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Research on Reverse Logistics Network Design Considering Consumers

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Abstract

Resource and environmental issues are becoming more and more serious, and the contradiction between environmental protection and economic development has become more and more prominent. Countries around the world have advocated the reuse of resources and waste products, and reverse logistics has entered an important stage of development. As a long-term and strategic decision-making problem of reverse logistics system, reverse logistics network design is an important research direction of reverse logistics research. Based on the research and collation of literature on reverse logistics network in recent years, this paper discusses and analyzes network design research issues, quantitative models, solving algorithms, current research status of consumers' willingness to recycle, and its influence on reverse logistics network design recovery rate.

Keywords

Reverse Logistics Network; Recycling Willingness; Mathematical Model.

1. Introduction

With the advancement of science and technology and the rapid economic development, people's lives have been greatly facilitated, and various products have emerged one after another, but they also consume a lot of energy and resources, and generate a large amount of waste. If these wastes are discarded at will, If it is not properly handled, it will cause serious damage to the environment and cause irreparable losses. In order to seek long-term development and actively respond to environmental protection laws and regulations, more and more companies have incorporated reverse logistics business into their corporate development strategies. Many experts and scholars have done a lot of research on the problems of product recycling and reverse logistics. The research found that the recycling and reuse of waste products can provide effective help to solve resource and environmental problems and help enterprises while ensuring the quality of remanufactured products. Reduce production costs and improve economic efficiency. In order to solve the problem of promoting the recycling of waste products, all sectors of society have made efforts. Government departments provide various subsidies and tax preferential policies for recycling companies. A large number of experts and scholars have studied and explored the field of reverse logistics, and explored the inherent laws from the reverse logistics strategy, tactics, and operation levels. Conduct empirical research to combine theory and practice. Some scholars have pointed out that the main reason for the low recycling rate of waste products is the information asymmetry between consumers and recycling companies. Understanding consumer preferences for disposal and incorporating consumer behavior preferences into the design of reverse logistics systems will help promote consumers Participate in recycling activities to improve the operational efficiency of recycling companies. Whether it is from the perspective of social benefits, environmental protection, and economic benefits, the implementation of reverse logistics

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treatment of waste products is of great significance. In this context, this article combines domestic and foreign literature research and scientific modeling methods to combine consumer recycling willingness and behavior influencing factors with reverse logistics network design to stimulate consumer participation, increase product recycling rates, and promote sustainable development of the industry.

2. Research on Reverse Logistics Network Design

2.1. Research Status of Reverse Logistics

For the research on reverse logistics, foreign scholars started early. Reverse logistics network design is a difficult problem in the field of reverse logistics. Since the 1970s, there have been scholars who have studied reverse logistics networks in depth, and the research hotspots mainly focus on reverse logistics. The characteristics, functions and classification of the network, network optimization, site selection and transportation management, etc. Guiltiann and Nwokoye first analyzed the reverse logistics network structure in 1975. They divided the reverse channels into four types based on the organizational role of the circulation companies participating in the reverse logistics in the regeneration or remanufacturing activities, and constructed different types in consideration of cost factors. Reverse logistics network [1]. Spicer and Johnson divide the reverse logistics network into three operating modes: manufacturer recycling, manufacturer responsible organization recycling, and third-party reverse logistics recycling based on the difference between the leading providers of the recycling network. Through qualitative analysis, they point out that third-party reverse logistics recycling is the best model [2]. Vander took Volkswagen as the research object, and conducted a detailed analysis of the reverse logistics network and inventory control of its engines and engines [3]. Through the comparison of forward and reverse logistics networks, Ginter found that due to the scattered sources of reverse logistics, there are big differences in the location of recycling centers, etc., and it has made improvements to the traditional facility location model [4]. Fleischmann et al. combed and studied the literature on reverse logistics networks, and concluded that the general process of the recycling network of waste products is: recycling-testing-sorting-remanufacturing-distribution. According to the type and quality of the recycled products, the recycling network can be divided into remanufacturing, Recycling and reuse etc. The reason why the operating efficiency of reverse logistics is lower than that of general logistics is discussed. It is believed that the scattered sources of waste products, high uncertainty, complex recycling network structure, and unbalanced supply and demand of recycled products will all have an impact on it [5,6].

2.2. Research Issues on Reverse Logistics Network

Although reverse logistics activities can be regarded as the expansion and continuation of forward logistics activities, they are much more complicated than general forward logistics. The functions required by reverse logistics networks include: acquisition/collection, detection and classification, reprocessing, redistribution, Disposal, etc. The specific network facilities and functions are as follows:

(1) Recycling center: Collect waste products from various channels. Manufacturers, distributors, and retailers may all undertake the task of recycling waste products, but their basic tasks are the same for recycling or simple disposal of waste products.

