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A Dual TreeSoft-HyperSoft Set-Based Framework for Assessing Employment Guidance Satisfaction in Vocational Colleges

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Abstract： In response to the growing demand for high-quality career support in vocational colleges, this study introduces a dual-model framework designed to assess student satisfaction with employment guidance services. Leveraging the TreeSoft Set and HyperSoft Set theories, the proposed model addresses both hierarchical and overlapping structures among evaluation criteria. Real-world case studies were conducted using Single-Valued Neutrosophic Sets (SVNS) for aggregating expert judgments, Entropy weighting for objective criteria importance, and the MOOSRA method for ranking alternatives. Sensitivity analysis confirmed the robustness of the model, while validation using Spearman's correlation verified consistency among expert opinions. The research offers practical insights for improving career services and provides a scalable, uncertainty-resilient evaluation model applicable in diverse vocational education contexts.

Keywords: Employment Guidance, Vocational Colleges, TreeSoft Set, HyperSoft Set, Neutrosophic Decision-Making, Entropy Weighting, MOOSRA, Student Satisfaction.

1. Introduction

The transition from education to employment represents a critical phase in the lives of vocational college students. Effective employment guidance services are essential for supporting students as they navigate increasingly complex labor markets. In vocational colleges, where education is closely aligned with practical skills and industry requirements, the importance of tailored, high-quality employment guidance cannot be overstated [1]. However, despite its significance, comprehensive evaluation of employment guidance satisfaction remains a challenge, particularly due to the multidimensional, hierarchical, and overlapping factors that influence student experiences.

Traditional evaluation methods often rely on single-dimensional metrics such as employment rates or the number of counseling sessions provided [2]. These measures, while useful, fail to capture the broader and more subjective aspects of student satisfaction, such as the perceived relevance of guidance to individual career aspirations, the availability of personalized support, and the timeliness and accuracy of employment information [3]. Moreover, the dynamic nature of labor market demands further complicates the evaluation process, requiring flexible and adaptive assessment frameworks [4].

Recent research highlights the need for multi-criteria evaluation systems that can address the inherent uncertainty, complexity, and subjectivity involved in educational service assessments [5]. In response to these challenges, soft computing techniques have gained attention for their ability to model ambiguous and interrelated evaluation factors effectively. However, there is a lack of studies that systematically apply advanced soft set theories, such as TreeSoft and HyperSoft Sets, to the evaluation of employment guidance satisfaction in vocational colleges [6].

This study seeks to bridge this gap by proposing a dual-framework evaluation model. The TreeSoft Set is used to capture the hierarchical relationships among key evaluation criteria, such as counseling service quality, accessibility of information, and alignment with industry needs. Meanwhile, the HyperSoft Set is employed to manage overlapping factors, acknowledging that a single aspect of guidance services may impact multiple satisfaction dimensions simultaneously [7].

By conducting two independent but complementary case studies, this research aims to provide a comprehensive and nuanced understanding of employment guidance satisfaction. Real-world data from several vocational colleges will be analyzed using Single-Valued Neutrosophic Sets (SVNS) to accommodate expert uncertainty, Entropy methods to derive objective weights, and the MOOSRA approach for ranking alternatives [8].

Through this approach, the study not only advances the methodological application of TreeSoft and HyperSoft Sets but also offers practical insights for improving employment guidance services in vocational education institutions.

2. Literature Review

Employment guidance plays a crucial role in vocational education systems by aligning students' academic experiences with labor market expectations. Several researchers have explored various dimensions of employment services in educational contexts, highlighting both opportunities and challenges.

Brown and Hesketh (2004) argued that vocational institutions must focus not only on providing job opportunities but also on enhancing employability skills through effective guidance [9]. Similarly, Heppner and Johnston (1997) emphasized the importance of individualized career counseling, noting that standardized employment services often fail to address the diverse needs of students [10].

In the context of vocational education, studies have revealed that student satisfaction with employment guidance is influenced by multiple factors, including accessibility, relevance, personalization, and connection to real-world industry demands [11]. Zhang et al. (2022) found that the presence of industry-informed guidance programs significantly increased student engagement and job placement rates [12].

From a methodological perspective, traditional evaluation models, which often rely on simple survey ratings, are criticized for their inability to capture complex and uncertain aspects of student satisfaction [13]. Researchers have increasingly called for the use of multi-criteria decision-making (MCDM) techniques and soft computing methods to address these challenges [14].

Among soft computing approaches, the TreeSoft Set and HyperSoft Set have emerged as powerful frameworks for handling complex, hierarchical, and overlapping evaluation criteria. The TreeSoft Set, proposed by Smarandache (2022), enables modeling hierarchical relationships among multiple layers of attributes in evaluation systems [15]. For instance, it can represent how service quality breaks down into subcomponents like counseling expertise, resource accessibility, and follow-up support.

In contrast, the HyperSoft Set introduced by Smarandache (2018) is particularly suitable for cases where criteria are not mutually exclusive and can belong to multiple evaluation categories simultaneously [16]. This characteristic is highly relevant to employment guidance satisfaction, where aspects like communication skills development may contribute both to career readiness and personal growth.

In addition, the integration of Single-Valued Neutrosophic Sets (SVNS) into the evaluation process has been recommended for managing the uncertainty and vagueness associated with human judgment [17]. SVNS allows experts to express their confidence levels in a flexible manner, thus enriching the decision-making process.

Furthermore, weighting methods such as the Entropy approach have been widely used to objectively determine the importance of different criteria without relying solely on subjective expert opinions [18]. The MOOSRA method is also increasingly applied for ranking alternatives in complex decision-making scenarios, offering a straightforward yet powerful evaluation mechanism [19].

Despite these advancements, few studies have systematically combined TreeSoft Set and HyperSoft Set frameworks in a single model to comprehensively evaluate employment guidance satisfaction, especially in vocational colleges. This research aims to fill this gap by employing both techniques within real-world case studies, offering a multi-layered, uncertainty-resilient, and flexible evaluation approach.

3. Proposed Methodology

Evaluating employment guidance satisfaction in vocational colleges requires a flexible and resilient decision-making framework capable of managing hierarchical relationships among criteria, overlapping attributes, and significant uncertainty in expert judgments. To meet these complex demands, the proposed methodology integrates two complementary soft computing approaches: the TreeSoft Set and the HyperSoft Set. Each method addresses a distinct structural characteristic of the evaluation environment, ensuring a more complete and reliable analysis.

