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Multi-Criteria Evaluation Of Student Career Readiness Using An Intelligent Topsis-Based Decision Support System

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ABSTRACT

The assessment of student career readiness requires a systematic approach that considers multiple competencies and experiences relevant to workplace demands. This study develops an intelligent decision support system based on the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to evaluate and map student career readiness. The study uses 20 student samples and five assessment criteria: field-specific competence (C1), internship experience (C2), communication skills (C3), digital literacy (C4), and English language proficiency (C5). Each criterion is assigned a weight based on its relative importance. The TOPSIS method involves decision matrix construction, normalization, weighted normalization, determination of positive and negative ideal solutions, distance calculation, and preference value calculation. The results show that Y11 achieved the highest preference value of 0.8296, followed by Y6 (0.7951), Y19 (0.7274), Y5 (0.7116), and Y2 (0.6999), while Y9 obtained the lowest preference value of 0.3112. Based on the classification results, 1 student (5%) was categorized as Highly Ready, 5 students (25%) as Ready, 12 students (60%) as Moderately Ready, and 2 students (10%) as Not Ready. These findings demonstrate that TOPSIS can effectively rank and classify student career readiness based on multiple assessment criteria. The proposed system can support higher education institutions in identifying students' readiness levels and developing more objective, targeted, and data-driven career development strategies.

Keyword : Career Readiness, Decision Support System, Students, Multi-Criteria, TOPSIS, Career Assessment

INTRODUCTION

The increasingly dynamic nature of the professional world demands that students possess career readiness supported not only by academic ability but also by competencies and the capacity to adapt to professional environments. Nuriani et al. Indicate that student career readiness requires further strengthening, particularly regarding adaptability and career planning [1]. Internship experiences also contribute to students' job readiness, communication skills, collaboration abilities, and digital competencies [2]. Furthermore, digital literacy and adaptability are becoming increasingly important in enhancing students' employability competencies [3]. Career readiness is a multidimensional concept encompassing soft skills, hard skills, communication, digital literacy, adaptability, and practical experience; therefore, an approach capable of simultaneously considering various criteria is required. TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is a Multi-Criteria Decision Making (MCDM) method that can be used to evaluate alternatives based on their proximity to an ideal solution. Research by Arman et al. Applied TOPSIS to recommend career alternatives for students based on competencies, achieving a testing accuracy of 96% [4]. The application of TOPSIS also demonstrates its capability in addressing student decision-making problems involving multiple

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criteria. Ishak et al. [5] utilized TOPSIS to identify top-performing students based on proximity to the ideal solution, while [6] Developed a TOPSIS-based Decision Support System (DSS) incorporating both academic and non-academic criteria to generate more objective decisions.

A Decision Support System (DSS) is used to assist in decision-making based on predetermined criteria. Decision-making involves a systematic approach to a problem, encompassing the process of transforming data into information and incorporating factors that must be considered during the decision-making process [7]. Decision-making is the process of selecting an alternative course of action to achieve specific goals or objectives [8]. DSS methods are problem-solving techniques suitable for implementation within a system, enabling the system to facilitate decisions regarding high-performing employees in a hospital setting [9]. The characteristics of a Decision Support System are as follows [9]: 1. There are multiple choices or alternatives. 2. There are constraints involved in the decision-making process. 3. There is a pattern or model used to determine the best course of action amidst constraints. 4. There are multiple criteria or variables serving as references for the decision. 5. There are risk factors involved, requiring speed, precision, and accuracy in the decision outcomes [10].

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is a Multi-Criteria Decision Making (MCDM) method that identifies the best alternative based on its proximity to the positive ideal solution and its distance from the negative ideal solution [11]. This method allows for the integration of various criteria with differing characteristics, thereby systematically ranking alternatives [12]. Its implementation involves several stages: constructing the decision matrix, normalization, weighting, determining positive and negative ideal solutions, calculating the distance of each alternative, and determining preference values [13]. TOPSIS is capable of handling both benefit and cost criteria, making it applicable to a wide range of decision-making problems [14]. Utilizing TOPSIS within a decision support system can enhance objectivity and transparency, as the evaluation process relies on structured mathematical procedures [15]. In the field of education, the TOPSIS method has been applied to rank students based on various indicators [6]. Furthermore, TOPSIS can be combined with weighting methods—such as Entropy Weighting—to derive criterion weights more objectively [16]. Recent research has also advanced TOPSIS by incorporating more adaptive distance approaches to address inter-attribute correlations in complex decision-making scenarios [13]. Differences in weighting methods can influence criterion priorities and the stability of ranking results; consequently, determining weights is a crucial aspect of TOPSIS implementation [17].

