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Research Article

Security Strategy Optimization and Algorithm Based on 3D Economic Sustainable Supply Chain

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Based on the background of system intelligence in the Internet of things era, this paper applied the design field of interaction design and user experience in the early days, and conducted further in-depth investigation through a large number of case studies and the use of quantitative and qualitative investigation methods. Based on this, the theories and strategies of the interaction design between enterprise members and intelligent machines were put forward and tested by actual design. At present, air pollution, energy shortage, and other issues are becoming more and more prominent, and calls for energy conservation, emission reduction, strengthening corporate social responsibility, and reducing the impact of economic development on the environment and society are growing. Therefore, companies must rethink their strategies and adapt their supply chains. Based on limited resources, enterprise machines have traditionally acted as a tool or a communication tool for a person. Yet, at the same time as the economy develops, the direct interaction between human and machine gradually emerges, and the economic development of an enterprise is bound to contradict environmental protection and social responsibility. Therefore, for enterprises, in different periods, different priority strategies will be adopted for the three dimensions of economy, environment, and society. The results showed that the economic benefit has increased by about 30% or more, and the ecological pollution has been reduced by about 40% on the original basis. Under the action of a sustainable supply chain, consumer satisfaction tends to be full and can be maintained at about 97%. In this context, the comparative analysis of the strategic optimization of enterprises in the supply chain is the focus of this thesis.

1. Introduction

At present, research on sustainable supply chain networks mainly focuses on corporate social responsibility assessment, technology selection, energy conservation, emission reduction, etc., but less consideration is given to strategic decisions based on different priorities under the three-dimensional economic sustainable supply chain. With the development of technology and the arrival of the era of intelligent network, the relationship between humans and machines has become increasingly close.

This paper broke the previous research that only quantified sustainable supply chain networks. First, it conducted a theoretical analysis of enterprises under different strategies and then built a sustainable supply chain network model. Then, it was studied from the two main aspects: first, through the analysis of the optimal countermeasures in terms of price, technology, and social responsibility in different strategies, it was determined which strategy is the most favorable under the condition of equilibrium; and second, through the establishment of a closed-loop supply chain network, the optimal sustainable supply chain network was determined by solving the situation that the demand was affected by corporate social responsibility, and the optimal mode of the sustainable supply chain network under various strategies was compared to provide reference and suggestions for enterprises when making strategic decisions and optimization.

In the early research, it was found that the current research on human-computer interaction was based on human unit, or human-machine surface interaction, without considering the deep development trend and design requirements of human-machine interaction in the age of the intelligent network. It started from the new social environment and the development of human-human social relations; this paper proposed the concept of machine social role and defined its meaning. The issues were analyzed, and the following conclusions were drawn: when economic and environmental goals conflict with social goals, it is more reasonable and practical for the company to determine the priority strategy for the supply chain. It is appropriate to first consider environmental and economic goals and then strategies for social goals. In addition, to a certain extent, the priority strategy of the supply chain has a driving effect on the economy, society, and the environment, but once a certain limit is exceeded, it will have an adverse impact on the economy, society, and the environment. In the process of undertaking social responsibilities, enterprises must first achieve a balance between the economy and the environment. Therefore, under the circumstance of limited resources, environmental protection investment should be a priority.

2. Related Work

Supply chain responsiveness is a way for companies to gain a competitive advantage by responding quickly to consumer demands. The competitive business environment forces companies to solve problems that require flexibility and quick response within the framework of cost efficiency. Harsasi and Minrohayati took supply chain responsiveness as an intermediate variable and observed the impact of supply chain management on competitive advantage. Three hundred and thirty-four garment manufacturers in Indonesia were surveyed by postal questionnaire. Only fifty-seven questionnaires were valid and could be used for further analysis. The data were analyzed through mathematical analysis, which showed that all independent variables have a positive impact on the dependent variable, proving that supply chain management and supply chain responsiveness have a positive impact on gaining a competitive advantage [1]. Samaranayake aimed to document research into the development of a conceptual framework for supply chains. The aim was to develop a comprehensive framework and provide a way to plan the many components in the supply chain, such as suppliers, materials, resources, warehouses, activities, and customers. The proposed framework was based on a single structuring technique, where bills of materials, warehouse lists, item networks, and operational routes in manufacturing and distribution networks were combined into a single structure. The framework was described with digital examples in manufacturing and distribution environments. Findings of the numerical testing showed that each network in the supply chain provides an integrated approach to planning and executing many components to further improve the supply chain environment [2]. Park et al. studied and developed a mixed integer linear programming model that integrates multimodal transport into a switchgrass-based bioethanol supply chain. The two modes of transportation were truck and rail. The Park et al. study aimed to minimize the total cost of cultivation/harvest, infrastructure, storage process, bioethanol production, and transportation. Strategic decisions, including the number and location of intermodal facilities and biorefineries, as well as tactical decisions, such as the amount of biomass to be transported, processed, and converted to bioethanol, were all validated using the North Dakota case study. It was found that the multimodal transport option is more cost-effective than the single mode of transport, resulting in a lower cost of bioethanol. A sensitivity analysis was performed to demonstrate the impact of key factors on MTSBSC decision-making and bioethanol costs [3]. Liao and Chung research was an attempt to determine the economic order quantity of deteriorating goods under the condition of allowing delayed payment, in which the supplier provides the retailer with the allowable delay period, and the retailer in turn provides the maximum trade credit period to its customers. The chain supply chain system developed a theorem to determine the retailer's optimal ordering strategy under the above conditions. These results help decision makers of retailers to accurately determine optimal costs, and a numerical example demonstrates the applicability of the proposed method [4]. One of the most interesting topics in supply chain management (SCM) is the integrated supplier-buyer production-inventory problem, where the key issue is determining the economic lot size for each shipment and delivery. Most of the research on this issue assumes that the product is screened and the process is perfect, but in practice, there may be screening errors with imperfect quality. Lin considered a simple single-supplier/single-buyer supply chain system in which products received were of defective quality and a 100 percent screening process was performed, with possible inspection errors. Its purpose was to determine the optimal number of shipments and the size of each shipment to minimize the combined annual cost incurred by the supplier and buyer. At the same time, a cost model was developed for the supply chain system and a solution was proposed to find the optimal strategic solution [5]. The Internet of things is widely used in various fields because of its high intelligence and diversity. IoT security has perception information, network environment, and user requirements. Based on the multilayer and multidimensional features of the security elements of the Internet of things and security-oriented system indicators, it adopts the autonomous idea of "cluster users" collaboration, integrates the concept of independent disciplines, and fine-tunes the "single-user" process to improve the overall security performance. Multilayer security elements, from microscopic to perception layer, from singular to plural, realize autonomous configuration and adjustment, and realize self-update and optimization of the overall security of the system. Zheng et al. adopted a multidimensional constrained optimization method to optimize the perceptual layer configuration. In the process, the configuration requirements were fed back to the cluster users at each layer; therefore, the security configuration optimization was triggered from the perspective of the perception layer [6]. Song et al. gave the embedding optimization strategy through theoretical derivation: optimizing the embedding modification position and optimizing the embedding modification direction. The quantitative relationship between the pixel modification probability and the difference between adjacent pixels was obtained through theoretical derivation, and it was proved that random ±1 modification cannot definitely enhance the steganographic security. The research can provide theoretical guidance for the design of steganographic algorithms. Compared with previous studies, the proposed embedding optimization strategy has the outstanding advantages of being easy to implement and effectively improving steganographic security [7]. With the continuous advancement of computer technology and economy, the computer industry continues to grow, and the demand for innovative talents in the Internet of things information age is growing rapidly. In this paper, the author analyzes the 3D practical teaching framework of computer graphics for social development, from modeling, rendering, lighting, texture, etc., all based on computer graphics algorithms and theories of the Internet of Things. Guo proposed a 3D computer graphics teaching framework, from the basic theory of computer graphics to experimental projects. According to the training and evaluation model of 3D teaching, public enterprises can fully understand the knowledge system of a computer, teach effective learning methods, and then better optimize strategies [8].

