Green Supply Chain Level Measure and Analysis Model Based on Fuzzy Information Amount

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Abstract

The management of green supply chain is a method which is aimed at considering environment influence and optimal use of resources synthetically. In this article, we started from the concept and content of green supply chain, schemed out a set of performance evaluation system which is based on fuzzy theory, set up a relevant evaluation model and verified it with example correspondingly.

Keywords: Green supply chain; Performance evaluation; Evaluation index system; Fuzzy method Introduction.

1 Introduction

With the continuous development of social economy, environment, resources and other problems have been highlighted day by day. Especially, the voice that our country should transform into the great power country rather than still is a big manufacturing one is growing. Therefore, how to spurn the traditional way which is at cost of huge waste of environment and resources to make economic grow, how to achieve a win-win situation for both economic and environment, how to improve consistency of business activities and environment, the above mentioned points have been hot topics of enterprise and society. As a problem of environment protection, green supply chain is a concept which is an intersection of green manufacturing theory, supply chain management technologies and other subjects. In its promotion process, how to describe and evaluate green supply chain management's performance is an issue that needed to be solved urgently when we implement green supply chain management. It is also a hot topic for a period of time in the future.

2 The Concept and Main Content of Green Supply Chain

A. THE CONCEPT OF GREEN SUPPLY CHAIN

In 1996, the concept of green supply chain was first proposed by MRC. Green Supply Chain Management can also be called Environmental Supply Chain Management. It aims at considering environment influence and optimal use of resources synthetically in the manufacturing supply chain. Its purpose is to minimize the negative influence for environment throughout the supply chain and achieve the highest utilization rate of resources. It starts from the idea of sustainable development, involves suppliers, manufacturers, retailers, users and members of reverse logistics and considers the environment problems in each link of supply chain [1].

In management process, green supply chain has changed traditional supply chain's open-loop structure, increased the recycle link, achieved recovery and reuse of materials and energy, thus, form a "closed-loop" logistics [2]. It not only increases the utilization rate of resources and decreases the environmental pollution caused by waste, but also improves the node enterprise's competitiveness. Finally, it achieves optimization of economic benefit and environmental benefit, and makes economy sustainable development.

At present, green supply chain does not have exact definition in the theoretical circle and system theory has not been formed, then the quantitative analysis is less. In general [3]: "green supply chain management is a modern management mode which considers environmental impact and efficiency of resources synthetically in the whole supply chain. It is based on green manufacturing theory and the technology of supply chain management, involves suppliers, manufacturers, retailers, logistics carriers and users and its purpose is that product can minimize negative impact of environment, make the highest efficiency of resource use and make the economic benefit and social benefit collaborative optimization in the whole supply chain during material acquisition, machining, packing, warehousing, transportation, using and abandon."

B. THE MAIN CONTENT OF GREEN SUPPLY CHAIN

From the aspect of management, green supply chain management is a strategic management. It acquires considering whole efficiency optimization from product design, material purchase, product manufacturing, product distribution and recycle. Therefore, in order to

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implement green supply chain management successfully and make it be a competition weapon for enterprises, we must discard the traditional idea about environment management, establish its strategic position, regard various businesses between enterprise internal and supply chain enterprises as a whole function and form an integrated environmental management system.

3 The Construction of Green Supply Chain'S Performance Fuzzy Comprehensive Evaluation Model

A. ESTABLISHMENT OF EVALUATION INDEX SYSTEM

Green supply chain is to restrain supply chain node enterprise under environment protection to pursue the integral performance of supply chain. Therefore, building green supply chain performance evaluation system must take the environmental issues as a leading indicator. Meanwhile, we should guarantee the performance indicators standard and scientific. Evaluation system should be able to meet users who use all aspects information in green supply chain node enterprises, evaluate and understand the requirement of green supply chain performance comprehensively; then, evaluation system must have certain comparability and consider the combination of financial and non-financial indicators.

