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A Green Supplier Selection Method based on Utility and Comprehensive Expert Weights in the Internet of Things

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Abstract

At present, the contradiction between enterprise development and environmental protection is becoming increasingly prominent. The problem of green supplier selection in IoT (Internet of things) has attracted more and more attention from scholars. Thus, this paper, aiming at the problem of enterprise green supplier selection, uses the utility conversion method to pre-process the data, and proposes a comprehensive method for determining the weight of experts. Finally, the effectiveness of the method is further tested by the empirical analysis.

Keywords: comprehensive expert weight, green standard, green supplier selection, Internet of things

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INTRODUCTION

At present, the enterprises in IoT are facing more and more requirements on environmental issues. The traditional way of focusing on individual enterprise could not satisfy the current needs of environmental protection. It is essential to consider the environmental impact from the perspective of whole supply chain. Choosing the right green supplier is of great significance for promoting the coordinated development of economy and environment and enhancing the efficiency of supply chain operation.

Most researches focus on green supplier selection and green supply chain. For example, Odeyale (2014), and Gao et al. (2017) proposed a green supplier selection decision-making model based on the trapezoid fuzzy soft set. Tseng (2013), and Hsu et al. (2015) used the method of decision-making tests and assessment laboratories to analyze the carbon management in the supply chain.

Therefore, many scholars have conducted research on the selection of green suppliers and have made useful explorations. However, there are few research focus on data pre-processing, and comprehensive expert weight. Therefore, this paper establishes a green supplier evaluation index system, uses the utility transformation method to pre-process the data, proposes a green supplier selection model in IoT, and finally tests the validity of the method through empirical analysis.

GREEN SUPPLIER SELECTION MODEL

Data Pre-processing

Qualitative data processing

For the qualitative data v_i, different experts have different preferences for the same evaluation objects. Normally, the types of experts can be divided into risk aversion, risk neutral and risk seeking. The utility function curves of specific qualitative evaluation are shown in **Fig. 1**, the function of $u(v_i) = (v_i/k)^\alpha$ can be used to calculate the utility value of expert evaluation results $v_i(0 < v_i < k)$ where α is the risk factor. When the attitude of experts is risk-aversion type, $\alpha > 1$; when the attitude of experts is neutral, $\alpha = 1$; when the attitude of experts is risk-seeking type, $0 < \alpha < 1$.

Quantitative data processing

In general, the utility-based conversion method could be also used in the process of quantitative data. The utility curves of both cost indicators and benefit indicators are shown in **Fig. 2**, For the cost indicator v_j^c, the utility function can be expressed as: $u(v_j^c) = -\left(\frac{v_j^c - v_{\min}^c}{v_{\max}^c - v_{\min}^c}\right)^\beta + 1$, where, $\beta(\beta > 1)$ is the cost coefficient, the utility function can be expressed as: $u(v_j^b) = \left(\frac{v_j^b - v_{\min}^b}{v_{\max}^b - v_{\min}^b}\right)^\chi$, where, $\chi(0 < \chi < 1)$ is the benefit coefficient.

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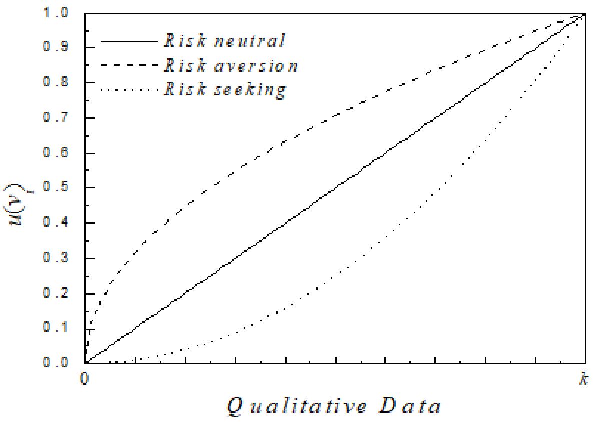

