

Based on VIKOR's Renewable Resources Standard Requirement Study

Hu Biao, Sun Xue

Industrial Engineering, School of Management, Tianjin University of Technology,
300384 China

Corresponding author: 13370306755@163.com

Abstract: At present, the study of standard requirements is still missing. Firstly, this paper constructs an evaluation index system of renewable resource standard demand from four aspects: environmental demand, resource demand, economic demand and social demand. Secondly, VIKOR method is used to construct the standard requirement evaluation model. Finally, the paper makes an empirical analysis of ten major renewable resource standards in China. It is desirable to be able to provide decision support for that relevant sector through research on the requirement for demand standards of renewable resources.

1. The introduction

Standard requirements run through all stages of building, implementation, and evaluation of the standard system. It plays an important role in the improvement of standard system, the short-term maximization of implementation and the rationality of the evaluation. The study of domestic scholars on circular economics focuses mainly on theoretical research^[1] and the construction of the standard system^[2]. The study of scholars lacks a targeted study on standard needs, and it limits the development of our circular economy. Therefore, analyzing the standard requirements of different degree has become a problem to be solved in the field of circulation economy in our country. According to the existing data analysis, the study on multi-attribute evaluation focuses on the project priority evaluation, while the other studies are scattered in the aspects of ecological recovery^[3] and quality improvement^[4]. The AHP method, TOPSIS method and VIKOR method use are more, and VIKOR method to overcome the deficiency of the former two methods. This paper selects VIKOR method and establishes an evaluation index system to evaluate the standard demand of renewable resources.

2. Evaluation index system of renewable resources standard demand

2.1 Environmental demand

Environment is the living space of human beings and the quality of environment affects the quality of human life. We should constantly improve the environmental quality and optimize the space for human survival. Priority should be to high pollution, high emissions, toxic and hazardous standard revised, renewable resources of implementation. In this paper, therefore, waste discharge and environmental pollution level are selected as environmental demand indicators.

2.2 Resource demand

Natural resources are a material basis for human survival, and the limitations of resources limit the development of economic society. In order to protect natural resources and save resources, it is



necessary to make and implement the rules on the regeneration resources with large consumption and scarce resources, so as to guarantee the sustainable utilization of natural resources. In this paper, therefore, recycling amount of renewable resources, utilization rate of recycling and original reserves of resources are selected as resource demand indexes.

2.3 Economic demand

The demand for renewable resources is closely related to economic development. To the utmost extent improve the economic value of renewable resources recycling, reduce environmental governance. We should prioritize the recycling and recycling costs, recycling costs, and the import of renewable resources. In this paper, therefore, recycling value, recycling cost and import of renewable resources are selected as economic demand indexes.

2.4 Social demand

The revision of standards needs to meet social needs, and the standards to meet social needs can be accepted by the society. Enterprises are the main applicators of standards. Whether enterprises are willing to implement relevant standards is related to whether the standards can give full play to the effects of standards and the development progress of the standardization of the whole circular economy. In this paper, therefore, degree of social acceptance and number of recycling enterprises are selected as economic demand indexes. Specific indicators in the following table 1.

Table 1. Standard demand evaluation index system of renewable resources.

Total goal	Level indicators	Index weight	The secondary indicators	Index weight	Total weight
Renewable resource standard requirements	Environmental demand	0.3	Waste discharge A1	0.6	0.18
			Environmental pollution level A2	0.4	0.12
			Recycling amount of renewable resources A3	0.4	0.16
	Resource demand	0.4	Utilization rate of recycling A4	0.3	0.12
			Original reserves of resources A5	0.4	0.16
			Recycling value A6	0.4	0.08
	Economic demand	0.2	Recycling cost A7	0.4	0.08
			Import of renewable resources A8	0.2	0.04
			Degree of social acceptance A9	0.5	0.05
	Social demand	0.1	Number of recycling enterprises A10	0.5	0.05

3. Based on VIKOR's waste standard demand assessment model

3.1 VIKOR method

VIKOR method is first proposed in 1998 by professor Opricovic, which a multiple attribute decision making method to complex system^[5-6]. The basic idea is to define the positive ideal solution and the negative ideal solution, and to use the Lp-metric aggregate function for comprehensive evaluation. The formula is as follows:

$$L_{pj} = \left(\sum_{i=1}^m A_i^p \right)^{1/p}, \quad A_i = \frac{\omega_i(f_i^* - f_{ij})}{f_i^* - f_i^-} \quad (1)$$

3.2 VIKOR method evaluation procedure

Suppose there are n evaluation scheme, remember to $F = \{F_1, F_2, \dots, F_n\}^T$, with m evaluation indicators, remember to $A = \{A_1, A_2, \dots, A_m\}^T$. The evaluation value of the i th index of scheme F_j is denoted as f_{ij} , then evaluation matrix $F = (f_{ij})_{n \times m}$. The evaluation steps are as follows:

(1) Determine the weight of each attribute value

When evaluate VIKOR, need to make sure that the weight of each attribute value has been confirmed. The weight vector is $\omega = \{\omega_1, \omega_2, \dots, \omega_m\}^T$.