3. Optimal Supply Chain Strategy Algorithm Based on Three-Dimensional Economy

3.1. Meaning of Sustainable Supply Chain and the Integration of Strategic Security Optimization. As far as sustainable development is concerned, some scholars have proposed a three-dimensional economy, and pointed out that in order to seek their own development, enterprises must also ensure the balance of economic prosperity, environmental protection, and social welfare; that is, sustainability is at the intersection of three dimensions of economy, environment, and society [9]. Only by focusing on sustainable development can enterprises and their own supply chains truly improve social welfare and reduce environmental pollution. The three-dimensional economy requires enterprises to transform from the pure profit goal to the profit maximization of realizing the triple goals of economy, environment, and society [10]. People's attitude towards the Internet of things can no longer be limited to mechanical tools. The communication between humans and intelligent systems has also changed from "information communication" to "emotional communication," and the interaction between "human-machine" and "human" is also changing. Changes in interaction patterns lead to changes in human relationships [11]. With the gradual development of human-computer interaction technology and the mobility of enterprise equipment, it has penetrated into people's daily life. Economic benefits, environmental benefits, and social benefits are interrelated [12]. Most of the survey results showed that reducing environmental pollution and fulfilling corresponding social responsibilities have a significant correlation with corporate profits. First of all, the acquisition of profits provides a certain amount of capital for environmental protection and social responsibility so that companies can invest more in environmental protection technology, increase jobs, and protect workers' lives, so as to undertake more social responsibilities [13]. In addition, enterprises actively participate in environmental protection and fulfill social responsibilities, which can effectively improve the company's brand image, win customers, and bring long-term benefits to the company. The most significant benefits of sustainable supply chain management are manifested in three levels; namely, the first level is economic performance, the second level is environmental performance, and the third level is social performance [14]. Since sustainable supply chain cooperation occurs at the three-dimensional junction of economy, society, and environment, companies in the supply chain should start from a strategic perspective and long-term goals, rather than simply pursuing any one or two of the three dimensions [15]. The sustainable supply chain structure is shown in Figure 1.

3.2. Traditional Supply Chain and Sustainable Supply Chain. In the process of overhauling traditional supply chain processes, managers are increasingly aware that companies must address sustainability issues in supply chain operations. Sustainable development generally refers to "the use of its resources to meet current needs without compromising the ability of future generations." The concept was vague at first, but scholars paid more attention to environmental issues in order to more accurately apply the concept of sustainable development in supply chain practice, that is, sustainable supply chain management starts from the environmental perspective of the supply chain, and proposed a supply chain coordinated with the environment [16]. However, as research continues to deepen, the term sustainable development is gradually combined with social, environmental, and economic responsibility. At present, the research on "sustainable supply chain" in academia mainly focuses on the concept of "sustainable supply chain"; that is, "in order to achieve economic, environmental, and social goals, companies integrate the concept of sustainable development into the enterprise interior and supply chain in production, sales, storage, and information exchange" [17]. With the in-depth understanding of the three-dimensional theory, in the practice of discussing the sustainable supply chain, it is necessary to emphasize its key factors and clarify its related concepts. This paper referred to the relevant literature in the field of supply chain and sustainable supply chain to deepen the research and understanding of this topic [18].

