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Topsis-Based Decision Support System for Ranking Student Achievement

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ABSTRACT

Determining outstanding students at Madrasah Manarul Huda has so far relied on homeroom teachers manually summing academic scores from the national Rapor Digital Madrasah (RDM) system with non-academic records – attendance, extracurricular activity, and competition achievement – without any criteria weighting, so the resulting ranking varies with each teacher's judgement and the process takes longer than it should. This study applies the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to build a web-based decision support system that ranks students using six weighted criteria: report-card score, Qur'an memorization (tahfiz), attitude and discipline, attendance, extracurricular participation, and competition achievement. The weight of each criterion was determined through direct rating in structured discussions with the madrasah head and homeroom teachers. The system was developed with the Waterfall model using native PHP and a MySQL database; data were collected through observation, interviews, literature review, and questionnaires. The TOPSIS procedure covered matrix normalization, weighting, determination of the positive and negative ideal solutions, and calculation of the final preference value used for ranking. The system was evaluated with three tests: black-box testing across 62 scenarios in 13 modules, all of which were valid; user acceptance testing (UAT) with 10 respondents, averaging 93.46% (very feasible category); and a Spearman rank-correlation accuracy test against the unweighted manual ranking of 14 students, yielding a coefficient of 0.7363 (strong category). These results indicate that the system's ranking is consistent with, yet meaningfully corrective of, the previous manual assessment.

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1. INTRODUCTION

Comprehensive measurement of learner competence is one of the core functions of assessment in an education system. Assessment that uses varied techniques, provides clear feedback, and actively involves students has been shown to encourage learners to improve their own outcomes at the basic-education level [1]. Assessment therefore does not stop at the formality of reporting scores; it is also a tool for teachers to map the strengths and weaknesses of each student and a basis for decisions on how to improve instruction.

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The challenge changes, however, once assessment is used to decide who deserves to be recognized as an outstanding student. Subjectivity often emerges when an assessor relies too heavily on personal perception without adequate criteria, producing decisions that are less fair and less accurate [2]. As a remedy, criteria weighting that covers academic achievement, activeness, discipline, courage, and behavior can be combined with the Analytic Hierarchy Process (AHP) for weighting and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) for ranking; this combination has been shown to make the selection process more objective and to reduce personal bias [2].

At Madrasah Manarul Huda, student academic scores were until recently managed manually in Microsoft Excel. Following the mandatory nationwide rollout of the Rapor Digital Madrasah (RDM) by the Ministry of Religious Affairs from the Odd Semester of the 2025/2026 academic year, the madrasah switched to recording academic scores through RDM. However, RDM's function remains limited to recording and printing report cards from the score ledger compiled by each subject teacher; it is not designed to determine outstanding students. Non-academic data such as attendance, extracurricular participation, and competition achievement are still recorded separately by homeroom teachers, who must manually reconcile the two data sources and sum them without any weighting between criteria. Preliminary interviews with the madrasah indicated that this manual process has been reasonably reliable in substance; the problem lies not in the quality of the assessment itself but in the absence of formal weighting and of an integrated system that combines academic and non-academic data.

Applying TOPSIS to this kind of problem is not new. It has been used to select outstanding students at the junior-secondary level [3] and, combined with AHP, to assess teacher performance at the senior-secondary level [4]. A common pattern emerges from both studies: as the number and diversity of criteria increase, simple summation struggles to capture the differing importance of each criterion, which is exactly where TOPSIS helps. This study follows a similar pattern for the context of Madrasah Manarul Huda, with criteria and conversion scales designed together with the madrasah. The difference is that the weight of each criterion here was determined through direct rating in discussion with the madrasah rather than through AHP – a reasonable choice given the relatively small number of criteria and the madrasah's already clear understanding of the relative priority among assessment aspects, so that the pairwise comparisons required by AHP were not yet felt to be necessary; a more formal weighting approach such as AHP remains open for future development and is treated as a limitation of this study.

The system built in this study is not intended to replace RDM as the official national-level score-recording system; rather, it complements RDM in the aspect it does not cover, namely multi-criteria decision-making to rank outstanding students. RDM serves as the source of academic data, while the system proposed here acts as a decision layer on top of it. This is the study's main contribution: an integrated, weighted, multi-criteria ranking layer – combining official academic records with locally managed non-academic records – for a use case (madrasah-level student-achievement selection) that has not previously been addressed by TOPSIS-based studies in the literature. Building on this rationale, this study applies TOPSIS to build a system that computes the ranking of outstanding students based on criteria weights agreed upon together with the madrasah.

