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Decision Support System for Selecting Business and Industrial Partners (DUDI) for Industrial Internship Placement Using the Simple Additive Weighting (SAW) Method at SMK Negeri 1 Barus Utara

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ABSTRACT

Vocational High Schools (SMKs) play a strategic role in producing graduates who are competent, skilled, and prepared to meet the demands of the industrial workforce. One of the core programs designed to achieve this objective is the Industrial Internship Program (Praktik Kerja Industri/Prakerin), which enables students to apply the theoretical knowledge acquired in the classroom to real workplace environments. However, selecting appropriate Business and Industrial Partners (Dunia Usaha dan Dunia Industri—DUDI) remains a challenging task due to the involvement of multiple evaluation criteria, including curriculum compatibility, industrial facilities, accessibility, accommodation costs, and partner reputation. At SMK Negeri 1 Barus Utara, the selection process is still conducted manually, making it susceptible to subjectivity and inconsistency. This study proposes a Decision Support System (DSS) employing the Simple Additive Weighting (SAW) method to objectively rank potential DUDI partners based on predefined evaluation criteria and their corresponding weights. The research adopts a quantitative approach within the Multi-Criteria Decision Making (MCDM) framework. Five assessment criteria were established through interviews with internship coordinators, and five DUDI partners were evaluated as alternatives. The findings indicate that PT Sibolga Citra Komputindo achieved the highest preference score (0.7700), making it the most suitable internship partner. The implementation of the SAW method demonstrates its effectiveness in producing objective, transparent, and measurable recommendations, thereby improving the quality of internship management and supporting informed decision-making in vocational education.

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INTRODUCTION

Vocational High Schools (Sekolah Menengah Kejuruan—SMKs) play a strategic role in producing skilled human resources who are work-ready, competent, and competitive in both the digital economy and conventional industrial sectors (Susanto & Rahmawati, 2021). One of the core programs incorporated into the SMK curriculum to achieve this objective is the Industrial Internship Program (Praktik Kerja Industri—Prakerin), also referred to as Field Work Practice (Praktik Kerja Lapangan—PKL). Through this program, students are provided with opportunities to apply the theoretical knowledge and practical competencies acquired during their studies in real workplace environments (Prasetyo & Hidayat, 2022).

SMK Negeri 1 Barus Utara, one of the vocational education institutions located in Central Tapanuli Regency, Indonesia, regularly assigns its students to various Business and Industrial Partners (Dunia Usaha dan Dunia Industri—DUDI). The success of the internship program largely depends on the suitability and quality of the selected DUDI partners. Appropriate partner selection not only ensures the achievement of students' competencies but also improves operational cost efficiency, time effectiveness, and occupational safety throughout the internship period (Hidayat, 2020).

Despite its importance, the process of identifying and selecting DUDI partners at SMK Negeri 1 Barus Utara continues to face several challenges. Internship placement decisions are still performed manually, making the selection process highly subjective. School administrators often encounter difficulties in simultaneously evaluating multiple critical criteria, including the compatibility between students' areas of specialization and industrial needs (skill match), geographical distance and accessibility, availability of industrial mentoring facilities, company reputation, and students' accommodation and living expenses during the internship program (Rahayu & Handayani, 2023). Such a manual selection process increases the risk of

inappropriate student placement, which may ultimately reduce the effectiveness of experiential learning and negatively affect both students and industry partners (Arifin, 2021).

To address the complexity of this multi-criteria decision-making (MCDM) problem, a computerized Decision Support System (DSS) is required (Turban et al., 2020). A DSS enables the systematic processing of multiple evaluation criteria in a rapid, transparent, and measurable manner, thereby generating objective and reliable recommendations for decision-makers (Pressman & Maxim, 2020).

Among various MCDM techniques, the Simple Additive Weighting (SAW) method has been widely recognized as one of the most effective approaches for solving weighted decision-making problems (Setiawan & Kurniawan, 2020). Commonly referred to as the weighted sum method, SAW calculates the weighted aggregation of performance ratings across all evaluation criteria (Fishburn, 1967). The method was selected in this study because of its capability to generate accurate assessments based on predefined criterion weights and attribute types (benefit or cost), while maintaining computational efficiency that facilitates implementation within an integrated decision support system (Pratama & Putra, 2022).

By integrating the SAW method into a Decision Support System, school administrators and internship coordinators at SMK Negeri 1 Barus Utara can objectively rank potential DUDI partners according to the established evaluation criteria. The proposed system is expected to enhance the governance and effectiveness of the internship program, strengthen collaboration between vocational schools and industrial partners, and contribute to the application of computer science methodologies in vocational education management. Furthermore, this study provides an academic reference for the implementation of multi-criteria decision-making techniques in educational decision support systems (Pratama & Putra, 2022; Setiawan & Kurniawan, 2020).