3.3. Optimization of Sustainable Supply Chain Is Inseparable from the Three-Dimensional Economy. Supply chain refers to the combination of multiple interdependent economic organizations through the collaborative management of

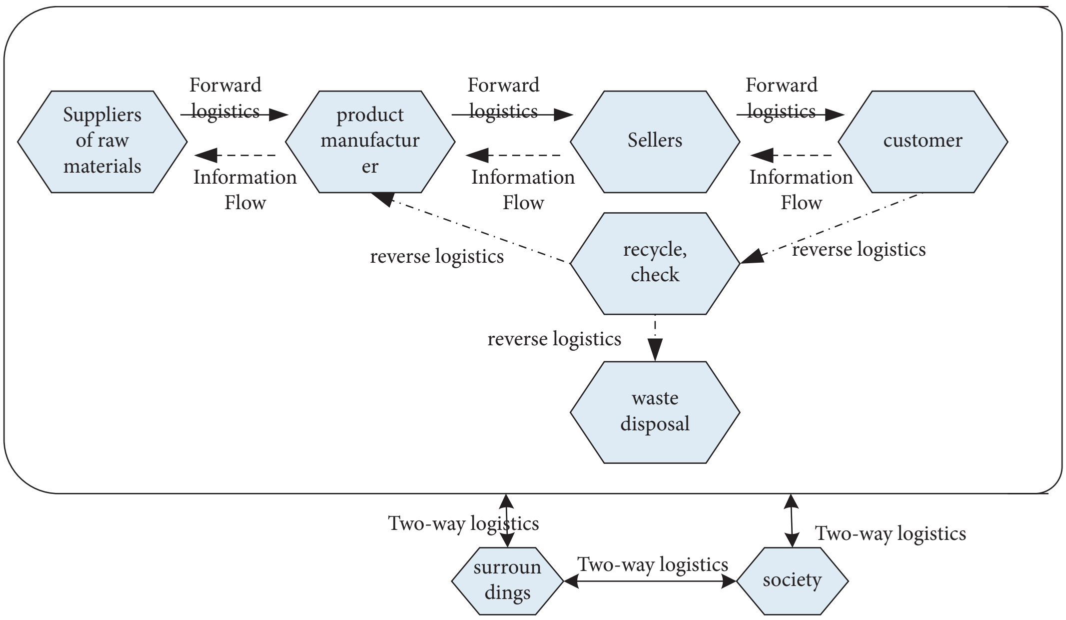

Figure 1: Sustainable supply chain structural diagram.

various resources, such as inventory and information. With the increasingly fierce market competition, the traditional competition has gradually evolved into the competition of supply chains [19]. Therefore, sustainable supply chain management needs to incorporate environmental and social issues into the planning and operation of the supply chain, so as to improve the economic benefits of the enterprise and ensure its overall benefits, thereby improving environmental performance and social performance of supply chain members [20]. Since the members of the supply chain are an independent economic organization, they can engage in the operation of multiple supply chains at the same time in the case of seeking common interests. Therefore, there are competition and cooperation among members. In cooperation and competition, there are inevitably many risks such as asset specificity, environmental uncertainty, information risk, and performance ambiguity [21]. A simplified schematic diagram of the supply chain is shown in Figure 2.

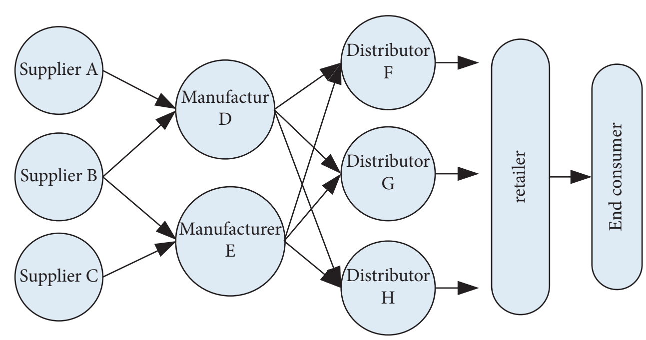

Figure 2: Simplified schematic diagram of the supply chain.

3.4. Supply Chain Application and Corporate Social Responsibility. In recent years, the rapid development of Internet technology has changed the business structure and mode of operation of enterprises. The combination and development of 5G and various Internet technologies has laid a solid technical foundation for enterprises to develop innovative businesses. Among them, the sustainable supply chain technology based on the Internet of things is widely used in supply chain scenarios. From the perspective of sustainable development, this paper compared and analyzed the results of domestic and foreign research on enterprise supply chain informatization. For IoT applications in the supply chain, this research focused on each link. From production, logistics, to consumers, this study incorporated all actors in sustainable supply chains into different production processes and logistic layouts, while others only involve corporate users. Sources of product names and other information in the region are available to all stakeholders. Although the information collection and sharing of the Internet of things has penetrated into all aspects of the supply chain, the depth and influence of sharing is still quite limited. In most cases, members of the sustainable supply chain system can only obtain product information, and the sustainable development evaluation information, which is also closely related to stakeholders, has not been effectively collected and utilized. A simple supply chain network is shown in Figure 3.

Different scholars have different understandings of corporate social responsibility. The US Economic and Trade Commission recommends that the social responsibility of a "three-center" company consists of three concentric circles. From outside to inside is an invisible responsibility to promote the development of society. In the process of realizing economic responsibility, five aspects such as corporate social responsibility, economic responsibility, legal responsibility, moral responsibility, and corporate voluntary responsibility should be fully considered. In short, CSR emphasizes that companies should not only pursue