Fig. 1. Utility curve of qualitative data

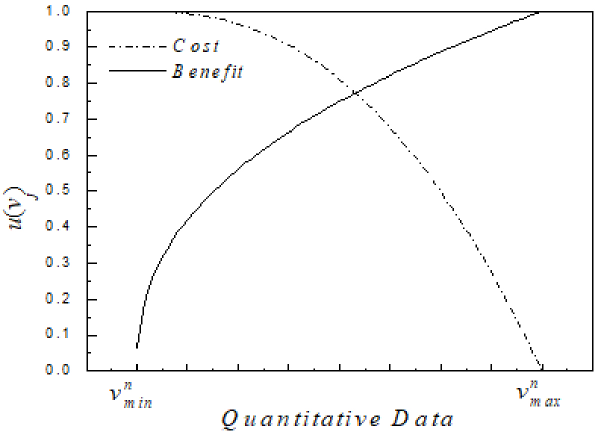

Fig. 2. Utility curve of quantitative data

Model Building

To let $N(n = 1,\dots,N)$ experts evaluate $D(d = 1,\dots,D)$ solutions, and the logic weight of expert is calculated by using the consistency test results, $\lambda_n^{\log}$ is the logical weight of Expert E_n, CR_n is the consistency test results. As the value of CR_n is less than 0.1, the value of b is generally 10. After normalization, the logical weight $\lambda_n^{\log *}$ is obtained.

It is assumed that the results of any two experts' evaluation of each scheme are expressed as vector x and y, and then, the total ranking result is obtained by calculating the comprehensive weight and evaluation values.

EMPIRICAL ANALYSIS

This paper selects four people including purchase manager, production manager, relevant expert and consumer representative to participate in the selection process in four green suppliers. The original data can be pre-processed by utility transformation method. Then, the attribute weights are obtained through the traditional AHP, and are normalized as follows:

$$w = (0.2654, 0.0218, 0.2243, 0.0336, 0.0901, 0.0605, 0.1616, 0.1427)^T$$

The consistency test result of the evaluation matrix of expert E_1 is calculated:

$CR_1 = 0.0852$, and $\lambda_1{}^{\log} = 1/(1 + 10 * 0.0852) = 0.540$

And in the same way, the $\lambda_2^{\log} = 0.555$, $\lambda_3^{\log} = 0.504$, $\lambda_3^{\log} = 0.504$, then, $\lambda_1^{\log *} = 0.250$, $\lambda_2^{\log *} = 0.257$, $\lambda_3^{\log *} = 0.233$, $\lambda_4^{\log *} = 0.260$, and the content weights can be calculated as $\lambda_1^{\text{int}} = 0.453$, $\lambda_2^{\text{int}} = 0.440$, $\lambda_3^{\text{int}} = 0.473$ and $\lambda_4^{\text{int}} = 0.515$. After normalization, $\lambda_1^{\text{int}*} = 0.241$, $\lambda_2^{\text{int}*} = 0.234$, $\lambda_3^{\text{int}*} = 0.251$ and $\lambda_4^{\text{int}*} = 0.274$, and the comprehensive weights $\lambda_1 = 0.241$, $\lambda_2 = 0.240$, $\lambda_3 = 0.234$, $\lambda_4 = 0.285$, and the overall evaluation results can be calculated as shown in **Table 1**.

Table 1. Total evaluation results of each scheme

H_1	H_2	H_3	H_4
0.7953	0.6429	0.6709	0.7210

The final ranking result is $H_1 > H_4 > H_3 > H_2$. It is clear that the supplier H_1 is the best one in the selection.

CONCLUSIONS

There are some drawbacks in traditional expert weight determination methods. Therefore, a green supplier selection method based on utility and comprehensive expert weight is proposed, which not only solves the problem of data distortion caused by raw data pre-processing, but also considers the consistency as well as the similarity, and further be demonstrated by empirical analysis. The practical result shows that the method is effective and feasible.

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