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Retraction

Retracted: Extended DPL-VIKOR Method for Risk Assessment of Technological Innovation Using Dual Probabilistic Linguistic Information

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] S. Ashraf, M. Ijaz, M. Naeem, S. Abdullah, and L. B. Alphonse-Roger, "Extended DPL-VIKOR Method for Risk Assessment of Technological Innovation Using Dual Probabilistic Linguistic Information," *Journal of Mathematics*, vol. 2023, Article ID 7570984, 15 pages, 2023.

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Research Article

Extended DPL-VIKOR Method for Risk Assessment of Technological Innovation Using Dual Probabilistic Linguistic Information

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The main objective of the present study is to evaluate the multicriteria group decision-making problem in risk management for technological innovation projects (TIPs) under dual-probabilistic linguistic information. The suggested approach is based on an enhanced dual probabilistic linguistic-vise kriterijumska optimizacija kompromisno resenje (DPL-VIKOR) technique to assess risk management in TIP employing probabilistic linguistic information. The conventional VIKOR approach is incapable of dealing with the complexity and difficulty of risk assessment in TIP. Therefore, we incorporated the information included in the dual probabilistic linguistic term set. In DPL-VIKOR, we investigated the relationship between the positive ideal solution (PIS) of the alternative and the negative ideal solution (NIS). To deal with the multicriteria group decision-making problem of risk assessment in TIP, we proposed the extended DPL-VIKOR approach rather than the traditional VIKOR method. We compared the findings to those of several decision-making problem techniques and examined the effectiveness and reliability, as well as advantages of the proposed approach. From the comparison and sensitivity analysis, we conclude that the proposed method is more reliable and effective for evaluating the best alternative in risk management problems for TIP.

1. Introduction

Innovation is crucial for economic development and employment potential, benefiting both society and the economy. Purchasing goods or services from low-wage nations such as China and western economies can only compete and thrive via innovation, characterized as the development of new and improved technologies and operational processes [1]. According to Afuah [2], innovation entails the application of prior knowledge in order to develop a new product or service that customers desire. The term "innovation" refers to the commercialization of a novel concept. Process innovation refers to the introduction of a new or modified method of manufacturing a product. The term "product innovation" refers to the production or modification of an existing product. Innovations available in a variety of manifestations and degrees of uniqueness. This shows that organizations take risks in order to create and launch new products successfully and promptly. Thus, risk identification and management are viewed as critical capabilities in innovative organizations [3]. Organizations that want to survive must innovate at a rapid speed despite simultaneously contending with market uncertainty. This leads into an improvement in the risk level of organizations. The risk is the potential of an unpredictable event occurring and its outcomes. Any aspect that has an effect on a project's performance might be a source of risk. The risk occurs whenever this influence has an unexpected and material effect on the project's performance [4]. Companies get into collaborative partnerships in order to limit the risks involved with innovation, because they possess the requisite resources, including expertise [5]. The risk assessment of technological innovation initiatives is a problem for both researchers and practitioners. Fierce competition in technology and marketing urges technological innovation projects (TIP) focused companies to occupy an advantageous position in the process of accelerating industrial integration [6].

However, some internal and external risks of the business, such as technical risks, market risks, policy risks, and management risks are always affected by TIP [7]. As a consequence, these risks may cause companies to underperform to attain their objectives and incur large losses, and their effect is sometimes difficult to precisely evaluate. Thus, objective risk identification, quantifiable risk assessment, and comprehensive risk management are very important for TIP [6, 8]. This will not only enable business managers to make the correct decision, such as slowing or continuing the introduction of TIP but can also attract the attention of venture finance firms to ensure the project's successful completion.

The risk assessment project is a multi-criteria group decision-making (MCGDM) [9, 10] process with probability and fuzzy uncertainty that plays a crucial role in choosing suitable scientific research initiatives. In the MCGDM process, several individuals are typically want to participate in decision making [11, 12], and decision-makers (DMs) also want to provide their decision matrix, rank and choose the good method [13, 14]. Many DM require to evaluate the risk factor indices (criteria) for risk assessment of TIP, provide the weight data of each metric, and provide their assessment [15, 16]. Due to the external environment's uncertainty and imperfection, evaluating weight data and assessing each substitute or criterion for internal business growth is complex for decision-makers at this step and achieving a comprehensive and reliable judgment is challenging. In addition, linguistic knowledge has special significance for decision makers, because verbal judgments about occurrences may result in imprecise ambiguity [13]. In this context, DPLTS is an improved the precision expressions model relevant to risk assessment of the TIP in the MCGDM phase. Since this not only consisting of other potential linguistic words but also includes their possibilities or levels of confidence, that can help DM more reliably assess and compare each alternatives or criteria [17–19]. For illustration, an effective team of ten analysts is selected to evaluate innovative threat under a few competing parameters using the linguistic variable set to evaluate risk assessment for a TIP [20].

$$\mathbb{k} = \{k_{-2} = \text{low}, k_{-1} = \text{slightly low}, k_0 = \text{medium}, k_1 = \text{slightly high}, k_2 = \text{high}\}. \quad (1)$$

For one situation, the expert may claim that he/she is 40% confident that the risk is average, and 60% confident that the risk is relatively high. From the other scenario, four specialists are allowed to assume that the threat is mild, while six experts are allowed to insure also that risk is relatively higher. Then, these two linguistic terms can describe the value of the linguistic terms of these two instances $\text{DPLTS} = \{\text{medium}\,(0.4), \text{slightly high}\,(0.6)\}$.

Even so, we discovered on the basis of literary works that the DPLTS system coupled both with DM methods is unusual for risk assessment of TIP. As we know, when solving MCGDM problems, there are two solutions that are Pareto's best option [21]. Since a set of preinferior options is often created by MCGDM, it often contrasts with our primary idea. As a result, it is difficult to choose only one or more of the best choices to be the best fit for Pareto. Although evaluating the degree of proximity of a specific approach to the optimal solution is the basic principle of reasonable compromise, consensus technology offers an efficient way to deal with contradictory parameters [17, 22]. But a collaboration solution concept is much more fitting. While the measurement falsity in risk assessment for technical innovation plans caused by probability uncertainties and fuzzy uncertainty can be compensated [13, 14]. And, a paper considers that the MCGDM is much more suitable based on the method of agreement programming with DPLTSs. After all, most researchers use traditional approaches, such as the analytical hierarchy process (AHP), on the study basis the outlook relating to the risk management model of TIP [23], approach to Bayesian network [24], BP neural network [21], etc. To find the best optimum solutions, which can also lead to the risk assessment outcomes being biassed. For the path, graph-based AHP for risk objectivity in TIP can be used by Huang et al. [22]. For risk assessments, applicable to allow the use of AHP and fault tree analysis (FTA), shield tunneling machine (TBM). In addition, many papers use consensus methods to assess risk. In addition to lack of probabilistic linguistic knowledge, they have also reached certain types of results. For example, VIKOR is one of the most common concession approaches for solving MCGDM problems. Many techniques of compromise solutions,used often such as the LINMAP process [21], ORESTE method [25], and Vahdani et al. [26]. In order to enhance the risk assessment process, a new FMEA approach was introduced by incorporating a fuzzy belief system and TOPSIS. Li et al. [27] presented the inhanced VIKOR modle to takcle the risk evaluation in projects of technological innovation under probabilistic linguistic information.