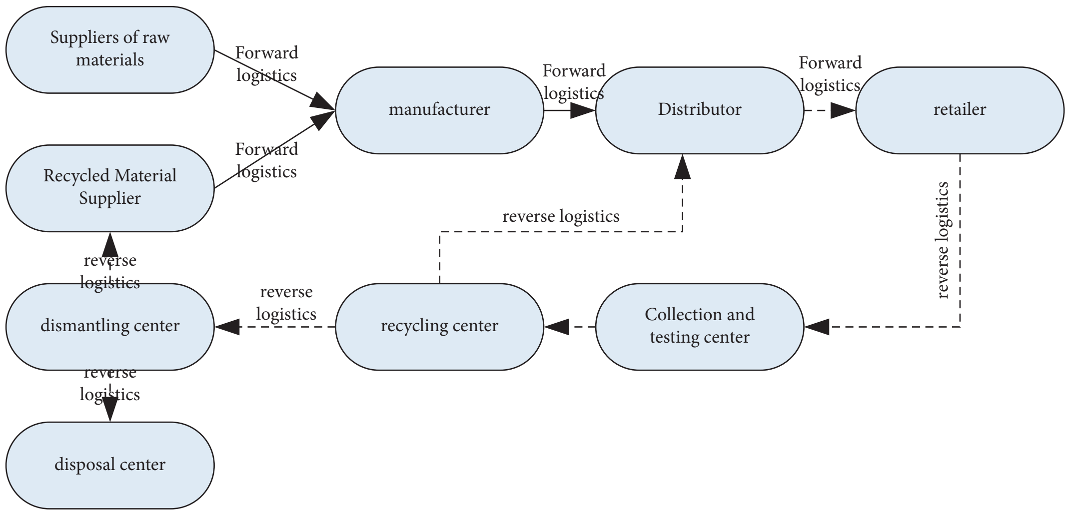

Figure 3: Simple supply chain network structure.

Table 1: Measures of corporate social responsibility.

Stakeholders	Social influence	Index	Core theme
Worker	Safety	Lost days due to work attrition	Labor, human rights
Worker	Fair working conditions	Number of jobs created	Labor, human rights
Community	Community development	Number of jobs created	Community development
Community	Environment	Amount of waste generated	Environment
Consumer	Safe consumption	Quantity of potentially hazardous products	Consumer issues

economic interests, but also pay attention to their contributions to the environment, customers, employees, and communities. However, if viewed from a development process point of view, corporate social responsibility is more concerned with promoting and maintaining relationships with stakeholders. Table 1 shows the measures of corporate social responsibility.

3.5. Sustainable Supply Chain Design Theory and Algorithm Model. In terms of economic purposes, the primary goal is to maximize profits, and for the company, its main profit method is the sales of products. In terms of environmental protection purposes, minimizing emissions, especially in the manufacturing process, for companies, can reduce environmental pollution by investing in technologies that save energy and reduce emissions. Therefore, in terms of environmental protection indicators, the most important issue is to determine the optimal investment in carbon emission technologies. In regard to sustainable supply chains, corporate social responsibility (CSR) is based on the work the company creates. For companies, the more energy they put into social responsibility, the more jobs they create. Therefore, in terms of social goals, the most important thing is to make the best social responsibility. In this model, there is no game between manufacturers and retailers. Therefore, the research of this model has certain reference significance for enterprises that combine production and sales.

In this model, the following decision variables are identified:

η: the company's CSR work, $\eta \in [0, 1]$

Z: the degree of investment in energy-saving and consumption-reduction technology, $z \in [0,1]$

P: product price.

In the case of a company, the greater the social responsibility it undertakes, the more jobs it creates. However, due to human resource constraints, the jobs that can be created will not grow indefinitely. From the perspective of marginal benefits, the marginal role of corporate social responsibility work under unit cost is diminishing. Conversely, a company can provide all the jobs for society as a whole. At the same time, for enterprises, by increasing investment in energy-saving and emission-reduction technologies, environmental pollution can be reduced, but their emission costs will gradually rise. This is because the limitations of the actual technology make it more difficult to reduce pollution, so investment must be increased to develop new technologies.

Therefore,

$$D = a - bp + k_1 z + k_2 \sqrt{\eta}. \quad (1)$$

Among them, a is the basic market capability, that is, supply chain products; b, k_1, and k_2 are the sensitivity factors of p, z, and η, respectively. The larger b, k_1, k_2, the more sensitive the commodity price, energy-saving and emission-reduction technology investment and social responsibility efforts. b, k_1, and k_2 are all positive numbers.

The profit expression for this company is as follows:

$$\pi_1 = \left(a - bp + k_1 z + k_2 \sqrt{n}\right)(p - c) - \frac{1}{2} s z^2 - hn. \quad (2)$$

The company's profit mainly includes three aspects: first, product sales revenue; second, energy-saving and emission-reduction technology; and third, enterprise's investment in social responsibility.

It is assumed that the total investment in energy-saving and emission-reduction technologies is $I = 1/2sz^2$.

Among them, s is the investment amount of energy-saving and emission-reduction technology. The larger the s is, the higher the required energy-saving and emission-reduction investment cost, and the cost has nothing to do with the required value; it is a one-time investment cost.

According to the CSR effort cost function form proposed by previous scholars, it is assumed that the CSR effort cost is $B = h\eta$, h is the CSR effort cost investment coefficient, and the larger the h is, the greater the required CSR effort cost. The same is a one-time investment cost.

The carbon emission function of the company is expressed as follows:

$$\pi_2 = \left(a - bp + k_1 z + k_2\sqrt{n}\right)(e - kz). \tag{3}$$

Among them, e' is the initial unit carbon emission of the product, and k' is the unit carbon emission saved through carbon emission technology investment.

So, e'-$k'z$ is the current unit emission after investing in energy-saving and emission-reduction technology.

The company's CSR function is expressed as follows:

$$\pi_3 = \left(a - bp + k_1 z + k_2\sqrt{\eta}\right)g\left(1 + \sqrt{\eta}\right). \tag{4}$$

In formula (4), g' is the unit of employment opportunities. As production increases, the expansion of the production line will bring more jobs, but they will have fewer and fewer jobs. Growth is not static but gradually tends to be balanced and saturated with the growth of market demand. Therefore, this paper assumed that there is a power function between g' and η.

In summary, the model is expressed as follows:

$$\begin{aligned} &\text{Max}\,\pi_1 = \left(a - bp + k_1 z + k_2\sqrt{\eta}\right)(p - c) - \frac{1}{2}sz^2 - hn \\ &\min \pi_2 = \left(a - bp + k_1 z + k_2\sqrt{\eta}\right)(e - kz) \quad . \\ &\max \pi_3 = \left(a - bp + k_1 z + k_2\sqrt{\eta}\right)g\left(1 + \sqrt{\eta}\right) \end{aligned} \tag{5}$$

The model solution and analysis are as follows.

