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Research Article

Green Logistics Partner Selection Based on Pythagorean Hesitant Fuzzy Set and Multiobjective Optimization

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With the deepening of the uncertainty and fuzziness of people's understanding of things, it becomes more convenient to use fuzzy decision making in evaluating schemes. These schemes not only include quantitative data but also consider more and more uncertainty evaluation information. In fuzzy theory, the Pythagorean fuzzy set is extended, both of which are less than or equal to 1, which increases the scope of application. This paper mainly studies the selection of green logistics. Based on the original TOPSIS principle, this paper introduces a Pythagorean fuzzy symmetric cross entropy to describe the difference between two Pythagorean fuzzy numbers and proves its rationality. The model is applied to the selection of green logistics and compared with the results obtained by other different methods, which also shows the effectiveness and practicability of the model. It extends the use of fuzzy sets and can solve some problems that cannot be solved by intuitionistic fuzzy sets before.

1. Introduction

With the influence of global economic integration, more and more companies, regions, and even countries are coming together due to competition or cooperation, and decision making is an essential part of it. People involved in decision making increase and the rights of individuals to participate expand, the speed of decision making becomes slower, and the process becomes more complex. Thus, multiobjective decision making has developed into an extremely important research area in modern decision theory and decision science, with far-reaching applications in engineering, logistics, medicine, and military [1].

The selection of suppliers is gradually diversified and globalized, and the economic and practical significance of supplier selection is becoming more and more prominent, which can help enterprises to reasonably reduce their operating costs and gradually improve the operational efficiency, especially with the increasing severity of resource scarcity and environmental problems, the supply chain management is also increasingly advocating "green". Therefore, the evaluation and decision of green logistics has become a more important part. In the selection and multiobjective decision-making stage of green logistics based on the collected data, the selection of criteria may not be unique and uncertain, and the criteria need to be established according to the analysis on the decision objectives. Moreover, at this stage of supply chain development, not all data are precise and can be described accurately, and some of the criteria have uncertain and vague data descriptions [2]. More guidelines are some linguistic descriptions that cannot be directly described by data, such as green image of suppliers, green competitiveness, and production capacity of suppliers. Thus, multiobjective decision making for suppliers in a fuzzy environment is a worthwhile research problem [3].

Multiobjective decision making usually means that there are multiple alternatives and decisions are made after evaluating them under multiple criteria. Sets have evolved from the classical one containing deterministic elements to include fuzzy sets with fuzzy element descriptions, and thus, the multiobjective decision making developed on the set theory is extended to fuzzy multiobjective decision making. In existing multiobjective decision problems, which in turn increase the difficulty of multiobjective decision problems [4]. In fuzzy criterion decision making, the development of intuitionistic fuzzy sets is more complete and mature, but because the range of its elemental affiliation and disaffiliation is the sum of the two is less than or equal to 1 limits the situation where the uncertainty of both the affiliation and disaffiliation of the evaluation value under some criterion is larger and leads to its sum being greater than 1. Reference [5]. Therefore, the research on the selection of green logistics based on the Pythagorean fuzzy environment done in this paper has some practical significance.

Chapter 1 describes the current research background of green logistics selection and the main structure of this paper. Chapter 2 introduces the current status of domestic and foreign research in related fields and summarizes the research significance of this paper. Chapter 3 studies the green logistics in an environment and gives a multiobjective decision based on the priority set operator and Pythagorean symmetric cross-entropy model. Chapter 4 tests and analyzes the scheme proposed in this paper. Chapter 5 summarizes the research contents of this paper and gives an outlook on future research directions.