METHODS

Research Framework

This study employed a quantitative research approach by implementing a Decision Support System (DSS) based on the Multi-Criteria Decision Making (MCDM) framework. The research procedure was systematically designed to generate recommendations for selecting Business and Industrial Partners (Dunia Usaha dan Dunia Industri—DUDI) as Industrial Internship (Praktik Kerja Industri—Prakerin) placements for students of SMK Negeri 1 Barus Utara. The research was conducted through the following stages:

1. **Problem Identification and Literature Review**
   The initial stage focused on identifying the problems associated with the existing manual process of selecting DUDI partners at SMK Negeri 1 Barus Utara. Subsequently, a comprehensive literature review was conducted by examining previous studies, scientific journals, textbooks, and other relevant references related to Decision Support Systems (DSS), Multi-Criteria Decision Making (MCDM), and the Simple Additive Weighting (SAW) method.
2. **Data Collection**
   The data collection stage aimed to obtain the information required for the decision-making process. The collected data consisted of DUDI partner alternatives, evaluation criteria, and the corresponding weights assigned to each criterion. Data were obtained through interviews with the internship committee and questionnaires distributed to stakeholders involved in the internship placement process.
3. **Criteria Analysis and Weight Assignment**
   At this stage, the evaluation criteria (Cj) used to assess each DUDI alternative were determined. Each criterion was classified as either a benefit attribute, where higher values indicate better performance, or a cost attribute, where lower values are preferred. Subsequently, each criterion was assigned a weight (Wj) according to its relative importance in the internship partner selection process.
4. **Implementation of the SAW Algorithm**
   The implementation of the Simple Additive Weighting (SAW) method began by constructing a decision matrix (X) containing the performance values of each alternative with respect to every evaluation criterion. The decision matrix was then normalized to produce the normalized matrix (R). Finally, the preference value (Vi) for each alternative was calculated by multiplying each normalized criterion value by its corresponding criterion weight and summing the results.

5. **Ranking Process**
   The final stage involved ranking all DUDI alternatives based on their preference values (Vi). The alternative with the highest preference value was ranked first and recommended as the most suitable internship placement. The resulting ranking serves as a decision support tool for school administrators in selecting the most appropriate DUDI partner according to the established evaluation criteria.

Criteria and Weight Assignment

Based on interviews conducted with the internship management team of SMK Negeri 1 Barus Utara, five primary evaluation criteria (C_1–C_5) were established along with their respective attribute types and weights (Wj) (Devlin, 2021; Hasibuan & Safitri, 2023).

Table 1. Evaluation Criteria and Weight Assignment

Code	Evaluation Criterion	Attribute Type	Weight (Wj)	Percentage
C1	Curriculum Compatibility / Field of Expertise	Benefit	0.30	30%
C2	Availability of Facilities and Industrial Supervision	Benefit	0.25	25%
C3	Distance and Accessibility	Cost	0.20	20%
C4	Estimated Living and Accommodation Costs	Cost	0.15	15%
C5	Partner Reputation and Track Record	Benefit	0.10	10%
Total			**1.00**	**100%**

Source: Interview results with the Internship Management Team of SMK Negeri 1 Barus Utara (2026).

The evaluation criteria were assessed using qualitative ratings converted into crisp numerical values ranging from 1 to 5, where 1 = Very Poor, 2 = Poor, 3 = Fair, 4 = Good, and 5 = Excellent (Setiawan & Kurniawan, 2020).

Mathematical Formulation of the SAW Method

The Simple Additive Weighting (SAW) method determines the weighted sum of performance ratings for each alternative across all evaluation criteria (Fishburn, 1967). The computational procedure consists of the following steps.

Decision Matrix Construction

The first step of the SAW method is constructing the decision matrix (X), which represents the performance values of each DUDI alternative with respect to all evaluation criteria. The decision matrix has dimensions of m × n, where m denotes the number of alternatives and n denotes the number of evaluation criteria.

The decision matrix is formulated as follows:

$$X=\begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix}$$

Normalization Process

Each element x_{ij} is normalized into r_{ij} using the following equations (Fishburn, 1967; Setiawan & Kurniawan, 2020):

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{\max(x_{ij})}, & \text{if } j \text{ is a benefit criterion} \\ \dfrac{\min(x_{ij})}{x_{ij}}, & \text{if } j \text{ is a cost criterion} \end{cases}$$

where:

r_{ij} = normalized performance rating of alternative i for criterion j;

x_{ij}= original performance value of alternative $i$for criterion j;
$\max(x_{ij})$= maximum value of criterion j;
$\min(x_{ij})$= minimum value of criterion j.