Because the environmental indicator is mainly about saving and reducing emissions for sustainable development, if it is to be converted into an economic indicator, its emissions must be added to the CO_2 tax. Let c_t be the carbon tax per unit of carbon emissions, and the conversion process is as follows:

$$\begin{aligned} \min \pi_2 &= \left(a - bp + k_1 z + k_2\sqrt{\eta}\right)(e - kz) \\ &= \min \pi_2 = \left(a - bp + k_1 z + k_2\sqrt{\eta}\right)(e - kz)c_t \\ &\xrightarrow{\text{令}} ec_t = e\ ,\ k'c_t = k'\ \ \min \pi_2 = \left(a - bp + k_1 z + k_2\sqrt{\eta}\right)(e - kz). \end{aligned} \tag{6}$$

As for social goals, this paper believed that due to the investment of social responsibility, more job opportunities will be brought. Therefore, if it is to be converted into an economic indicator, the conversion process is as follows:

$$\begin{aligned} &\max \pi_3 = \left(a - bp + k_1 z + k_2\sqrt{\eta}\right)g\left(1 + \sqrt{\eta}\right) \\ &\left(a - bp + k_1 z + k_2\sqrt{\eta}\right)g\left(1 + \sqrt{\eta}\right)j_o \\ &\xrightarrow{\text{令}} g' j_o = g\ \ \max \pi_3 = \left(a - bp + k_1 z + k_2\sqrt{\eta}\right)g\left(1 + \sqrt{\eta}\right). \end{aligned} \tag{7}$$

The model after conversion is expressed as follows:

$$\begin{aligned} &\text{Max}\,\pi_1 = \left(a - bp + k_1 z + k_2\sqrt{\eta}\right)(p - c)\frac{1}{2}sz^2 - h\eta \\ &\min \pi_2 = \left(a - bp + k_1 z + k_2\sqrt{\eta}\right)(e - kz) \quad . \\ &\pi_3 \ = \left(a - bp + k_1 z + k_2\sqrt{\eta}\right)g\left(1 + \sqrt{\eta}\right) \end{aligned} \tag{8}$$

Then, through the reverse inference method, the strategies are obtained by the following theorems:

Equilibrium solutions (p_1, z_1, η_1) exist for all strategies, and the equilibrium solutions for each strategy are the same:

Best CSR efforts: $\eta_1 = 1$;

The optimal level of investment in energy conservation and emission reduction: $z_1 = 1$;

Optimal product price: $p_1 = a + k_2 + k_1 + bc/2$.

They are listed below for ease of expression:

The first strategy, the goal of most companies, is to make money, so it will not be influenced by the government and big companies. Under enormous pressure, they have to consider economy first, and environment and society second.

The second strategy, for some manufacturers, is in the face of pressure from the government and the general public; it is necessary to carry out strategy optimization and algorithm analysis from the company's three-dimensional supply chain in order to achieve emission-reduction standards. When the emission standard fails to meet the requirements and the corporate image is damaged, if the company wants to restore its image and earn certain benefits, it must take environmental protection as the primary task, taking into account both the economy and the society.

The third strategy is that some state-owned enterprises, within the scope of the SASAC's business operations, must first aim at "people-oriented," followed by the economy and the environment.

The fourth strategy is for some foreign trade companies; because of their strict international trade laws and regulations, in order to make them meet environmental protection requirements and social needs, enterprises must take into account the needs of economy, environment, and society.

A simple classification is shown in Table 2.

Taking the first strategy as an example, since π_3 is an increasing linear function with respect to η, the optimal CSR effort is $\eta_1 = 1$. Substitute $\eta_1 = 1$ into the π_2 function to get $\pi_2 = (a - bp + k_1 z + k_2)$ $(e - kz)$, and π_2 is a decreasing function on $z \in [0, 1]$, so the optimal energy-saving and emission-reduction investment level $z_1 = 1$; substitute $\eta_1 = 1$, $z_1 = 1$ into function π_1 to obtain its optimal commodity price $p_1 = a + k_2 + k_1 + bc/2$.

Table 2: Different strategic approaches.

Target strategy	Strategy 1	Strategy 2	Strategy 3	Strategy 4
Economy	Two	Three	Three	Two
Surroundings	Three	Two	Three	Two
Society	Four	Three	Two	Three

The strategies included in the first strategy are both economic and environmental. In this strategy, the company's contribution to society and investment in the environment must be above 1. This showed that in the absence of conflicting environmental and social goals, companies can think independently about economic issues and can devote maximum investment to environmental and social goals.

The second strategy has an equilibrium solution (p_2, z_2, η_2):

The best investment level for energy saving and emission reduction:

$$z_2 = \frac{ek_1 - k(a - bc + bg)}{2kk_1}. \tag{9}$$

Best CSR efforts:

$$\eta_2 = \left(\frac{(k_2 + bg)[k(a + bg - bc) + ek_1]}{2k((bg + k_2) - 4bh)}\right)^2. \tag{10}$$

The best product price:

$$p_2 = \frac{bgk[(gb + 3k_2)(c - g) + g(a + e)] + 2k(c - g)(k_2 - 3bh)(gk_2 - 2h)(ek_1 + ak)}{k((bg + k_2) - 4bh)}. \tag{11}$$

If and only if $h > k_2 g$, $k_1(e - 2k) < k(a - bc + bg) < ek_1$, $k_2 + bg > \sqrt{4bh}$, $a + (ek_1/k) + (8bh/k_2 + bg) < bc + bg + 2k_2$, $2b > bg - k_2$

So in the second strategy, the first is the concern for the environment, and the second is the impact on the economy and society. Therefore, companies must first determine their own investment in energy conservation and emission reduction, and then determine their own prices and social efforts. On this basis, using the method of reverse reasoning, the market supply and demand balance solution in the second stage is obtained first, and then the technical input in the first stage is analyzed on this basis.