METHODOLOGY

This study employs a quantitative approach using the Multi-Criteria Decision Making (MCDM) method—specifically the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)—to evaluate and rank students' career readiness. The criteria utilized include disciplinary competence (C1), internship or project experience (C2), communication skills (C3), skills (C4), digital literacy (C5), and English proficiency. These six criteria serve as the assessment variables for measuring the students' level of career readiness. Data were gathered from academic and non-academic records as well as questionnaires, with each criterion weighted according to its level of importance. All criteria were categorized as "benefit" criteria, as higher values indicate a higher level of career readiness. The data were then processed through the TOPSIS stages: normalization, weighting, determination of positive and negative ideal solutions, distance calculation, and the derivation of preference values. The final results were used to determine the rankings and career readiness categories for the students: highly ready, ready, moderately ready, and not yet ready.

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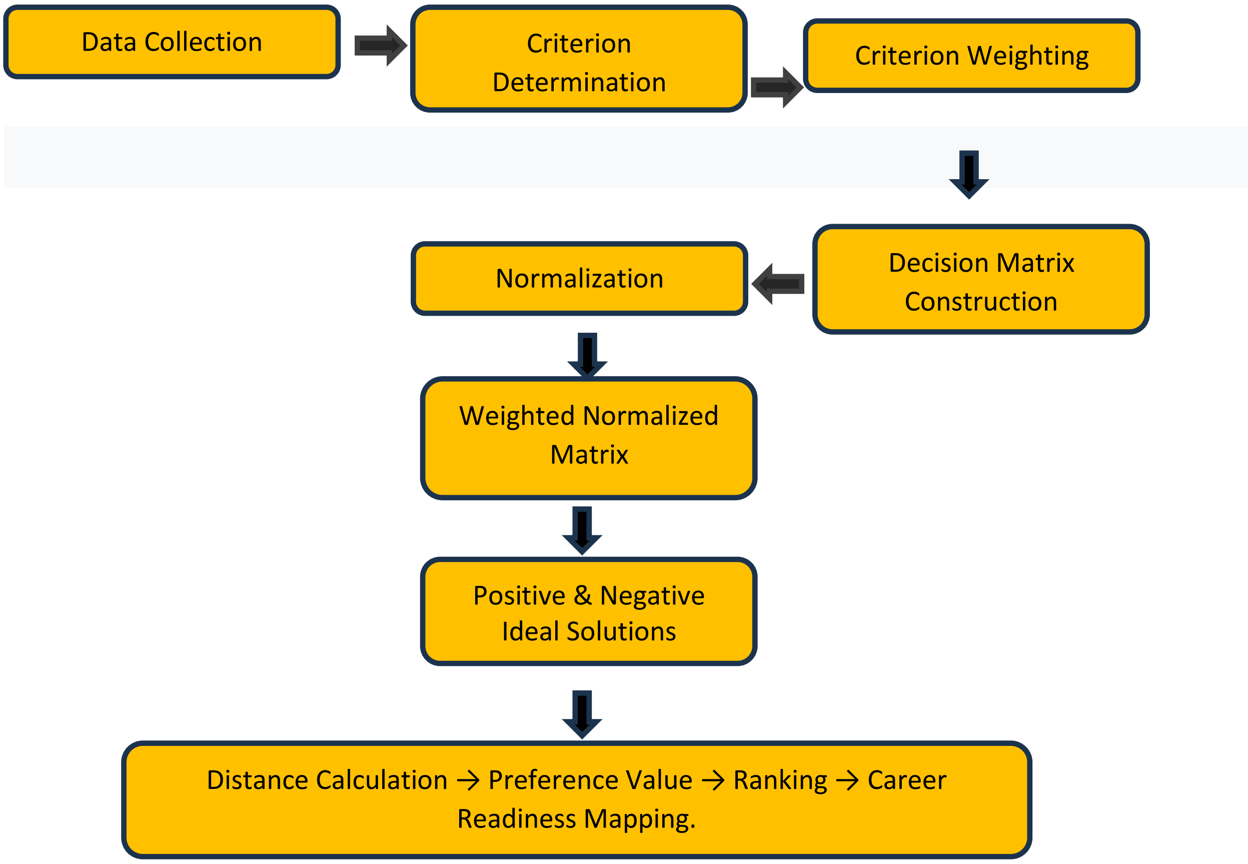