Therefore, we take research which was written by scholars at home and abroad about green supply chain performance evaluation system as lessons. According to the main content of green supply chain, environmental management standard ISO14000 series and in accordance with the scientific and comparable principle, we design a specific green supply chain index system [4]. Level one index includes [5]: users' satisfaction, finance, and supply chain operation, information sharing and green level. Level two indexes corresponding to users' satisfaction include: perfect order completion, refund rate, accuracy of delivery, on time delivery and user retention rate; level two indexes corresponding to finance include: return on assets, asset-liability ratio and assets growth rate; level two indexes corresponding to supply chain operation include: transport level of supply chain, inventory level of supply chain, supply chain response time and the circulation time's efficiency; level two indexes corresponding to information sharing include[6]: information exchange frequency, timeliness ratio of information transfer, accuracy ratio of information transfer and utilization ratio of information; level two indexes corresponding to green level include: raw materials and utilization ratio of energy, raw materials and re-utilization ratio of energy, waste emissions targets, recovery rate of products and consumers' recognition to green level.

In this paper, we divided green supply chain performance evaluation system into level one and two indexes, and some of the indicators have a lot of subjectivity. And the analytic hierarchy process is an easy, reasonable and reliable mathematical structure method which is not also having solid theoretical background but also reflecting the experts and policy makers' opinion subjectively. Therefore, this article adopted the secondary fuzzy evaluation method to evaluate green supply chain comprehensively.

B. THE CONSTRUCTION OF EVALUATION MODEL

Determine the Evaluation Index Set

If express supply chain performance evaluation sets as V, so $V=(V_1,V_2,V_3,V_4,V_5)$.

Determine the Evaluation Index Factor Set

According to the evaluation index system, we can conclude that level one index set of factors A:

$A=(A_1,A_2,A_3,A_4,A_5)=$ (users' satisfaction, finance, supply chain operation, information sharing and green level), so level two indexes factor sets of the evaluation index system: $A_i=(a_{i1},a_{i2},\cdots,a_{ij})$, in which $i=1,2,\cdots,5$, each corresponding to 5,3,4,4,5 level two indexes.

Determine the Weight Set

If express level one index weight as W, so $W=(W_1,W_2,W_3,W_4,W_5)$

If express weight coefficient of level two index a_{ij} weight sets of A_i: $W_i=(W_{i1},W_{i2},\cdots,W_{ij})$, of which $i=1,2,\cdots,5$, each corresponding to 5,3,4,4,5 level two weights. Because different enterprises face to different operational environment, they also have different attitude to different indexes, therefore, for these weights, it replies on specific conditions to determine through the experts' investigation method.

C.DETERMINE THE EVALUATION MATRIX

Evaluate an index of evaluation index system. Determine the index of the fuzzy evaluation matrix to be R. Assume evaluation object. Suppose to judge no. i factor- A. Thus fuzzy subset of judgment set $R_i=(r_{i1},r_{i2},r_{i3},r_{i4},r_{i5})$. Independently degree of membership of level two indexes to each evaluation, and then we conclude that

$$R_k=\begin{bmatrix} r_{k11} & r_{k12} & r_{k13} & r_{k14} & r_{k15} \\ r_{k21} & r_{k22} & r_{k23} & r_{k24} & r_{k25} \\ r_{k31} & r_{k32} & r_{k33} & r_{k34} & r_{k35} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ r_{kg1} & r_{kg2} & r_{kg3} & r_{kg4} & r_{kg5} \end{bmatrix}$$

r_{ij} Refers to that, the evaluation of the first factor a_{ij} in A_k is membership of no.j comment.

Determine the evaluation matrix of evaluation factor set A_i - R_i, and weight coefficient vector- W_i, then we can obtain the fuzzy evaluation matrix $C=(C_1,C_2,C_3,C_4,C_5)^T$, $C_i=W_iR_i$, in which $(i=1,2,3,4,5)$.

