A Review on Evaluation and Selection for Green Supplier

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Abstract: With the worsening of environment, in recent years, the problem of green supplier evaluation and selection become a hot research area. However, a systematic review with regard to the problem is scare at present. The article aims at presenting a literature review of related research of green supplier evaluation and selection. First, comprehensive analysis about the results of document retrieval is presented; Second, the criterion related to the problem are classified into two groups, traditional criteria and green criteria, which have be elaborated; Third, those evaluation method and corresponding theories are detailed classification analysis; Ultimately, the consequences show that the criteria system and evaluation method of the problem, taking into account big data and forming a theory of green supplier evaluation and selection are worthy for further study.

Keywords: Green supply chain; Supplier selection; Criteria system; Evaluation method; Literature review

1. Introduction

With the continuous deterioration of the environment, people's environmental awareness gradually increased, the traditional supply chain management aims to study how to achieve the overall optimization of the supply chain, while ignoring the implementation process in the destruction of the environment[1]. From 1994, Webb [2]proposed the concept of green procurement, to 1996, the green supply chain concept by the United States Michigan State University Institute of Manufacturing officially put forward[3], the concept of the core is the environmental factors into the supply chain into the whole process, the domestic scholars DanBin[4] on this basis, summed up the concept of green supply chain is also widely cited. Walton[5] believes that the green supply chain is to consider the supplier into the enterprise's environmental management, Wang YingLuo[6] that green suppliers constitute a green supply chain is one of the important elements.

The choice of green suppliers is one of the most important decision-making issues in green supply chain management. [7-11] 1997, Noci [12] first proposed the issue of green supplier evaluation and selection, and then chose the right green supply Businesses are also increasingly valued by business managers and researchers [13-15]. Most of the research on this issue is focused on both evaluation and selection methods [16-20]. At present, although there are more rich research results, but in the determination of indicators and methods of choice, for reference review literature is still relatively small. In view of this, this paper has reviewed the problem of green supplier evaluation and selection. This paper first describes and analyzes the collected literatures, and then summarizes the evaluation indexes and research methods involved in the study of the problem, and finally draws the following four areas worthy of further study: 1, to explore the scientific index system , 2, using a variety of evaluation methods for comparative analysis, 3, the problem into the large data environment for research, 4, to build the problem of a complete theoretical system.

2. Literature Collection and Analysis

2.1. To determine the search terms

In view of the problem of green supplier evaluation and selection, we need to consider the corresponding index system [9,20,21], and some scholars have also included it as part of the green supply chain performance evaluation [15,22-24]. Therefore, this article identified the following foreign literature search keywords:green supplier & criteria、green supplier & evaluation、green supplier & index、green supplier & indicator、green supplier & selection、green supply chain & criteria、green supply chain & evaluation、green supply chain & index、green supply chain & indicator、green supply chain & selection ; The key words to determine the Chinese literature search are: green supplier, green supply chain performance, green supply chain evaluation.

2.2. Search results and analysis

The search results of the foreign literature retrieved in the Science Direct database are shown in Table 1, and the total number of search results is 321, among which 174 are repeated and 147 are valid. The results of the

Chinese literature retrieved in China are shown in Table 2. The results of the preliminary search are 55, of which 1 is valid and 54 are valid.

Compared with Table 1 and Table 2, it can be seen that the number of results retrieved by Chinese literature is much less than that of foreign literature, and the data are limited. There is no trend analysis and periodical statistics on Chinese literature.

Table 1. Foreign Literature Search Results

keywords	quantity
green supplier & criteria	30
green supplier & evaluation	33
green supplier & index	7
green supplier & indicator	7
green supplier & selection	45
green supply chain & criteria	52
green supply chain & evaluation	54
green supply chain & index	11
green supply chain & indicator	27
green supply chain & selection	55
Preliminary results	321
Repeat literature	174
Valid literature	147

Table 2. Chinese Literature Search Results

keywords	quantity
Green supplier	29
Green Supply Chain Performance	17
Green Supply Chain Evaluation	8
Preliminary results	55
Repeat literature	1
Valid literature	54

3. Summary of Indicators

For green supplier evaluation and selection issues, the evaluation indicators involved both the traditional supplier evaluation and selection of indicators, but also should focus on the green nature of the evaluation indicators, so as to truly meet the green supplier evaluation and selection The purpose of [10,11,16,22,25-28]. This chapter mainly reviews the traditional and green indicators involved in the evaluation and selection of green suppliers.