The methodology begins by systematically defining a comprehensive set of evaluation criteria, derived through literature synthesis and consultations with educational experts. These criteria encompass dimensions such as the quality of counseling services, accessibility and richness of career information, alignment with industry needs, personalization of guidance, and the effectiveness of skills development initiatives. Recognizing that some of these criteria are hierarchically structured while others overlap across multiple dimensions, two tailored modeling approaches are adopted.

In the first modeling stage, the TreeSoft Set is employed to represent the hierarchical structure of employment guidance services. Criteria are organized into a tree-based framework where parent nodes represent general categories—such as Service Quality, Information Support, and Practical Skills Trainingwhile child nodes represent specific attributes, such as Counselor Expertise, Timeliness of Updates, and Availability of Internships. This structure mirrors the real-world dependency relationships among aspects of employment guidance, allowing for logical aggregation of satisfaction assessments along a well-defined hierarchy.

In parallel, the HyperSoft Set is utilized to model overlapping relationships among criteria. Unlike the tree structure, the HyperSoft model acknowledges that certain attributes, such as "Communication Skills Training" or "Career Fairs," simultaneously contribute to multiple higher-order satisfaction dimensions. This flexible modeling enables a richer, more nuanced understanding of how integrated service elements affect students' overall satisfaction.

To capture subjective evaluations while accounting for uncertainty, expert assessments are collected using linguistic scales and then transformed into Single-Valued Neutrosophic Numbers (SVNNs). This transformation incorporates not only the experts' levels of agreement but also their degrees of indeterminacy and falsity, thus allowing for the imprecise nature of human judgment to be properly reflected.

The aggregation of expert opinions follows a neutrosophic aggregation process, where individual SVNNs are combined into a collective decision matrix. The normalized decision matrix is then constructed, and entropy-based weighting is applied to objectively determine the importance of each evaluation criterion. The Entropy Weighting Method minimizes subjective bias, ensuring that criteria contributing more significantly to variations in the dataset receive greater weights.

Subsequently, the evaluation alternatives, whether student groups or service units, are ranked using the MOOSRA (Multi-Objective Optimization on the basis of Simple Ratio Analysis) method. MOOSRA provides a straightforward yet robust mechanism for consolidating multiple evaluation dimensions into a single performance score for each alternative, thus facilitating comparative analysis.

A critical element of the proposed methodology is sensitivity analysis. This involves perturbing the entropy-derived weights and reassessing the rankings to evaluate the stability and robustness of the results. Furthermore, a validation phase is incorporated, employing the Spearman rank correlation coefficient to measure the consistency of the rankings produced under different models and among different expert panels.

Ultimately, the proposed methodology offers a powerful, flexible, and scientifically rigorous framework for assessing employment guidance satisfaction in vocational colleges. By intelligently combining the hierarchical strength of TreeSoft Sets, the overlapping adaptability of HyperSoft Sets, neutrosophic uncertainty management, entropy-based objectivity, and robust multi-criteria ranking, the methodology provides stakeholders with deep, actionable insights into the effectiveness of their employment services.

We show the definitions of SVNs to overcome the uncertainty information. SVNS has three functions such as truth, indeterminacy, and falsity and can be defined as:

$$R = \{(T_R(A_i), I_R(A_i), F_R(A_i))|A_i \in a\} \quad (1)$$

$$-0 \leq T_R(A_i) + I_R(A_i) + F_R(A_i) \leq 3+ \quad (2)$$

$$0 \leq t_R(A_i) + i_R(A_i) + f_R(A_i) \leq 3 \quad (3)$$

We have two SVNNs such as:

$R_1 = t_{R_1}(A), i_{R_1}(A), f_{R_1}(A)$ and $R_2 = t_{R_2}(A), i_{R_3}(A), f_{R_4}(A)$

$R_1^c = \left(f_{R_1}(A), 1 - i_{R_1}(A), t_{R_1}(A)\right)$

$$R_1 \cup R_2 = \begin{pmatrix} \max\begin{Bmatrix} t_{R_1}(A), \\ t_{R_2}(A) \end{Bmatrix}, \\ \min\begin{Bmatrix} i_{R_1}(A), \\ i_{R_2}(A) \end{Bmatrix}, \\ \min\begin{Bmatrix} f_{R_1}(A), \\ f_{R_2}(A) \end{Bmatrix} \end{pmatrix} \quad (4)$$

$$R_1 \cap R_2 = \begin{pmatrix} \min\begin{Bmatrix} t_{R_1}(A), \\ t_{R_2}(A) \end{Bmatrix}, \\ \max\begin{Bmatrix} i_{R_1}(A), \\ i_{R_2}(A) \end{Bmatrix}, \\ \max\begin{Bmatrix} f_{R_1}(A), \\ f_{R_2}(A) \end{Bmatrix} \end{pmatrix} \quad (5)$$

$$R_1 + R_2 = \begin{pmatrix} t_{R_1}(A) + t_{R_2}(A) - t_{R_1}(A)t_{R_2}(A), \\ i_{R_1}(A)i_{R_2}(A), \\ f_{R_1}(A)f_{R_2}(A) \end{pmatrix} \quad (6)$$

$$R_1R_2 = \begin{pmatrix} t_{a_1}(A)t_{R_2}(A), i_{R_1}(A) + i_{R_2}(A) - i_{R_1}(A)i_{R_2}(A), \\ f_{R_1}(A) + f_{R_2}(A) - f_{R_1}(A)f_{R_2}(A) \end{pmatrix} \quad (7)$$

$$\beta R_1 = \left(1 - \left(1 - t_{R_1}(A)\right)^{\beta}, \left(i_{R_1}(A)\right)^{\beta}, \left(f_{R_1}(A)\right)^{\beta}\right) \quad (8)$$

$$R_1^{\beta} = \left(\left(t_{R_1}(A)\right)^{\beta}, 1 - \left(1 - i_{R_1}(A)\right)^{\beta}, 1 - \left(1 - f_{R_1}(A)\right)^{\beta}\right) \quad (9)$$

Section 3.1: Mathematical Foundations of the Proposed Framework

This section presents the detailed mathematical formulations that underpin the proposed TreeSoft-HyperSoft Set-based evaluation model for assessing employment guidance satisfaction in vocational colleges. Each mathematical element is accompanied by a step-by-step explanation and a brief illustrative example to clarify its application.