2. Related Works

Fuzzy set (FS) is a fundamental and widely used concept, and Zadeh proposed to express the uncertainty and fuzziness of decision information in terms of the degree of affiliation and the FS theory developed rapidly [6]. However, it is not enough to describe uncertainty by affiliation alone, so Attanassov proposed by expressing the fuzziness and uncertainty of decision information by using the concepts of disaffiliation and hesitation simultaneously [7]. Subsequently, Gau and Buehrer defined the vague set. After this, the hesitant fuzzy set (HFS), which allows affiliation to be expressed in the form of multiple sets of possible values to express the degree of hesitation of the decision maker in expressing goal preferences in the decision process, was proposed [7]. Although fuzzy sets have been developed extensively, they still cannot solve the case. For example, an expert expresses his opinion that a solution satisfies a criterion to the extent of 0.8 and does not satisfy it to the extent of 0.5. The situation cannot be solved by intuitionistic fuzzy sets (because the sum of 0.8 and 0.5 is already greater than one). Therefore, which expands the space in which the affiliation and disaffiliation degrees in a set should be satisfied, i.e., [8]. The relationship between the Pythagorean affiliation and complex numbers is also well discussed by Yager and Abbasov and proved that Pythagorean affiliation is a subset of complex numbers, called π-i numbers, and proposed the underlying set operator to set the criterion satisfaction.

Cross entropy is a measure that can determine the difference of two sets. Bhandari and Pal defined cross entropy in a fuzzy set by means of an affiliation function. The principle of maximum cross entropy can be used to select representative samples from large databases and is used in machine learning and decision trees [9]. Fan et al. gave a multiobjective and cross entropy in the Pythagorean environment [10].

The success of green logistics selection is an important part of the successful implementation of green purchasing in retail companies, and the selection of suitable green logistics means that a part of the environmental impact can be eliminated and thus the environmental performance can be improved [11]. In 1994, Webb gave the idea of green purchasing by studying the environmental impact of certain products to advocate the selection of suitable raw materials through environmental guidelines, while focusing on the recycling of materials by the concept of green purchasing. The National Science Foundation funded a $400,000 study on “Environmentally Complex Manufacturing”, which was then adopted as an important research component. At present, the research on green supply chain has achieved certain results, but it has not formed a complete systematic theory, while not many domestic enterprises accept and advocate the concept of GSCM [12]. Many scholars at home and abroad have introduced the knowledge of fuzzy aspects and other theories into the various steps of green logistics selection.

A series of studies on fuzzy multiobjective green logistics selection problems in the form of trapezoidal fuzzy numbers were conducted by Wu Jian et al. Gao et al. introduced trapezoidal a fuzzy soft set into green logistics multiattribute group decision making [13]. In the green logistics selection process, both Wang Dao Ping and Zhou Qinghua et al. used the entropy value method to improve TOPSIS based on hierarchical analysis and intuitionistic fuzzy environment, respectively [14]. Zhou Rongxi et al. increased the dynamics of the evaluation process by network hierarchical analysis and a radial basis function neural network model [15]. Hsu et al. used the selection of indicators in the supply chain selection process. Büyüközkan G et al. proposed a hybrid integration of DEMATEL, ANP, and TOPSIS, which can test GSCM [16]. Tseng et al. used gray correlation analysis to rank alternative suppliers whose data are represented by linguistic preferences and the proposed method can solve the criterion problem in GSCM [17]. Hashemi combined network analysis process and improved gray correlation analysis and rank suppliers separately [18]. Mirhedayatian et al. used network data envelopment analysis to make an evaluation of GSCM performance, and YijieDou et al. used a gray process-based network analysis model to explore the intrinsic relationship between GSCM and supplier performance [19, 20]. Banaeian et al. comparatively analyzed TOPSIS when combining fuzzy sets for green logistics selection. VOKOR and GRE methods [21]. Jian Li used a green logistics selection problem where the given information is probabilistic hesitant fuzzy information [22].

The affiliation space described in the Pythagorean fuzzy sets is larger compared, which is ideal for expressing fuzzy information while having stronger applications and more effective in dealing with uncertainty problems [23]. In the evaluation of green logistics, the decision information with fuzzy uncertainty is usually given, and sometimes the weight of the criterion for judging the candidate green logistics may not be accurately determined, so the study of such problems has certain theoretical and practical significance [24]. Therefore, this paper enriches the study of Pythagorean fuzzy sets theoretically by studying the Pythagorean fuzzy sets, giving the aggregation operator for fuzzy information aggregation from two aspects, and verifying the validity and rationality of the proposed operator by combining it with cross-entropy theory [25]. In addition, this paper improves the existing methods and models for decision selection of suppliers and provides new ideas and solutions for decision makers.

