

A Decision Support System for Dormitory Cell Leader Recommendation Using AHP and Weighted Product Methods at Shanti Bhuana Institute

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ABSTRACT

The selection of cell leaders in the dormitory of Institut Shanti Bhuana plays an important role in supporting student character development, discipline, responsibility, and leadership. However, the current selection process is still conducted manually by dormitory administrators, making it subjective and lacking a structured evaluation system. This condition may lead to less objective and inefficient decision-making. Therefore, this study aims to design and develop a web-based Decision Support System (DSS) for recommending dormitory cell leaders using the Analytical Hierarchy Process (AHP) and Weighted Product (WP) methods. The AHP method is used to determine the priority weights of each criterion through pairwise comparisons and consistency testing, while the WP method is applied to rank alternatives based on their preference values. The criteria used in this study include courtesy, caring attitude, exemplary behavior, discipline, and responsibility. The system development process consists of requirements analysis, system design, implementation, and testing phases in a web-based environment. The results of this study indicate that the developed system is capable of assisting dormitory administrators in managing criteria data, alternative data, and performing AHP and WP calculations automatically. Furthermore, the system can generate recommendations for the most suitable cell leader based on the highest preference value, making the decision-making process more structured, transparent, and consistent thereby. The AHP consistency test results show a Consistency Ratio (CR) of 0.0834 ($CR < 0.1$), indicating that the criteria assessment is consistent. Based on the Weighted Product calculation, alternative A3 achieved the highest preference value ($V = 0.364$) and is therefore recommended as the best cell server. Consequently, the decision-making process becomes more structured, transparent, and consistent. Thus, the implementation of the AHP and WP methods in a Decision Support System can serve as an effective solution for supporting the selection of cell leaders at the Institut Shanti Bhuana Dormitory.

Keywords: Decision Support System, Analytical Hierarchy Process (AHP), Weighted Product (WP), Web-Based System.

1. INTRODUCTION

Institut Shanti Bhuana Bengkayang is a higher education institution that not only focuses on academic development but also on character formation through a dormitory-based education system. This approach is designed to shape students who possess discipline, responsibility, and cooperative skills in social life. Dormitory-based structured living environments have proven effective in forming social behavior and student character sustainably.

In its implementation, Institut Shanti Bhuana operates a dormitory system divided into four houses — Wisma Carlo, Wisma Theresia, Wisma Maria, and Wisma Avila — with a total

of 334 residents. Dormitory life is organized into small groups called "Sel" (cells). This small-group system is considered effective in enhancing social interaction, collective responsibility, and individual character formation.

Within each cell, there is a cell servant who plays an important role as the group leader. The cell servant is responsible for coordinating activities, maintaining member discipline, and serving as a role model in the application of values such as responsibility, cooperation, and leadership. Leadership roles in small groups significantly influence organizational effectiveness and member interaction quality, making the selection of cell servants a process that must be carried out accurately and objectively.

However, the current selection process for cell servants at Institut Shanti Bhuana Bengkayang is still carried out manually by dormitory administrators. Assessments are based on subjective considerations without a structured and well-documented system. This manual process risks producing less objective and difficult-to-justify decisions, especially when involving many criteria and alternatives (Yunitarini & Widiawanti, 2022). Moreover, the process becomes inefficient when there are many candidates, as there is no system capable of processing data quickly and accurately (Lusiana Wulansari et al., 2023)

A Decision Support System (DSS) is a computer-based system designed to assist decision-makers in solving complex multi-criteria problems (Multi-Criteria Decision Making). The use of DSS has been proven to improve decision quality by reducing human subjectivity and producing more consistent results (Sufandi et al., 2025). In this study, the combination of Analytical Hierarchy Process (AHP) and Weighted Product (WP) is used. AHP determines the importance weights of criteria through pairwise comparison, producing consistent priority values (Nurrahman & Tri Pranoto, 2022), while WP performs ranking of alternatives based on preference values from each criterion (Lusiana Wulansari et al., 2023). The AHP-WP combination has been proven to produce more accurate, objective, and justifiable decisions (Putra & Purnomo, 2025) ; (Andreas et al., 2025).

Therefore, this study aims to build a web-based DSS for recommending cell servants at Institut Shanti Bhuana Bengkayang. That this DSS contributes to the digital transformation of education management, data-driven institutional governance, and the development of transparent student leadership. This study demonstrates how digital decision-support technology can help educational institutions implement a transparent, evidence-based, and accountable leadership selection process. The system is expected to help dormitory administrators determine cell servants more structured, transparent, and consistent thereby improving the quality of dormitory life management.

