

# Evaluation Method of Building Engineering Design Quality

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**Abstract**—The goal of this paper is to research the evaluation method on the documents' quality of building engineering design, which included four parts mainly: introducing the system engineering of building engineering design, forming the assessment index system on quality of building engineering design and utilizing a fuzzy comprehensive evaluation method to evaluate the quality of constructing documents design. It was shown that the building engineering design quality can be evaluated perfectly and reasonably through the quality multi-layered assessment method with Fuzzy evaluation. Then the building engineering quality will be improved.

**Keywords**- building engineering design, quality assessment, fuzzy comprehensive evaluation

## I. INTRODUCTION

The design quality of building engineering is the key to assure quality of project, by which the concrete prophase plan of engineering quality goal and level can be embodied. There is a direct relation between the quality of engineering design and engineering construction. Moreover, compared with total expenses of lifecycle and total proceeds the cost of design is nearly ignored because it only accounts for 0.1%. However, design quality is very important because of its effect on the expenses and proceeds of constructing, operating, managing and developing business[1]. So it is important to assess the quality of engineering design before it is put into practice. In this paper, Making the building engineering design system as the research object, the author erect the evaluation index system on quality of building engineering design, and form the quality multi-layered evaluation method with Fuzzy evaluation based on the system engineering theory.

## II. SYSTEM ENGINEERING OF BUILDING ENGINEERING DESIGN

System engineering of building engineering design is a whole research in the course of developing the system of building engineering design. The theory and method of it was utilized to study the system engineering problem appeared in the building system design. The aim of applied system engineering of building engineering design is to acquire the best effect, including economy, finance, safety, quality, taste, function, environment and society, based on the least devotion in designing the building system.

From the different angles which comprise the investor, user, architecture designer, structure engineer and others engineer involving with the building engineering design,

different system problems of building engineering will be located.

### A. The system problem of the investor

The general target of the investor is to achieve the best effect of building construction at the limited capital pumped into. In terms of the inner structure of the engineering, the investor hope to get the larger using space at the lower construction cost. With regard to the outer structure of the engineering, the investor wish to meet the highest demand of function proposed by the user at the little service. So the basic system problem of the engineering design is formed.

### B. The system problem of the user

The general purpose of the user is to get the place meeting the function demanded at the least expense in order to have the best conformity caused by the best economy effect. Several system problems of building design to the user can be formed through establishing the assessment rules of the value based on the self general object.

### C. The system problem of the architect

Meeting the request put forward by the investor and user, providing the desirable design product, erecting the design reputation and create the social value are the general object of the architect. Thus the architect must take the benefits of the investor and user into consideration to achieve the self goal.

### D. The system problem of the structure engineer

When the structure engineer carry out the structure design, his aim is offering the safe and economic structure to promote the development of the building function and the expressment of the building design art. Hence, the system problems of the structure engineer include several sub objects such as united coordination between the structure space and building space, safe structure, the lowest construction cost and so on.

### E. The system problem of the professional technology engineer

The design of the engineering technology contains the design of the water supply and sewage, heat supply, gas supply, lighting, equipment, transportation and fire fighting in addition to the design of the architecture and structure. The relevant system problems of the professional technology engineer is the important part of the building design system.

The general object of the professional technology engineer is to provide the conform and effective building

environment for the user at the lowest cost and improve the development of the building function. So the system problem of the professional technology engineer comprises economic design, effective environment and conform utilization[2,3].

### III. FORMING EVALUATION INDEX SYSTEM FOR QUALITY OF BUILDING ENGINEERING DESIGN

#### A. *Proposing the evaluation index system of building engineering design quality*

Because index system of building engineering design quality adopted is to take the design document as the study object and qualitatively and quantitatively analyze the uncertain factors located in design document, the quality and the developing rule of the design document for building engineering can be reflected more accurately[4]. It is very sophisticated to establish the evaluation index system of building engineering design quality suitable for design character of building engineering because of complicated design condition and various design factors acting on each other.

In view of lack of quality assessment method in Chinese building engineering design, the thought of forming quality evaluation method with the Fuzzy comprehensive assessment method in system engineering field is raised. The relations among various indexes must be considered from the general angle of relevant profession affecting the design quality of the building engineering before various layer indexes are founded resting on the basic principle and method of establishing index system. Through this systematized and structured assessment system, the quality condition of building engineering design can be scientifically described and expressed.

#### B. *Quality evaluation in stages of building engineering design*

Because the design of engineering is finished in stages respectively, the quality property of various design phase have different emphasis. However, the quality evaluation needs to consider the quality content, the course of forming quality and the integrality of embodying quality. So the quality evaluation of building engineering design is divided into scheme design phase evaluation and construction document design phase evaluation.

#### C. *Index system for quality of building engineering design at different evaluation phase*

At first, the preliminary assessment index system is aroused through the means-ends analysis method. Then tow times investigation are carried out by the expert meeting law in order to modify the preliminary index system. The index systems for document quality at scheme design phase and constructing document design phase are shown as a) and b) in Fig.1.