In this paper, we proposed VIKOR method with DPLTSs to carry out risk evaluations of TIP in order to improve the precision and impartiality of risk evaluation of TIP. Since VIKOR is among the most common solution methods, choosing a sensible compromise that's also nearest to the perfect suitable response is the key concept of the VIKOR technique. A PL-VIKOR procedure was introduced by Zhang and Xing integrating the PTLSs, [28]. However, the traditional PL-VIKOR method only considers the connection between each alternative and the optimistic ideal, while ignoring the connection between each alternative and the NIS. The goal of our work is to first improve the current PL-VIKOR approach, and then, based on these research gaps, to propose improved DPL-VIKOR method under probabilistic linguistic uncertainty. In this new process we introduce the connection between each alternative and the detrimental ideal way to improve the DPL-VIKOR method, they add the relationship between each alternate and NIS. In addition, this article utilizes the improved DPL-VIKOR approach to make probabilistic linguistic knowledge accessible for risk assessment of TIP. The paper contributions can be summed up in the three folds as follows:

(1) To solve the MCGDM problem more accurately and comprehensively in the probabilistic linguistic setting, we are developing a new approach called the improved DPL-VIKOR method. The improved method of DPL-VIKOR also considers the relationship between each alternative and PIS and the relationship between each alternative and NIS. Therefore, this new method makes up for the shortcomings of the traditional PL-VIKOR method. The conventional PL-VIKOR technique only reflects the relationship between each alternative and the PIS, but overlooks the relationship between each alternative and the NIS. We use a more appropriate method to normalize DPLTS and ensure that when scheming the distance measure between two PLTS to get the three measures, they take the same number of linguistic terms with the similar normal distribution.

(2) Its the first time that DPLTSs have adopted the improved DPL-VIKOR approach to counter the danger of TIP. In contrast with traditional approaches, the improved DPL-VIKOR approach is more suitable for risk assessment. In addition, combined with the value of DPLTSs, this compromise approach framework will make the risk assessment more detailed and analytical, filling the current research gap.

(3) For the company's managers and the venture capital firms, having a detailed and objective risk assessment of the TIP has clear practical guiding importance. Using the improved PL-VIKOR method and DPLTS to determine and deal with TIP risks is more conducive for officials to allow TIP goals and risk reduction goals throughout the process, which not only reduces DM mistakes and losses but also reduces them to a certain extent Company cost. In addition, the scientific method and template for determining the risks of TIP would be used for risk evaluations.

This article is structured as follows. In Section 2, the fundamental principles related to DPLTSs are reviewed. The enhanced DPL-VIKOR technique for MCGDM is developed in Section 3. Section 4 introduces the improved DPL-VIKOR approach to resolve the practical issue of danger to venture capital from TIP. Section 5 presented the comparison analysis of the established methodology with existing methods in the literature. In Section 6, some findings and possible studies are summarized.

2. Preliminaries

Usually experts tend to issue linguistic terms to express their preferences, rather than objective assessments, such as quantitative assessments. When dealing with MCGDM challenges, such as "good," "medium," or "bad," there are several linguistic expression methods, such as a set of unwilling fuzzy linguistic terms [29], types 2 fuzzy set, double hierarchy hesitant fuzzy linguistic term set [30], linguistic terms with weakened hedges [31], and 2-tuple linguistic model [32].

Even so, not available the current linguistic interpretation methods to reflect the confidence of the linguistic terms assessed by individuals or the meaning of the probability distribution of the overall language terms of all community DM experts. To overcome the shortcoming, the concept of PLTS was defined by Pang et al. [17] in which the probabilities are involved to the assessment provided by the experts to calculate them extra correctly.

Let $\Bbbk = \{k_r \mid r = -t, \ldots, -1, 0, 1, \ldots, t\}$ be a LTS, the DPLTSs can be defined as

$$D^L(p) = \left\{ \left\langle \begin{matrix} L_{(k)} p_{(k)}, M_{(k)} q_{(k)} \mid L_{(k)}, M_{(k)} \in \Bbbk, P_{(k)} q_{(k)} \geq 0, k = 1, 2, \ldots, *D^L(p), *D^L(q), \\ \sum_{k=1}^{*L(p), L(q)} p_{(k)}, q_{(k)} \leq 1 \end{matrix} \right\rangle \right\}, \quad (2)$$

where $L_{(k)}(p_{(k)})$ the linguistic word correlated with likehood is $(p_{(k)})$ and $M_{(k)}(q_{(k)})$ is the linguistic term associated with the probability $(q_{(k)})$, $*L_{(k)}, M_{(k)}$. In all the various linguistic words, the number is the $D^{L}(p)$ with the DPLTSs. In addition to presenting several possible linguistic values on an object (alternative or attribute), the experts may also represent the probabilistic data of the value set [33]. Relative to other approaches to the modelling of linguistic knowledge for representation, in the DPLTSs DM may assist in defining the object simultaneously of the perspective linguistic expressions and probability. For example, we all see the number of linguistic words with DPLTS is less than 1. For the sake of calculating innocence, Pang et al. [17] defiend a strategy for normalising in DPLTSs. Given a DPLTS as $\sum_{k=1}^{*L(p),L(q)} p_{(k)}, q_{(k)} < 1$, then the normalized DPLTSs

$$\dot{D^{L}}(p) = \left\{ \left\langle \left\langle \dot{L}_{(k)}\dot{p}_{(k)}, \dot{M}_{(k)}\dot{q}_{(k)} \right\rangle \middle| \dot{L}_{(k)}, \dot{M}_{(k)} \in \mathbb{k}, \left(\dot{p}_{(k)}\right)\left(\dot{q}_{(k)}\right) \geq 0, \atop k = 1, 2, \ldots, *D^{L}(p), *D^{L}(q) \right\rangle \right\}, \tag{3}$$

where

$$\left(\dot{p}_{(k)}\right)\left(\dot{q}_{(k)}\right) = \sum_{k=1}^{*D^{L}(p), *D^{L}(q)} p_{(k)}, q_{(k)} \leq 1 \quad \forall k = 1, 2, \ldots, *D^{L}(p), *D^{L}(q). \tag{4}$$

Some transfermation function for *DPLTS* is introduced by Gou et al. [34] to defiend some operational laws on the basis of these function.

Definition 1. Let $\mathbb{k} = \{k_r \mid r = -t, \ldots, -1, 0, 1, \ldots, t\}$ be a LTS the expression for equivlanet information for membership and nonmembership grade can be define as

$$\begin{aligned} &f\colon [-\varphi, \varphi] \longrightarrow [0, 1], f(k_r) = \frac{t}{\varphi} + \frac{1}{2} = \tau, \\ &f\colon [-\varphi, \varphi] \longrightarrow [0, 1], f(k_r) = \frac{t}{\varphi} + \frac{1}{2} = \upsilon. \end{aligned} \tag{5}$$

Definition 2. The inverse function that can show the equivalent information for limguistic term k_t can be describe as

$$\begin{aligned} &f^{-1}\colon [0, 1] \longrightarrow [-\varphi, \varphi], f^{-1}(\tau) = k_{(2\tau-1)t} = k_t, \\ &f^{-1}\colon [0, 1] \longrightarrow [-\varphi, \varphi], f^{-1}(\upsilon) = k_{(2\upsilon-1)t} = k_t, \end{aligned} \tag{6}$$

on the basis of above definition, some opreational laws are define as follows.