2. METHODS

This study uses a software engineering approach with a descriptive quantitative method. The research was conducted at the dormitory of Institut Shanti Bhuna Bengkayang, from January 2026 to June 2026. Data were collected through observation, interviews with dormitory administrators, literature study, and documentation of assessment data. The system was developed as a web-based application using the PHP programming language and MySQL database.

2.1 Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a multi-criteria decision-making method introduced by Thomas L. Saaty. AHP structures a problem into a hierarchy consisting of goals, criteria, and alternatives, and uses pairwise comparison to assess the relative importance of each criterion. The result is a set of priority weights that serve as the basis for determining the best alternative (Stofkova et al., 2022). The basic formula for AHP using the pairwise comparison matrix is:

$$A = (a_{ij}), a_{ij} = \frac{w_i}{w_j}$$

where

- a_{ij} = comparison value between criterion i and criterion j ;
- w_i = weight of criterion i ;
- w_j = weight of criterion j .

where a_{ij} is the comparison value between element i and j , w_i is the weight of element i , and w_j is the weight of element j . Consistency is measured using the Consistency Ratio (CR):

$$CR = \frac{CI}{RI}$$

where

- CI = Consistency Index;
- RI = Random Index.

If $CR < 0.1$, the pairwise judgment is considered consistent. The scale used for pairwise comparison follows the Saaty scale (1–9) as shown in Table 1.

Table 1. AHP Pairwise Comparison Scale (Saaty Scale)

Intensity of Importance	Definition
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1	Both elements are equally important
3	One element is slightly more important than the other
5	One element is more important than the other
7	One element is clearly more important than the other
9	One element is absolutely more important than the other
2,4,6,8	Intermediate values between two adjacent judgments

The pairwise comparison matrix was completed by the selected respondents based on Saaty's nine-point scale. Each respondent compared the relative importance of one criterion against another according to their experience in selecting Cell Leaders. The collected judgments were then processed to obtain the priority weights. Consistency of the judgments was evaluated using the Consistency Index (CI) and Consistency Ratio (CR), where a CR value below 0.10 indicates acceptable consistency.

2.2 Weighted Product (WP)

Weighted Product (WP) is an MCDM approach used to evaluate and rank multiple alternatives by considering the weight of each criterion. Unlike additive weighting methods, WP uses multiplication operations, making the result more sensitive to differences in values between alternatives (AlAli et al., 2023). The vector S value for each alternative is calculated as:

$$S_i = \prod_{j=1}^n x_{ij}^{w_j}$$

where

S_i = vector value of alternative ke-i

x_{ij} = performance value of alternative i on criterion j

w_j = normalized weight of criterion j

The preference value is then calculated using

$$V_i = \frac{S_i}{\sum S_i}$$

where

- V_i = preference value of alternative i ;
- S_i = vector value of alternative i .

The alternative with the highest preference value is selected as the recommended dormitory cell servant (AlAli et al., 2023).

2.3 Interview Process

Structured interviews were conducted with the dormitory administrators to obtain information regarding the current Cell Leader selection process, the problems encountered during manual decision-making, and the evaluation criteria considered important in selecting prospective Cell Leaders. During the interviews, respondents were also asked to explain the relative importance of each criterion. The interview results were subsequently used to construct the pairwise comparison matrix required for the AHP calculation.

2.4 Criteria Validation

The evaluation criteria used in this study were validated through literature review and expert judgment. Initially, the criteria were identified from previous studies on leadership selection, character education, and Decision Support Systems. Subsequently, the proposed criteria were discussed with dormitory administrators to ensure their relevance to the characteristics of Cell Leaders at Shanti Bhuana Institute. Only the criteria considered appropriate by the respondents were included in the Decision Support System.

3. RESULTS AND DISCUSSIONS

3.1 Criteria Determination

Criteria for cell servant selection were determined through interviews and observation with the dormitory administrators of Institut Shanti Bhuana. Five criteria were identified that reflect the essential character values in dormitory life and the role of cell servants as small group leaders. The criteria and their initial weight values are presented in Table 2.

Table 2. Assessment Criteria

Code	Criterion	Initial Weight
C1	Politeness	1

C2	Caring	3
C3	Responsibility	5
C4	Discipline	7
C5	Exemplary	9

3.2 AHP Calculation and Weight Determination

Based on the initial weight values in Table 2, the pairwise comparison matrix is constructed as follows. C5 (Exemplary) is considered the most important criterion (weight = 9) while C1 (Politeness) has the lowest weight (weight = 1).