#### D. *Evaluation standards for quality of building engineering design at different phase*

The criterion layer, which is composed of evaluation standards for effecting and contributing design quality of various relevant factors, is the basic layer of quality analysis in the layer structure model. Depending upon the prevailing national law, rule, management standards and technology standards involving with engineering design, different assessment standards responding to different evaluation index are ascertained. Only sectional assessment standards are illustrated with table 1 because of the limited paper length.

### IV. FUZZY COMPREHENSIVE EVALUATION OF QUALITY FOR BUILDING ENGINEERING DESIGN

The assessment model is also set up at scheme design phase and constructing document design phase, so this course is illustrated with the formation of assessment model of construction document design phase in this paper.

#### A. *The grade aggregate of quality assessment for design*

Building engineering design is the core of architectural engineering construction. Once it is recognized, according to which the construction of engineering project should be operated. Moreover, besides the quality of construction and installation, primary engineering characters are all determined by the documents of the design not are reversed. Depending upon the idea that precaution is primary[5] the grade of quality evaluation will be divided into three level such as safety grade, general safety grade and danger grade, i.e.  $n=3$ . Then the responding evaluation grade aggregate  $V$  can be expressed as:

$$V = \{v_1, v_2, v_3\} = \{\text{acceptable, general acceptable, unacceptable}\} \quad (1)$$

#### B. *The Aggregate U of Evaluation Factor*

In view of the inherent relations of the assessment index of design document shown in Fig.1, the aggregate of evaluation factor  $U$  is divided into eight sub factor aggregates, namely:

$$U = \{U_1, U_2, U_3, U_4, U_5, U_6, U_7, U_8\} \quad (2)$$

These eight sub factor aggregates represent functionality, safety, economy, feasibility, adaptability, timeliness, durability and design document respectively.

#### C. *Making the first and second comprehensive assessment on each sub factor aggregate $U_i$ respectively.*

First, forming the assessment matrix of single factor:  $R_i$  ( $i=1,2,3,4,5,6,7,8$ ).

Then, the weight coefficient is distributed. In order to ascertain the importance of the factor in the building engineering system the weight aggregate of every factor at any layer is erected by the layer analysis. Hence, the weight vector  $A_i$  ( $i=1,2,3,4,5,6,7,8$ ) of each factor in sub factor aggregate  $U_i$  ( $i=1, 2, 3, 4$ ) can be achieved.

At last calculating the fuzzy change  $U$  into  $V$  as equation

$$b_i = A_i \circ R_i, \quad i=1,2,3,4,5,6,7,8 \quad (3)$$

#### D. making the third comprehensive assessment

Assessment matrix  $R$  of every single factor can be formed by  $b_i$  based on taking  $U_i$  as a element. After the weight vector  $A_i$  of four sub factors are gotten according to the AHP method, the third comprehensive assessment is taken as below:

$$b = A \circ R, \quad i=1,2,3,4,5,6,7,8 \quad (4)$$

$b$  is turned into  $b'$  with the normalization processing, and the final assessment effect of quality of building engineering design can be determined in accordance with the maximum subordination principle[6].

#### V. CONCLUSION

Making the building engineering design system as the study object, the author break through the traditional thinking model and engineering approach, applying the system thought and method for assessment method research. So the quality multi-level assessment method with Fuzzy evaluation was formed. It is hoped to complete the assessment system and mechanism for the building engineering design. Through quality evaluating in stages and on various layer, the building engineering design quality can be evaluated scientifically, rightly and objectively. At the same time the hidden problems and management defects can be accurately found through this evaluation system with

using the quality and quantity analysis way. It was helpful to greatly increases the ability to forecast, prevent and control engineering accidents, by which the building engineering quality will be improved.

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#### REFERENCES

- [1] Kaixun Sha. "Quality assessment of building design: the apocalypse of international experiences". Architecture Economy, vol. 4, pp. 80-844, April 2004.
- [2] Weipin Xiao. "Building system engineering". Chongqing: Chongqing university press, 1992, pp. 2~119.
- [3] Weipin Xiao. "Brief remarks on modern building engineering design as a system". Building Science Research of Sichuan, vol. 3, pp. 35-36, Jun 1991.
- [4] Chundong Guo, Aizu Chen. "Quality assessment model of road engineering". Industry Science and Technology of Hebei, vol. 3, pp.
- [5] Lan Lu, Lingdong Wang, Liping Bian. "Safety Fuzzy assessment method of constructing site". Industry engineering, vol. 11, pp. 49-53, Nov 2003.
- [6] Ling Ye, Xinfu Hu. "The Fuzzy comprehensive assessment of industrial building scheme". Building Science Research of Sichuan, vol. 2, pp. 168-171, April 2006.