(2) Detection and classification: The types and quality of waste products collected through recycling points vary widely. Only after testing and classification, can they enter designated places for processing activities according to specific conditions, such as downgrading and reusing products, second-hand sales, and refurbishing parts, Harmless disposal of waste, etc. In

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order to save transportation distance and inspection cost, centralized inspection is usually selected.

(3) Reprocessing: Reprocessing methods include reuse, remanufacturing and recycling. Among them, reuse refers to products that have good appearance and perfect functions after inspection and simple cleanup directly enter the second-hand market; remanufacturing mainly refers to the processing of remanufactured parts collected by the recycling center and the value-added repair of discarded parts; recycling is Refers to the waste products containing a variety of reusable materials, and the materials obtained after detection and decomposition are used in the manufacturer's channels for reuse or into the second-hand material market.

(4) Waste disposal: Dispose of waste products that no longer have use value due to technical or economic reasons by means of transportation, incineration, and landfill. This operation needs to be completed by a professional processor with special qualifications.

(5) Redistribution: refers to the re-circulation of products whose value has been restored on the market to complete the distribution activities. In addition to establishing a separate redistribution network, in order to improve operational efficiency, collection and distribution can be integrated, and the distribution of original new products and remanufactured products can also be integrated, but this will make the reverse logistics network more complicated.

2.3. Reverse Logistics Network Design Model

The commonly used models in reverse logistics network design can be divided into simulation methods and mathematical programming methods. Simulation methods have been widely used in logistics planning technology. Simulation models can comprehensively describe random uncertain variable elements and real problems, and use computer technology for programming simulation. Mathematical programming models can be divided into optimization models, heuristic models and expert models. The optimization model is the application of operations research knowledge to design a mathematical model to obtain the optimal solution to a decision-making problem. Commonly used models include integer programming model, mixed integer programming model and Random integer programming model, the objective function of the reverse logistics network design model is generally divided into single objective function and multi objective function, single objective function mostly aims at the minimum total network operating cost (profit maximization) as the goal, Jiao Z et al. studied the uncertainty The closed-loop supply chain design problem in the environment is aimed at maximizing profit, and carbon emissions are the limiting condition. Yue Hui, Zhong and others set up the stochastic planning model of remanufacturing reverse logistics network with the objective function of maximizing the remanufacturing profit of recycled products, and verified the feasibility of the model by numerical simulation. Multi-objective functions generally take into account environmental factors, such as carbon emissions, on the basis of cost minimization. In addition, factors such as the number of product types, network levels, and forward and reverse integration are often taken into consideration. Yan Nanna and Li Ming aimed to minimize the total cost and minimize the environmental impact of the site selection problem for the reverse network of end-of-life vehicles. The carbon emissions were converted into monetary costs to represent the environmental goals when the model was established. Pat studied the recycled paper network distribution model to improve the paper recycling system. The purpose of the model is to reduce the cost of reverse logistics, while improving the quality of recycled paper as one of the goals. Constraints in the mathematical model of reverse logistics networks generally need to consider flow balance constraints, parameter non-negative and binary constraints, production capacity constraints, etc., to construct a channel structure from the consumer terminal to the production site and the secondary circulation of remanufactured products to the consumer terminal. In addition, single-period and multi-period problems are often considered in the mathematical model of reverse logistics networks. The single-period

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mathematical model only considers the current stage and uses existing relevant data to complete the network design; the multi-period mathematical model not only needs to consider the current stage of the network Operating conditions. we must also forecast future demand and consider longer-term planning and design. For example, Jiang Fang discussed the recycling and reuse of plastic products, and established a multi-objective and multi-period reverse logistics network design model with a six-month cycle to optimize the resource input at each stage and reduce the uncertainty risk of the system. At present, experts and scholars have made remarkable achievements in multi-level, multi-product, and forward and reverse network integration. The establishment of an uncertain environment model in the research will be the focus of future logistics network planning research. The uncertain factors that pay more attention to mainly include the generation rate of waste products, the price of product recycling, the quality of recycled products, and the capacity of equipment. The solutions to uncertain problems in the model mainly include random planning, fuzzy theory, scenario analysis, and robust optimization. The solution method of the network model can be divided into four categories: precise algorithm (such as branch and bound method, Bender's decomposition method), heuristic algorithm (genetic algorithm), multi-objective programming algorithm, optimization solving software, such as LINGO software because of its powerful modeling Language, read and write database functions are widely used in solving linear and nonlinear integer programming problems.

3. Research on Consumers' Willingness to Recycle in Reverse Logistics Network

As people's awareness of environmental protection continues to increase, more and more people pay more attention to the recycling of waste products.