3. Problem of Green Logistics Options in a Fuzzy Environment of Pythagoras

There is no unified definition of green logistics. The first proposed man who believed that green logistics can restrain the environmental pollution.

Green logistics distributes products to customers in the mode of sea land intermodal transportation. After reaching an agreement with customers, on the one hand, they cooperate with production enterprises and logistics carriers and conduct on-site investigation on the storage, shipment, and delivery conditions of products in the port warehouse during the period, so as to ensure the safety of product storage and the timely and smooth logistics shipment [26]. On the other hand, we can efficiently exchange important information with customers, such as the receiving port, transfer place, and receiving point, so as to deliver the products to customers accurately at the first time. On the basis of deeply tapping the potential of existing land and water transportation, they also carefully deduce the key points of sea land intermodal transportation and various possible abnormalities in advance and check the potential hidden dangers of transportation one by one [27]. At the same time, by strengthening the whole process supervision and real-time tracking and coordination, we can timely grasp the situation of products in transit. The structure diagram of various elements of green logistics is shown in Figure 1.

3.1. Theory and Model. The ordinary Pythagorean defined as single-valued Pythagorean fuzzy sets.

Any Pythagoras fuzzy is expressed as follows:

$$P = \{\langle x, \mu_P(x), \nu_P(x)\rangle x \in X\}. \tag{1}$$

Satisfying the following constraints:

$$0 \le (\mu_P(x))^2 + (\nu_P(x))^2 \le 1. \tag{2}$$

The smaller the value of x, the more information about x and the more accurate it is; and vice versa.

For simplicity, the elements of the PFS $(\mu_P(x), \nu_P(x))$ are defined as Pythagorean fuzzy numbers (PFN), which can be written as $\gamma = P(\mu_P, \nu_P)$, and whose hesitations also satisfy $\pi_y = \sqrt{1 - (\mu_P)^2 - (\nu_P)^2}, \mu_P \in [0,1]$, $\nu_P \in [0,1]$, $0 \le (\mu_P)^2 + (\nu_P)^2 \le 1$.

$\gamma_1 = P(\mu_{P1}, \nu_{P1})$ and $\gamma_2 = P(\mu_{P_2}, \nu_{P2})$ are two PFNs; a proposed ordering between them is defined as follows.

$$\gamma_1 \ge \gamma_2 . \mu_{P1} \ge \mu_{P2}, \nu_{P1} \le \nu_{P2}. \tag{3}$$

$\gamma = P(\mu_P, \nu_P)$ is a PFS.

$$S_{\text{Zhang}}(\gamma) = (\mu_P)^2 - (\nu_P)^2. \tag{4}$$

$S_{\text{Zhang}}(\lambda) \in [-1,1], S_{\text{Zhang}}(\lambda)$ The larger the PFN, the larger the corresponding PFN.

$$S_{Y_{\text{an}}}(\gamma) = \frac{(\mu_P)^2 - (\nu_P)^2 + 1}{2}. \tag{5}$$

A more practical tool by Hwan based on distance measure for ranking or selecting the optimal solution, which is widely used in multiobjective decision making; Dulticriteria Zhang and Xu extended TOPSIS to PFS and defined the concept of score function and distance based on PFN. Functions in (4) and (5) are used to determine is defined as x^+ and has the following form.

$$x^+ = \{C_j, \max_i < s(C_j(x_i))\rangle | j = 1, 2, \ldots, n\}. \tag{6}$$

In practical multiobjective decision problems, there is not necessity. That is, x^+ is not a feasible solution and does not satisfy $x^+ \in X$. On the contrary, x^+ is the optimal solution in the multiobjective decision problem. However, the shortest distance between the solution and x^+ does not guarantee that x^+ has the maximum distance. We define the Pythagorean fuzzy NIS as x^- , which is expressed as follows:

$$x^- = \{C_j, \min_i < s(C_j(x_i))\rangle j j = 1, 2, \ldots, n\}. \tag{7}$$

Likewise, usually in a real multiobjective decision problem, there is not necessarily x^-; in other words, x^- may be a non-feasible solution, i.e., $x^- \in X$. Otherwise, x^- is the worst solution in the multiobjective decision problem and should be eliminated first in the decision process.