Definition 3. Let $\mathbb{k} = \{k_r \mid r = -t, \ldots, -1, 0, 1, \ldots, t\}$ be an LTS, $D^{L}(p), D^{L}(p_1), D^{L}(p_2)$ be three DPLTSs, and for a possitive real number λ can be define as follows:

(1) $D^{L}(p_1) \oplus D^{L}(p_2) = f^{-1}\left(\bigcup_{\upsilon_1^{i} \in f(L_1), \upsilon_1^{j} \in f(L_2)} \left\{ \begin{array}{c} (\upsilon_1^{i} + \upsilon_2^{j} - \upsilon_1^{i}\upsilon_2^{j})(p_1^{i}p_2^{j}), \\ \{(\upsilon_1^{i}\upsilon_2^{j})(q_1^{i}q_2^{j})\} \end{array} \right\} \right)$, $i = 1, 2, \ldots, *D^{L}(p_1),\ j = 1, 2, \ldots *D^{L}(p_2)$

(2) $D^{L}(p_1) \otimes D^{L}(p_2) = f^{-1}\left(\begin{array}{c} \bigcup_{\upsilon_1^{i} \in f(M_1), \upsilon_1^{j} \in f(M_2)} \{(\upsilon_1^{i}\upsilon_2^{j})(q_1^{i}q_2^{j})\}, \\ \{(\upsilon_1^{i} + \upsilon_2^{j} - \upsilon_1^{i}\upsilon_2^{j})(p_1^{i}p_2^{j})\} \end{array} \right)$, $i = 1, 2, \ldots, *D^{L}(p_1),\ j = 1, 2, \ldots *D^{L}(p_2)$

(3) $\lambda D^{L}(p) = f^{-1}\left(\bigcup_{\upsilon^{i} \in f(M)} \{(1 - (1 - \upsilon^{i})^{\lambda}(p^{i})), (\upsilon^{i})^{\lambda}(q^{i})\}\right)$, $i = 1, 2, \ldots *D^{L}(p)$

(4) $(D^{L}(p))^{\lambda} = f^{-1}\left(\bigcup_{\upsilon^{i} \in f(M)} \{(\upsilon^{i})^{\lambda}(q^{i})\}, (1 - (1 - \upsilon^{i})^{\lambda}(p^{i}))\right)$, $i = 1, 2, \ldots, *D^{L}(p)$

(5) $(\overline{D^{L}(p)}) = f^{-1}\left(\bigcup_{\upsilon^{i} \in f(M)} \{(1 - \upsilon^{i})(p^{i}), (\upsilon^{i})^{\lambda}(q^{i})\}\right)$, $i = 1, 2, \ldots, *D^{L}(p)$

On the basis of equations (5) and (6), the score and deviation function for a DPLTS can be define as follows.

Definition 4. Let

$$D^{L}(p) = \left\{ \left\langle L_{(k)}p_{(k)}, M_{(k)}q_{(k)} \middle| L_{(k)}, M_{(k)} \in \mathbb{k}, P_{(k)}q_{(k)} \geq 0, k = 1, 2, \ldots, *\overset{L}{\underset{P}{D}}, *\overset{L}{\underset{q}{D}} \right\rangle \right\}, \tag{7}$$

be a DPLTS. Then there is the score and deviation function of $D^L(p)$ Can be found as, respectively,

$$E\left(D^L(p)\right) = \frac{\sum_{k=1}^{*D^L(p)} f\left(L_{(k)}\right)p_{(k)}/\sum_{k=1}^{*D^L(p)} p_{(k)} + \sum_{k=1}^{*D^L(p)} f\left(M_k\right)q_{(k)}/\sum_{k=1}^{*D^L(p)} q_{(k)}}{2}$$

$$\cdot\left(\sum_{k=1}^{*D^L(p)} f\left(L_{(k)}\right) - E\left(D^L(p)\right)^2 p_{(k)}\right)^{1/2}/\sum_{k=1}^{*D^L(p)} p_{(k)}+ \tag{8}$$

$$\tau\left(D^L(p)\right) = \frac{\left(\sum_{k=1}^{*D^L(p)} f\left(M_{(k)}\right) - E\left(D^L(p)\right)^2 q_{(k)}\right)^{1/2}/\sum_{k=1}^{*D^L(p)} q_{(k)}}{2},$$

for two DPLTS $D^L(p_1)$ and $D^L(p_2)$, it is possible to do a comparison between DPLTS:

(1) If $E(D^L(p_1)) > E(D^L(p_2))$,then $D^L(p_1)$ is superior $D^L(p_2)$denoted by $(D^L(p_1)) > (D^L(p_2))$

(2) If $E(D^L(p_1)) = E(D^L(p_2))$, then

(a) If $\tau(D^L(p_1)) > \tau(D^L(p_2))$, then $D^L(p_1)$ is superior $D^L(p_2)$, denoted by $(D^L(p_1)) > (D^L(p_2))$

(b) If $\tau(D^L(p_1)) = \tau(D^L(p_2))$, then $D^L(p_1)$ is indifferent to $D^L(p_2)$, denoted by $(D^L(p_1)) \sim (D^L(p_2))$

The PL-VIKOR technique is built on this foundation of Wu et al. [35] will establish the distance measurement between two DPLTS developed an adaptation method to ensure that two DPLTS use a similar number of linguistic words and probability distributions. The DPLTSs $(D^L(p_1))$ and $(D^L(p_2))$. The normalise corresponding DPLTSs are

$$\begin{aligned} D^L(p_1) &= \left\{\left\langle\left\langle \bullet\, L_{1(k)}\bullet\, p_{1(k)}, \bullet\, \dot{M}_{1(k)}\bullet\, q_{1(k)}\right\rangle \mid k = 1, 2, \ldots, K\right\rangle\right\},\\ D^L(p_2) &= \left\{\left\langle\left\langle \bullet\, L_{2(k)}\bullet\, p_{2(k)}, \bullet\, \dot{M}_{2(k)}\bullet\, q_{2(k)}\right\rangle \mid k = 1, 2, \ldots, K\right\rangle\right\}, \end{aligned} \tag{9}$$

then

$$d\left(\left(D^L(p_1)\right), \left(D^L(p_2)\right)\right) = \frac{1}{2}\begin{pmatrix} \sum_{k=1}^{*D^L(p)} p_{(k)}\left(\left(f\left(D^L(p_1)\right) - f\left(D^L(p_2)\right)\right)^2\right)+ \\ \sum_{k=1}^{*D^L(p)} q_{(k)}\left(f\left(D^L(p_1)\right) - f\left(D^L(p_2)\right)\right)^2 \end{pmatrix}^{(1/2)}. \tag{10}$$

Example 1. Let $\Bbbk = \{k_r \mid r = -t, \ldots, -1, 0, 1, \ldots, t\}$ be LTS,

$$\begin{aligned} D^L(p_1) &= \left\langle \begin{matrix} \{s_0(0.3)s_1(0.7), \mu_0(0.5)\mu_1(0.5)\}, \{s_1(0.5)s_2(0.5), \mu_0(1)\}, \\ \{s_{-1}(0.4)s_{-2}(0.6), \mu_1(0.5)\mu_2(0.5)\} \end{matrix} \right\rangle \\ D^L(p_2) &= \left\langle \begin{matrix} \{s_{-1}(0.3)s_0(0.7), \mu_1(0.5)\mu_2(0.5)\}, \{s_1(0.5)s_2(0.5), \mu_0(1)\}, \\ \{s_{-1}(0.4)s_{-2}(0.6), \mu_0(0.5)\mu_1(0.5)\} \end{matrix} \right\rangle. \end{aligned} \tag{11}$$