Many experts and scholars believe that consumers' recycling behavior has an important impact on the establishment of recycling systems. Through empirical research, Young et al. found that although direct economic incentives can effectively stimulate consumers to participate in recycling activities, the effect is not lasting. Improving consumers' environmental awareness is an important aspect of promoting recycling activities [7]. Darby analyzed specific recycling cases through a case study method, and found that consumers' personal recycling habits and income variables in demographic characteristics have a significant impact on recycling behavior. Vining through research on consumer recycling knowledge, demographic characteristics, recycling motivation, etc., believe that the main factors that hinder consumers from participating in recycling are the long recycling distance, complex recycling channels, and waste of time and money [8]. Lu Yingying and Zhao Xu used Shanghai residents as the research objects to investigate the characteristics of consumer recycling behavior and influencing factors. The research results are consistent with other scholars' results in recycling habits and behavior control cognitive factors, but they believe that subjective norms have no significant effect on recycling behavior. Dai Ying et al. discussed the literature on consumer recycling behavior from the three aspects of consumer recycling behavior influencing factors, analysis methods, and how to improve the recycling rate of waste products, and reviewed the research results of domestic and foreign scholars. On the basis of the reverse supply chain, Zhang Xian et al. divided consumers into active participation and passive participation in recycling, and passively participating consumers usually need economic incentives (pre-incentive and post-incentive). Based on the research of consumers' intention to participate in recycling activities. Lan believes that insufficient consumer participation is the key constraint factor in the construction of the current recycling system. Among them, recycling convenience, publicity information, service motivation, and economic factors are the main objective factors that affect recycling enthusiasm. Factors, and make an analysis and comparison of the three classic recycling modes.

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Starting from individual consumers, Li Huan studies the factors that affect consumer intentions and recycling behaviors, and how to better promote the conversion of behavioral intentions into e-waste recycling actions. Consumer recycling behavior is a key part of the recycling system, and it has gradually become the focus of academic circles. When scholars analyze consumer recycling behavior, they are mainly based on the theory of planned behavior. The theory of planned behavior is derived from the rational behavior theory of Ajzen and Fishbein, adding perceptual behavior control on the basis of the original theoretical model. The theory of planned behavior believes that human behavior is mainly affected by individual factors and social factors, and willingness is the most direct antecedent variable of the actor, but human behavior is not always controlled by personal will. Behavioral attitude, subjective norms, and perceptual control will also have an effect on behavioral willingness. Consumers' recycling willingness and behavior are affected by many factors, and there are many domestic and foreign researches on this issue. Horn summarizes its influencing factors into internal and external incentives and internal and external stimulating factors: internal incentives are consumers' recognition of recycling behavior. Inner willingness to participate in the recycling action; external incentives means that consumers can obtain material rewards or get the incentive recognition of their relatives and friends for participating in the recycling action; internal stimulating factors are consumers' participation in the recycling action, increasing the behavior and results of the recycling of waste products The awareness of environmental protection and the improvement of environmental protection awareness; and the external stimulus is that the recyclers actively provide convenient recycling facilities, good recycling services and appropriate recycling prices, etc., in order to reduce the time and money cost of consumers and make them active Participate in recycling operations. It can be seen from the above four types of factors that internal and external incentives and internal promotion factors belong to the subjective initiative of consumers, and only external promotion factors are related to the reverse logistics network design and can be determined by corporate decision-making. The closer the recycling center is to the consumption area, the larger the service radius, the better the service quality, the more convenient the product recycling, the higher the recycling price, and the higher the consumer's enthusiasm for recycling. The research on reverse logistics network design under uncertain environment is a difficult point of current research and will become a hot issue in future research.

4. Summary

This article summarizes and compares the research in three aspects: research questions, research methods, and consumers' willingness to recycle. Discuss the future research trend of reverse logistics network design, and provide suggestions and directions for scholars in the future research. In the current research, most of the durable goods such as electronic products, automobiles, washing machines, etc. are studied. There is a lack of research on the recycling and reuse of paper, plastic, packaging and other products. Almost all existing researches focus on the cost optimization of the enterprise's establishment of reverse logistics networks, and many researches are conducted from the perspective of overall cost optimization of the supply chain. The research lacks consideration of customer service level, supply chain responsiveness, risk tolerance, and environmental impact of recycling activities. Multi-objective optimization has become a future research trend. The most commonly used planning models in logistics network design are integer programming models, mixed integer programming models, and random integer programming models. Most of the models are static models, and the research on dynamic models is insufficient. The research on the uncertainty of reverse logistics is the key and difficult point, and it is also the weakness of the existing research.

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