Figure 1. Research Methodology

The following are the steps of the TOPSIS method for determining the final result:

1. Construct a normalized decision matrix using the formula:

   $$r_{ij} = \frac{x_{ij}}{\sqrt{\Sigma_{i=1}^{m} x^2{}_{ij}}} \qquad (1)$$

   Where,
   r = normalized decision matrix
   x = alternative value
2. Calculate the weighted normalized value using the formula:

   $$y_{ij} = w_i . r_{ij} \qquad (2)$$

   Where,
   y = weighted normalized decision matrix
   w = weights
   r = normalized decision matrix
3. Determining the negative ideal solution value using the formula:

   $$A^+ = (y_1^+, y_2^+, \ldots, y_n^+) \qquad (3)$$

4. Determining the negative ideal solution value using the formula

   $:A^- = (y_1^-, y_2^-, \ldots, y_n^-)$ (4)
5. Determine the distance of the weighted values from the positive and negative ideal solutions using the equation:
6. $D_i^+ = \sqrt{\Sigma_j^n = i\,(y_1^+ - y_{ij})^2}$ (5)
7. $D_i^- = \sqrt{\Sigma_j^n = i\,(y_{ij} - y_1^-)^2}$ (6)
8. determine the preference value for each alternative, using the equation:

   $$V_1 = \frac{D_1^-}{D_1^- + D_1^+}$$

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RESULTS AND DISCUSSION

This study used 20 student samples as alternatives to evaluate their career readiness. Each student was assessed based on five criteria: Academic Competence (C1), Internship Experience (C2), Communication Skills (C3), Digital Literacy (C4), and English Proficiency (C5). These five criteria were used to describe various aspects related to student readiness to enter the workforce. Each alternative was scored on a scale of 1 to 5, with higher scores indicating a higher level of ability or readiness.

1. Alternative Data

a. Criteria Table

Tabel 1. Criteria

Code	Criteria	Weight
C1	Field-Specific Competence	25%
C2	Internship/Project Experience	25%
C3	Communication Skills	20%
C4	Digital Literacy	15%
C5	English Language Proficiency	15%
	Total	**100%**

Table 1. presents the criteria and weights used to evaluate student career readiness. Five criteria were selected, namely Field-Specific Competence (C1), Internship/Project Experience (C2), Communication Skills (C3), Digital Literacy (C4), and English Language Proficiency (C5). C1 and C2 receive the highest weights of 25% each, indicating that disciplinary competence and practical experience are considered the most important factors in assessing career readiness. Communication Skills (C3) is assigned a weight of 20%, while Digital Literacy (C4) and English Language Proficiency (C5) each receive 15%. The total weight is 100%, and all criteria are treated as benefit criteria, meaning that higher scores indicate higher student career readiness.

Table 2. Student Sample Data for Career Readiness Evaluation

Kriteria	C1	C2	C3	C4	C5
Y1	5	3	5	3	3
Y2	4	2	5	4	5
Y3	3	3	4	3	4
Y4	4	4	4	4	3
Y5	3	3	5	5	4
Y6	4	4	5	4	5
Y7	5	5	4	3	3
Y8	2	4	4	4	2
Y9	2	3	3	3	3
Y10	2	4	3	4	4
Y11	3	4	4	5	5
Y12	4	5	5	4	2
Y13	3	5	4	5	3
Y14	4	3	3	3	4
Y15	3	3	4	3	4
Y16	4	3	5	2	4
Y17	5	4	4	2	5
Y18	4	4	3	3	5
Y19	3	2	4	5	5
Y20	4	2	4	4	3
Results	16,40121947	16,18641406	18,60107524	16,82260384	17,54992877

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2. **Determination of Criteria and Weight**

This study establishes five main criteria as a basis for assessing students' level of career readiness, namely:

1. C1 Scientific Competence: Mastery of knowledge, application of knowledge, and ability to solve problems in the scientific field.
2. C2 Internship Experience: Length/frequency of internships, relevance of internships, and practical work experience.
3. C3 Communication Skills: Conveying ideas, presentations, and oral and written communication.
4. C4 Digital Literacy: Use of technology, digital applications, information retrieval, and data management.
5. C5 English Language Skills: Reading, writing, listening, and speaking in English.
6.

