

# The study of evaluation index system on construction enterprise's circular economy

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**Abstract.** The development of circular economy is an important way to judge quality of enterprise development and to realize the sustainable development of enterprises. This paper will combine the characteristics of the development of circular economy in construction enterprise to construct circular economy evaluation index system. Then it uses fuzzy mathematics theory and hierarchical analysis evaluation method for comprehensive evaluation of circular economy development level. Through the empirical analysis, the paper provides the reference basis for construction enterprises to further improve the level of circular economy.

## 1 Introduction

At present, our country's economy will continue to maintain steady and rapid development, the steady progress of urbanization construction has brought a new round of development opportunities to the construction industry. For a long time, the traditional construction enterprise one-sided pursued construction speed and benefits, but ignored the comprehensive utilization of resources and ecological environment protection, so triggering a series of quality, resources and environment problems, that seriously affect the survival and development of construction enterprises. Therefore, the development of circular economy is a fundamental way of shifting the mode of economic growth and realizing the sustainable development to construction enterprise<sup>[1]</sup>. In this process, how to scientific constructing evaluation index system of circular economy, accurate evaluating circular economy development level become the

## 2 Design of circular economy evaluation index

According to combining the basic connotation of circular economy, the design of the recycling economy evaluation index system is divided into three levels, and 12 indicators. Target layer is expressed in X; criterion layer are respectively with the X1 ~ X3. Each type of criterion layer and formed several evaluation goal set index layer respectively with Xij. Comprehensive evaluation of circular economy projects need combine different types of all kinds of index. Because the role and impact of different indicators for project are not identical, it is necessary to give criteria weights for indicators. This paper use analytic hierarchy process (AHP). Firstly structure a judgment matrix and assignment on the basis of consulting the opinions of experts. Then the weights are calculated for each level, finally test the judgment matrix consistency that suggesting each level and each index weight is acceptable<sup>[2-4]</sup>. Make a Consistency check for judgment matrix, consistency index  $CI = (\lambda_{max} - n) / (n - 1)$ ; consistency ratio  $CR = CI / RI$ ; operational researcher A .L. Sat gives the value of RI (only when the  $CR < 0.10$ , think that the index weight is acceptable)<sup>[5]</sup>. The concrete index system is shown



on table 1. The Consistency check result is shown on table 2.

**Table 1:** Circular economy evaluation index system

Target layer	Criterion layer X <sub>i</sub>	Weights Y <sub>i</sub>	Index layer X <sub>ij</sub>	Weights Z <sub>ij</sub>
X	Resources and benefit indicators X <sub>1</sub>	0.123	Capital preservation increment rate X <sub>11</sub>	0.254
			Return on equity X <sub>12</sub>	0.216
			Profit and tax amount X <sub>13</sub>	0.373
	Resource recycling indicators X <sub>2</sub>	0.557	Energy consumption per unit of output value X <sub>14</sub>	0.118
			Water consumption per unit of output value X <sub>15</sub>	0.039
			Efficiency of energy comprehensive utilization X <sub>21</sub>	0.422
			Waste-residue comprehensive utilization rate X <sub>22</sub>	0.335
			Waste-water comprehensive utilization rate X <sub>23</sub>	0.158
			Waste-gas disposal rate X <sub>24</sub>	0.085
	Resource output indicators X <sub>3</sub>	0.32	Waste-residue emission reduction rate X <sub>31</sub>	0.665
			Waste-water emission reduction rate X <sub>32</sub>	0.231
			Waste-gas emissions reduced rate X <sub>33</sub>	0.104

**Table 2:** Consistency check result

	λ <sub>max</sub>	CI	RI	CR
X1	5.171	0.043	1.12	0.038
X2	4.224	0.075	0.9	0.083
X3	3.087	0.044	0.58	0.075
X	3.018	0.009	0.58	0.016