3.1. Traditional indicators

The traditional indicators involved in the evaluation and selection of green suppliers mainly include the following aspects: product quality, price cost, production and supply capacity, transportation, service level, enterprise qualification, etc. [10,29-35].

A detailed summary of these aspects of traditional indicators is listed in Table 3.

Table 3. Green Supplier Evaluation and Selection Issues Related to the Summary of Traditional Indicators

Main aspect	literature	Indicator details	Main aspect	literature	Indicator details
product quality	[9-11,30,33,35-44]	1.Quality management system 2.ISO quality certification 3.Rate of qualified products 4.Rate of customer rejection 5.Quality assurance 6.quality inspection 7.quality improvement 8.quality stability	Transportation	[15,30,36,40,45]	1.Transport distance 2.mode of transport 3.guarantee and compensation 4.geographical location 5.place of delivery 6.delivery method
Price cost	[10,11,30,31,33-35,37-40,42,46-48]	1.Product price 2.price stability 3.cost reduction space 4.inventory cost 5.transportation cost 6.ordering cost	Service Level	[10,22,29-31,37,39,40,44,45,49]	1.Problem solving time 2.response time 3.complaints about average time 4.customer complaint rate 5.service attitude 6.customer complaints 7.customer responsiveness 8.maintenance service level 9.information sharing 10.after-sales service 11.product identification and traceability
Production and supply capacity	[10,11,22,27,29,32,33,37-39,41-43]	1.Information level 2.product flexibility 3.time flexibility 4.quantity flexibility 5.production capacity 6.equipment utilization agility 7.on-time delivery rate 8.out-of-stock frequency 9.order fulfillment rate 10.order processing accuracy	Qualification	[11,29,33-35,42,49]	1.Management level 2.innovation ability 3.enterprise reputation 4.staff quality 5.enterprise stability 6.organizational culture 7.long-term cooperation intention 8.enterprise scale 9.market share 10.technical cooperation 11.equipment level 12.business philosophy

3.2. Green indicators

The selection and determination of the green nature indicators is a crucial part of the green supplier evaluation and selection [4,10,13,50]. The green indicators mainly include the following aspects: green cost and benefit, environmental protection concept, clean production,Green design,green products, green logistics, etc. [7,10,13,19,26,29-33], Table 4 on these aspects were detailed description and summary analysis.

Table 4. Summary of Green Indicators for Green Supplier Evaluation and Selection Issues

Main aspect	literature	Indicator details
Green cost and benefit	[10,11,13,15,16,24,25,28,29,31,34,45]	1.Environmental protection investment 2.Green investment margins 3.recovery efficiency 4.cost recovery 5.waste disposal costs 6.R & D costs 7.environmental audit
Environmental protection concept	[9-11,13,15,16,18,22, 24-26,28,29,32,34,45]	1.Green culture 2.environmental protection project situation 3.environmental protection system certification 4.employee environmental awareness 5.environmental responsibility, 6.green customer ratio 7.green procurement 8.green storage
Clean manufacturing	[8,10,11,13,15,16,22, 24-26,28,29,31,32,34, 45]	1.Waste disposal 2.raw material utilization 3.equipment utilization 4.energy efficiency 5.recycling rate 6.pollution control 7.clean energy use
Green Design	[8-11,13,15,16,24-26,28,29,33,34]	1.Green product life cycle 2.green technology applications 3.green packaging 4.process design 5.product design 6.new product development
Green Logistics,	[10,11,13,15,16,22,24,25,28,34]	1.Product recovery 2.waste recycling 3.reverse logistics 4.green distribution

4. Summary of Research Methods

Green supplier evaluation and selection is a typical multi-objective decision problem [9,20,24], and there are many uncertainties in the decision-making process [41,44]. Thus, a variety of theoretical approaches are commonly used to solve the corresponding decision problem [20,24]. This chapter reviews the theoretical basis and the specific method of solving this problem.

4.1. Basic theory

The basic theories used in the literature to solve this problem are: game theory, soft-set theory, gray theory [8], entropy [29,33] Rough set theory [8,23,29], operational research [9,38], statistics [10,46], fuzzy mathematics [9,13,14] and so on.