$X = \{x_1, x_2, \ldots, x_n\}$ be a finite theoretical domain, $A, B \in X$, then the cross entropy of A with respect to B is as follows:

$$I(A,B) = \sum_{i=1}^{n}\left(\mu_A(x_i)\ln\frac{\mu_A(x_i)}{\mu_B(x_i)} + (1-\mu_A(x_i))\ln\frac{1-\mu_A(x_i)}{1-\mu_B(x_i)}\right). \tag{8}$$

3.2. Description of Decision-Making Methods. In this section, the uncertainty caused by the use of the Euclidean distance in distance measurement is eliminated by introducing Pythagorean fuzzy symmetric cross entropy to determine the "distance" between two PFNs, and the uncertainty information can be retained to the maximum extent [28].

A multiobjective decision is the estimated value of each solution under each criterion, respectively. Now, consider a multiobjective decision problem in a Pythagorean, satisfying $0 \le w_j \le 1$ and $\sum_{j=1}^{n} w_j = 1$. Now, we define the estimate of the solution x_i under the criterion $C_j (j = 1, 2, \ldots, n)$ as $C_j(x_i) = (u_{ij}, \nu_{ij})$. So, the multiobjective decision problem whose elements are PFNs has the following matrix form:

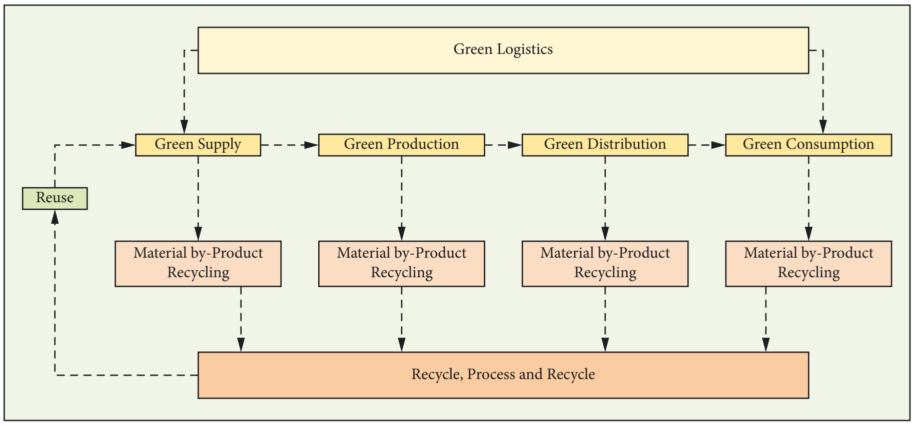

Figure 1: Structure diagram of all elements of green logistics.

$$R=\left(C_j(x_i)\right)_{m\times n}=\begin{matrix} x_1 & (u_{11},v_{11}) & (u_{12},v_{12}) & \cdots & (u_{1n},v_{1n}) \\ x_2 & (u_{21},v_{21}) & (u_{22},v_{22}) & \cdots & (u_{2n},v_{2n}) \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ x_m & (u_{m1},v_{m1}) & (u_{m2},v_{m2}) & \cdots & (u_{mn},v_{mn}) \end{matrix}. \tag{9}$$

Each element of the matrix $C_j(x_i)=P(u_{ij},v_{ij})$ is a PFN, u_{ij} indicates the value of the solution x_i v_{ij} indicates the value of the solution x_i not satisfying the criterion. C_j

To efficiently decide on problems containing PFNs, this section proposes a cross-entropy and TOPSIS based method in a Pythagorean fuzzy environment, and the specific steps are as follows:

(1) Standardized Decision matrix

First, the decision information $C_j(x_i)$ in the decision matrix R must be normalized. For a multiobjective of PFN, the decision matrix $\overline{R}=(C_j(x_i))_{n\times n}$, with elements of $C_j(x_i)$, the evaluated values of the solution $x_i\in X$ under the criterion $C_j\in C$, is created first.

$$C_j(x_i)=\begin{cases}\widehat{C}_j(x_i), C_j\in B,\\ \widehat{C}_j(x_i)^C, C_j\in C,\end{cases} \tag{10}$$

The criterion in set B is benefit-based; the criterion in set C is cost-based, and $C_j(x_i)^c$ is the complement of $C_j(x_i)$. The standardized matrix is $R=(C_j(x_i))_{n\times n}$.