2. RESEARCH METHOD

2.1. Data Collection

Four data-collection techniques were used. Observation was carried out directly on the existing student-ranking process at Madrasah Manarul Huda to obtain a thorough understanding of the current system. Interviews were held with the head of the madrasah foundation, homeroom teachers, and the teaching staff to explore the assessment criteria considered important, the obstacles faced, and expectations for the system to be built. A literature study reviewed textbooks, accredited research journals, and scientific articles related to decision support systems and the TOPSIS method as the theoretical foundation. A questionnaire was distributed to the madrasah to collect data on system requirements, the urgency of existing problems, and the inter-criteria weights used in the TOPSIS calculation.

2.2. System Development Method

The Software Development Life Cycle (SDLC) is a common framework for building information systems, spanning planning, analysis, design, implementation, and maintenance. The Waterfall model, one of the most widely used SDLC models for web-based systems, offers a structured, sequential approach but tends to be rigid when requirements change mid-development; it suits systems whose requirements can be fully identified from the outset, whereas Prototyping better suits systems that are customized and adjusted to user requests incrementally. This characteristic underlies the choice of Waterfall here: the functional requirements of the

student-achievement assessment system at Madrasah Manarul Huda were already mapped from the preliminary study through observation and interviews, so the risk of mid-project specification changes was small. A similar finding was reported when a web-based student-monitoring system was built with PHP, MySQL, and Waterfall, which was shown to simplify attendance and score recording and to let parents monitor academic progress in real time [5]. A closer precedent applied Waterfall to build a TOPSIS-based decision support system for best-student selection at MIN 5 Bandar Lampung, which ran according to black-box testing and contributed positively to school administration [6]. These two cases are relevant references, although the assessment criteria and data scales at Madrasah Manarul Huda are not fully identical to either study.

Five Waterfall phases were carried out. Requirements analysis: data were gathered through in-depth interviews with the madrasah head and homeroom teachers and through direct observation of the running assessment process; six assessment criteria and their weights were established at this stage through a Likert-scale questionnaire. System design: wireframes and interface mock-ups were created in Figma, the system flow was modeled in UML notation (use-case, activity, sequence, and class diagrams) in Draw.io, and the database schema was designed through an ERD and an LRS [10]–[12]. Implementation (coding): modular native-PHP code was written, MySQL table structures were built according to the LRS, the seven-step TOPSIS algorithm was coded in a separate module, and a responsive interface was developed using Bootstrap 5. Testing: black-box testing was applied to verify the functionality of every page and feature from the input–output side [27]. Maintenance: the final phase covers defect repair after handover, updating score data for subsequent semesters, and adjusting criteria weights if the madrasah's assessment policy changes.

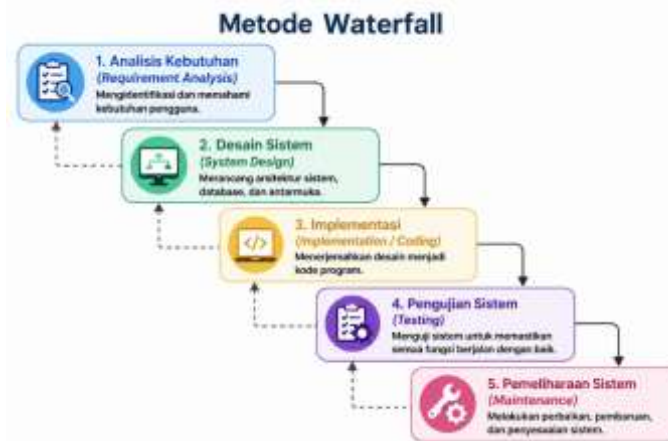


Figure 1. Five phases of the Waterfall system-development model applied in this study

Native PHP together with a MySQL database has been widely and successfully used to build comparable academic and administrative information systems, including student-score processing [15], multiuser web information systems [16], inventory and borrowing systems [17], [18], website-based academic information systems [19], and online examination systems [20]; this track record supports the choice of the same stack for the system in this study.

2.3. TOPSIS Method

TOPSIS is one of the most widely applied multi-criteria decision-making (MCDM) methods because of its straightforward logic: the best alternative should have the shortest distance from the positive ideal solution and the longest distance from the negative ideal solution [7]. Its accuracy is sensitive to the normalization technique used for benefit and cost criteria, so the normalization method should be chosen deliberately rather than by default [9], and hierarchical or non-monotonic criteria structures may require a more robust variant of the standard procedure [8]. In this study, all six criteria are of the benefit type and no hierarchical relationship among them was required, so the classical vector-normalization TOPSIS procedure below was used.