Then the distance of $D^L(p_1)$ and $D^L(p_2)$ can be calculated as

$$d\left(\left(D^L(p_1)\right),\left(D^L(p_2)\right)\right) = \sqrt{\begin{pmatrix} 0.3\times(f(s_0)-f(s_{-1})+0.7\times(f(s_1)-f(s_0)+0.5\times \\ (f(s_1)-f(s_1)+0.5\times(f(s_2)-f(s_2) \\ +0.4\times(f(s_{-1})-f(s_{-1})+0.6\times(f(s_{-2})-f(s_{-2}) \\ +0.5\times(f(\mu_0)-f(\mu_1)+0.5\times(f(\mu_1)-f(\mu_2)^2 \\ +1\times(f(\mu_2)-f(\mu_2)^2+0.5\times(f(\mu_1)-f(\mu_0)^2 \\ +0.5\times(f(\mu_2)-f(\mu_1)^2 \end{pmatrix}^2} \tag{12}$$
$$= 0.2545.$$

3. Improved DPL-VIKOR Method of MCGDM System

The VIKOR (VIse Kriterijumska Optimizacija kompromisno Resenje in Serbian; a solution that implies multi-standard optimization compromise) is a useful but DM method for voting on compromise options. In dealing with MCGDM issues, the VIKOR approach is very rational, particularly when they have criteria that are incompatible and incompatible. All of the VIKOR techniques were created with the basic measure of "Intimacy" in mind, as well as the "ideal" solution known as the Lp-metric, which is used as an aggregation tool in compromise programming. The primary characteristics of VIKOR's measures are as follows:

(1) Linear standardization
(2) The optimum solution must be documented
(3) Distances from optimal solutions are approximated
(4) Calculation of substitute compromise assessments
(5) Collect franchise alternatives by franchise value

The VIKOR approach is now widely employed in a variety of sectors, including mountain destination selection, forest protection and afforestation, and earthquake reconstruction.

However, in the current research, almost all VIKOR methods in the context of DM only include the connection between each alternative and PIS, while ignoring the connection between each alternative and NIS. As a result, in a probabilistic linguistic context, this study improves the existing PL-VIKOR approach and introduces a new DPL-VIKOR method.

First and foremost, the DPLTS MCGDM problem can be summarized as follows.

Let $A=\{A_1,A_2,\ldots A_n\}$, be a set of alternatives, $C=\{c_1,c_2,\ldots,c_m\}$ is a set of m criteria, and $W=\{\omega_1,\omega_2,\ldots,\omega_n\}^T$ its weight vector with $W_j\geq 0$ and $\sum_{j=1}^{n}W_j=1$. Numerous experts $U=\{e_1,e_2,\ldots,e_k\}$ are invited to provide their assessments on each alternative for each standard of a given LTS. $T=\{T_t/t=-\varphi,\ldots.-1,0,1,\ldots,\varphi\}$, and the weight vector of experts is $W=\{\omega_1,\omega_2,\ldots,\omega_r\}^T$ with $w_n\geq 0$, $n=1,2,\ldots,m$ and $\sum_{n=1}^{R}W_n=1$. The assessment of each expert can be a dual probabilistic linguistic decision matrix,is denoted by DPLTSs and then all these evaluations. $D^{DL}(p)=(L^{c_{(k)}}(p_i),M^{c_{(k)}}(q_i))_{m\times n}$ By gathering all elements into a set in the same area, where

$$D^{cL}(p_1)=\{\langle(L^{c_{(k)}}(p_i),M^{c_{(k)}}(q_i))\,|\,k=1,2,\ldots,K\rangle\}. \tag{13}$$

And, then we can choose the optimum value of the $D^{+L}(p_1)$. And, the worst value of the $D^{-L}(p_1)$ and associated with each criterion c_j based on the following rules:

$$D^{+L}(p_1)=\left\{\begin{array}{c} \max\limits_{i=1,2,\ldots m} L^c_{(i)}(p_j),M^c_{(i)}(q_j)\text{for the benefit criterion } c_j \\ \min\limits_{i=1,2,\ldots,m} L^c_{(i)}(p_j),M^c_{(i)}(q_j)\text{for the cost criterrion } c_j \\ \text{for all } j=1,2,\ldots,n \end{array}\right\}, \tag{14}$$

$$D^{-L}(p_1)=\left\{\begin{array}{c} \min\limits_{i=1,2,\ldots,m} L^c_{(i)}(p_j),M^c_{(i)}(q_j)\text{ for the benefit criterion } c_j \\ \max\limits_{i=1,2,\ldots m} L^c_{(i)}(p_j),M^c_{(i)}(q_j)\text{for the cost criterrion } c_j \\ \text{for all } j=1,2,\ldots,n \end{array}\right\}, \tag{15}$$

Then, the PIS $D^{+L}(p)=\{D^{+L}(p_1),D^{+L}(p_2),\ldots,D^{+L}(p_n)\}$ and the NIS $D^{-L}(p)=\{D^{-L}(p_1),D^{-L}(p_2),\ldots,D^{-L}(p_n)\}$ can be obtained. An example of the aggregating technique and rules can be put up as follows.

Example 2. Let $\Bbbk=\{k_r\,|\,r=-t,\ldots,-1,0,1,\ldots,t\}$ be an LTS ,and $A=\{A_1,A_2,A_3\}$, is a set of three possibilities, $c=\{c_1,c_2,c_3\}$ is a set of three criterian, two experts decision metrices are

$$D^L(p_1)=\begin{pmatrix}\{s_0(0.6)s_1(0.4),\mu_0(0.6)\mu_1(0.4)\},\{s_1(0.3)s_2(0.7),\mu_{-1}(0.7)\mu_0(0.3)\},\\ \{s_{-1}(1),\mu_0(1)\}\{s_0(1),\mu_{-2}(1)\},\{s_0(0.6)s_1(0.4),\mu_{-2}(0.4)\mu_{-1}(0.6)\},\\ \{s_{-2}(0.5)s_{-1}(0.5),\mu_0(0.5)\mu_1(0.5)\}\{s_0(0.6)s_1(0.4),\mu_1(0.4)\mu_2(0.6)\},\\ \{s_1(01),\mu_0(1)\},\{s_{-1}(0.2)s_{-2}(0.8),\mu_0(0.4)\mu_1(0.6)\}\end{pmatrix},$$
$$D^L(p_2)=\begin{pmatrix}\{s_0(0.2)s_1(0.8),\mu_0(0.4)\mu_1(0.6)\},\{s_1(0.3)s_2(0.7),\mu_{-1}(0.7)\mu_0(0.3)\},\\ \{s_{-2}(0.5)s_{-1}(0.5),\mu_0(1)\}\{s_0(1),\mu_{-1}(0.5)\mu_{-2}(0.5)\},\\ \{s_0(0.5)s_1(0.5),\mu_{-2}(0.5)\mu_{-1}(0.5)\},\{s_{-1}(0.3)s_{-2}(0.5),\mu_0(0.5)\mu_1(0.5)\}\\ \{s_1(1),\mu_1(0.5)\mu_2(0.5)\},\{s_1(0.5)s_2(0.5),\mu_0(1)\},\{s_{-1}(0.5)s_{-2}(0.5),\mu_1(1)\}\end{pmatrix}. \quad (16)$$