TABLE I. EXAMPLE OF EVALUATION STANDARDS FOR QUALITY OF BUILDING ENGINEERING DESIGN AT DIFFERENT PHASE

code	Evaluation standard	value	score
HJ	<i>Environment effect</i>		
HJ <sub>1</sub>	<i>Architecture art</i>		
	1. Indoor effect: a moderate proportion of interior space, color coordination, a concise and neat view and feel comfortable.	50	
	2. Shape and elevation effect: beautiful architectural form reflecting the local climate characteristics and architectural cultural heritage, the building exterior aesthetic features such as size, proportion, facade, hue and so on.	50	
HJ <sub>2</sub>	<i>The relation of building and environment</i>		
	1. Building bases should be selected in the safe ground lacking geological disasters or flood risk.	15	
	2. The overall layout of buildings should be combined with the local characteristics of natural and geographical environment, not damaging the natural ecological environment.	15	
	3. Around the buildings there are ability to access to sunlight, natural light, natural ventilation and other health conditions.	15	
	4. Air, soil and water around the buildings should not damage the health of people and ensure the health safety of the environment;	15	
	5. The garbage, waste gas, wastewater and the noise, glare generated in the use of building and should be treated and effectively controlled respectively.	15	
	6. The overall shape and color processing of building should be coordinated with the surrounding environment;	15	
	7. Building site should be done virescence whwre landscaping design sould be beautified and outdoor facilities be perfected.	10	

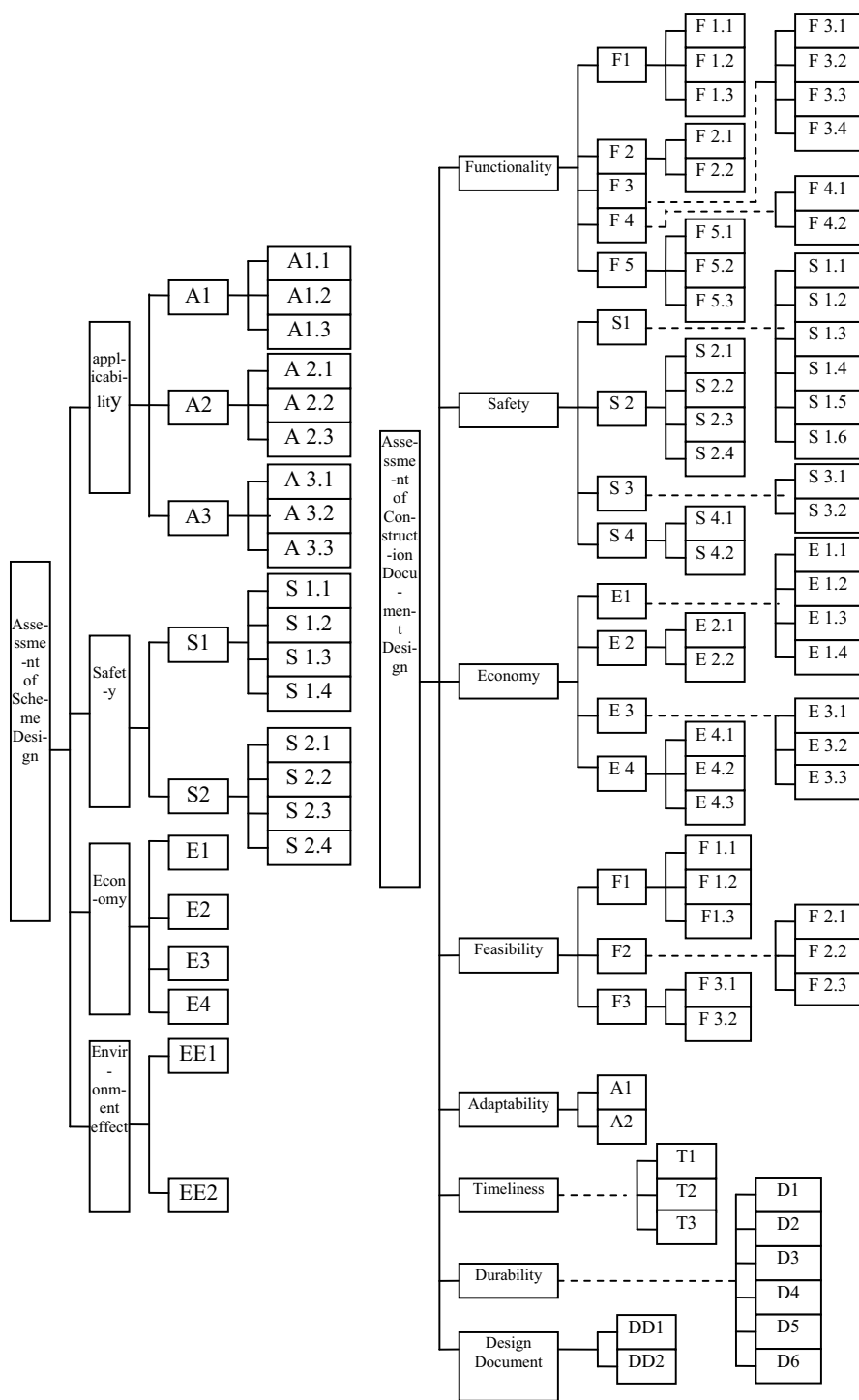


Figure 1. The assessment index system of building design quality: (a) Index system of document assessment at scheme design phase, (b) Index system at construction document design phase of document assessment