(2) Calculate x^+ and x^-

$$\begin{aligned} x^+ &= (C_1(x^+), C_2(x^+), \ldots, C_n(x^+)),\\ x^- &= (C_1(x^-), C_2(x^-), \ldots, C_n(x^-)). \end{aligned} \tag{11}$$

(3) Calculate the cross entropy between the schemes x_i and x^+, x^-

The cross entropy between the i-th solution x_i and the Pythagorean fuzzy are calculated respectively, and the cross entropy between x_i and x^+, x^- are used to replace the distances between x_i and x^+, x^-, respectively.

(4) Calculate the relative closeness of the scheme x_i

The principle and is denoted as $\zeta(x_i)\,(i=1,2,\ldots,\mathrm{m})$, which is calculated as follows.

$$\zeta(x_i)=\frac{D(x_i,x^-)}{D_{\max}(x_i,x^-)}-\frac{D(x_i,x^+)}{D_{\min}(x_i,x^+)}. \tag{12}$$

Among them

$$\begin{aligned} D_{\max}(x_i,x^-) &= \max\nolimits_{1\le i\le m} D(x_i,x^-),\\ D_{\min}(x_i,x^+) &= \min\nolimits_{1\le i\le m} D(x_i,x^+). \end{aligned} \tag{13}$$

(5) Determine the optimal solution.

The larger the solution $\zeta(x_i)$, the better the solution and vice versa. The optimal solution is determined based on the optimal order of all solutions.

3.3. Multiobjective Decision Problem Based on a Pythagorean Fuzzy Priority Set Operator. When dealing with multiple targets, it is more appropriate to use a Pareto optimal frontier. Similarly, assuming two objective functions, for solution a, no other solution can be found in the variable space to be better than solution a (note that both objective function values must be better than the function values corresponding to a), then solution a is the Pareto optimal solution.

In the previous section, the weights of the criteria are given together by the experts based on their existing experience, but in fact there may be a priority relationship between the criteria and the weight vector that cannot be given directly. The priority scores and the priority aggregation operator proposed by Yager take into account the situation when there is a priority relation between criteria, and this section gives the Pythagorean fuzzy priority aggregation operator based on the operator proposed by Yager in the Pythagorean fuzzy environment. This prioritization operator in the Pythagorean fuzzy environment proves the basic properties it satisfies, and then gives a multiobjective decision model and an example to solve the green logistics the feasibility and stability of the model.

The priority fraction and the priority set operator were first proposed by Yager and are related as follows:

$C = \{C_1, C_2, \ldots, C_n\}$ is assumed that the criteria have a priority relationship with each other: $C_1 > C_2 > \cdots > C_n$, indicating that when $i < k$, C_i has a greater priority relationship than C_k. Assume that for any scheme $x \in X, C_i(x) \in [0,1]$ shows the satisfaction of scheme x under this criterion C_i. Therefore, the prioritized aggregation operator is defined as follows:

$$PA(C_i(x)) = \sum_{i=0}^{n} W_i C_i(x), \quad (14)$$

where $W_i = T_i / \sum_{i=1}^{n} T_i$, provides $T_1 = 1$, when $i > 1$, $T_j = \prod_{j=1}^{j-1} C_k(x)$. The ratio $T_i / \sum_{i=1}^{n} T_i$ represents the degree of priority among all programs.

The operator is proposed in this section between the criteria, i.e., their ratio in the operator, rather than being given subjectively by the decision maker. Both the set of options X and the set of criteria C are defined as in the previous section, and the preference relation between criteria is assumed to be: $C_1 > C_2 > \cdots > C_n$, which shows that the criteria C_i have a higher preference relation than the criteria when $C_k i < k$. The estimated value of the scheme x_i under the criterion C_j is $C_j(x_i) = (u_{ij}, v_{ij})$. Assume that $R = (C_j(x_i))_{n\times n}$ is a Pythagorean. After $x^+ x^- x^+ = (1,0), x^- = (0,1)$, the evaluation value of each solution under all criteria is assembled using the PFPWA operator or PFPWG operator, the degree of difference between all feasible solutions is calculated based on the Pythagorean fuzzy symmetric cross-entropy measure. Moreover, the specific decision steps are as follows:

(1) Standardized decision matrix

(2) Calculation of aggregation value

Calculate the value of the solution x_i after aggregation, i.e., PFPWA operator and PFPWG operator aggregation value.