In order to explore the green supply relationship between enterprises, Ji based on the evolutionary game theory put forward a full consideration of the manufacturer waste recycling and the two sides of the co-op trend of the game model; Zhao game theory analysis of enterprises in Green supply chain background to reduce carbon emissions and the use of raw materials, the choice of strategic issues. Gao Xiaoliang proposed a multi-objective group decision model based on soft set of green supplier selection.

The theoretical approach used in this field is mainly linear programming [38] and multiobjective programming [9,16], factor analysis used in statistics [10], hypothesis testing [46], regression Analysis, gray theory used in the gray correlation analysis [11,43], gray system method [8,35], these theoretical methods and fuzzy mathematics, rough sets and entropy are often used by scholars, Or as a theoretical basis for improving a method. The specific use of these research methods will be described in detail in the next section.

4.2. Research methods

For the green supplier evaluation and selection problem, Noci [12] proposed for the first time a comprehensive consideration of green evaluation indicators and corporate environmental protection capabilities to suppliers sorting screening method model, after more and more evaluation methods by the researchers , And for the study of medical devices [40], textiles, mining industry [23,29], service areas [24], electronics industry [13], automobile industry.Industry green supplier evaluation and selection.

Some scholars have used AHP to solve the problem of green supplier evaluation and selection. Marimin used AHP to select the optimal decision-making scheme to improve the green productivity of natural rubber supply chain. Lee proposed an extended fuzzy AHP method based on the use of the Delphi method to distinguish between traditional and green indicators. In the study of AHP and other methods, some scholars have proposed an improved AHP [33] and a two-stage fuzzy AHP model based on entropy method and fuzzy logic, respectively. Efendigil [37] proposed a Based on fuzzy AHP and Artificial Neural Network (ANN), Shaw [38] also proposed a decision method based on fuzzy AHP and fuzzy multiobjective linear programming. Senthil proposed a A method based on AHP and approximation

to the Technique for Order Preference to Similar Solution (TOPSIS).

Some scholars have also used Data Envelopment Analysis (DEA) to study the green supplier evaluation and selection problem. Dobos studied the selection and evaluation system of index weight based on DEA. In this paper, Mirndayatian and Kumar [19] proposed the network DEA (Network DEA) and the network of DEA (Network DEA), respectively, for the double influencing factors in the evaluation process, unreasonable output, fuzzy number, and the factors considering the weight limit and carbon emission monitoring. Green DEA (Green DEA). In the joint use of DEA and other methods, Mahdiloo proposed a multi-objective linear programming data envelope analysis method, Kuo [17] proposed an integrated DEA, ANN, network analysis (Analytic Network Process, ANP), Wang Yan [30] proposed a joint model based on DEA and TOPSIS.

On the use of TOPSIS to solve the problem of green supplier evaluation and selection, some scholars based on fuzzy set theory, triangular fuzzy number [13] and rough set theory [23] proposed the corresponding fuzzy TOPSIS decision-making methods; Combined with other methods to carry out research, such as the combination of TOPSIS, decision making and evaluation experiment (Decision Making Trial and Evaluation Laboratory Model, DEMATEL), ANP and other methods proposed a corresponding fuzzy multi-objective decision-making method [20,31]; Tyagi [50] Based on the Delphi method, a hierarchical performance evaluation model based on fuzzy TOPSIS is proposed.

On the study of ANP's evaluation and selection of green suppliers, Tseng proposed a multi-objective decision-making method based on ANP, gray theory and entropy. Hsu proposed an ANP- (NGT) [39], Radial Basis Function (RBF) [27], Gray Relational (Gray Relational), and so on. In this paper, (GRA) [11], multi-objective programming [16], DEMATEL, Triple Bottom Line (TBL) and other theoretical methods are used in combination, and their respective methods and models are proposed.

The study of the DEMATEL approach in the evaluation and selection of green suppliers mainly uses this method to explore the key factors or indicators that affect green supply chain management [41] and the causal relationship between these key indicators Scholars use the DEMATEL method in conjunction with fuzzy set theory and intuitionistic fuzzy number to explore the determinants of uncertainty in uncertain environments.