We differentiate for π_1+π_3 with respect to p, η and set its first derivative to zero to get the response function of selling price and CSR effort:

$$\begin{aligned} p_2 &= -\frac{z_2 k_1 - (bg - k_2)\sqrt{\eta_2} + a + bc - bg}{2b} \\ \sqrt{\eta_2} &= \frac{(bg - k_2)p_2 - gk_1 z_2 - ag + (c - g)k_2}{2(h - gk_2)} \end{aligned}. \tag{12}$$

$\partial(\pi_1 + \pi_3)/(\partial p_2) = -2b < 0$, and $|\partial(\pi_1 + \pi_3)/(\partial p_2)| = 2b > |\partial(\pi_1 + \pi_3)/\partial p_2 \partial\sqrt{\eta_2}| = bg - k_2$.

So the equilibrium point exists and is unique, if and only if $h > k_2 g$, $2b > bg - k_2$

Next, we substitute the response functions of p_2 and η_2 into π_2 and derive z to obtain z_2, that is,

$$z_2 = \frac{k(a - bc + bg) - ek_1}{2kk_1}. \tag{13}$$

We substitute z_2 into the response functions of p_2 and $\sqrt{\eta_2}$ to get

$$\begin{aligned} \sqrt{\eta_2} &= \frac{(k_2 + bg)[k(a + bg - bc) + ek_1]}{2k((bg + k_2) - 4bh)} \\ p_2 &= \frac{bgk[(gb + 3k_2)(c - g) + g(a + e)] + 2k(c - g)(k_2 - 3bh)(gk_2 - 2h)(ek_1 + ak)}{k((bg + k_2) - 4bh)} \end{aligned}. \tag{14}$$

z_2, $\eta_2 \in [0, 1]$, so if and only if $k_1(e - 2k) < k(a - bc + bg) < ek_1$, $k_2 + bg > \sqrt{4bh}$, $a + ek_1/k + 8bh/k_2 + bg < bc + bg + 2k_2$, the equilibrium solution exists.

Figure 4 shows a summary of the sustainable supply chain approach.

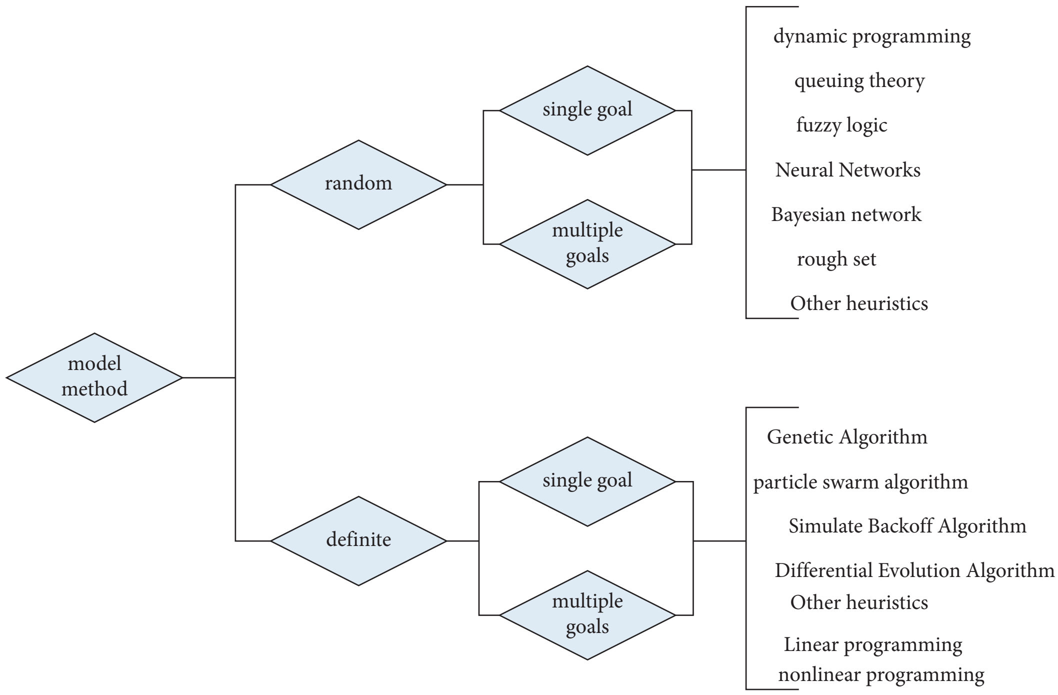

Figure 4: Summary of sustainable supply chain approaches.

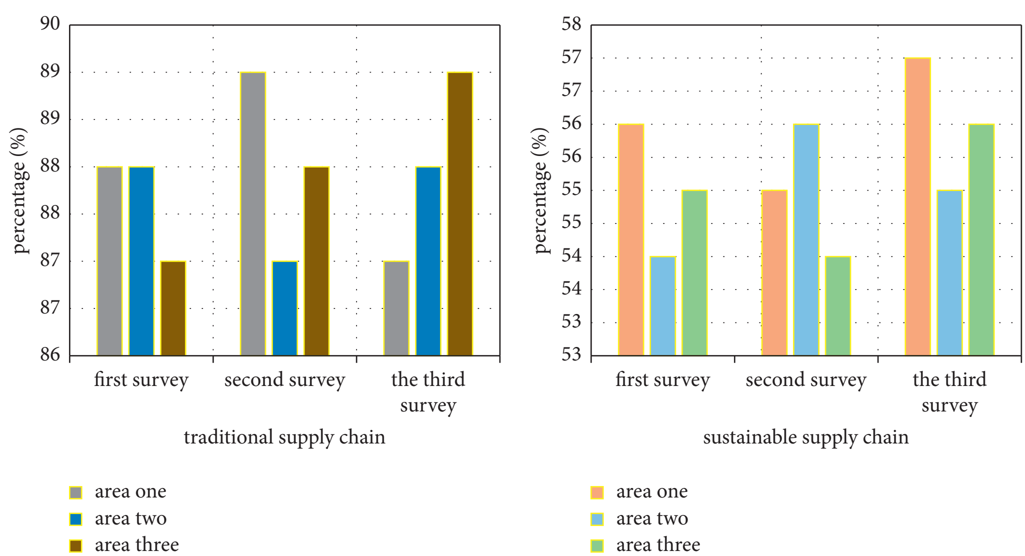

Figure 5: Comparison between ecological pollution before and after optimization.