Represents the weight vector of the expert is $w=\{0.3,0.3\}^{\mathrm{T}}$. Therefore, the collective selection matrix can be calculated as follows:

$$D^{cL}(p)=\begin{pmatrix}\{s_0(0.32)s_1(0.12)s_2(0.56),\mu_0(0.46)\mu_1(0.54)\},\\ \{s_1(0.30)s_2(0.7),\mu_{-1}(0.7)\mu_0(0.3)\},\\ \{s_{-1}(0.65)s_{-2}(0.35),\mu_0(1)\}\{s_{-1}(1),\mu_{-1}(0.35)\mu_{-2}(0.65)\},\\ \{s_0(0.53)s_1(0.47),\mu_{-1}(0.47)\mu_{-2}(0.53)\},\\ \{s_{-1}(0.5)s_{-2}(0.5),\mu_0(0.85)\mu_1(0.15)\}\\ \{s_0(0.18)s_1(0.82),\mu_1(0.47)\mu_2(0.53)\},\\ \{s_1(0.55)s_2(0.35),\mu_0(1)\},\\ \{s_{-1}(0.41)s_{-2}(0.59),\mu_0(1)\mu_1(0.82)\}\end{pmatrix}. \quad (17)$$

Furthermore, if c_1 and c_2 are the income criteria and c_2 is the cost criterion, PIS and NIS can be calculated using equations (14) and (15).

$$D^{+L}(p)=\left\{\begin{matrix}\{s_0(0.18)s_1(0.82),\mu_1(0.47)\mu_2(0.53)\},\\ \{s_0(0.53)s_1(0.47),\mu_{-1}(0.47)\mu_{-2}(0.53)\},\\ \{s_{-1}(0.5)s_{-2}(0.5),\mu_0(0.85)\mu_1(0.15)\}\end{matrix}\right\},$$
$$D^{-L}(p)=\left\{\begin{matrix}\{s_{-1}(1),\mu_{-1}(0.35)\mu_{-2}(0.65)\},\\ \{s_1(0.55)s_2(0.35),\mu_0(1)\},\\ \{s_{-1}(0.65)s_{-2}(0.35),\mu_0(1)\}\end{matrix}\right\}. \quad (18)$$

The three development metrics mentioned above are obtained for MCGDM, according to the collective decision matrix, to express how close a solution is to the ideal solution. In the first location, the discrete form, respectively $D_{\lambda}^{L}(p)$ – metric, based on equation (10). The relation between each alternative and the NIS is introduced as a new definition of Dual probabilistic Linguistic Euclidean $D_{\lambda}^{L}(p)$ – metric is established. The calculation shown is as follows.

$$D^{\lambda L}(p) = \left(\sum_{j=1}^{n} \left(w_n \frac{d\left(\left(D^{+L}(p_j), D^{cL}(p_{ij})\right) - d\left(D^{-L}(p_j), \left(D^{cL}(p_{ij})\right)\right)\right.}{d\left(D^{+L}(p_j), D^{-L}(p_j)\right)} \right)^{\lambda} \right)^{1/\lambda}, \tag{19}$$

$$1 \le \lambda \le \infty, \quad i = 1, 2, \ldots, m, \tag{20}$$

in equation (10), there is

$$\frac{d\left(\left(D^{+L}(p_j), D^{cL}(p_{ij})\right) - d\left(D^{-L}(p_j), \left(D^{cL}(p_{ij})\right)\right)\right.}{d\left(D^{+L}(p_j), D^{-L}(p_j)\right)} \in [-1, 1]. \tag{21}$$

Definition 5. The Dual linguistic probabilistic Euclidean $D_{\lambda}^{L}(p)$ – metric. For an optional choice, A_i is defined as follows.

However, if a parameter λ is even number and when

$$\frac{d\left(\left(D^{+L}(p_j), D^{cL}(p_{ij})\right) - d\left(D^{-L}(p_j), \left(D^{cL}(p_{ij})\right)\right)\right.}{d\left(D^{+L}(p_j), D^{-L}(p_j)\right)} \in [-1, 0]. \tag{22}$$

The negative outcome will be changed to a possible outcome. To resolve this shortcoming, therefore, to make the Dual linguistic probabilistic Euclidean $D_{\lambda}^{L}(p)$ – metric Simper measure, we will let you measure, $\lambda = 1$ equation (19) can be reduced from Dual linguistic Probabilisticto Measure of Group Utility (DPLGU).

$$D^{\mathrm{LGU}_i}(p) = \left(\sum_{j=1}^{n} w_n \frac{d\left(\left(D^{+L}(p_i)\right), \left(D^{cL}(p_{ij})\right)\right) - d\left(\left(D^{-L}(p_i)\right), \left(D^{cL}(p_{ij})\right)\right)}{d\left(\left(D^{+L}(p_j)\right), \left(D^{-L}(p_{ji})\right)\right)} \right), \quad i = 1, 2, \ldots, m. \tag{23}$$

In fact, the Dual Linguistic Probabilistic individual regrets

$$D^{LIR_i}(p) = \max_{j=1,2,\ldots n} \left\{ w_n \frac{d\left(\left(D^{+L}(p_i)\right), \left(D^{cL}(p_{ij})\right)\right) - d\left(\left(D^{-L}(p_i)\right), \left(D^{c}(p_{ij})\right)\right)}{d\left(\left(D^{+L}(p_j)\right), \left(D^{-L}(p_{ji})\right)\right)} \right\}, \quad i = 1, 2, \ldots, m. \tag{24}$$

Completely, $D^{LUG_i}(p_i) \in [-1, 1]$ and $D^{LIR_i}(p_i) \in [-1, 1]$. Centered on these two steps, the Dual Linguistic Probabilistic Compromise $D^{Lc_i}(p)$ measure for the alternative A_i is determined as follows:

$$D^{Lc_i}(p_i) = \theta \frac{D^{\mathrm{LGU}_i}(p) - D^{+LGU}(p)}{D^{-LGU}(p) - D^{+LGU}(p)} + (1 - \theta) \frac{D^{LIR_i}(p) - D^{+LIR}(p)}{D^{-LIR}(p) - D^{+LIR}(p)}, \tag{25}$$

where $D^{+LGU}(p) = \min_i D^{\mathrm{LGU}_i}(p)$, $D^{-LGU}(p) = \max_i D^{\mathrm{LGU}_i}(p)$, $D^{+LIR}(p) = \min_i D^{LIR_i}(p)$, and $\theta\,(0 \le \theta \le 1)$ a parameter is a variable that can be changed.so without the loss of equality, we can put $\theta = 0.5$ on the basis of these three measures $D^{\mathrm{LGU}_i}(p)$, $D^{LIR_i}(p)$, and $D^{Lc_i}(p)$, we can find that the compromise solution should also be the best solution with the smallest value among the options of $D^{\mathrm{LGU}_i}(p), D^{LIR_i}(p)$, and $D^{Lc_i}(p)$. Therefore, we need to rank $D^{\mathrm{LGU}_i}(p), D^{LIR_i}(p)$, and $D^{Lc_i}(p)$ Increment in order to get the final compromise solution.

Still, it is very difficult to get a compromise solution that fulfils the metric $D^{\mathrm{LGU}_i}(p), D^{LIR_i}(p)$, and $D^{Lc_i}(p)$ simultaneously in most cases. Therefore, in order to obtain the best compromise, the following rules are given.

With the measure $D^{Lc_i}(p)$, assume that the right selection of alternatives are $A = \{A^{\tau(1)}, A^{\tau(2)}, \ldots, A^{\tau(n)}\}$. The alternative is the better compromise option, then $A^{\tau(1)}$ complies concurrently with the following two conditions:

(1) $D^{Lc_{A^{\tau(2)}}}(p) - D^{Lc_{A^{\tau(1)}}}(p) \geq 1/(m-1)$, where $A^{\tau(2)}$ is the alternative which ranks second in $D^{Lc_i}(p)$.

(2) In both $D^{\mathrm{LGU}_i}(p)$ and $D^{LIR_i}(p)$ the alternative $A^{\tau(1)}$ should also rank first. Furthermore, if one of the aforementioned factors is not met, the best method to reach a compromise is to consider other options.