(3) Determine $D_{PFS}(A, B)$ and $\zeta(x_i)$

Calculate the Pythagorean fuzzy symmetric cross entropy.

(4) Determine the scheme

$\zeta(x_i)$ The larger the value, the better the solution and vice versa. The best solution is selected based on the ranking value.

4. Experimental Results and Analysis

The models and methods are based on engineering fuzzy set theory. At the same time, it is also an expansion of engineering fuzzy set theory in theory and application and has a good operability and certain practical application value. Considering the characteristics of a large amount of fuzzy information in fuzzy optimization, fuzzy pattern recognition, and fuzzy clustering. These models have broader requirements for feature information. The application scope of the model is wider, which expands the application of engineering. Special fuzzy number and approximate fuzzy distance, a fuzzy clustering cyclic iterative model with an unknown weight, and a clustering center matrix are derived.

The selection of criteria in previous literature varies, and is how to make a choice decision given fuzzy decision information, so in this green logistics selection calculation example, referring to the green criteria in existing literature, this paper decides to select the big green criteria as green image, green supply chain management, eco-design, and innovation capability. Multiobjective decision making is the theory and method of scientific and reasonable selection of multiple conflicting objectives and then making decisions.

The example in this paper is a green logistics selection problem. There are five green logistics $X = \{x_1, x_2, x_3, x_4, x_5\}$, 6, and the six selected criteria represent product quality, service capability, green image, green supply chain management, eco-design, and innovation capability, in order to select the optimal green logistics. Figures 2 and 3 are its Pythagorean fuzzy decision diagrams, each element in the diagram represents the supplier under the corresponding criterion, which is expressed in the form of PFN; for example, the first element 0.2 in Figure 2 means the degree of satisfaction of the first green logistics under the first criterion product quality is 0.2, and the first element 0.5 in Figure 3 means the degree of dissatisfaction of the first green logistics under the first criterion product quality. The first element 0.5 in Figure 3 indicates that the first green logistics does not satisfy the first criterion product quality to the extent of 0.5, and so on. The weight vector relative to the decision matrix is $W = (0.20, 0.10, 0.30, 0.15, 0.15, 0.10)^T$.

The cross entropy between supplier x_i and x^+ and x^-, respectively, and the relative closeness of supplier to $x_i \zeta(x_i)$ are calculated and the results are shown in Figure 4.

From Figure 4, we can see that the ranking of the four suppliers is as follows:

$$x_3 > x_2 > x_1 > x_5 > x_4. \quad (15)$$

Figure 5 shows the calculated in this paper ordered number pairs are the cross entropy of each solution with positive and negative ideal solutions, respectively, with the TOPSIS method, the optimal supplier is the same, which is x_3 , while the ranking of the other solutions deviates, but the consistency of the results of the two cross-entropy formulas for the optimal and the worst solutions verifies their stability and feasibility. The cross entropy is a more appropriate measure of uncertain and discontinuous information, taking into account the ambiguity of information in the evaluation process and eliminating the uncertainty caused by the Euclidean distance.

The optimal supplier is selected based on the proposed PFPWA operator, PFPWG operator, and Pythagorean fuzzy symmetric cross-entropy measure. It is calculated that the PFPWA set values for each supplier x_i are as follows:

$$\begin{aligned} &x_1 = <0.3037, 0.5679>, x_2 = <0.5407, 0.5257>, \\ &x_3 = <0.5826, 0.4335>, \\ &x_4 = <0.4833, 0.6504>, x_5 = <0.5662, 0.7001>. \end{aligned} \quad (16)$$