This paper adopted the multi-index strategy method, in the three-dimensional economic environment, to determine the optimal cost, the greatest social responsibility, and the investment in energy-saving and emission-reduction technology of enterprises under different strategies. From the above analysis, it can be seen that at present, enterprises can only invest in energy conservation and emission-reduction technologies or social responsibility, or when their own interests are damaged (that is, the contradiction between the economy and the environment, or the contradiction between the economy and society), the enterprise can determine which one or both goals are more reasonable and realistic.

4. Comparison between Sustainable Supply Chain and Traditional Supply Chain under the Three-Dimensional Economy

A supply chain is a functional network system composed of suppliers, manufacturers, distributors, retailers, and consumers, which surrounds the core enterprise's raw material procurement, production, processing, storage, and end-user acquisition of products. The traditional supply chain management is aimed at maximizing the interests of the enterprise, and manages and controls the production efficiency, cost efficiency, etc. of the enterprise, resulting in ignoring the impact on the environment and society.

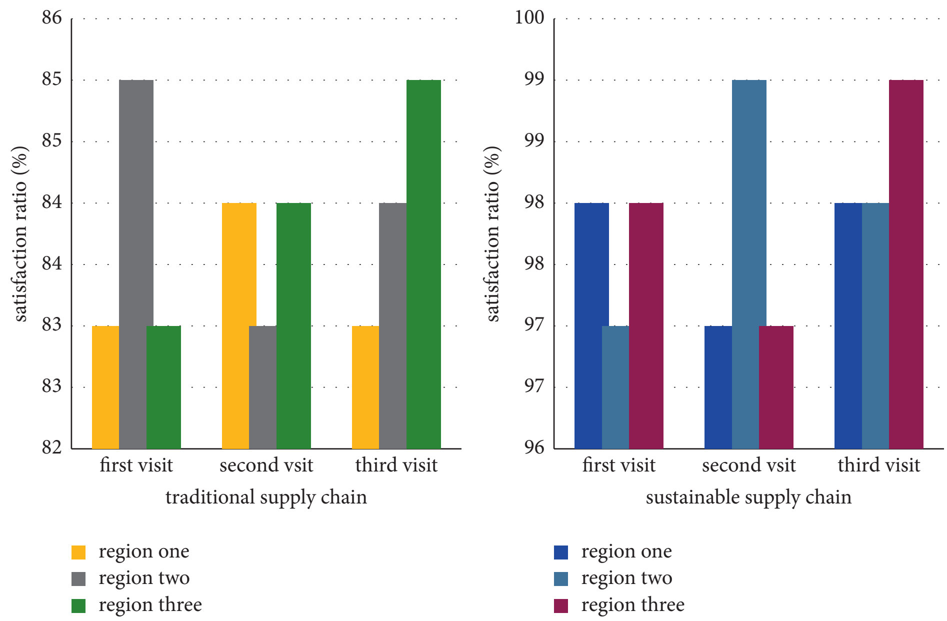

Figure 6: Consumer satisfaction comparison between supply chains.

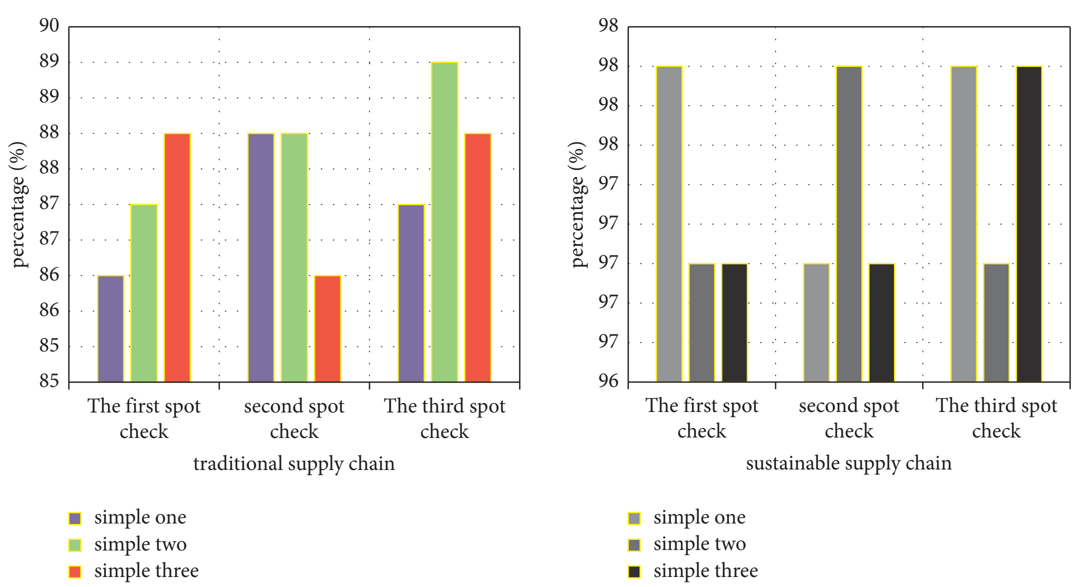

Figure 7: Comparison between product quality compliance rates under the two supply chains.