(2) To standardize the evaluation

In order to eliminate the unit effects of different variables and data of the order of magnitude of the impact, it is necessary to standardize the original data processing. The decision matrix is obtained after the standardization process $W = (w_{ij})_{n \times m}$.

(3) Determine the positive ideal solution f_i^* and negative ideal solution f_i^-

$$\begin{aligned} f_i^* &= \left[\left(\max_j f_{ij} \mid i \in I_1 \right), \left(\min_j f_{ij} \mid i \in I_2 \right) \right] \\ f_i^- &= \left[\left(\min_j f_{ij} \mid i \in I_1 \right), \left(\max_j f_{ij} \mid i \in I_2 \right) \right] \end{aligned} \quad (2)$$

(4) The optimal solution (S), the worst solution (R) and the benefit ratio (Q) of the comprehensive evaluation are determined and sorted from small to large.

$$S_j = \sum_{i=1}^m A_i, \quad R_j = \max A_i$$

$$Q_j = v \left(S_j - \min_j S_j \right) / \left(\max_j S_j - \min_j S_j \right) + (1 - v) \left(R_j - \min_j R_j \right) / \left(\max_j R_j - \min_j R_j \right) \quad (3)$$

(5) Determine the compromise plan

First, define the conditions for compromise:

Condition 1: $Q^r - Q^{r-1} \geq 1/(n-1)$, $2 \leq r \leq m$, Among them Q^r represents the ranking value in r bit after sorting Q .

Condition 2: $(S^{r-1} < S^r) \cup (R^{r-1} < R^r)$. Among them S^r , R^r respectively represents the ranking value in r bit after sorting S, R .

And then sort them:

If the above two conditions are set up, sort of Q is the ultimate sort of alternative.

If only meet conditions 1, then the r -th plan and the $r-1$ st plan are compromise solutions.

If only meet conditions 2, then the $r-1, r, \dots, b$ plan b is a compromise solution, $Q^b - Q^{r-1} \geq 1/(n-1)$.

4. Assessment of renewable resources standard requirements

With the development of circular economy, the kinds of recycling and utilization of renewable resources are increasing. According to the different types can be divided into non-metal renewable resources, metal renewable resources and waste electrical and mechanical equipment. This paper selected waste non-ferrous metals (F1), waste electrical and electronic products (F2), waste steel (F3), waste paper (F4), scrap cars (F5), waste plastics (F6), waste tires (F7), scrap ships (F8), waste glass (F9), waste batteries (F10) renewable resources as evaluation objects, and conducted in-depth discussion on their standard requirements.

4.1 Empirical analysis

(1) Determine the weight. Using analytic hierarchy process (AHP) to determine the weights, please first five experts at all levels index between the relative importance scores, and then build a judgment matrix, it is concluded that the weight of each evaluation index values, as shown in table 1.

(2) Data normalization processing. The original data were standardized by the range difference method. The range method is a linear transformation of the original data to map the original data to $[0, 1]$. The formula is: new data = (original data - min)/(max - min). Standardized processing results are shown in table 2.

(3) According to the formula to calculate positive ideal solution and negative ideal solution, the calculation results as shown in table 3.

(4) According to the formula to calculate the S, R, Q, and sorted, the calculation results as shown in table 4.

(5) According to the above calculation results and sorting principles, the standard requirements of renewable resources are sorted. The sorting results are as follows:

F3, F1>F6, F7, F10>F5, F2, F8>F4, F9

From the sorting result, degree of standard requirements of renewable resources can be divided into four levels. The first layer, scrap steel (F3) and waste non-ferrous metals (F1) are the two renewable resources with the highest standard demand. Second layer, waste plastics (F6), waste tire (F7) and waste batteries(F10). The fourth layer, waste paper (F4) and waste glass (F9) are the two renewable resources with the lowest standard demand, waste electrical and electronic products (F2), waste automobile (F5) and waste ship (F8). The fourth layer, waste paper (F4) and waste glass (F9) are the two renewable resources with the lowest standard demand.

Table 2. Standard processing.