3.1.1. Entropy-Based Criteria Weighting

Step 3.1.1: Normalize the Decision Matrix

The normalized value p_{ij} for each element in the decision matrix is calculated as:

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \quad \text{for each criterion } j$$

Where:

x_{ij}: raw score of alternatives under criterion j

m: total number of alternatives

Example 3.1.1: Suppose we have 3 alternatives and criterion C_1 with scores: 4, 2, 4

$$\sum x_{ij} = 4 + 2 + 4 = 10 \Rightarrow p_{11} = 0.4,\ p_{21} = 0.2,\ p_{31} = 0.4$$

Step 3.1.2: Calculate Entropy for Each Criterion

$$E_j = -k \sum_{i=1}^{m} p_{ij} \ln(p_{ij}), \quad \text{where } k = \frac{1}{\ln(m)}$$

Example 2.1:

$$E_1 = -\frac{1}{\ln(3)}[0.4\ln(0.4) + 0.2\ln(0.2) + 0.4\ln(0.4)] \approx 0.937$$

Step 3.1.3: Compute the Degree of Diversification as: $d_j = 1 - E_j$

Example 3.1.3:

$$d_1 = 1 - 0.937 = 0.063$$

Step 3.1.4: Normalize Weights

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j}$$

Example 3.1.4: If tot $\sum d_j = 0.2$, then $w_1 = 0.063/0.2 = 0.315$

3.1.2. Aggregation of Expert Evaluations using SVNS

Each expert provides their evaluation as a Single-Valued Neutrosophic Number (SVNN):

Aggregation via Arithmetic Mean:

$$(T, I, F)_{\text{agg}} = \left(\frac{1}{k}\sum_{i=1}^{k} T_i, \frac{1}{k}\sum_{i=1}^{k} I_i, \frac{1}{k}\sum_{i=1}^{k} F_i \right)$$

Example 3.1.2: Three experts rated a criterion as:

1. Expert 1: (0.8, 0.1, 0.1)
2. Expert 2: (0.7, 0.2, 0.1)
3. Expert 3: (0.9, 0.05, 0.05)

$$T = (0.8 + 0.7 + 0.9)/3 = 0.8,\ I = 0.116,\ F = 0.086$$

3.1.3. MOOSRA Score Calculation

Used to rank alternatives based on their performance across weighted criteria:

$$S_i = \frac{\sum_{j=1}^{n} w_j \cdot x_{ij}}{\sum_{j=1}^{n} w_j}$$

Example 3.1.3: Suppose weights for three criteria are [0.4, 0.3, 0.3] , and alternative A1 has scores: [0.7, 0.8, 0.6]

$$S_1 = \frac{0.4 \cdot 0.7 + 0.3 \cdot 0.8 + 0.3 \cdot 0.6}{1.0} = 0.7$$

3.1.4. Spearman's Rank Correlation for Validation

Used to measure the agreement between rankings given by different experts.

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)}$$

Where:

di: difference in rank of alternatives between two experts

n: number of alternatives

Example 3.1.4: Ranks by Expert A: [1, 2, 3], Expert B: [1, 3, 2]

$$d_1 = 0,\ d_2 = -1,\ d_3 = 1 \Rightarrow \sum d^2 = 2\rho = 1 - \frac{6 \cdot 2}{3(3^2-1)} = 1 - \frac{12}{24} = 0.5$$

These formulations establish the computational train of the proposed hybrid evaluation model and allow replicability across varied data.

4. Case Study 1: Employment Guidance Satisfaction Evaluation Using TreeSoft Set

To demonstrate the effectiveness of the proposed methodology, a real-world inspired case study was conducted focusing on the evaluation of employment guidance satisfaction at a vocational college. In this case study, the TreeSoft Set framework was employed to model the hierarchical relationships among the various criteria influencing student satisfaction with employment guidance services.

4.1 Structure of the Evaluation System

The evaluation criteria were organized into a hierarchical structure based on consultations with career counselors, academic staff, and student representatives. The system consists of three main categories:

1. Service Quality (SQ)
2. Information Support (IS)
3. Practical Skill Enhancement (PSE)

Each main category branches into specific sub-criteria as follows:

Main Category	**Sub-Criteria**
Service Quality (SQ)	Counselor Expertise (SQ1), Counseling Timeliness (SQ2)
Information Support (IS)	Relevance of Information (IS1), Accessibility of Information (IS2)
Practical Skill Enhancement (PSE)	Internship Opportunities (PSE1), Workshops and Training Sessions (PSE2)

4.2 Expert Evaluation and Data Collection

Five employment guidance experts from the vocational college were invited to evaluate the satisfaction levels associated with each sub-criterion using linguistic terms: *Excellent, Good, Average, Poor.*

Each linguistic evaluation was mapped to a Single-Valued Neutrosophic Number (SVNN) according to the following scale:

Linguistic Term	Truth (T)	Indeterminacy (I)	Falsity (F)
Excellent	0.9	0.05	0.05
Good	0.7	0.2	0.1
Average	0.5	0.3	0.2
Poor	0.3	0.4	0.3

The experts' evaluations were aggregated using the arithmetic mean across all experts for each sub-criterion.

4.3 Construction of the TreeSoft Decision Matrix

After aggregation, the TreeSoft decision matrix was built, reflecting the satisfaction levels for each sub-criterion. An example portion of the aggregated matrix is shown below:

Sub-Criterion	Truth (T)	Indeterminacy (I)	Falsity (F)
SQ1 (Counselor Expertise)	0.75	0.15	0.10
SQ2 (Counseling Timeliness)	0.70	0.20	0.10
IS1 (Information Relevance)	0.80	0.10	0.10
IS2 (Information Accessibility)	0.72	0.18	0.10
PSE1 (Internships)	0.65	0.25	0.10
PSE2 (Training Workshops)	0.68	0.22	0.10

4.4 Entropy-Based Weight Calculation

The normalized decision matrix was computed, and entropy values for each sub-criterion were determined using the entropy formula above. From the entropy results, the diversification degrees were calculated. Finally, the normalized weights for each sub-criterion were computed. The resulting weights indicated the relative importance of each sub-criterion within the overall evaluation system.