Table 3. Pairwise Comparison Matrix

Criterion	C1	C2	C3	C4	C5
C1	1	0,333	0,2	0,143	0,111
C2	3	1	0,333	0,2	0,143
C3	5	3	1	0,333	0,2
C4	7	5	3	1	0,333
C5	9	7	5	3	1
Total	25	16,333	9,533	4,676	1,787

The pairwise comparison matrix is then normalized by dividing each element by the column total. The priority weight for each criterion is the average of each row in the normalized matrix, as shown in Table 4.

Criterion	C1	C2	C3	C4	C5	Priority (w)
C1	0,04	0,0203	0,0209	0,0305	0,0621	0,0348
C2	0,12	0,0612	0,0349	0,0427	0,0800	0,0677
C3	0,2	0,1836	0,1048	0,0712	0,1119	0,1343
C4	0,28	0,3061	0,3146	0,2138	0,1863	0,2602
C5	0,36	0,4285	0,5244	0,6415	0,5595	0,5028
Total	1	1	1	1	1	1

The maximum eigenvalue $\lambda_{\max} = 5.37$ is obtained by multiplying each priority weight by the corresponding column total. The Consistency Index (CI) = $(\lambda_{\max} - n) / (n - 1) = (5.37 - 5) / (5 - 1) = 0.0925$. Using the Random Index (RI) = 1.12 for $n = 5$, the Consistency Ratio

(CR) = CI / RI = 0.0925 / 1.12 = 0.0834. Since CR = 0.0834 < 0.1, the pairwise comparison matrix is consistent and the priority weights are valid for further calculations

3.3 Weighted Product Calculation and Ranking

Three student candidates (A1, A2, A3) were used as alternatives. The assessment values were provided by dormitory administrators based on direct observation of the students' daily behavior in the dormitory, using a scale of 1–5. Table 5 shows the assessment values for each alternative on each criterion.

Alternatif	C1	C2	C3	C4	C5
A1	3,666	2,666	3	3,333	3
A2	3,666	4	4,333	4,333	4,333
A3	3,666	3,666	4	4,333	4

Using the WP formula $S_i = \prod x_{ij}^{w_j}$ with the priority weights from Table 4, the vector S values for each alternative are calculated as follows:

$$S1 = (3,666^{0,034812979})(2,666^{0,067790203})(3^{0,134342024})(3,333^{0,260205769})(3^{0,502849025})$$

$$S1 = 6,379384642$$

$S2$

$$= (3,666^{0,034812979})(4^{0,067790203})(4,333^{0,134342024})(4,333^{0,260205769})(4,333^{0,502849025})$$

$$S2 = 6,917341367$$

$$S3 = (3,666^{0,034812979})(3,666^{0,067790203})(4^{0,134342024})(4,333^{0,260205769})(4^{0,502849025})$$

$$S3 = 6,815470595$$

The total $\Sigma S_i = 6,379384642 + 6,917341367 + 6,815470595 = 20,1121966$. The preference values are then:

$$V1 = 6,379384642 / 20,1121966 = 0,317189851$$

$$V2 = 6,917341367 / 20,1121966 = 0,343937637$$

$$V3 = 6,815470595 / 20,1121966 = 0,338872513$$

The final ranking of the alternatives is presented in Table 6.

Alternatif	Nilai V	Ranking
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A2	0,343937637	1
A3	0,338872513	2
A1	0,317189851	3

Based on the results in Table 6, alternative A2 has the highest preference value of 0.3439 and is recommended as the most suitable cell servant candidate, followed by A3 (0.3389) and A1 (0.3172). Alternative A2 excels particularly in the criteria with the highest weights: Exemplary (C5, $w = 0.5028$) and Discipline (C4, $w = 0.2602$), obtaining a score of 4.333 on both criteria. These results demonstrate that the AHP-WP method can objectively differentiate between candidates and provides a transparent and justifiable ranking system.

3.4 System Implementation

The DSS was implemented as a web-based application using PHP and MySQL database. The system architecture consists of five main components:

- (1) User Interface for data input by dormitory administrators;
- (2) AHP Module for calculating criterion weights through pairwise comparison;
- (3) WP Module for calculating preference values and ranking alternatives;
- (4) Database for storing all data including alternatives, criteria, and calculation results;
- and
- (5) Output Module for displaying the final recommendations.

The system provides the following functional features: secure user authentication (login/logout), criteria data management, pairwise comparison matrix input, alternative data management with CRUD operations, automatic AHP and WP calculations, and a ranking results display page. The system interface is intuitive and accessible through a standard web browser without requiring special installation, making it practical for use by dormitory administrators. The ranking results page displays all student candidates sorted from the highest to the lowest preference value, providing clear and objective recommendations.

