

WEB-BASED ELEMENTARY SCHOOL SELECTION DECISION SUPPORT SYSTEM USING A COMBINATION OF SMART AND TOPSIS METHODS

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Abstract: Choosing the right elementary school is a crucial milestone for a child's future. However, the large number of school options in Asahan Regency with diverse criteria such as accreditation, facilities, fees, curriculum, and accessibility often makes it difficult for parents. Decision-making tends to be based on subjective word-of-mouth recommendations, which risks triggering bias. This research aims to develop an adaptive and objective web-based elementary school selection Decision Support System (DSS) framework to minimize such bias. The system is designed using a hybrid model that combines the Simple Multi-Attribute Rating Technique (SMART) method as a dynamic criteria weighting engine based on parents' preferences, and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method to rank ten alternative schools. System testing was conducted through black-box testing functionality and empirical accuracy testing using Spearman Rank Correlation involving 40 respondents. The black-box testing results confirmed that all main system operations ran perfectly with a 100% success rate. Validity testing demonstrated very high accuracy, with a Spearman correlation coefficient of 0.89, demonstrating significant alignment between the system's recommendations and actual choices on the ground. Thus, the SMART-TOPSIS framework has proven reliable as a data-driven approach to helping parents choose the best elementary school.

Keywords: decision support system; elementary school; SMART; TOPSIS

Abstrak: Memilih sekolah dasar yang tepat merupakan tonggak awal krusial bagi masa depan anak. Namun, banyaknya pilihan sekolah di Kabupaten Asahan dengan keberagaman kriteria seperti akreditasi, fasilitas, biaya, kurikulum, dan aksesibilitas sering kali menyulitkan orang tua. Pengambilan keputusan pun cenderung didasarkan pada rekomendasi subjektif dari mulut ke mulut, yang berisiko memicu bias. Penelitian ini bertujuan mengembangkan kerangka kerja Sistem Pendukung Keputusan (SPK) pemilihan sekolah dasar berbasis web yang adaptif dan objektif guna meminimalkan bias tersebut. Sistem dirancang menggunakan model hibrida yang mengombinasikan metode Simple Multi-Attribute Rating Technique (SMART) sebagai mesin pembobotan kriteria dinamis sesuai preferensi orang tua, serta metode Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) untuk memeringkat sepuluh sekolah alternatif. Pengujian sistem dilakukan melalui uji fungsionalitas black-box testing dan uji akurasi empiris menggunakan Korelasi Peringkat Spearman dengan melibatkan 40 responden. Hasil black-box testing mengonfirmasi seluruh operasi utama sistem berjalan sempurna dengan tingkat keberhasilan 100%. Uji validitas menunjukkan akurasi sangat tinggi dengan koefisien korelasi Spearman sebesar 0,89, membuktikan keselarasan signifikan antara rekomendasi sistem dan pilihan nyata di lapangan. Dengan demikian, kerangka SMART-TOPSIS ini terbukti andal sebagai pendekatan berbasis data untuk membantu orang tua memilih sekolah dasar terbaik.

Kata kunci: sekolah dasar; sistem pendukung keputusan; SMART; TOPSIS

INTRODUCTION

Selecting an elementary school represents a foundational milestone that significantly shapes a child's academic path and character development [1]. In Asahan Regency, the steady expansion of both public and private primary education options provides families with a diverse landscape of choices [2]. However, this abundance introduces unexpected complexities for parents, as schools exhibit stark variations in accreditation tiers, facility quality, tuition costs, extracurricular curricula, and geographic accessibility [3],[4]. Without a structured information platform, a severe information asymmetry emerges recommendations or superficial school popularity, often resulting in a misalignment between a child's specific developmental needs and the profile of the selected institution [5].

Deploying a computer-based Decision Support System offers a structured approach to resolving this multi-criteria dilemma [6], [7]. The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is highly regarded for its capability to rank alternatives based on their geometric proximity to a positive ideal solution and distance from a negative ideal solution. Nonetheless, a standalone TOPSIS application suffers from an inherent constraint: its reliance on static, predefined weights. In school selection scenarios, criterion prioritization is highly subjective and cannot be uniformly applied across all users. While one family might treat financial constraints as their overriding priority, another might prioritize geographic proximity or institutional accreditation [8], [9].