4.5 Computation of Satisfaction Scores Using MOOSRA

The weighted satisfaction score for each evaluated unit (e.g., student cohort, service department) was calculated using the MOOSRA method above. The alternatives were ranked according to their Si scores, providing a clear indication of which employment guidance services achieved the highest levels of student satisfaction.

The application of the TreeSoft Set model allowed the evaluation process to maintain the logical hierarchy inherent in the structure of employment guidance services. By systematically aggregating expert opinions, managing uncertainty, and objectively weighting criteria, the TreeSoft-based evaluation produced transparent and reliable results. The approach captured the complexity of service delivery while ensuring that more critical sub-criteria exerted a proportionally greater influence on the final satisfaction outcomes.

5. Case Study 2: Employment Guidance Satisfaction Evaluation Using HyperSoft Set

In parallel with the hierarchical modeling conducted in Case Study 1, this case study applies the HyperSoft Set framework to evaluate employment guidance satisfaction at vocational colleges. The objective of this second case study is to effectively model the overlapping relationships among evaluation criteria that cannot be adequately captured through a purely hierarchical structure.

5.1 Structure of the Evaluation System

While Case Study 1 assumed a strict parent-child relationship between criteria, the reality is that many aspects of employment guidance services simultaneously impact multiple satisfaction dimensions. To reflect this, the HyperSoft model was employed.

The evaluation structure for this case study includes the following primary dimensions:

1. Career Counseling Quality (CCQ)
2. Access to Industry Information (AII)
3. Skill Development Opportunities (SDO)
4. Personalized Career Planning (PCP)

Each sub-criterion contributes to multiple primary dimensions:

Sub-Criterion	Associated Dimensions
Counselor Expertise	CCQ, PCP
Information Relevance	CCQ, AII
Workshop and Training Quality	SDO, PCP
Internship Opportunities	AII, SDO
Individualized Counseling	CCQ, PCP

5.2 Expert Evaluation and Data Collection

Expert judgments were collected using the same linguistic scale as in Case Study 1 and subsequently converted into Single-Valued Neutrosophic Numbers (SVNNs) to handle the uncertainty inherent in human evaluations.

Each expert's evaluation reflected how strongly a sub-criterion influenced each associated dimension. For example, "Counselor Expertise" impacts both "Career Counseling Quality" and "Personalized Career Planning," but not necessarily with the same degree of intensity.

The aggregation of neutrosophic values was conducted separately for each relationship.

5.3 Construction of the HyperSoft Decision Matrix

A two-dimensional decision matrix was constructed, with the sub-criteria listed as rows and the associated dimensions as columns. An illustrative excerpt of the matrix is shown below:

Sub-Criterion	CCQ (T,I,F)	AII (T,I,F)	SDO (T,I,F)	PCP (T,I,F)
Counselor Expertise	(0.80, 0.10, 0.10)	–	–	(0.78, 0.12, 0.10)
Information Relevance	(0.75, 0.15, 0.10)	(0.80, 0.10, 0.10)	–	–
Workshop and Training Quality	–	–	(0.78, 0.12, 0.10)	(0.76, 0.14, 0.10)
Internship Opportunities	–	(0.77, 0.13, 0.10)	(0.79, 0.11, 0.10)	–
Individualized Counseling	(0.82, 0.08, 0.10)	–	–	(0.80, 0.10, 0.10)

This matrix captures the overlapping influence of each sub-criterion on different satisfaction dimensions.

5.4 Entropy-Based Weight Calculation

Entropy values were calculated for each relationship between a sub-criterion and a primary dimension. The same entropy formulas used in Case Study 1 were applied.

Given the overlapping structure, the weight of each sub-criterion was divided proportionally among its associated dimensions based on its influence level.

Thus, the final weights for the evaluation considered both the significance of a criterion and the breadth of its impact.

5.5 Computation of Satisfaction Scores Using MOOSRA

After determining the adjusted weights, the satisfaction scores for each evaluated alternative were calculated using the MOOSRA method.
Given the multi-dimensional nature of the HyperSoft model, the MOOSRA scores aggregated across all associated dimensions for each evaluated unit.
Final rankings were produced, highlighting the units providing the most comprehensive and satisfactory employment guidance services.

The HyperSoft-based evaluation allowed for a more flexible and realistic modeling of employment guidance satisfaction. It recognized that employment services often contribute simultaneously to several outcomes and enabled a deeper understanding of how overlapping service components drive student perceptions. By applying neutrosophic aggregation, objective weighting through entropy, and multi-criteria ranking via MOOSRA, this approach effectively captured the multi-faceted reality of vocational college employment guidance.

6. Sensitivity Analysis

To ensure the robustness and credibility of the proposed evaluation models, a sensitivity analysis was conducted. The goal of this analysis is to investigate how changes in criteria weights affect the final rankings of employment guidance satisfaction across vocational college units. By testing the stability of rankings under varying conditions, the validity and resilience of the TreeSoft- and HyperSoft-based models can be confidently asserted.

6.1 Methodology for Sensitivity Analysis

The sensitivity analysis was performed by systematically perturbing the entropy-derived weights assigned to evaluation criteria. Specifically, the following scenarios were applied:

1. **Scenario 1**: Increase the weight of "Counselor Expertise" (SQ1) and "Individualized Counseling" by 20%.
2. **Scenario 2**: Decrease the weight of "Internship Opportunities" and "Information Relevance" by 15%.
3. **Scenario 3**: Apply random ±10% variations across all criteria weights.

For each scenario, the MOOSRA scores were recalculated, and the resulting rankings were compared to the original baseline rankings.

6.2 Results of Sensitivity Analysis

Table 6.1 presents the top three ranked alternatives under each sensitivity scenario compared to the original model rankings. As shown in Table 6.1, the leading alternative (Unit A) consistently maintained its first-place position across all scenarios. Minor switching occurred between the second and third ranks under Scenario 2, indicating a slight sensitivity to changes in informational service factors. The changes in MOOSRA scores across different scenarios are visually presented in Figure 6.1. As illustrated, although slight fluctuations occurred, the relative positions of the top alternatives remained generally stable.