(a) If only condition 2 is not met, then both conditions are satisfied. $A^{\tau(1)}$ and $A^{\tau(2)}$. The best compromise options are known to be.

(b) If condition 1 is satisfied, then $A^{\tau(1)}, A^{\tau(2)}, \ldots, A^{\tau(k)}, 1 \leq k \leq m$ the best options for compromise are $A^{\tau(k)}$ can be obtained on the basis of $D^{Lc_{A^{\tau(k)}}} - D^{Lc_{A^{\tau(1)}}} < /(m-1)$ with maximum k. Based on the description above, an algorithm is developed to demonstrate the MCGDMM process for improving the PL-VIKOR approach.

3.1. The Improved DLP-VIKOR Algorithm for MCGDM Problems

Input: the set of alternatives $A = \{A_1, A_2, \ldots, A_m\}$, the set of criteria $c = \{c_1, c_2, \ldots, c_n\}$ and the decision matrices $D^{DL}(p) = (L^{r(k)}(p_i), M^{r(k)}(q_i))_{m\times n}\ (r = 1, 2, \ldots, R)$ assembled by experts.

Output: the right solution for compromise.

Step 1: computing all matrices for decisions $D^{DL}(p) = (L_{ij}^{r(k)}(p_{ij}), M_{ij}^{r(k)}(q_{ij}))_{m\times n}, \quad (r = 1, 2, \ldots, R)$. Through the matrix of mutual decisions $D^{cL}(p) = (L_{ij}^{c(k)}(p_{ij}), M_{ij}^{c(k)}(q_{ij}))_{m\times n}$.

Step 2: calculate the measures $D^{\mathrm{LGU}_i}(p)$, $D^{LIR_i}(p)$, and $D^{Lc_i}(p)$ for each alternative A_i depend on equations (23) and (26)

Step 3: in increasing orderd $D^{\mathrm{LGU}_i}(p)$, $D^{LIR_i}(p)$, and $D^{Lc_i}(p)$ rank three measures.

Step 4: based on these two circumstances and the two rules described above, come up with a compromise.

Step 5: end.

4. Implementing the Improved DPL-VIKOR Method to Carry Out a Case Study of Risk Assesment of Technological Innovation Projects

A TIP still requires a lot of funds from venture capital companies. Its drive is to achieve corresponding investment income by industrializing TIP [36]. Before conducting a risk assessment, first define the risk category, then create a risk index method and evaluate the weight of the risk scale. When completing these measures, the enhanced PL-VIKOR approach can be carried out a TIP risk assessment.

4.1. Risk Identification of Projects for Technical Advancement. The risk classification of TIP is primarily focused on internal risk for organizations and external risk for businesses [37]. Technological risks, management risks, production risks, and financial risks are internal risks. Environmental risk and business risk are also internal risks.

The technical risk of TIP is related to the potential failure of the wrong research field in the R&D process [38]. In TIP, some R&D ventures require enormous investment and long-term periods. The harm will be extreme once the incorrect research path or reproductive cells technology was selected.

The possibility of TIP being handled due to poor management of the TIP [39] refers to the lack of innovation. Inadequate organization and teamwork, insufficient attention from senior executives, or stubbornly making the incorrect judgments can all contribute to a lack of technological advancement.

The market risk of TIP means that, owing to the uncertain and rapidly evolving market, the new outcomes does not satisfy market demand [40]. The market risk mainly includes adaptive capabilities with regard to business changes, sensitivity to the business environment, and changing customer needs. The market outlook can be very strong before theTIP is launched,while the innovation is finished, a lot of changes have occurred in the market prospect. Customers could not accept the new product anymore.

The likelihood of failure induced by elements such as social policies, national or municipal legislation, rules, and policies is linked to the environmental risks of technological innovation initiatives. TIP may not be compliant with environmental, energy, technology, or science policies, or it may be unable to secure a license to import raw tools and equipment. Consequently, it is not possible to effectively execute technical break through programmers.

4.1.1. Evaluate the System's Indicator Scores and Measure the Number of Risk Indicators. Any risk factors may be involved in the TIP, and the connection between these elements are difficult. The structure of the risk index system must therefore be consistent with the systemic principle, the science concept, and the global morality [41]. The systematic concept means that the layout of risk index schemes should systematically reflect the main risks of various aspects and the precise way of industrial technological innovation. According to scientific theory, the quantity of danger indicators must be appropriate and adequate. If there are many risk indicators, the risk indicator system does not fully represent the enterprise's technological progress risk. Therefore, the successful setting of the risk index ensures that the main index is included, minimizes overlapping indexes and makes them clear and relevant. The universal principle means that the common choice for most companies should be the risk index. The danger of technological progress is centered on subjective viewpoints.

According to the three principles and the literature given above, [37–40]. The risk index framework is constructed according to risk identification and the above-given concepts on the basis of technology risks, environmental risk, management risks, and market risk [42]. And, through expert surveys, statistical analysis and other methods, the developed framework is refined, updated, supplemented and finalised. Table 1 displays the final risk index system. This risk evaluation methodology has four levels of risk indices.

In the TIP, the relative value of each risk index varies from one another [43]. The weights should be correctly and allocated into order to represent the significance of each risk index. In this article, we invite three risk management experts to send out scores according to the significance of risk indices, and we use the AHP [44, 45] Methodology for assessing the weight of individual risk indexes, as shown in Table 2.

We are interviewing a venture capital company to learn about their three alternative technology innovation venture capital plans. The alternative is expressed as $A = \{A_1, A_2, A_3\}$. There are four criteria to be determined easily according in Table 2, and we put fourth-level criteria into our calculations. All parameters are denoted as $C = \{c_1, c_2, c_3, c_4\}$ on the basis of the given LTS.

$$R = \{r_{-2} = \text{low}, r_{-1} = \text{slightlylow}, r_0 = \text{medium}, r_1 = \text{slightlyhigh}, r_2 = \text{high}\}. \tag{26}$$

Three of the experts we invited were $u^r = \{e_1, e_2, e_3\}$. They are invited to analyse the alternatives on the basis of four parameters and to carry out their evaluations with equal significance. The tests are seen in $D^L(p) = (L_{ij}^{r(k)}(p_{ij}), M_{ij}^{r(k)}(q_{ij}))_{3\times 4}$, $(r = 1, 2, \ldots, R)$.