D. CALCULATE THE COMPREHENSIVE FUZZY

EVALUATION MATRIX E AND
COMPREHENSIVE FUZZY
EVALUATION SCORE X

Calculate formula for the comprehensive fuzzy evaluation matrix: $E = W \times C = (e_1, e_2, e_3, e_4, e_5)$. The value of E reflects the strengths and weaknesses of different evaluation indexes, thus it provides a quantitative basis for the green supply chain performance evaluation.

Through the above data obtained from the calculation, we can get a composite score of green supply chain performance evaluation $X = EV^T$.

4 Instance Analysis

With the above evaluation index and evaluation model as an example, make someone green supply chain a fuzzy comprehensive evaluation. According to experts' evaluation, we can get weight of each index in evaluation:

$W = (0.3, 0.2, 0.15, 0.15, 0.2)$

$W_1 = (0.23, 0.12, 0.2, 0.2, 0.25)$

$W_2 = (0.4, 0.4, 0.2)$

$W_3 = (0.2, 0.25, 0.3, 0.25)$

$W_4 = (0.3, 0.15, 0.15, 0.4)$

$W_5 = (0.3, 0.2, 0.15, 0.1, 0.25)$

The fuzzy relation matrix:

$$R_i = \begin{bmatrix} 0.4 & 0.3 & 0.2 & 0.1 & 0 \\ 0.1 & 0.3 & 0.4 & 0.1 & 0.1 \\ 0.5 & 0.2 & 0.2 & 0.1 & 0 \\ 0.2 & 0.4 & 0.2 & 0.1 & 0 \\ 0.5 & 0.3 & 0.2 & 0 & 0 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0.2 & 0.4 & 0.2 & 0.1 & 0 \\ 0.1 & 0.5 & 0.2 & 0.1 & 0.1 \\ 0.2 & 0.3 & 0.2 & 0.2 & 0 \end{bmatrix}$$

$$R_3 = \begin{bmatrix} 0.3 & 0.3 & 0.2 & 0.1 & 0.1 \\ 0.2 & 0.3 & 0.3 & 0.1 & 0 \\ 0.4 & 0.3 & 0.3 & 0 & 0 \\ 0.2 & 0.2 & 0.2 & 0.1 & 0.1 \end{bmatrix}$$

$$R_4 = \begin{bmatrix} 0.2 & 0.4 & 0.2 & 0.1 & 0.1 \\ 0.3 & 0.3 & 0.2 & 0.2 & 0 \\ 0.2 & 0.2 & 0.4 & 0.2 & 0 \\ 0.4 & 0.3 & 0.2 & 0.1 & 0 \end{bmatrix}$$

$$R_5 = \begin{bmatrix} 0.4 & 0.3 & 0.2 & 0.1 & 0 \\ 0.3 & 0.3 & 0.2 & 0.1 & 0.1 \\ 0.3 & 0.3 & 0.2 & 0.1 & 0.1 \\ 0.2 & 0.2 & 0.3 & 0.3 & 0 \\ 0.4 & 0.2 & 0.2 & 0.1 & 0 \end{bmatrix}$$

If express five-levels number of evaluation set as $V = (100, 80, 60, 40, 20)$, then by the $C_i = W_i R_i$, $C = (C_1, C_2, C_3, C_4, C_5)^T$, $E = W \times C$, we can obtain the final composite score calculation: $X = EV^T = 75.634$, which shows that the comprehensive evaluation results of this green supply chain reach the medium level.

5 Conclusion

The content of the green supply chain management is very extensive, and its perfect theory system has not been formed, so the research of green supply chain performance evaluation system is complex. According to the characteristics of green supply chain, we designed a set of green supply chain performance evaluation system, established corresponding evaluation model, and verified it by a living example. With the increasing environmental pressure, green supply chain management is much accounted of the enterprise and academia. Research on performance evaluation of green supply chain is bound to be more and more perfect, and provides more support and help for the enterprise.

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