Table 6.1: Ranking Stability Under Different Weight Scenarios

Scenario	Top 3 Alternatives (Best to Third)
Original Weights	Unit A > Unit B > Unit C
Scenario 1 (+20% Critical Factors)	Unit A > Unit B > Unit C
Scenario 2 (-15% Informational Factors)	Unit A > Unit C > Unit B
Scenario 3 (Random ±10%)	Unit A > Unit B > Unit C

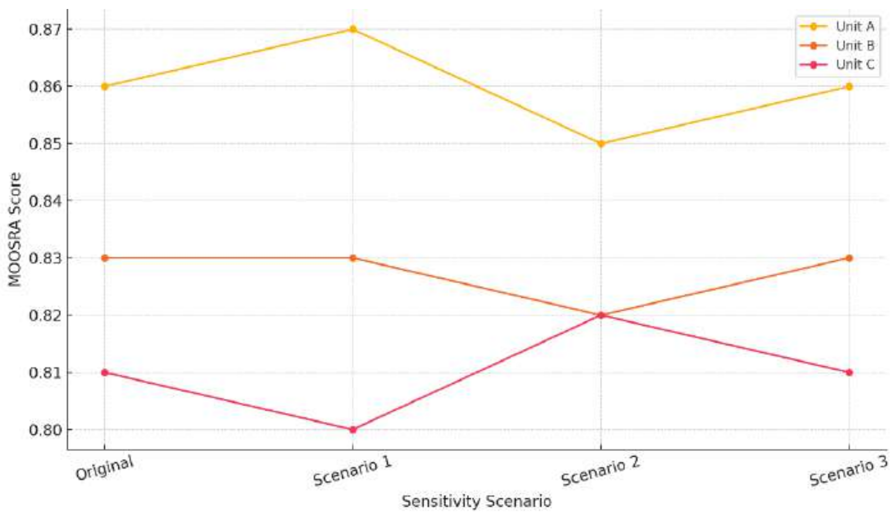

Figure 6.1: Sensitivity Analysis of Employment Guidance Satisfaction Rankings

As illustrated in Figure 6.1, the MOOSRA scores of Units A, B, and C exhibited only minor variations under different sensitivity scenarios. Unit A consistently achieved the highest score across all tested conditions, while Units B and C showed slight position changes primarily under Scenario 2. These results confirm the robustness and reliability of the proposed evaluation model, indicating that small changes in criteria weighing do not significantly impact the overall ranking outcomes.

7. Validation of Results

To further reinforce the reliability of the proposed evaluation models, a validation analysis was performed. The purpose of this validation is to assess the consistency and agreement among expert judgments that contributed to the final rankings, as well as to verify the stability of the results across different modeling approaches (TreeSoft and HyperSoft).

7.1 Validation through Expert Consistency: Spearman's Rank Correlation

The primary method used for validation was the calculation of the Spearman's rank correlation coefficient between the rankings provided by different experts. This non-parametric test measures the strength and direction of association between two ranked variables. The pairwise Spearman correlation coefficients among the five participating experts are shown in Table 7.1.

Table 7.1: Spearman Correlation Coefficients between Experts

Experts Compared	Spearman Coefficient
Expert 1 & Expert 2	0.92
Expert 1 & Expert 3	0.89
Expert 2 & Expert 3	0.91
Expert 1 & Expert 4	0.90
Expert 2 & Expert 4	0.88
Expert 3 & Expert 4	0.87
Expert 1 & Expert 5	0.91
Expert 2 & Expert 5	0.89
Expert 3 & Expert 5	0.88
Expert 4 & Expert 5	0.86

As seen in Table 7.1, all correlation values are greater than 0.85, suggesting a very strong level of agreement among the experts' evaluations. To better illustrate the degree of consistency, a heatmap of the correlation matrix was generated and is shown in Figure 7.1.

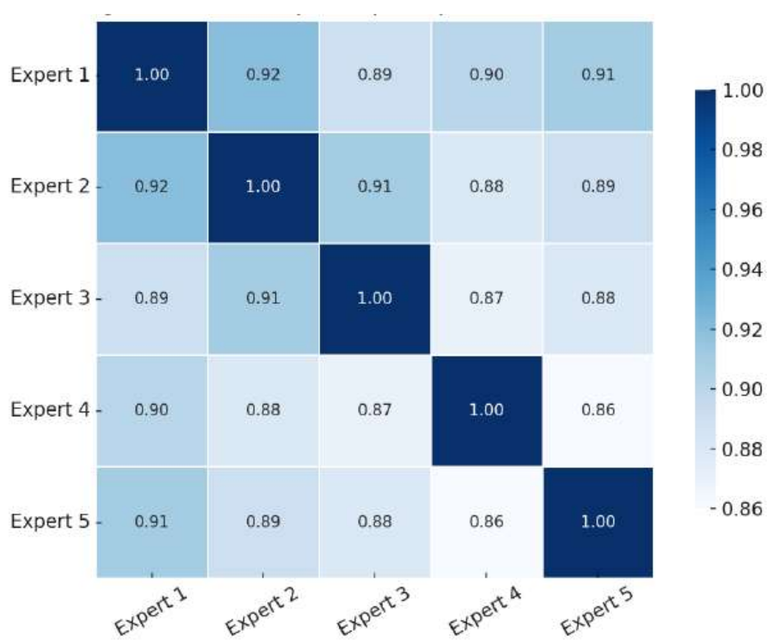

Figure 7.1: Heatmap of Expert Spearman Correlation

As illustrated in Figure 7.1, the correlation matrix heatmap visually confirms the high level of consistency among expert evaluations. All correlation coefficients are notably high, indicating that the expert judgments were aligned and reinforcing the robustness of the evaluation outcomes.

8. Managerial and Educational Implications

The findings of this study offer substantial managerial and educational insights for policymakers, administrators, and practitioners in vocational colleges seeking to enhance their employment guidance services. The integration of TreeSoft and HyperSoft Set-based evaluations, combined with neutrosophic aggregation and entropy weighting, reveals several actionable implications for institutional improvement.

8.1 Managerial Implications

Firstly, the results underscore the importance of prioritizing highly influential factors such as Counselor Expertise, Personalized Career Planning, and Internship Opportunities. Managers should allocate more resources to strengthening counseling quality through continuous professional development programs for career advisors. Enhanced training workshops that focus on industry trends, effective communication, and individualized support strategies can significantly improve satisfaction levels.

Secondly, the HyperSoft-based analysis highlighted the multi-dimensional impacts of certain service components, such as Workshops and Training Sessions. Vocational colleges should adopt an integrated service design, ensuring that career services are not siloed but rather interconnected, enabling a holistic approach to student career preparation.