This lack of flexibility can be effectively mitigated by coupling TOPSIS with the Simple Multi-Attribute Rating Technique (SMART). The SMART

framework excels at calculating criteria weights linearly and dynamically based on direct user inputs. By engineering a hybrid framework, SMART operates as an adaptive weighting engine tailored to financial constraints of individual parents, while TOPSIS functions as an objective ranking engine that processes these calibrated weights across alternative schools. While prior literature has explored hybrid MCDM applications for educational placement, a critical gap remains: most existing studies overlook post-development empirical validation and routinely publish raw institutional identities, thereby compromising confidentiality ethics [10], [11].

This research addresses these shortcomings by developing and evaluating a web-based, hybrid SMART-TOPSIS for elementary school selection in Asahan Regency. To ensure academic rigor and uphold research ethics, this research introduces two key methodological refinements. First, the identities of the ten alternative elementary schools are fully anonymized using a systematic coding structure to safeguard institutional reputations. Second, the system's ranking accuracy is empirically validated via Spearman's Rank Correlation analysis involving forty parent respondents acting as real-world users. This dual-layered evaluation ensures that the resulting system is not merely a functional software prototype, but a highly precise tool capable of accurately mirroring rational human decision-making in the field.

METHOD

This research designs and evaluates a web-based decision support system utilizing a hybrid multi-criteria decision-making framework. To provide a clear

logical flow, the methodology is structured into three progressive operational phases: the First Stage (SMART Weighting), the Second Stage (TOPSIS Evaluation), and the Final Stage (System Ranking and Empirical Validation). The breakdown of each step within these stages is detailed below.

SMART Weighting (Criteria Prioritization)

The first stage focuses on capturing and processing dynamic human preferences to establish normalized criteria weights W_j for the five selection criteria (C1 – C5).

Step 1: Assigning Raw Importance Scores, The system captures the raw importance score (P_j) assigned by parents for each criterion C_j based on a scale of 0 to 100 depending on their individual priorities.

Step 2: Weight Normalization, To ensure the total sum of all weights equals 1 $\sum w_j = 1$, the raw scores are normalized linearly using the SMART formula [15]:

$$W_j = \frac{P_j}{\sum_{k=1}^n P_k} \quad (1)$$

Where n represents the total number of evaluation criteria ($n = 5$).

TOPSIS Evaluation (Matrix Processing)

The second stage utilizes the dynamic weights derived from the SMART phase to evaluate the ten anonymized elementary school alternatives (A1 through A10).

Step 3: Constructing the Initial Decision Matrix, An initial decision matrix $X = x_{ij}$ is constructed, where x_{ij} represents the performance value of alternative

school A_i ($i = 1, 2, \dots, 10$) against criterion C_j .

Step 4: Vector Normalization, The initial matrix is normalized into a comparable scale matrix $R = R_{ij}$ to eliminate different measurement units using the following formula:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad (2)$$

Step 5: Computing the Weighted Normalized Matrix, The vector-normalized values are multiplied by the dynamic weights generated from the SMART stage to produce the weighted normalized matrix

$$V = [v_{ij}] \\ U_{ij} = W_j \times r_{ij} \quad (3)$$

Final Stage: Ideal Selection, Ranking, and System Validation

The final stage identifies the optimal school alternatives and subjects the entire framework to empirical validation.

Step 6: Determining Positive and Negative Ideal Solutions, The Positive Ideal Solution (A^+) and Negative Ideal Solution (A^-) are identified based on criteria classification (Benefit or Cost):

$$A^+ = (v_1^+, v_2^+, \dots, v_n^+)$$

Where $v_j^+ = \max v_j$ (benefit) or $\min v_j$

$$A^- = (v_1^-, v_2^-, \dots, v_n^-)$$

Where $v_j^- = \min v_j$ (benefit) or $\max v_j$

Step 7: Calculating Separation Measures, the geometric Euclidean distance of each school alternative from A^+ and A^- is computed:

$$S_i = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^+)^2} \quad (4)$$

Step 8: Calculating the Closeness Coefficient and Final Ranking, the relative closeness to the ideal solution (C_i) is calculated to determine the final ranking. Alternatives are sorted in descending order:

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-} \quad (5)$$

Step 9: Empirical Validation via Spearman's Rank Correlation, to ensure the system accurately mirrors rational human judgment, the automated rankings are statistically correlated with the actual manual choices of 40 parent respondents using Spearman's Rank Correlation:

$$\tau_s = 1 - \frac{6 \sum d_i^2}{N(N^2 - 1)} \quad (6)$$

RESULT AND DISCUSSION

The results and discussion section strictly focuses on the direct outputs of

the implemented research framework, excluding raw design steps to highlight meaningful findings. The system validation is divided into two main phases: functional validation to ensure software integrity, and empirical validation to measure algorithmic accuracy.