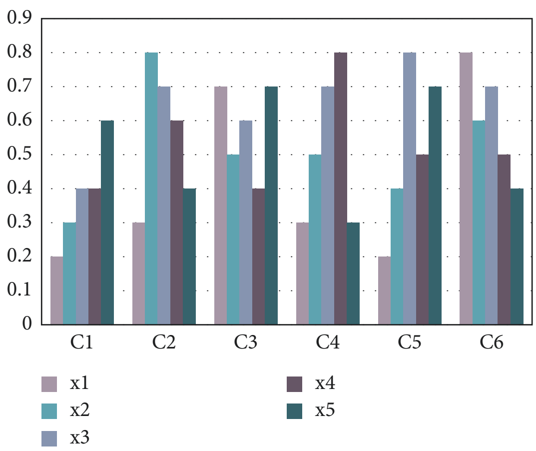

Figure 2: Corresponding values of the fuzzy decision set satisfaction of Pythagoras.

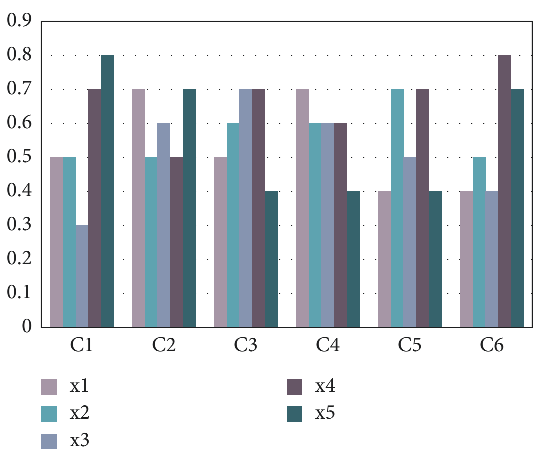

Figure 3: Corresponding values of dissatisfaction in the fuzzy decision set of Pythagoras.

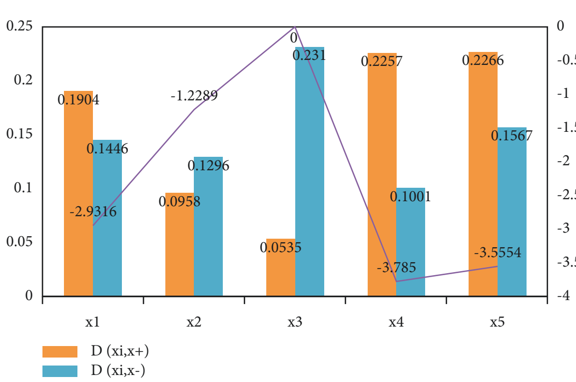

Figure 4: Results based on the cross-entropy proposed in this paper.

The cross-entropy D_{PFN} and relative closeness $\zeta(x_i)$ were calculated for each supplier x_i and $x^+ = \langle 1, 0\rangle$ and $x^- = \langle 0, 1\rangle$.

In Figure 6, the calculation process of the PFPWG operator is similar to that of the PFPWA operator, and the aggregation value of each solution is calculated according to the formula of the PFPWG operator. The cross-entropy D_{PFN} and relative closeness $\zeta(x_i)$ are calculated for each supplier x_i and $x^+ = \langle 1, 0\rangle$, $x^- = \langle 0, 1\rangle$, respectively, and the results are shown in Figure 7. The ranking results are consistent with those of the PFPWA operator. Therefore, x_3 is the optimal supplier.

In this paper, three different methods are used to compare and analyze the same case, and the final calculation results of all methods are shown in Figure 8, given the

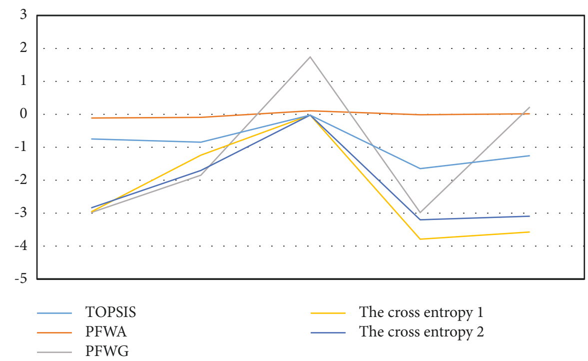

Figure 5: Comparison of the calculation results of different schemes.