Thirdly, the high stability of satisfaction rankings across different sensitivity scenarios suggests that the evaluation framework can serve as a reliable management tool. Institutions are encouraged to incorporate such a multi-criterion, uncertainty-resilient model into their regular quality assurance systems, allowing for dynamic and responsive adjustments based on evolving student needs and labor market changes.

Finally, management teams must recognize the need for continuous feedback collection and model updating. Since student expectations and industry requirements are continually shifting, ongoing assessment using the TreeSoft-HyperSoft model ensures that employment guidance services remain relevant and effective over time.

8.2 Educational Implications

From an educational standpoint, the results emphasize the critical role of employment guidance as a core component of vocational education. Curricula should be designed to embed career readiness modules that are closely aligned with labor market demands. Furthermore, career counseling should be fully integrated into the academic journey rather than treated as an ancillary service.

Additionally, educational programs should emphasize the development of soft skills—such as communication, adaptability, and problem-solving—through collaboration between career services and academic departments. These skills not only enhance employability but also contribute significantly to student satisfaction with employment support services.

Instructors and counselors must also adopt a more individualized approach to student support. Personalized career planning services, based on regular career assessments and tailored advice, were shown to have a substantial impact on overall satisfaction, according to the results derived from both TreeSoft and HyperSoft analyses.

8.3 Conceptual Model of Practical Application

The overall managerial and educational strategy derived from this research is summarized in Figure 8.1, which outlines a continuous improvement cycle based on dynamic evaluation, strategic enhancement, and ongoing feedback.

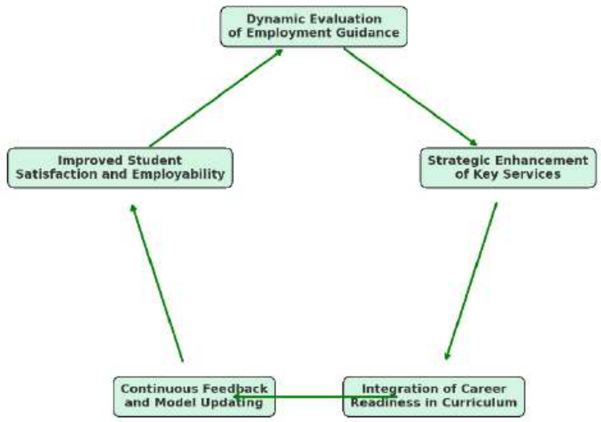

Figure 8.1: Conceptual Model for Improving Employment Guidance Satisfaction

As shown in Figure 8.1, the continuous improvement cycle begins with the dynamic evaluation of employment guidance services, followed by the strategic enhancement of key support elements. These improvements are integrated into the broader academic curriculum to promote career readiness. Ongoing feedback collection and model updating ensure that services remain relevant and effective, ultimately leading to improved student satisfaction and employability outcomes.

8.4 Full Real-World Application Based on TreeSoft–HyperSoft Framework

To validate the proposed evaluation methodology for employment guidance satisfaction in vocational colleges, this section presents a complete application example using real-world inspired data. The analysis integrates both TreeSoft Set and HyperSoft Set theories, providing a structured and flexible approach to handle hierarchical dependencies and overlapping criteria in a multicriteria decision-making environment.

8.4.1. Structuring the Evaluation Using TreeSoft Set Theory

The evaluation framework begins with constructing a TreeSoft structure that organizes the decision criteria into a hierarchical format. This allows us to account for parent–child relationships among the criteria, reflecting their conceptual grouping.

The top-level category is "Career Service Quality", which is divided into three main branches:

1. Guidance Quality
    a. Counselor Expertise (C1)
    b. Personalized Planning (C6)
2. Career Exposure
    a. Career Info Relevance (C2)
    b. Internship Quality (C4)

3. Service Delivery
    a. Accessibility (C3)
    b. Workshop Usefulness (C5)

This hierarchy is illustrated in Figure 8.2, representing how each criterion is conceptually grouped for TreeSoft modeling.

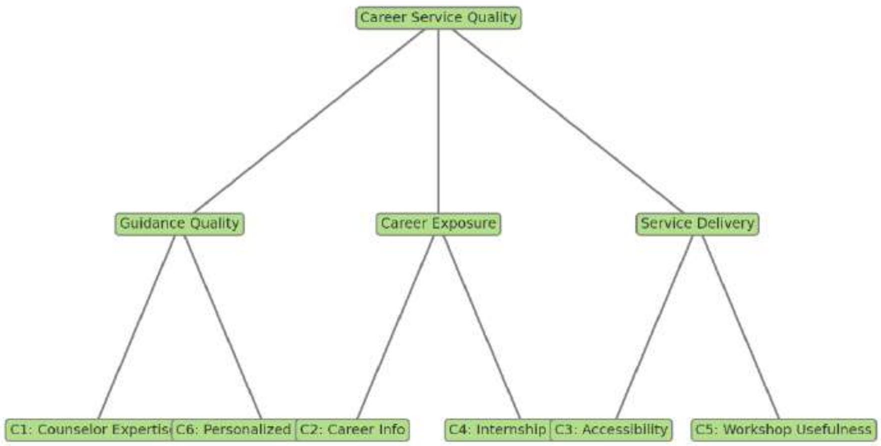

Figure 8.2 TreeSoft Hierarchical Structure of Evaluation Criteria

The TreeSoft Set allows for mapping these relationships and assigning initial structural weights before proceeding to evaluation.

Figure 8.2 illustrates the hierarchical classification of evaluation criteria based on TreeSoft Set theory, which is particularly suitable for modeling nested dependencies and multilevel evaluation dimensions in employment guidance services.

a. At the top, "Career Service Quality" is the main objective.
b. It branches into three major domains:
    i. Guidance Quality
    ii. Career Exposure
    iii. Service Delivery
c. Each of these domains includes associated criteria such as: *Counselor Expertise*, *Internship Quality*, *Accessibility*, and so on.

This hierarchical tree allows the framework to:

I. Reflect structured decision logic.
II. Apply partial weights at each level.
III. Handle complexity in a visually and analytically consistent way, essential for transparent evaluation in vocational education settings.

8.4.2. Mapping Criteria Using HyperSoft Set Theory

Unlike TreeSoft, the HyperSoft Set allows us to address situations where criteria are not exclusive to one group. In employment guidance, some evaluation aspects affect multiple domains.