$$D^{L1}(p) = \left\{ \begin{array}{c} \begin{pmatrix} \{s_0(0.4)s_1(0.6), \mu_0(0.6)\mu_1(0.4)\}, \{s_{-1}(0.5)s_{-2}(0.5), \mu_1(0.4)\mu_2(0.6)\}, \\ \{s_1(0.6)s_2(0.4), \mu_{-2}(0.6)\mu_{-1}(0.4)\}, \{s_{-2}(0.4)s_{-1}(0.6), \mu_1(0.6)\mu_2(0.4)\} \end{pmatrix} \\ \begin{pmatrix} \{s_1(0.6)s_2(0.4), \mu_0(0.6)\mu_1(0.4)\}, \{s_{-2}(0.4)s_{-1}(0.6), \mu_0(0.5)\mu_1(0.5)\}, \\ \{s_0(0.3)s_1(0.7), \mu_{-2}(0.6)\mu_{-1}(0.4)\}, \{s_1(0.2)s_2(0.8), \mu_0(0.4)\} \end{pmatrix} \\ \begin{pmatrix} \{s_{-2}(0.7)s_{-1}(0.3), \mu_1(0.5)\mu_2(0.5)\}, \{s_1(1), \mu_1(0.3)\mu_2(0.7)\}, \\ \{s_{-2}(0.4)s_{-1}(0.6), \mu_0(1)\}, \{s_1(0.5)s_2(0.5), \mu_0(0.4)\mu_1(0.4)\} \end{pmatrix} \end{array} \right\},$$

$$D^{L2}(p) = \left\{ \begin{array}{c} \begin{pmatrix} \{s_0(0.6)s_1(0.4), \mu_0(0.6)\mu_1(0.4)\}, \{s_{-1}(0.5)s_{-2}(0.5), \mu_1(0.5)\mu_2(0.5)\}, \\ \{s_1(0.6)s_2(0.4), \mu_{-2}(0.3)\mu_{-1}(0.7)\}, \{s_{-2}(0.4)s_{-1}(0.6), \mu_1(0.6)\mu_2(0.4)\} \end{pmatrix} \\ \begin{pmatrix} \{s_1(0.8)s_2(0.2), \mu_0(0.6)\mu_1(0.4)\}, \{s_{-2}(0.6)s_{-1}(0.4), \mu_0(0.8)\mu_1(0.2)\}, \\ \{s_0(0.2)s_1(0.8), \mu_{-2}(0.6)\mu_{-1}(0.4)\}, \{s_1(0.6)s_2(0.4), \mu_0(1)\} \end{pmatrix} \\ \begin{pmatrix} \{s_{-2}(0.8)s_{-1}(0.2), \mu_1(0.8)\mu_2(0.2)\}, \{s_1(1), \mu_1(0.4)\mu_2(0.6)\}, \\ \{s_{-2}(0.8)s_{-1}(0.2), \mu_0(1)\}, \{s_1(0.8)s_2(0.2), \mu_0(0.6)\mu_1(0.4)\} \end{pmatrix} \end{array} \right\}, \tag{27}$$

$$D^{L3}(p) = \left\{ \begin{array}{c} \begin{pmatrix} \{s_1(1), \mu_0(0.4)\mu_1(0.6)\}, \{s_{-1}(0.4)s_{-2}(0.6), \mu_1(0.3)\mu_2(0.7)\}, \\ \{s_1(0.3)s_2(0.7), \mu_{-2}(0.3)\mu_{-1}(0.7)\}, \{s_{-2}(1), \mu_1(1)\mu_2\} \end{pmatrix} \\ \begin{pmatrix} \{s_1(0.6)s_2(0.4), \mu_0(0.5)\mu_1(0.5)\}, \{s_{-2}(1), \mu_0(0.2)\mu_1(0.8)\}, \\ \{s_0(0.3)s_1(0.7), \mu_{-2}(0.5)\mu_{-1}(0.5)\}, \{s_1(0.2)s_2(0.8), \mu_0(1)\} \end{pmatrix} \\ \begin{pmatrix} \{s_{-2}(0.8)s_{-1}(0.2), \mu_1(0.8)\mu_2(0.2)\}, \{s_1(0.5)s_2(0.5), \mu_1(1)\}, \\ \{s_{-2}(0.3)s_{-1}(0.7), \mu_0(0.8)\mu_1(0.2)\}, \{s_1(0.8)s_2(0.2), \mu_1(1)\} \end{pmatrix} \end{array} \right\}.$$

Table 1: The measures DPLGU_i, DPLIR_i, and DPLC_i for alternatives.

	A_1	A_2	A_3
DPLGU_i	0.076	−0.3246	−0.0281
DPLIR_i	0.3164	0.2201	0.2876
DPLC_i	0.8013	0.2761	0.7453

Then, to deal with this MCGDM issue, we can use the improved DLP-VIKOR method and carry out the risk assessment of these projects. The comparative study between the improved method of DPL-VIKOR and some current methods of decision-making is also completed.

4.1.2. The Improving DLP-VIKOR Method Solves This MCGDM Problem Based on Algorithm 1

Table 2: Risk index and weight indexes.

Risk categories	Weight of the index
Technology c_1	0.26
Environment c_2	0.27
Management c_3	0.22
Market c_4	0.25

Step 1. Aggregate all DMs $D^{DL}(p) = (L_{ij}^{r(k)}(p_{ij}), M_{ij}^{r(k)}(q_{ij}))_{3\times 4}$, $(r = 1, 2, \ldots, R)$

Through the common matrix of decisions

$$D^{cL}(p) = \left(L_{ij}^{c(k)}(p_{ij}), M_{ij}^{c(k)}(q_{ij})\right)_{3\times 4}, \tag{28}$$

based on expert's weight vectors $\omega = \{0.3, 0.4, 0.3\}$:

$$D^{cL}(p) = \left\{\begin{array}{c} \left(\begin{array}{c} \left\{s_0\left(\frac{9}{25}\right)s_1\left(\frac{16}{25}\right), \mu_0\left(\frac{27}{50}\right)\mu_1\left(\frac{23}{50}\right)\right\}, \left\{s_{-1}\left(\frac{47}{100}\right)s_{-2}\left(\frac{53}{100}\right), \mu_1\left(\frac{41}{25}\right)\mu_2\left(\frac{59}{100}\right)\right\}, \\ \left\{s_1\left(\frac{51}{100}\right)s_2\left(\frac{49}{100}\right), \mu_{-2}\left(\frac{33}{100}\right)\mu_{-1}\left(\frac{67}{100}\right)\right\}, \left\{s_{-2}\left(\frac{29}{50}\right)s_{-1}\left(\frac{21}{50}\right), \mu_1\left(\frac{18}{25}\right)\mu_2\left(\frac{7}{25}\right)\right\} \end{array}\right) \\ \left(\begin{array}{c} \left\{s_1\left(\frac{17}{25}\right)s_2\left(\frac{8}{25}\right), \mu_0\left(\frac{57}{100}\right)\mu_1\left(\frac{43}{100}\right)\right\}, \left\{s_{-2}\left(\frac{33}{50}\right)s_{-1}\left(\frac{17}{50}\right), \mu_0\left(s_{-2}\left(\frac{53}{50}\right)\right)\mu_1\left(s_{-2}\left(\frac{47}{100}\right)\right)\right\}, \\ \left\{s_0\left(\frac{13}{50}\right)s_1\left(\frac{37}{50}\right), \mu_{-2}\left(\frac{57}{100}\right)\mu_{-1}\left(\frac{43}{100}\right)\right\}, \left\{s_1\left(\frac{9}{25}\right)s_2\left(\frac{16}{25}\right), \mu_0(1)\right\} \end{array}\right) \\ \left(\begin{array}{c} \left\{s_{-2}\left(\frac{77}{100}\right)s_{-1}\left(\frac{23}{100}\right), \mu_1\left(\frac{71}{100}\right)\mu_2\left(\frac{29}{100}\right)\right\}, \left\{s_1\left(\frac{17}{20}\right)s_2\left(\frac{3}{20}\right), \mu_1\left(\frac{11}{50}\right)\mu_2\left(\frac{9}{20}\right)\right\}, \\ \left\{s_{-2}\left(\frac{53}{100}\right)s_{-1}\left(\frac{47}{100}\right), \mu_0\left(\frac{47}{50}\right)\mu_1\left(\frac{3}{50}\right)\right\}, \left\{s_1\left(\frac{71}{100}\right)s_2\left(\frac{29}{100}\right), \mu_0\left(\frac{9}{25}\right)\mu_1\left(\frac{16}{25}\right)\right\} \end{array}\right) \end{array}\right\}. \tag{29}$$

Step 2. To measure $D^{\mathrm{LGU}_i}(p)$, $D^{LIR_i}(p)$, and $D^{Lc_i}(p)$. Based on equations (11)–(13) for any alternate A_i. Table 1, shows that the lower the risk index value, the better the performance of technological innovation venture capital projects, especially because the risk index value is a cost criterion.