Preference Value Calculation

The final preference value for each alternative is calculated by summing the weighted normalized values of all evaluation criteria (Pratama & Putra, 2022).

$$V_i = \sum_{j=1}^{n} w_j \, r_{ij}$$

where:
V_i= preference value of alternative i;
w_j= weight assigned to criterion j;
r_{ij}= normalized value of alternative $i$for criterion j.

The alternative with the highest preference value is considered the optimal recommendation for the Industrial Internship (*Prakerin*) placement.

RESULTS AND DISCUSSION

Results

Data Analysis and Collection

Data on prospective Business and Industrial Partners (Dunia Usaha dan Dunia Industri—DUDI) for the Industrial Internship (Praktik Kerja Industri—Prakerin) program were collected at SMK Negeri 1 Barus Utara through direct observation and interviews with the internship committee. To simulate and validate the effectiveness of the proposed decision support system, five DUDI partners that are frequently selected as internship destinations for vocational students were chosen as sample alternatives. The selected alternatives are as follows:

A₁: PT Tapanuli Mediatama
A₂: CV Barus Informatika
A₃: Bengkel Kerja Nusantara
A₄: PT Sibolga Citra Komputindo
A₅: Utami Digital Printing

Each alternative was evaluated using the five predefined criteria (C₁–C₅). The assessment employed a crisp rating scale ranging from 1 to 5, where 1 = Very Poor, 2 = Poor, 3 = Fair, 4 = Good, and 5 = Excellent.

Table 2. Decision Matrix of DUDI Alternatives

Alternative	DUDI Partner	C₁ (Benefit)	C₂ (Benefit)	C₃ (Cost)	C₄ (Cost)	C₅ (Benefit)
A₁	PT Tapanuli Mediatama	4	4	3	2	4
A₂	CV Barus Informatika	5	3	2	3	3
A₃	Bengkel Kerja Nusantara	3	5	4	4	5
A₄	PT Sibolga Citra Komputindo	4	4	2	2	4
A₅	Utami Digital Printing	3	3	1	2	3

Simple Additive Weighting (SAW) Computation

Decision Matrix Construction

Based on Table 2, the decision matrix $X$is represented as follows:

$$X = \begin{bmatrix} 4 & 4 & 3 & 2 & 4 \\ 5 & 3 & 2 & 3 & 3 \\ 3 & 5 & 4 & 4 & 5 \\ 4 & 4 & 2 & 2 & 4 \\ 3 & 3 & 1 & 2 & 3 \end{bmatrix}$$

The extreme values for each evaluation criterion are determined as follows:

C₁ (Benefit): $\max(x_{i1}) = 5$
C₂ (Benefit): $\max(x_{i2}) = 5$
C₃ (Cost): $\min(x_{i3}) = 1$
C₄ (Cost): $\min(x_{i4}) = 2$
C₅ (Benefit): $\max(x_{i5}) = 5$

Normalization of the Decision Matrix

Following the SAW normalization procedure for benefit and cost criteria (Fishburn, 1967), the normalized values are obtained as follows.

Criterion C₁ (Benefit)

Alternative	Normalized Value
A₁	0.80
A₂	1.00
A₃	0.60
A₄	0.80
A₅	0.60

Criterion C₂ (Benefit)

Alternative	Normalized Value
A₁	0.80
A₂	0.60
A₃	1.00
A₄	0.80
A₅	0.60

Criterion C₃ (Cost)

Alternative	Normalized Value
A₁	0.333
A₂	0.500
A₃	0.250
A₄	0.500
A₅	1.000

Criterion C₄ (Cost)

Alternative	Normalized Value
A₁	1.000
A₂	0.667
A₃	0.500
A₄	1.000
A₅	1.000

Criterion C₅ (Benefit)

Alternative	Normalized Value
A₁	0.80

A_2	0.60
A_3	1.00
A_4	0.80
A_5	0.60

The resulting normalized decision matrix $R$is

$$R = \begin{bmatrix} 0.80 & 0.80 & 0.333 & 1.00 & 0.80 \\ 1.00 & 0.60 & 0.50 & 0.667 & 0.60 \\ 0.60 & 1.00 & 0.25 & 0.50 & 1.00 \\ 0.80 & 0.80 & 0.50 & 1.00 & 0.80 \\ 0.60 & 0.60 & 1.00 & 1.00 & 0.60 \end{bmatrix}$$

Preference Value Calculation and Ranking

The criterion weight vector is defined as

$$W = [0.30, \ 0.25, \ 0.20 \ 0.15 \ 0.10]$$

The preference value for each alternative is obtained by multiplying the normalized matrix by the corresponding criterion weights.