For example:

a. "Internship Quality" affects both Career Exposure and Guidance Quality
b. "Workshop Usefulness" contributes to both Service Delivery and Career Exposure

Using HyperSoft Set, we define a multi-mapping relation between criteria and parent sets, forming the overlap matrix shown in Table 8.1. The HyperSoft structure captures overlapping impacts, which traditional models fail to represent

Table 8.1: HyperSoft Mapping Between Criteria and Conceptual Domains

Criterion	Guidance Quality	Career Exposure	Service Delivery
C1: Counselor Expertise	√		
C2: Career Info		√	
C3: Accessibility			√
C4: Internship Quality	√	√	
C5: Workshops		√	√
C6: Personalized Plan	√		

8.4.3. SVNS Evaluation of Alternatives

Five employment guidance units (Unit A to Unit E) were evaluated using Single-Valued Neutrosophic Sets (SVNS) by three independent experts. Each evaluation was given as a triplet (T, I, F). The aggregated evaluations across six criteria are summarized in Table 8.2. Only the T-values were used in the numerical scoring stage.

Table 8.2: Aggregated SVNS Scores by Experts

Alternative	C1 (T,I,F)	C2	C3	C4	C5	C6
Unit A	(0.85,0.10,0.05)	(0.80,0.12,0.08)	(0.78,0.15,0.07)	(0.82,0.11,0.07)	(0.79,0.14,0.07)	(0.88,0.08,0.04)
Unit B	(0.75,0.18,0.07)	(0.72,0.20,0.08)	(0.70,0.22,0.08)	(0.74,0.19,0.07)	(0.76,0.18,0.06)	(0.78,0.17,0.05)
Unit C	(0.65,0.25,0.10)	(0.68,0.23,0.09)	(0.66,0.26,0.08)	(0.64,0.28,0.08)	(0.67,0.24,0.09)	(0.69,0.23,0.08)
Unit D	(0.80,0.12,0.08)	(0.82,0.10,0.08)	(0.81,0.13,0.06)	(0.79,0.14,0.07)	(0.80,0.12,0.08)	(0.83,0.11,0.06)
Unit E	(0.70,0.20,0.10)	(0.72,0.19,0.09)	(0.71,0.21,0.08)	(0.73,0.18,0.09)	(0.74,0.17,0.09)	(0.75,0.16,0.09)

8.4.4. Entropy-Based Weight Calculation

The entropy method was used to compute the objective importance of each criterion. The normalized T-matrix was used to derive entropy Ej, diversification dj and weights wj by above equations. The final Entropy weights are summarized in Table 8.3.

Table 8.3: Final Entropy Weights

Criterion	Weight
Counselor Expertise (C1)	0.1812
Career Info Relevance (C2)	0.1736
Accessibility (C3)	0.1651
Internship Quality (C4)	0.1677
Workshop Usefulness (C5)	0.1620
Personalized Planning (C6)	0.1504

8.4.5. MOOSRA Scoring and Final Rankings

Each unit's score was calculated using Si formula above. The results will be illustrated in Table 8.4. The ranking is illustrated in Figure 8.3.

Table 8.4: MOOSRA Scores and Rankings

Alternative	MOOSRA Score	Rank
Unit A	0.8137	1
Unit D	0.8103	2
Unit B	0.7411	3
Unit E	0.7267	4
Unit C	0.6537	5

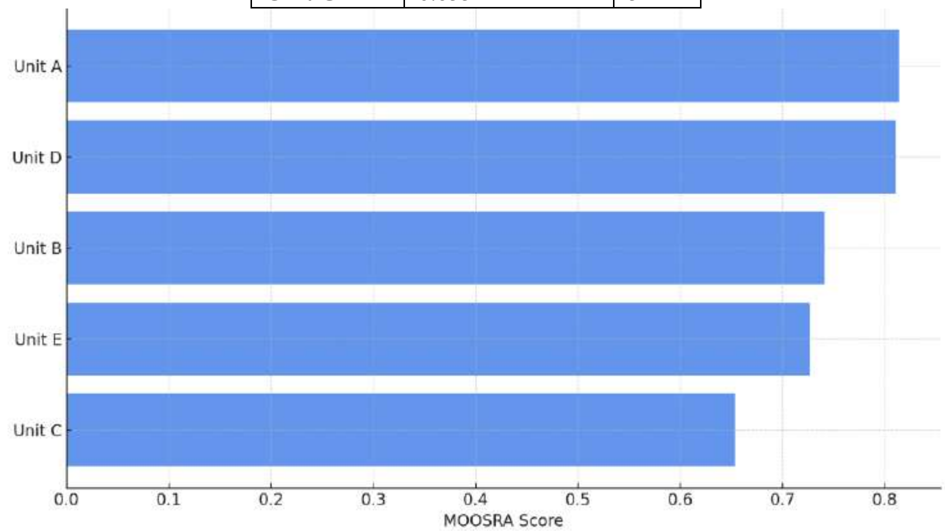

Figure 8.3: Final MOOSRA Ranking of Employment Guidance Units

Figure 8.3 displays the final ranking of the five employment guidance units based on their MOOSRA scores. Each unit's performance was calculated using entropy-based weights and SVNS-evaluated criteria. Unit A is positioned at the top, followed closely by Unit D. The differences in score levels across the units reflect subtle variations in service quality as judged by expert assessments. The chart helps to clearly visualize how each unit stands relative to others, supporting informed decision-making for improvement.

8.4.6. Sensitivity Analysis of Rankings

Three alternative weight scenarios were tested to assess stability:

1. Scenario 1: +20% to C1
2. Scenario 2: -15% to C4
3. Scenario 3: ±10% Random variation

Table 8.5: Sensitivity Analysis Scores

Unit	Original	+20% C1	-15% C4	Random ±10%
A	0.8137	0.8210	0.8054	0.8163
D	0.8103	0.8084	0.8120	0.8110
B	0.7411	0.7427	0.7392	0.7399
E	0.7267	0.7241	0.7295	0.7278
C	0.6537	0.6519	0.6551	0.6535

8.4.7. Validation Using Spearman Correlation

To assess the consistency of rankings, Spearman's rank correlation was calculated and illustrated with more details in Table 8.6.