Table 3. Criteria Weight Values

Criteria	Weight
Highly Ready	5
Ready	4
Moderately Ready	3
Less Ready	2
Not Ready	1

3. **Decision Matrix**

The next stage involves normalizing the decision matrix based on the values assigned to each criterion. This normalization process aims to transform the initial values of each alternative into a uniform scale, allowing comparisons across different criteria. The resulting normalized values are then used in the subsequent TOPSIS calculation, as presented in the following table.

Table 4. Decision Values Normalized

Kriteria	C1	C2	C3	C4	C5
Y1	25	9	25	9	9
Y2	16	4	25	16	25
Y3	9	9	16	9	16
Y4	16	16	16	16	9
Y5	9	9	25	25	16
Y6	16	16	25	16	25
Y7	25	25	16	9	9
Y8	4	16	16	16	4
Y9	4	9	9	9	9
Y10	4	16	9	16	16
Y11	9	16	16	25	25
Y12	16	25	25	16	4
Y13	9	25	16	25	9
Y14	16	9	9	9	16
Y15	9	9	16	9	16
Y16	16	9	25	4	16
Y17	25	16	16	4	25
Y18	16	16	9	9	25
Y19	9	4	16	25	25
Y20	16	4	16	16	9

Table 4 presents the decision values for 20 student alternatives (Y1–Y20) across five evaluation criteria (C1–C5). The values represent the transformed decision scores obtained from the initial assessment of each student, with scores ranging from 4 to 25. These values are used as the basis for the subsequent TOPSIS calculation, including the normalization, weighting, determination of positive and negative ideal solutions, and ranking of student career readiness. The next stage involves

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calculating the normalized decision matrix based on the values assigned to each criterion. This normalization process is an essential step in the TOPSIS method because the criteria may have different numerical values and levels of measurement. Therefore, normalization is performed to transform the original decision values into a comparable scale while maintaining the relative performance of each alternative. The normalized values represent the contribution of each alternative to the corresponding criterion and provide a consistent basis for the subsequent calculation stages. After applying the normalization formula to all alternatives and criteria, the resulting values are presented in the following table.

Table 5. Normalized Data

Y1	0,30485538	0,185340619	0,268801665	0,178331489	0,170940865
Y2	0,243884304	0,123560413	0,268801665	0,237775319	0,284901441
Y3	0,182913228	0,185340619	0,215041332	0,178331489	0,227921153
Y4	0,243884304	0,247120825	0,215041332	0,237775319	0,170940865
Y5	0,182913228	0,185340619	0,268801665	0,297219149	0,227921153
Y6	0,243884304	0,247120825	0,268801665	0,237775319	0,284901441
Y7	0,30485538	0,308901032	0,215041332	0,178331489	0,170940865
Y8	0,121942152	0,247120825	0,215041332	0,237775319	0,113960576
Y9	0,121942152	0,185340619	0,161280999	0,178331489	0,170940865
Y10	0,121942152	0,247120825	0,161280999	0,237775319	0,227921153
Y11	0,182913228	0,247120825	0,215041332	0,297219149	0,284901441
Y12	0,243884304	0,308901032	0,268801665	0,237775319	0,113960576
Y13	0,182913228	0,308901032	0,215041332	0,297219149	0,170940865
Y14	0,243884304	0,185340619	0,161280999	0,178331489	0,227921153
Y15	0,182913228	0,185340619	0,215041332	0,178331489	0,227921153
Y16	0,243884304	0,185340619	0,268801665	0,11888766	0,227921153
Y17	0,30485538	0,247120825	0,215041332	0,11888766	0,284901441
Y18	0,243884304	0,247120825	0,161280999	0,178331489	0,284901441
Y19	0,182913228	0,123560413	0,215041332	0,297219149	0,284901441
Y20	0,243884304	0,123560413	0,215041332	0,237775319	0,170940865

Based on the normalization results, the maximum and minimum values for each criterion are subsequently identified. This stage is carried out to determine the positive ideal solution and the negative ideal solution required in the TOPSIS method. The maximum value of each benefit criterion represents the best performance and is therefore used to construct the positive ideal solution, while the minimum value represents the lowest performance and is used to construct the negative ideal solution. Since all criteria used in this study are categorized as benefit criteria, higher values indicate better student performance and a higher level of career readiness. The resulting maximum and minimum values for each criterion are presented in the following table.