Step 1 – Build the decision matrix X with elements x_{ij} for alternative i and criterion j . Step 2 – Normalize the matrix using (1).

$$r_{ij} = x_{ij} / \sqrt{\sum x_{ij}^2} \quad (1)$$

Step 3 – Compute the weighted normalized matrix using (2), where w_j is the weight of criterion j .

$$v_{ij} = w_j \times r_{ij} \quad (2)$$

Step 4 – Determine the positive ideal solution (A^+) and the negative ideal solution (A^-) as, respectively, the maximum and minimum of v_{ij} for each benefit criterion. Step 5 – Compute the separation of each alternative from A^+ and A^- using the Euclidean distances in (3) and (4).

$$D_i^+ = \sqrt{\sum (v_{ij} - v_j^+)^2}, \quad D_i^- = \sqrt{\sum (v_{ij} - v_j^-)^2} \quad (3)(4)$$

Step 6 – Compute the preference value (closeness coefficient) C_i for each alternative using (5); step 7 – rank alternatives by descending C_i , where the highest value indicates the strongest achievement position.

$$C_i = D_i^- / (D_i^+ + D_i^-) \quad (5)$$

2.4. Assessment Criteria and Weighting

Six assessment criteria were agreed upon with the madrasah and set out in a Parameter Standardization Agreement Sheet, all of the benefit type: report-card score (C1), tahfiz score (C2), attitude and behavior (C3), attendance (C4), extracurricular activeness (C5), and competition achievement (C6). Weights were assigned by direct rating according to the madrasah's assessment policy: academic achievement (report-card score) and memorization (tahfiz score) received the highest weights as the two primary indicators of learning success in a tahfiz-focused madrasah, followed by attitude and behavior as a core value of character education, then attendance, extracurricular activeness, and competition achievement as supporting factors [21]. Because weighting here was determined directly rather than through a formal pairwise method such as AHP [24], this is treated as a limitation open to further development. Table 1 lists the resulting criteria and weights.

Table 1. Assessment criteria and weights

Code	Criterion	Type	Weight
C1	Report-card score	Benefit	0.30
C2	Tahfiz score	Benefit	0.25
C3	Attitude & behavior	Benefit	0.20
C4	Attendance	Benefit	0.10
C5	Extracurricular activeness	Benefit	0.08
C6	Competition achievement	Benefit	0.07

2.5. System Testing Method

Functional correctness was verified with black-box testing, which checks a system's input–output behavior without inspecting its internal code [27]. User acceptance was measured with a closed, five-point Likert-scale questionnaire covering four dimensions – functionality, usability, interface, and utility – following common practice for UAT of decision support systems [28]; feasibility percentages were interpreted using conventional Likert-based categories to reduce the scale-bias risk noted for Likert instruments [23]. To test whether the system's weighted ranking meaningfully differs from and improves upon the previous unweighted manual ranking, a Spearman rank-correlation coefficient (ρ) was computed between the two rankings, following the common use of Spearman's method for ordinal, non-normally distributed data [29].

3. RESULTS AND DISCUSSION

3.1. Student Assessment Data

The system was evaluated using primary data from 14 students of class VIII-A, collected directly at the madrasah with permission. Scores for C1 and C2 were taken from the real score ledger; C3–C5 were converted from homeroom-teacher assessments recorded on the Manual Ranking Sheet (comparison data), signed by the homeroom teacher and acknowledged by the madrasah head. No student in this assessment period had a recorded competition achievement, so $C_6 = 0$ for every alternative; consequently this criterion did not numerically discriminate the ranking in this particular case study, a limitation discussed further in Section 4.

3.2. TOPSIS Ranking Result

Applying steps (1)–(5) to the 14-student dataset with the weights in Table 1 produced the closeness-coefficient ranking in Table 2. Alternative A7 obtained the highest preference value ($C_i = 1.0000$), followed by A5 (0.8193) and A6 (0.6683), while A9 obtained the lowest value (0.3056).

Table 2. TOPSIS ranking result for 14 students

Rank	Alternative	C_i
1	A7	1.0000
2	A5	0.8193
3	A6	0.6683
4	A4	0.6488
5	A14	0.6283
6	A13	0.5253
7	A3	0.4527
8	A1	0.4366
9	A2	0.4221
10	A8	0.4166
11	A10	0.3916
12	A12	0.3693
13	A11	0.3356
14	A9	0.3056

The final “outstanding” predicate is not read directly from this ranking. The system applies a two-stage filter: first, an eligibility check requiring every alternative to meet a minimum score on the four mandatory criteria (C1–C4) – an alternative that fails any one of these thresholds is excluded regardless of its TOPSIS preference value, while C5 and C6 carry no minimum since they are supplementary; second, alternatives that pass are ordered by C_i as in Table 2. This two-stage design keeps the ranking from being distorted by a single very high but otherwise borderline-eligible criterion score, and reflects a requirement the madrasah stated explicitly during the requirements-analysis interviews.