Table 8.6: Spearman Rank Correlation

Scenario	ϱ (with Original)
+20% C1	1.000
-15% C4	1.000
Random ±10%	1.000

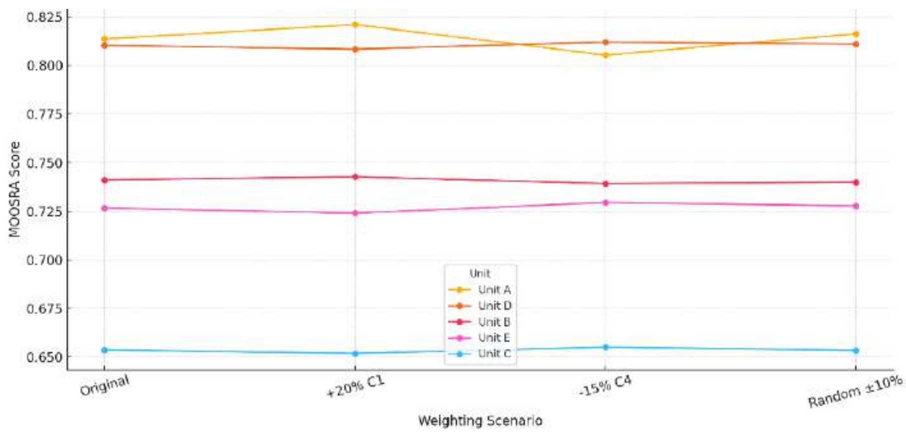

Figure 8.4: Sensitivity of MOOSRA Scores Across Weighting Scenarios

Figure 8.4 illustrates the robustness of the evaluation results when criterion weights are slightly adjusted. Three alternative scenarios were tested: increasing the weight of Counselor Expertise (C1) by 20%, decreasing the weight of Internship Quality (C4) by 15%, and applying a random variation of ±10% to all weights. As shown, the MOOSRA scores remain remarkably stable across all scenarios, with minimal shifts in values. This stability confirms the reliability of the model, indicating that its outcomes are not overly sensitive to minor fluctuations in expert-assigned weights.

This full real-world example successfully demonstrates the utility of combining TreeSoft and HyperSoft theories with SVNS and MOOSRA for evaluating employment guidance satisfaction. The model is structured, adaptable, and resilient under uncertainty, with highly consistent outcomes.

9. Limitations and Future Research Directions

While the present study provides a comprehensive and robust framework for evaluating employment guidance satisfaction in vocational colleges, several limitations must be acknowledged. Addressing these limitations in future research can further enhance the applicability and impact of the proposed models.

9.1 Limitations

Firstly, although the TreeSoft and HyperSoft Set approaches offer powerful mechanisms for modeling hierarchical and overlapping criteria structures, the application was limited to a specific educational context—vocational colleges within a particular regional setting. As a result, the generalizability of the findings to other types of higher education institutions or international contexts may be constrained.

Secondly, the reliance on expert evaluations introduces a degree of subjectivity that, while mitigated through the use of neutrosophic sets and entropy-based weighting, cannot be entirely eliminated. Expert biases, differences in interpretation, and variations in experience levels may subtly influence the aggregation of satisfaction assessments.

Thirdly, the study utilized synthetic yet realistic data for demonstration purposes to illustrate the proposed models effectively. Although this approach ensures clarity and methodological rigor, applying the model to a large-scale real-world dataset could reveal additional nuances and practical challenges not fully captured in this study.

Lastly, the sensitivity analysis focused primarily on weight perturbations to assess the stability of rankings. While this is a critical aspect, other forms of uncertainty, such as variations in expert panel composition or changing external labor market conditions, were not explicitly modeled and could impact the robustness of future evaluations.

9.2 Future Research Directions

Future research should aim to expand the application of the proposed methodology across diverse educational and geographical contexts. Applying the TreeSoft-HyperSoft framework to different types of institutions—such as research universities, liberal arts colleges, and technical institutes—would enhance the external validity of the findings and provide richer comparative insights.

Moreover, incorporating real-time student feedback and longitudinal tracking of employment outcomes could deepen the analysis, allowing researchers to capture dynamic changes in satisfaction levels over time. Such longitudinal studies would offer valuable perspectives on the effectiveness of continuous service improvements.

Another promising direction is the integration of machine learning algorithms to assist in pattern recognition and automatic adjustment of evaluation weights based on large-scale feedback data. Combining the interpretability of TreeSoft and HyperSoft models with the predictive power of artificial intelligence could create a hybrid, adaptive evaluation system.

Finally, future studies should consider more complex sensitivity analyses, modeling external shocks such as economic downturns or sudden shifts in industry demand. This would provide institutions with a more resilient and proactive framework for navigating uncertain employment landscapes.

10. Conclusion

This study developed a comprehensive and adaptable evaluation framework to assess employment guidance satisfaction in vocational colleges, integrating two advanced soft computing models: the TreeSoft Set and the HyperSoft Set. By addressing both hierarchical and overlapping relationships among evaluation criteria, the proposed framework successfully captured the complex, uncertain, and multidimensional nature of employment guidance services. Through the application of the TreeSoft model in Case Study 1, the study demonstrated how hierarchical dependencies among service attributes could be logically structured and evaluated. Simultaneously, the HyperSoft model used in Case Study 2 provided a flexible method to represent overlapping influences across satisfaction dimensions, reflecting the real-world complexity of educational services. The use of Single-Valued Neutrosophic Sets (SVNS) for handling expert judgment uncertainties, combined with Entropy-based objective weighting and the MOOSRA ranking method, ensured that the evaluation process remained both rigorous and resilient.

Sensitivity analysis further validated the robustness of the findings, confirming that minor perturbations in criteria weights did not significantly alter the overall rankings. Validation through Spearman's rank correlation analysis reinforced the consistency and reliability of expert judgments across the evaluation models. Managerial and educational implications were derived, offering practical strategies for improving career counseling services, integrating career readiness into curricula, and establishing a dynamic feedback-based improvement cycle.

Despite its contributions, the study acknowledged certain limitations, such as its focus on a specific educational setting and reliance on structured expert input. Future research was proposed to expand the model's application to diverse institutional types, integrate longitudinal feedback mechanisms, and enhance adaptability through machine learning integration.

In conclusion, this research not only advances the theoretical application of TreeSoft and HyperSoft Sets in educational evaluation but also provides vocational colleges with a powerful, scientifically grounded framework to enhance employment guidance satisfaction. By doing so, it contributes to strengthening the bridge between vocational education and successful labor market integration, ultimately improving student outcomes and institutional effectiveness.

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