Functional Validation Black Box Testing

Before assessing the accuracy of the decision-making algorithm, the web-based system's operational integrity was validated using the Black-Box testing method. This testing focuses exclusively on software functionality, ensuring that all user interfaces, data inputs, and background calculations execute properly without system failure. The testing scenarios covered the entire user journey, from data entry to the final ranking output. The results of the Black-Box testing are summarized in Table 1.

Table 1. Black-Box Testing Results for the Web-Based DSS

Test ID	Test Scenario/Feature	Expected Output	Actual Output	Status
TC-01	User Authentication	System grants access upon valid credentials and rejects invalid ones.	System successfully validates credentials and redirects user.	Valid
TC-02	Input SMART Priority Scores	System accepts numerical input (0-100) for parental criteria preferences.	Data is accurately captured and saved into the database without error.	Valid
TC-03	Input Alternative Schools Data	System allows the addition and editing of elementary school profiles.	School profiles are successfully updated and displayed in the data grid.	Valid
TC-04	SMART-TOPSIS Execution	System processes weights, normalizes matrices, and computes C_i^* values.	Algorithm executes instantly with no backend errors or crashes.	Valid
TC-05	Display Final Ranking Results	displays a descending sorted list of alternative schools.	UI accurately displays the final ranked list corresponding to the database.	Valid

From Table 1, all critical functionalities of the web-based DSS achieved a 100% success rate. The functional as-

sessments verified that the user interface elements, parent preference input engines, weight normalization scripts, and

TOPSIS matrix calculations execute flawlessly without runtime errors or logical mismatches. The absence of logical errors or system crashes confirms that the software is technically robust and ready for empirical evaluation.

Empirical Validation via Spearman's Rank Correlation

To validate the objective quality and scientific accuracy of the integrated SMART-TOPSIS model, empirical verification was conducted involving 40 parents respondents in Asahan Regency. The respondents provided their subjective school preferences manually, which were

subsequently analyzed alongside the automated rankings produced by the website platform.

The evaluation data were statistically measured using the Spearman Rank Correlation method to calculate the mathematical alignment between the system and real-world expectations. Due to space constraints, Table 2 illustrates the comparative analysis of the manual rankings versus the automated rankings for a representative sample of respondents evaluating the anonymized alternative elementary schools (A_1 to A_10) [12].

Table 2. Comparison of Manual Rankings vs. Automated System Rankings

Alternative School	System Rank (xi)	Manual Rank (yi)	Difference (di)	Squared Difference (di ²)
A1	1	1	0	0
A2	2	3	-1	1
A3	3	2	1	1
...
A10	10	9	1	1
Total				$\sum d_i^2 = 10$

In Table 2, the rank correlation for this specific respondent is calculated using Spearman's rank correlation coefficient formula, where N = 10 representing the total number of alternative schools:

$$\begin{aligned} \tau_s &= 1 - \frac{6(10)}{10(10^2-1)} = 1 - \frac{60}{990} \\ &= 1 - 0.0606 = 0.939 \end{aligned}$$

This result was systematically iterated across all 40 respondents to capture the overall system performance. The aggregate statistical assessment yielded an average Spearman correlation coefficient τ_s of 0.89. This value statistically confirms a highly positive correlation, proving empirically that the hybrid SMART-TOPSIS system's automated recommen-

dations strongly align with rational human decision-making, thereby validating its high level of accuracy and readiness for practical implementation in school selection scenarios.



Image 1. Dashbord Page

CONCLUSION

This research successfully developed an integrated web-based decision support system that combines the SMART and TOPSIS methods to resolve

the complexities of elementary school selection for parents in Asahan Regency. The system successfully overcomes personal bias and information asymmetry by delivering automated, scientifically grounded recommendations. Empirical testing using the Spearman Rank Correlation with 40 respondents confirmed a high level of accuracy and strong alignment between the hybrid algorithm outputs and manual parent preferences.

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