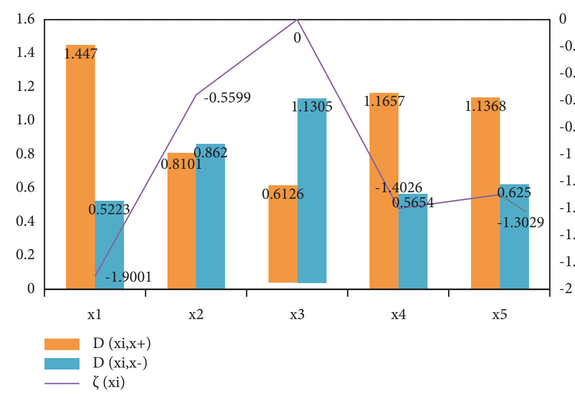

Figure 6: Results based on the PFPWA operator proposed in this paper.

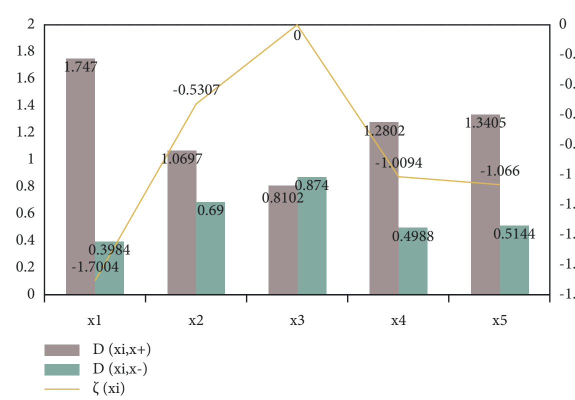

Figure 7: Results based on the PFPWG operator proposed in this paper.

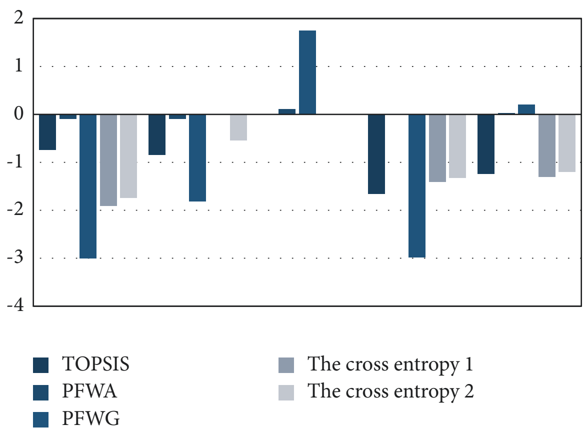

Figure 8: Comparison of the calculation results of different schemes.

criterion. From the comparison results in Figure 8, i.e., the PFPWA operator and the PFPWG operator are almost identical after the decision information is aggregated and then measured by the two cross-entropy formulas for the differences. Therefore, the stability and feasibility of the method proposed in this paper are verified.

5. Conclusion

This paper introduces the Pythagorean fuzzy set into the selection of green logistics and focuses on the selection of green logistics in the Pythagorean fuzzy environment. The objective model based on TOPSIS and cross entropy, Pythagorean fuzzy priority set operator, and cross entropy is established, which is applied to the case analysis of green logistics selection. Compared with other methods based on the same sample in the literature, the effectiveness of the model is verified. The comparison between the proposed operator and other calculation methods of the same green logistics selection algorithm proves the effectiveness of the proposed operator. It is more convenient to use fuzzy decision-making when evaluating schemes. These schemes not only include quantitative data but also consider more and more uncertain evaluation information. The application of sets solves the problem that cannot be solve.

The shortcomings of this paper and the directions that can be further studied on the basis of this paper include the following: first, in the future research, in addition to considering the preference relationship between standards, according to the priority, the proposed priority aggregation operator is extended from a single expert to solve the multiobjective group decision-making problem. Second, the calculation results with those, the model algorithm in this paper is analyzed to verify its effectiveness and rationality in future Pythagorean fuzzy environment. Third, the existing multiobjective generally does not have many criteria in the selection of criteria. We can increase the number of criteria and ensure the stability of the decision-making model, so as to improve the practicability of the Pythagorean fuzzy set in green logistics selection.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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