### 3 Empirical Analysis

#### 3.1 Single index evaluation

During the evaluation work, standardized treatment of original data will make specific indicators in a unified form, so it can reflect various performances more intuitive. According to the theory of fuzzy comprehensive evaluation, the process is put the raw data into the following formula, then a single index evaluation score is concluded. Assume for an evaluated object, A<sub>ij</sub> is the measured data of the first j index in the ith criterion layer. T<sub>ij</sub> is the index of satisfaction value which can be set to the advanced level. When an index data achieve this level, its value is the full mark. L<sub>ij</sub> is the lower limit index which can be set to the industry average. S<sub>ij</sub> is the evaluation score after calculation as follows:

Are indicator

$$S_{ij} = \frac{A_{ij} - L_{ij}}{T_{ij} - L_{ij}} \times 40 + 60 \quad (1)$$

Inverse indicator

$$S_{ij} = \frac{L_{ij} - A_{ij}}{T_{ij} - L_{ij}} \times 40 + 60 \quad (2)$$

Appropriate indicators

$$S_{ij} = \left( 1 - \frac{|A_{ij} - T_{ij}|}{|T_{ij} - L_{ij}|} \right) \times 40 + 60 \quad (3)$$

This study collected the original data from a construction enterprise provided the related data in 2014, and individual index value is based on statistical data to calculate. For example, the actual data of Waste-water emission reduction rate A<sub>32</sub> is 21.75%. The target data in the development of circular economy put forward by construction enterprises T<sub>ij</sub> and L<sub>ij</sub> respectively is 25% and 20%. According to the above formula (1), this single index evaluation score of 77 is calculated. Other indicators calculated results are shown on the table below.

### 3.2 Comprehensive index evaluation

According to the evaluation score of index and each index weights, use the below formula to calculate the comprehensive index of circular economy development level .Through using the weighted average method, the integrated evaluation conclusion is obtained<sup>[6-7]</sup>.When the index V is less than 60, it is the weak circulation. When the index V is from 60 to 80, it is the moderate circulation. When the index V is greater than 80, it is the strong circulation. The enterprise comprehensive index is showed on table 3.

$$W_i = \sum Z_{ij} \times S_{ij} \quad (4)$$

$$V = \sum W_i \times Y_i \quad (5)$$

**Table 3:** Comprehensive evaluation of circular economy development level

Index layer	S <sub>ij</sub>	Z <sub>ij</sub>	W <sub>i</sub>	Y <sub>i</sub>	V
Capital preservation increment rate X11	84	0.254			
Return on equity X12	80	0.216			
Profit and tax amount X13	83	0.373			
Energy consumption of per unit output value X14	77	0.118	82	0.123	
Water consumption per unit of output value X15	76	0.039			
Efficiency of energy comprehensive utilization X21	76	0.422			77
Waste-residue comprehensive utilization rate X22	80	0.335	78	0.557	
Waste-water comprehensive utilization rate X23	78	0.158			
Waste-gas disposal rate X24	75	0.085			
Waste-residue emission reduction rate X31	73	0.665			
Waste-water emission reduction rate X32	74	0.231	73	0.32	
Waste-gas emissions reduced rate X33	72	0.104			

From table 3, we learn that the construction enterprise's comprehensive evaluation index is only 77 in 2014, so it's in the moderate circulation. Some indexes such as resource utilization level and income effect indexes got higher scores, but other indexes such as the recycling and waste discharge indexes got scores below 80 points. Therefore according to the recycling economy evaluation analysis on the company, emission decrement index has a certain potential for improvement. The company need take pertinence of effective measures to increase the production process and production of technical reformation, so that the quality of the development and economic benefits will be improved.

### 4 Conclusion

Through empirical analysis, the establishment of a scientific circular economy evaluation index system can be objectively and comprehensively reflect the level of circular economy development of construction enterprises. It also can help to intuitive between all kinds of different measurement of specific indicators for comparison and analysis, and to provide a convenient for founding the problem, and determining the improvement direction. This evaluation index system and method is advantageous to the construction enterprises to speed up the transformation of the pattern of economic development, and improve the quality of development and economic benefits. It has certain applicability and accuracy, also has very good application and use value<sup>[8]</sup>.

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