Plan	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
F1	0.417	0.750	0.560	1	0.021	0.702	0.472	0.233	0.667	0.537
F2	0.090	0.5	0.026	0.806	0.125	0.034	0.389	0	0.333	0.000
F3	1.000	0.500	1.000	0.900	0.5	1.000	0.667	0.251	1.000	0.230
F4	0.043	0.00	0.136	0.8	0.596	0.02	0.028	1	0	1.000
F5	0.092	0.500	0.200	0.700	0.169	0.056	0.722	0.106	0.333	0.097
F6	0.276	1.000	0.125	0.080	0.142	0.405	0.444	0.174	0.667	0.939
F7	0.348	0.750	0.235	0.600	0.047	0.227	0.511	0	0.667	0.072
F8	0.061	0.50	0	0.960	0.107	0.000	0.178	0.170	0.333	0.015
F9	0	0.250	0.059	0.000	1	0.005	0.120	0	0.333	0.076
F10	0.309	1.000	0.312	0.200	0.000	0.104	1.000	0	0.333	0.087

Table 3. Positive ideal solution and negative ideal solution.

plan	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Positive ideal solution	1	1	1	0	0	1	1	1	1	1

Table 4. S, Q, R values and sorting

Plan	Sj	Rj	Qj	Sort by S	Sort by R	Sort by Q
F1	0.4653	0.1200	0.15038	3	3	2
F2	0.7459	0.1638	0.7847	7	8	7
F3	0.3431	0.1080	0	1	1	1
F4	0.8120	0.1726	0.9110	9	6	9
F5	0.6745	0.1634	0.7115	6	7	6
F6	0.4491	0.1400	0.3267	2	4	3
F7	0.6127	0.1174	0.3312	5	2	4
F8	0.7829	0.1690	0.7948	8	9	8
F9	0.8501	0.1800	1	10	10	10
F10	0.5491	0.1424	0.4420	4	5	5

4.2 Analysis of evaluation results

(1) The level of demand for scrap steel standards is the highest, mainly due to the large amount of

scrap steel, serious pollution of resources and environmental destruction. In 2015, China's waste iron and steel recycling rate was 14,380 tons, accounting for about 60% of all renewable resources. It is of great strategic significance for the development of renewable resources industry, resource conservation and environmental improvement to raise the requirement of renewable steel standard.

(2) Waste batteries, waste nonferrous metals, waste plastics and waste tires pose a great threat to the improvement of environmental quality. For example, the waste battery contains a large amount of heavy metals, such as zinc, lead, cadmium, mercury, manganese, etc. The heavy metals will contaminate the soil and water resources, affecting the health of the human body. Therefore, it is urgent to manage and restrain the recycling and treatment of waste by setting standards.

(3) Scrap car, ship and waste electric and electronic products can be broken down into a variety of renewable resources, increase recovery difficulty and cost recovery. At present, China should take the development of recycling technology as the main part and the national policy as the auxiliary part.

(4) Waste glass and waste paper two types of renewable resources, from the environmental point of view, less pollution and from the perspective of resources, it does not have unlimited availability, but has high storage capacity or reproducibility. To further save resources, it is more important to improve our production and living habits.

5. Conclusion

The following conclusions are drawn from the above research analysis: (1) According to the principles of scientific, rationality and operability, a standard demand evaluation index system of renewable resources is constructed from the four dimensions of environmental demand, resource demand, economic demand and social demand. (2) In this paper, a standard demand evaluation model based on VIKOR method is established to calculate and analyze the standard demand of renewable resources in China based on 2015 data. The empirical research in this paper shows that the four dimensions evaluation index system based on demand and the evaluation model based on VIKOR multi-attribute method can fully demonstrate its scientific and rationality in the evaluation of renewable resource demand.

References

- [1] Xue Lu, Xingpeng Chen J 2014 *Overview of research on circular economy theory China's (population resources and environment)* P 204-208
- [2] Yun Fu, Ling Lin, Liang Chen, et al J 2011 *Research on the construction of China's circular economy standard system* (China standardization)
- [3] Shanshan Feng, Jiang Chang, Wei Hou J 2016 *Priority evaluation of ecological restoration of coal mining subsidence area under the guidance of GI* (Journal of ecology) P9
- [4] Fuli Zhou, Xue Wang, Yun Lin, et al. J/OL *Based on the F - VIKOR priority to improve the quality of the parts to determine* (Computer integrated manufacturing system)
- [5] Opricovic S, Tzeng G J 2007 *Extended VIKOR method in comparison with outranking methods* (European Journal of Operational Research) P 514-529
- [6] Opricovic s. D 1998 *Multi Criteria Optimization of Civil Engineering Systems* (Belgrade: Faculty of Civil Engineering)