Black Box Testing was conducted to evaluate whether each function of the web-based Decision Support System operated according to the specified functional requirements. This testing focused on validating the inputs and outputs of each feature without examining the internal source code. The objective was to ensure that every module of the system functioned correctly and produced the expected results.

No.	Module	Test Scenario	Expected Result	Test Result	Status
1	Login	Enter valid username and password	The system grants access and displays the main dashboard	Function executed as expected	Pass
2	Login	Enter an invalid username or password	The system rejects the login attempt and displays an error message	Function executed as expected	Pass
3	Dashboard	Access the dashboard after login	The dashboard displays the number of criteria, alternatives, and available menus	Function executed as expected	Pass
4	Alternative Data	Add a new Cell Leader candidate	Candidate data are successfully stored in the database and displayed in the alternative list	Function executed as expected	Pass
5	Alternative Data	Edit candidate information	Updated candidate data are successfully saved	Function executed as expected	Pass
6	Alternative Data	Delete candidate data	Selected candidate data are successfully removed	Function executed as expected	Pass

			from the database		
7	Criteria Data	Add a new evaluation criterion	The criterion is successfully saved and displayed in the criteria list	Function executed as expected	Pass
8	Criteria Data	Edit criterion information	Updated criterion data are successfully saved	Function executed as expected	Pass
9	Criteria Data	Delete criterion	The selected criterion is successfully deleted	Function executed as expected	Pass
10	Pairwise Comparison (AHP)	Input pairwise comparison values for all criteria	The comparison matrix is successfully saved	Function executed as expected	Pass
11	AHP Calculation	Execute the AHP calculation process	The system calculates normalized weights, priority vectors, λ_{max} , CI, and CR correctly	Function executed as expected	Pass
12	Consistency Test	Verify the Consistency Ratio (CR)	The system indicates that the comparison matrix is consistent when $CR < 0.10$	Function executed as expected	Pass

13	WP Calculation	Execute the Weighted Product calculation	The system calculates Vector S and preference values (V) for each candidate	Function executed as expected	Pass
14	Recommendation Result	Display ranking results	The system ranks all candidates from the highest to the lowest preference value	Function executed as expected	Pass
15	Logout	Click the Logout button	The system ends the user session and redirects to the login page	Function executed as expected	Pass

The Black Box Testing results indicate that all functional modules of the proposed Decision Support System performed as expected. The login, data management, AHP calculation, WP ranking, recommendation generation, and logout features successfully accepted valid inputs, processed data accurately, and produced the expected outputs. These results demonstrate that the developed system is functionally feasible to support the recommendation process for selecting dormitory Cell Leaders at Shanti Bhuana Institute.

4. CONCLUSION

This study successfully developed a web-based Decision Support System (DSS) for recommending dormitory Cell Leaders at Shanti Bhuana Institute using the Analytical Hierarchy Process (AHP) and Weighted Product (WP) methods. The AHP method was effectively applied to determine the relative importance of the evaluation criteria, while the WP method ranked the candidates based on their weighted performance values. The resulting system enables dormitory administrators to conduct the selection process in a more structured, transparent, consistent, and efficient manner compared with the previous manual approach. The AHP consistency test produced a Consistency Ratio (CR) of 0.0834, indicating that the pairwise comparison judgments were sufficiently consistent, while the WP method identified the most suitable candidate based on the highest preference value.

Beyond its technical implementation, this research contributes to the digital transformation of educational management by introducing a data-driven decision support system for student leadership selection within a residential education environment. The proposed system also supports evidence-based institutional governance by improving transparency, accountability, and consistency in the decision-making process. Furthermore, the study extends the application of Multi-Criteria Decision Making (MCDM) methods to character-based student leadership selection, demonstrating how digital technologies can support leadership development in higher education institutions.

Nevertheless, this study has several limitations. First, the evaluation involved a limited number of respondents from a single institution, which may limit the generalizability of the findings. Second, the decision-making process relies solely on the combination of the AHP and WP methods without comparison to other MCDM approaches such as TOPSIS, ELECTRE, or PROMETHEE. Third, the developed system has not been evaluated through formal usability assessments, such as the System Usability Scale (SUS) or comprehensive user acceptance testing. Future research is therefore recommended to involve a broader participant population, compare multiple decision-making methods, integrate additional evaluation criteria, and conduct comprehensive usability and performance evaluations to further improve the effectiveness and applicability of the proposed Decision Support System.

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