of the project is 80.81, which is located between excellent and good, indicating that the assembly style construction quality is generally good, but there is still room for improvement. Among them, the evaluation scores of the three first-level indicators are all around 80, which is equivalent to the importance of quality in these three stages, and corresponding improvement measures need to be taken.

## 6. Conclusions

On the basis of the prefabricated building construction quality evaluation index system, by borrowing the fault tolerance and scalability, system security, and information delay of the wireless multimedia sensor network for evaluation and detailed analysis, in order to achieve real-time reduction and increase of multimedia sensor network nodes, we verify its inherent fault tolerance and scalability. This paper effectively combines the characteristics of the multimedia sensor network node and the prefabricated building itself to evaluate and analyze the construction quality of the domestic prefabricated building. Finally, the results of an example analysis show that the method proposed in this paper is of high value in the construction quality inspection of prefabricated buildings and can provide a reference for evaluating the construction quality of prefabricated buildings.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The author declares that there are no conflicts of interest.

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