Table 6. Max and Min values of weighted normalization

Alternatif	Kriteria				
	C1	C2	C3	C4	C5
Y1	0,0203237	0,0247121	0,0537603	0,0475551	0,0569803
Y2	0,016259	0,0164747	0,0537603	0,0634068	0,0949671
Y3	0,0121942	0,0247121	0,0430083	0,0475551	0,0759737
Y4	0,016259	0,0329494	0,0430083	0,0634068	0,0569803
Y5	0,0121942	0,0247121	0,0537603	0,0792584	0,0759737
Y6	0,016259	0,0329494	0,0537603	0,0634068	0,0949671
Y7	0,0203237	0,0411868	0,0430083	0,0475551	0,0569803
Y8	0,0081295	0,0329494	0,0430083	0,0634068	0,0379869
Y9	0,0081295	0,0247121	0,0322562	0,0475551	0,0569803
Y10	0,0081295	0,0329494	0,0322562	0,0634068	0,0759737

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Y11	0,0121942	0,0329494	0,0430083	0,0792584	0,0949671
Y12	0,016259	0,0411868	0,0537603	0,0634068	0,0379869
Y13	0,0121942	0,0411868	0,0430083	0,0792584	0,0569803
Y14	0,016259	0,0247121	0,0322562	0,0475551	0,0759737
Y15	0,0121942	0,0247121	0,0430083	0,0475551	0,0759737
Y16	0,016259	0,0247121	0,0537603	0,0317034	0,0759737
Y17	0,0203237	0,0329494	0,0430083	0,0317034	0,0949671
Y18	0,016259	0,0329494	0,0322562	0,0475551	0,0949671
Y19	0,0121942	0,0164747	0,0430083	0,0792584	0,0949671
Y20	0,016259	0,0164747	0,0430083	0,0634068	0,0569803
MAX	0,0203237	0,0411868	0,0537603	0,0792584	0,0949671
MIN	0,0081295	0,0164747	0,0322562	0,0317034	0,0379869

The next step is to calculate the positive and negative ideal solution matrices by summing the values of each criterion obtained from the weighted normalization matrix. For positive ideal solutions, the maximum value of each criterion is used, while for negative ideal solutions, the minimum value is used. These weighted values are then raised to the power of two during the calculation to obtain the desired final result.

Table 7. Distance Negative Ideal Solutions

Score Results Table D+	
DY1+	0,052149036
DY2+	0,02963925
DY3+	0,04264934
DY4+	0,043523104
DY5+	0,026424519
DY6+	0,018320814
DY7+	0,050633116
DY8+	0,061888522
DY9+	0,057711772
DY10+	0,035930587
DY11+	0,015797134
DY12+	0,059283652
DY13+	0,040307527
DY14+	0,046002399
DY15+	0,04264934
DY16+	0,053946019
DY17+	0,049446387
DY18+	0,039394264
DY19+	0,028149287
DY20+	0,049366927

Table 8. Distance Negative Ideal Solutions

Score Results Table D-	
DY1-	0,035930587
DY2-	0,069140245
DY3-	0,043523104
DY4-	0,04264934
DY5-	0,065201913

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DY6-	0,071075944
DY7-	0,038561888
DY8-	0,037311224
DY9-	0,026074518
DY10-	0,052149036
DY11-	0,076888119
DY12-	0,046306665
DY13-	0,058009055
DY14-	0,042757689
DY15-	0,043523104
DY16-	0,045159403
DY17-	0,061501833
DY18-	0,061931689
DY19-	0,075102373
DY20-	0,039338909

The final stage of the TOPSIS method is to calculate the preference value for each alternative using Equation (7). The preference value is obtained by dividing the distance of each alternative from the negative ideal solution by the sum of its distances from the negative and positive ideal solutions. This calculation produces a preference score ranging from 0 to 1, where a higher score indicates that an alternative is closer to the positive ideal solution and farther from the negative ideal solution. Therefore, alternatives with higher preference values are considered to have a higher level of career readiness. The resulting preference values are then used to rank the alternatives and identify the relative career readiness of each student. The results of the preference value calculation are presented in Table 9.