Figure 2. Class-ranking result page, showing rank, closeness coefficient, and predicate for the querying student

3.3. System Testing Results

Black-box testing covered 62 test scenarios across 13 functional modules of the system (authentication, student data, score input and import, criteria and weight management, TOPSIS computation, ranking, reporting, and related modules); all 62 scenarios produced the expected output, indicating that the implemented functions behaved correctly under the tested input conditions.

UAT was conducted with 10 respondents – 1 madrasah head and 9 homeroom teachers – selected through purposive sampling based on their direct authority to use the system. Table 3 summarizes the feasibility percentage per dimension.

Table 3. UAT feasibility results by dimension (n = 10)

Dimension	Total score	Max. score	Feasibility
Functionality	317	340	93.24%

Dimension	Total score	Max. score	Feasibility
Usability	133	145	91.72%
Interface	136	145	93.79%
Utility	143	150	95.33%
Overall	729	780	93.46%

The overall feasibility of 93.46% falls in the “very feasible” category. Utility scored highest (95.33%), indicating respondents perceived a real benefit in making the assessment process faster and more objective than the previous manual mechanism. Interface (93.79%) and Functionality (93.24%) were rated similarly high, reflecting clear, workable score-input forms and ranking tables and correctly functioning core features – student-data management, score input, Excel import, data validation, and TOPSIS computation. Usability scored lowest (91.72%), still “very feasible,” but suggesting that a minority of homeroom teachers less familiar with web-based systems needed a short adaptation period; this did not materially affect overall acceptance.

3.4. Accuracy Test Against Manual Ranking

To check whether the system's weighted ranking is both consistent with and correctively different from the previous, unweighted practice, the TOPSIS-based ranking was compared with a manual ranking of the same 14 alternatives, computed as a simple unweighted average of the same six criteria. With 14 paired ranks and a sum of squared rank differences $\sum d^2 = 120$, the Spearman coefficient from (6) is:

$$\rho = 1 - (6\sum d^2) / (n(n^2 - 1)) \quad (6)$$

$\rho = 1 - (6 \times 120) / (14 \times 195) = 1 - 720/2730 = 1 - 0.2637 = 0.7363$, which falls in the “strong” correlation category. This value shows that the system's ranking largely agrees with the intuitive manual ordering – supporting the face validity of the chosen criteria and weights – while the remaining, non-perfect correlation reflects exactly the cases (e.g., A14 and A3) where an unweighted average and a weighted TOPSIS score disagree because one alternative is strong on heavily weighted criteria (C1–C2) but weaker on lightly weighted ones, or vice versa. This is the intended, corrective effect of introducing formal criteria weighting rather than a defect of the method.

3.5. Discussion

Taken together, the three evaluations indicate that the proposed system is both functionally correct (100% valid black-box scenarios) and well received by its intended users (93.46% UAT feasibility), while its core analytical output – the TOPSIS ranking – shows strong but not perfect agreement with unweighted manual judgement, consistent with the goal of adding formal, transparent weighting rather than merely automating the previous process. Compared with prior TOPSIS-based student-selection studies [3], [4], [6], the novelty of this work lies less in the TOPSIS procedure itself – which follows the standard classical formulation – and more in integrating an official academic-data source (RDM) with locally managed non-academic records inside one weighted decision layer for a madrasah context, together with an explicit two-stage eligibility-then-ranking rule that reflects an institutional policy requirement rather than a purely mathematical one.

Two limitations should be noted for readers applying these results. First, because no student in the evaluated cohort had a recorded competition achievement, C6 could not be validated as an actual discriminating criterion in this dataset; its effect on the ranking would need to be re-examined with a cohort that has variation in this criterion. Second, weights were obtained by direct rating rather than a formal pairwise method, so the reported weights reflect this madrasah's stated priorities and should be re-elicited, ideally with AHP or a similar formal technique, before the system is transferred to another institution with different priorities.

4. CONCLUSION

This study built and evaluated a web-based TOPSIS decision support system that ranks student achievement at Madrasah Manarul Huda using six weighted criteria, integrating official RDM academic data with locally managed non-academic data in a single, formally weighted decision layer. Black-box testing (62 scenarios, 13 modules) was entirely valid, indicating the system's core functions work as specified. UAT with 10 respondents produced an overall feasibility of 93.46% (very feasible), with the strongest response on the system's perceived utility (95.33%) and the most room for improvement on usability (91.72%). A Spearman correlation of 0.7363 between the system's ranking and the previous unweighted manual ranking indicates the two are strongly related while the weighting still produces a meaningfully corrective re-ordering for several students, meeting the study's aim of making the selection process faster, more consistent, and more transparent than the manual practice it replaces. Future work should re-elicited the criteria weights through a formal pairwise

method such as AHP, and should validate the effect of the competition-achievement criterion on a cohort with actual variation in that criterion.

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