Alternative A_1 (PT Tapanuli Mediatama)

$$V_1 = (0.80 \times 0.30) + (0.80 \times 0.25) + (0.333 \times 0.20) + (1.00 \times 0.15) + (0.80 \times 0.10)$$
$$V_1 = 0.7367$$

Alternative A_2 (CV Barus Informatika)

$$V_2 = (1.00 \times 0.30) + (0.60 \times 0.25) + (0.50 \times 0.20) + (0.667 \times 0.15) + (0.60 \times 0.10)$$
$$V_2 = 0.7100$$

Alternative A_3 (Bengkel Kerja Nusantara)

$$V_3 = (0.60 \times 0.30) + (1.00 \times 0.25) + (0.25 \times 0.20) + (0.50 \times 0.15) + (1.00 \times 0.10)$$
$$V_3 = 0.6550$$

Alternative A_4 (PT Sibolga Citra Komputindo)

$V4$=0.80×0.30+0.80×0.25+0.50×0.20+1.00×0.15+0.80×0.10

$V4$=0.7700

Alternative A_5 (Utami Digital Printing)

$$V_5 = (0.60 \times 0.30) + (0.60 \times 0.25) + (1.00 \times 0.20) + (1.00 \times 0.15) + (0.60 \times 0.10)$$
$$V_5 = 0.7400$$

Final Ranking Results

Table 3. Final Preference Values and Ranking of DUDI Alternatives

Alternative	DUDI Partner	Preference Value	Rank	Recommendation
A_4	PT Sibolga Citra Komputindo	**0.7700**	**1**	Highest Priority
A_5	Utami Digital Printing	0.7400	2	Second Priority
A_1	PT Tapanuli Mediatama	0.7367	3	Third Priority
A_2	CV Barus Informatika	0.7100	4	Suitable
A_3	Bengkel Kerja Nusantara	0.6550	5	Alternative Consideration

Discussion

The results of the SAW analysis presented in Table 3 indicate that PT Sibolga Citra Komputindo (A_4) achieved the highest preference score of 0.7700, ranking first among all evaluated alternatives. This superior performance can be attributed to its high scores in curriculum compatibility (C_1) and availability of industrial facilities and supervision (C_2), combined with favorable values for distance (C_3) and living or accommodation costs (C_4). These characteristics make A_4 the most appropriate internship partner based on the established evaluation criteria.

The second-highest ranking was obtained by Utami Digital Printing (A_5) with a preference value of 0.7400. Although its curriculum compatibility score was only moderate, the alternative performed exceptionally well in the cost-related criteria, particularly accessibility and accommodation expenses, which significantly improved its overall preference score. PT Tapanuli Mediatama (A_1) ranked third with a preference value of 0.7367, followed by CV Barus Informatika (A_2) with a score of 0.7100.

Conversely, Bengkel Kerja Nusantara (A_3) obtained the lowest preference value (0.6550) and was therefore placed in the fifth position. Despite achieving excellent scores in curriculum compatibility and industrial facilities, its relatively poor performance in distance and living cost, both categorized as cost criteria, resulted in lower normalized values and consequently reduced its final preference score.

The findings demonstrate that the implementation of the SAW method provides a rational, objective, and transparent mechanism for selecting internship partners. Compared with conventional manual selection procedures, which are often influenced by subjective judgments (Rahayu & Handayani, 2023), the proposed Decision Support System enables multiple evaluation criteria to be assessed simultaneously and consistently. The ranking results consider not only students' academic compatibility and field of expertise but also practical aspects such as industrial facilities, accessibility, accommodation costs, and the reputation of DUDI partners. Therefore, the proposed system offers a reliable decision-making tool that can improve the quality and effectiveness of internship placement management at SMK Negeri 1 Barus Utara while supporting evidence-based decision-making in vocational education (Pratama & Putra, 2022).

CONCLUSION

This study demonstrates that the implementation of a Decision Support System (DSS) based on the Simple Additive Weighting (SAW) method effectively overcomes the limitations of manual and subjective evaluation in selecting Business and Industrial Partners (Dunia Usaha dan Dunia Industri—DUDI) for internship placements at SMK Negeri 1 Barus Utara. The proposed approach identified PT Sibolga Citra Komputindo (A_4) as the most suitable internship partner, achieving the highest preference score of 0.7700. By integrating multiple evaluation criteria, including curriculum compatibility, industrial facilities, accessibility, accommodation costs, and partner reputation, the proposed model provides objective, transparent, and measurable recommendations for student internship placement. The findings indicate that the DSS not only improves the accuracy and consistency of the decision-making process but also contributes to enhancing the governance and effectiveness of the industrial internship program while strengthening strategic collaboration between vocational education institutions and industry partners. Future research may extend this work by integrating hybrid MCDM approaches, such as AHP–SAW, TOPSIS, or Fuzzy MCDM, and implementing the proposed system as a web-based or mobile-based application with real-time data management to further improve its practicality and decision-making performance.

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