Table 9. Preference Values

Score Results Table Vi	
0,40793303	0,407933028
0,69994532	0,699945318
0,50506986	0,50506986
0,49493014	0,49493014
0,71160594	0,711605937
0,79506176	0,795061765
0,43233238	0,432332377
0,37612217	0,376122171
0,31120268	0,311202681
0,59206697	0,592066972
0,82956152	0,829561516
0,4385503	0,438550298
0,5900231	0,590023104
0,48172202	0,481722021
0,50506986	0,50506986
0,45567036	0,455670356
0,55432916	0,554329159
0,6112125	0,611212502
0,72737206	0,727372063
0,44347599	0,443475993

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The Score Results Table (Vi) presents the final preference values obtained from the TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method. The Vi value represents the relative closeness of each alternative to the positive ideal solution and its distance from the negative ideal solution. The value of Vi ranges from 0 to 1, where a higher Vi value indicates that an alternative is closer to the ideal solution and therefore has a higher preference or priority. Based on the calculation results, the preference values obtained for the 20 alternatives range from 0.3112 to 0.8296. The highest preference value is obtained by Alternative Y11, with a Vi score of 0.8296. This indicates that Y11 has the greatest relative closeness to the positive ideal solution and can therefore be considered the best-performing alternative among the evaluated alternatives.The second-highest score is obtained by Y19, with a Vi value of 0.7274, followed by Y6 with a score of 0.7951 and Y5 with 0.7116. Meanwhile, alternatives such as Y2 (0.6999), Y18 (0.6112), and Y10 (0.5921) also demonstrate relatively high preference values. These results indicate that these alternatives have relatively good performance based on the criteria and weights used in the TOPSIS analysis. On the other hand, Alternative Y9 has the lowest Vi value of 0.3112, indicating that it has the greatest distance from the positive ideal solution and/or is relatively close to the negative ideal solution. Therefore, Y9 obtains the lowest priority among the evaluated alternatives. Other alternatives with relatively low preference values include Y8 (0.3761), Y1 (0.4079), and Y7 (0.4323).

Table 10. The final result

Ranking	Alternative	Vi Value	Career Readiness
1	Y11	0,8296	Highly Ready
2	Y6	0,7951	Ready
3	Y19	0,7274	Ready
4	Y5	0,7116	Ready
5	Y2	0,6999	Ready
6	Y18	0,6112	Ready
7	Y10	0,5921	Moderately Ready
8	Y13	0,5900	Moderately Ready
9	Y17	0,5543	Moderately Ready
10	Y3	0,5051	Moderately Ready
11	Y15	0,5051	Moderately Ready
12	Y4	0,4949	Moderately Ready
13	Y14	0,4817	Moderately Ready
14	Y16	0,4557	Moderately Ready
15	Y20	0,4435	Moderately Ready
16	Y12	0,4386	Moderately Ready
17	Y7	0,4323	Moderately Ready
18	Y1	0,4079	Moderately Ready
19	Y8	0,3761	Not Ready
20	Y9	0,3112	Not Ready

Table 10 presents the final ranking of 20 students based on the TOPSIS Vi values. Y11 achieved the highest score (0.8296) and was classified as *Highly Ready*, followed by Y6 (0.7951) and Y19 (0.7274), which were classified as *Ready*. Meanwhile, most students were categorized as *Moderately Ready*, while Y8 (0.3761) and Y9 (0.3112) were classified as *Not Ready*. These results indicate that TOPSIS can effectively rank students according to their level of career readiness.

Table 10. The final result Percentage

Category	Number of Students	Percentage
Highly Ready	1	5%
Ready	5	25%
Moderately Ready	12	60%
Not Ready	2	10%
Total	20	100%

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The table presents the distribution of career readiness levels among 20 students based on the TOPSIS results. One student (5%) is classified as *Highly Ready*, while five students (25%) are categorized as *Ready*. The majority, 12 students (60%), fall into the *Moderately Ready* category, while two students (10%) are classified as *Not Ready*. These results indicate that most students have a basic level of career readiness but still require further competency development to improve their preparedness for entering the workforce. Overall, 90% of the students are classified at least as Moderately Ready, while 10% remain in the Not Ready category. This finding can provide a basis for higher education institutions to design targeted career development programs, particularly for students with lower levels of career readiness.

CONCLUSION

This study developed a TOPSIS-based intelligent decision support system to evaluate and rank student career readiness using multiple competency criteria, including field-specific competence, internship/project experience, communication skills, digital literacy, and English proficiency. The results for 20 students show that Y11 achieved the highest preference value (0.8296) and was classified as Highly Ready, while Y9 obtained the lowest preference value (0.3112) and was classified as Not Ready. Overall, 1 student (5%) was classified as Highly Ready, 5 students (25%) as Ready, 12 students (60%) as Moderately Ready, and 2 students (10%) as Not Ready. These findings indicate that the majority of students have a moderate level of career readiness and still require further development of their competencies. The proposed TOPSIS-based system can support higher education institutions in systematically evaluating, ranking, and mapping students' career readiness, as well as providing a basis for developing more targeted career guidance, competency development, and career preparation programs.

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