Therefore, there is still a long distance between the ideal level of natural interaction between enterprise personnel and intelligent machines. Technology is a big obstacle, and another obstacle is the idea that cannot be transformed into mechanical tools. Sustainable supply chain refers to the management of the three dimensions of sustainable development of logistics, information flow, and upstream and downstream enterprises in the supply chain from the perspectives of economy, environment, and society. Sustainable supply chain is to introduce the idea of sustainable development in the supply chain, and design and manage the supply chain from the three dimensions of economic, environmental, and social responsibility. From past experience, the competitiveness of the entire supply chain depends on the weakest link. That is to say, as long as there is a problem in one link, the entire supply chain will be hit hard. In this context, product quality issues, environmental pollution issues, and corporate social responsibility issues emerge one after another, attracting more and more attention. All in all, the impact of sustainable supply chain is mainly reflected in the ecological environment, economic benefits, product quality, consumer satisfaction, enterprise management, and so on. Figure 5 shows the comparison between ecological pollution before and after optimization.

Through three surveys in different regions, it can be found that more and more enterprises have changed their traditional perspective and began to focus on economic changes, deterioration of environmental pollution, public's

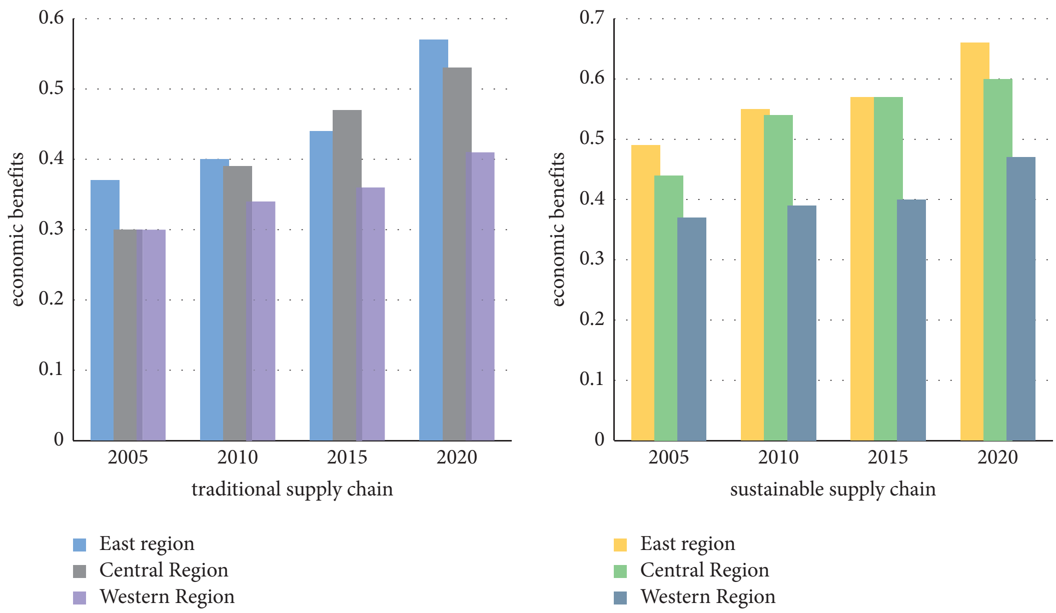

Figure 8: Comparison of economic benefits between supply chains.

transparency of the company's operations, environmental protection of consumers, and improvement of social responsibility as a whole, so as to get closer to the concept of sustainable development. The survey results showed that companies that have changed the traditional supply chain have made great improvements in environmental pollution, and energy-saving and emission-reduction technologies have improved in disguise. Figure 6 shows the comparison of consumer satisfaction between supply chains.

From three visits to different regions to investigate consumer satisfaction, it is found that the effect of sustainable supply chain makes consumer satisfaction almost 100%, while it is relatively difficult for traditional supply chain to reach 85%. The supply chain can help enterprises to implement the optimal strategy and can be distributed according to the statistics. It reduces resource loss and environmental pollution, achieves the optimal result of strategic optimization, greatly improves economic and social benefits, etc. It is understandable that consumer satisfaction is greatly improved. Figure 7 shows the comparison between product quality compliance rates under the two supply chains.

Through irregular random inspections, it is found that the compliance rate of samples produced by the traditional supply chain after a series of operations is basically maintained at around 87, and it is impossible to break the 90 mark, which is also a disguised loss for enterprises. However, actively adapting to the development trend of the Internet of things and actively improving the supply chain, the compliance rate of enterprises adopting a sustainable supply chain can be maintained at 97% or more, so the losses will inevitably be smaller and the economic benefits will be greater. The economic benefit comparison is shown in Figure 8.

From the comparison in Figure 8, it can be seen that the sustainable supply chain has a significant effect on improving economic efficiency. Therefore, when formulating and implementing relevant policies, it is necessary to fully consider factors such as the environmental, economic, and social responsibility in different regions to implement the optimal strategic decisions currently recommended, minimize losses, and increase consumer satisfaction to the highest level, thereby promoting economic and social development, enhancing environmental protection awareness, and improving economic efficiency and happiness index.

5. Conclusions

In general, the sustainable supply chain network design is based on the concept of sustainable supply chain, and the design principles mainly include the following points: profit maximization; environmental benefit maximization, that is, environmental pollution minimization; social benefit maximization; the principle of overall optimization and coordination; the principle of conformity to product characteristics; uncertainty, etc. The traditional supply chain management aims to reduce costs and improve services, and pays less attention to environmental issues. However, rising environmental concerns and concerns about resource depletion have prompted managers at all levels to adopt tougher environmental regulations. At the same time, the public's awareness of environmental protection is increasing day by day, and third-party environmental groups are putting more and more pressure on the company. Under the influence of this change, many companies have started environmental protection projects to solve environmental problems. In addition, due to the restrictions on the use and discharge of hazardous substances in regulations, companies must consider environmental factors to establish supply chains, prompting companies to extend environmental protection plans to suppliers and consumers, and actively promote the concept of sustainable development.

Data Availability

The datasets generated and/or analyzed during the current study are not publicly available due to sensitivity and data use agreement. No data were used to support this study.

Disclosure

The authors confirm that the content of the manuscript has not been published or submitted for publication elsewhere.

Conflicts of Interest

The authors declare that there are no potential conflicts of interest.

Authors' Contributions

All authors have seen the manuscript and approved to submit for publication.

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