The VIKOR (Vlsekriterijumska Optimizacija I Kompromisno Resenje) method has also been adopted by some scholars. Chithambaranathan [24] has proposed a method for evaluating environmental performance in service supply chain management. In this paper, Based on the VIKOR and gray theory evaluation methods, based on VIKOR, fuzzy set theory and triangular fuzzy number, Rostamzadeh [15] and Ruan Lianfa [34] also put forward their respective decision models

Genetic algorithms are also used by some scholars to study green supplier evaluation and selection issues. Based on genetic algorithms, integer programming and support trees, Wang proposed a closed-loop logistics model, Diabat proposed a carbon- Management of the heuristic algorithm; Huang based on genetic algorithms and game theory proposed to help decision makers weigh the profit and environmental impact of the model; Yeh [47] based on genetic algorithms and multi-objective programming, Mathematical Programming Model of Pareto Optimal Solution.

Finally, Wan proposed a fuzzy mathematical programming method for the solution of heterogeneous multi-attribute decision-making problem. Garg incorporated into the environment in the supply chain. In this paper, we study the evaluation and selection of green suppliers by using mathematical programming. This paper proposes a two-objective integer nonlinear programming problem, and uses the interactive multi-objective programming method to solve it. Kannan [9] proposed a method based on multi-objective programming and fuzzy multi-attribute utility theory for supplier Jakhar proposed a method based on fuzzy multi-objective linear programming, fuzzy AHP and structural equation model for the performance evaluation and flow distribution of green supply chain in garment industry.

In order to study the relationship between environmental management and corporate performance, the structural equation model is used to make assumptions about the six hypotheses proposed in the paper. Giovanni [46] in order to study the relationship between environmental management and corporate performance. In order to study the relationship between supplier relationship management and total quality management under environmental requirements, the author hypotheses about the seven hypotheses proposed by confirmatory factor analysis and regression analysis; Akman [10] evaluate the effectiveness of the indicators using factor analysis, and then uses the mean clustering to select the most important indicators for the selection of green suppliers. Good supplier.

In view of the problem of green supplier evaluation and selection, scholars have integrated the corresponding comprehensive evaluation method based on gray relational analysis, neural network, entropy theory,rough set theory and fuzzy set theory [29,32], and some scholars Using the operator [49], support vector machine [45] and other methods of the corresponding research; some scholars use software technology to develop the corresponding decision-making software and agent platform.

5. Summary and Revelation

5.1. Revelation

In view of the shortcomings of some literatures, in the process of reviewing all the literature, this paper summarizes four directions that merit further study: First, it can be seen from Table 3 and Table 4 that the evaluation indicators used in some of the literature are mostly directly used in the relevant literature. However, some of the meanings of the indicators are the same or similar, making the indicators redundant, so in the follow-up study it is necessary to use the relevant methods to reduce these redundant indicators in order to obtain a more scientific index system.

Second, in order to study the theoretical method used in this problem, most of the literature is to put forward an effective evaluation method, and then practice it to get the evaluation results. But these results are not compared with the results of other methods for comparison, so in the future can be considered using a variety of methods for comparative study to get a more practical and effective evaluation method. Other theoretical approaches can be introduced in the course of the study, such as customer satisfaction and logistics quality.

Thirdly, in recent years, with the introduction and development of large data concepts, the continuous development of data mining technology, some people have begun to supply chain management and large data combined research, so you can consider the green supplier Evaluation and selection issues into the context of large data, combined with data mining related methods or models to study.

Fourthly, at present, for the study and evaluation of green suppliers, although there are already rich research results, but most of these studies only for evaluation indicators and selection methods, and there is no complete theoretical framework. Therefore, how to sublimate it into a complete theoretical system is worth exploring.

5.2. Summary

Based on the search terms related to the evaluation and selection of green suppliers, this paper first retrieves the corresponding Chinese and English literatures and analyzes the search results. It can be seen from Figure 1 that this problem is getting more and more More attention and attention to the green supplier evaluation of the specific indicators involved in the summary, divided into the traditional indicators and green indicators of the two categories, and were carried out in detail; and then the selection and selection process used Finally, the results show that the evaluation and selection of green suppliers are worthy of further study in the aspects of index system and evaluation method, integration with large data and theoretical evaluation of evaluation.

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