Step 3. According to the obtained measurement values, as shown in Table 1, the ranking order of the alternatives can be obtained according to each indicator.

(1) In DPLGU_i steps, we take $A_2 > A_3 > A_1$

(2) In DPLIR_i steps, we take $A_2 > A_3 > A_1$

(3) In the DPLC_i steps, we take $A_2 > A_3 > A_1$

Step 4. Determine the compromise solution DPLGU_i, DPLIR_i, and DPLC_i, based on the above-given three measures. Hence, the optimal alternative is A_2.

Step 5. End.

5. Comparative Analysis

In this section, we presented the comparison analysis of the developed concept DLPTS based methodology with some existions methods in the literature. We divided this section into two parts.

One is based on DPLTS scores and differences and the other one is focus on the comparison of one linguistic probability variable with another linguistic probability variable. To begin, the score and deviation functions of the DPLTSs projected in this work are more accurate than the other two ways because the value received via the transfer function is more expressive than the value gained through the subscript. Furthermore, the utilisation of multiple dimensions, namely, probabilistic information and linguistic term subscriptions, will result in some data loss.

5.1. A Comparison of the Improved DLP-VIKOR and PL-VIKOR. These three phases can be calculated and shown on the basis of the PL-VIKOR method, respectively [28] inclosed in Table 3.

In the measures of $PLGU_i'$, $PLIR_i'$, PLC_i' listed in Table 3 cannot meet the recommended conditions:

(1) $PLC'_{A^{\sigma(2)}} - PLC'_{A^{\sigma(1)}} = 0.3280 - 0.2261 = 1019 < 0.5$

(2) The alternative A_2 ranks first in the PLC_i', and $PLIR_i'$, tests but second in the $PLGU_i'$

Therefore, we are unable to get the perfect alternative. However, we can get the optimal alternative through the improved DPL-VIKOR method.

5.2. Comparisons between the Enhanced System of PL-VIKOR and Current Methods. Over view of some current methods under the probabilistic linguistic environment to deal with the MCGDM process [17, 46, 47]. It is possible to obtain the DM results and view them in Table 4.

Based on the above-given two comparisons, the summary is as follows:

(1) This is shown in Table 4, which is based on the standard PL-VIKOR approach [28]. It is impossible to find the best compromise solution. This technique only considers the link between some of the alternatives and the PIS, but it ignores the relationship between the alternatives and the NIS. Furthermore, the distance metric employed in the classic PL-VIKOR approach is based on a normalisation procedure that necessitates the inclusion of certain components to the shorter PLTS. As a result, the enhanced DPL-VIKOR approach is more accurate and reasonable than the standard PL-VIKOR method.

(2) Some DM outcomes can be obtained in Table 4, based on some existing methods [17, 46, 47, 49, 55]. For the aggregation operators [17], the PL-TOPSIS method [17], the PL-MULTIMOORA method [46], the PL-DNMA method [48], and the PL-LINMAP [49] method the DM outcome is the same as that of the improved PL-VIKOR process. The PL-TOPSIS Method [17]; however, it only takes into account the degrees of deviation (or distance) between the alternative and the PIS and the degrees of deviation (or distance) between the alternative and the NIS, but it neglects the degrees of deviation (or distance) between the ideal positive solution and the ideal negative solution. In addition, the process of PL-MULTIMOORA [46]: three measures are required, but the third measure, called the Probabilistic Linguistic Full-Multiplicative Type Model, is unable to function if only the profit criteria or cost criteria are present in the decision-making problem.

Table 3: Final Ranking Results.

	A_1	A_2	A_3	Ranking orde r
$PLGU_i'$	0.7378	0.5980	0.4826	$A_3 > A_2 > A_1$
$PLIR_i'$	0.2600	0.1728	0.2300	$A_2 > A_3 > A_1$
PLC_i'	1.0000	0.2261	0.3280	$A_2 > A_3 > A_1$

Table 4: Results of decision-making based on certain current processes.

Authors	Methods	Ranking order
Pang et al. [17]	Aggregation operators	$A_2 \succ A_3 \succ A_1$
Pang et al. [17]	PL TOPSIS method	$A_2 \succ A_3 \succ A_1$
Wu et al. [46]	PL MULTIMOORA method	$A_2 \succ A_3 \succ A_1$
Liao and Wu [48]	PL DNMA	$A_2 \succ A_3 \succ A_1$
Liao et al. [49]	PL LINMAP method	$A_2 \succ A_3 \succ A_1$
Teng and Liu [50]	PL TODIM method	$A_3 \succ A_2 \succ A_1$
Wu et al. [46]	PL GLDS method	$A_2 \succ A_1 \succ A_3$
Wu and Liao [51]	PL ORESTE method	$A_2 \succ A_1 \succ A_3$
Liao et al. [52]	PL ELECTRE	$A_2 \succ A_1 \succ A_3$
Wu et al. [53]	PL PROMETHEE	$A_2 \succ A_1 \succ A_3$
Feng et al. [54]	PL QUALIFLEX	$A_2 \succ A_1 \succ A_3$
Liang et al. [47]	PL GRA	$A_2 \succ A_1 \succ A_3$
The proposed method	Improvedd DLP VIKOR	$A_2 \succ A_3 \succ A_1$

The following is an overview of the major benefits: the modified DPL-VIKOR technique considers the alternative's link with the PIS as well as the alternative's interaction with the NIS. Second, the PLTS normalization process is more reasonable than the classic PL-VIKOR distance calculation method. Finally, when it comes to assessing the risk of TIP MCGDM with PLTSs, the enhanced DPL-VIKOR approach is a good tool to improve risk assessment outcomes and incentive's managers to do scientific risk analysis.

6. Conclusions and Future Directions for Study

Every organization aspires to be successful. Profit growth, market share leadership supported by customer satisfaction, and the ability to innovate define success today. The role of technological innovation projects in the presence of dual-probability linguistic information was investigated in this article. The TIP is always vulnerable to external and internal risks. The impact of these risks may result in failures, and these failures may result in significant losses for the company. It is necessary to develop a risk assessment target for these uncertain risks. As a result, in order to conduct a reasonable risk assessment of TIP, some DM methods, such as the VIKOR method in conjunction with the probabilistic linguistic term set, should be recommended. The PL-VIKOR method, on the other hand, failed to explain the relationship between each alternative and NIS and PIS. To avoid this gap, the risk evolution system in the TIP must be accurate and comprehensive. Our research looks at a new method called the improved DPL-VIKOR method, which clarifies the relationship between each alternative and PIS as well as between each alternative and NIS and is used to solve the dual probabilistic linguistic system MCGDM under risk assessment. In order to show the superiority of our proposed method, we compared our proposed model with existing methods [33] (such as aggregation-based methods), PL-TOPSIS method [32] for risk evaluation of TIP under Probabilistic Linguistic system.

In the future, we will eventually provide more logical decision-making procedures in a probabilistic linguistic framework. We will also extend our work to the Dombi norms, Yager norms, and Frank norms. Furthermore, we will use our proposed work for various methods like TOPSIS method and TODIM method.

Data Availability

The data used in the manuscript are hypothetical and can be used by anyone by just citing this article.

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

All authors have contributed equally to this article.

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