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Enhancing Selection Effectiveness of KIP Fund Recipients Using SAW Method

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Abstract
The selection process for recipients of the Indonesia Smart Card (KIP) fund at Nusantara PGRI University had been conducted manually and inefficiently. Thus, this paper focuses on developing a model that can effectively select potential recipients based on predetermined criteria. The study aimed to create a Decision Support System (DSS) using the Simple Additive Weighting (SAW) method to streamline the selection process. The SAW method was chosen due to its ability to handle multi-attribute criteria through weighting and matrix normalization. Data were collected through interviews, observations, and literature reviews, using 12 assessments. The system successfully ranked candidates, with A2 identified as the top priority (score: 0.7278), and the calculation results were validated through manual testing using Excel, confirming the system's consistency.

Keywords:
Selection, KIP Fund, DSS, SAW Method

1. Introduction

The Smart Indonesia Card (KIP) is an educational assistance program from the Indonesian government aimed at underprivileged or economically vulnerable groups. KIP serves as an identity marker to receive educational assistance under the Smart Indonesia Program (PIP) [1]. Nusantara PGRI University of Kediri (UNP Kediri) is a higher education institution eligible to enroll KIP recipient students. Based on interviews with the Vice Rector I of Student Affairs at UNP Kediri, there are several eligibility criteria for receiving KIP funding assistance. Data constitutes a collection of raw facts or information in the form of symbols, numbers, words, or images obtained through observation or sourced from specific references [2]. The current application provides various online design tools that offer ease of use, comprehensive features, and flexibility, making it suitable for graphic design businesses [3].

The rapid advancement of technology has made it easier and faster for many people to complete various tasks [4]. The main challenge faced by program administrators lies in the numerous criteria that must be considered, making it difficult to prioritize potential KIP recipients without an accurate support system. Therefore, the design and implementation of a support system becomes crucial to ensure the smooth administration of the KIP program [5]. A Decision Support System (DSS) is a computerized system designed to facilitate and support decisions when evaluating multiple alternatives. Its primary purpose

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is to generate decisions through automated processing based on predetermined criteria, utilizing computerization as a tool to streamline the selection process [6].

The SAW method calculates the total of weighted performance scores for each alternative across all criteria. This method allows criteria evaluations to be tailored based on the specific needs of an organization. To ensure comparability among alternatives, the SAW method includes a normalization process of the decision matrix values to a standardized scale [7]. The advantage of using the SAW method compared to other decision support system (DSS) methods lies in its ability to provide accurate assessments, as it is based on predetermined values and incorporates the weights of each criterion or attribute[8].

To achieve the defined objectives, it is essential to ensure the effective management of resources, continuous improvement of operational processes, and enhancement of performance standards. These efforts contribute to increased efficiency, better outcomes, and alignment with organizational goals [9]. The proposed solution to this problem involves developing a system to facilitate and improve the KIP (Indonesia Smart Card) fund recipient selection process. This will be achieved by implementing a DSS using the SAW method. It is expected that this research will facilitate and improve the efficiency of selecting recipients for the KIP (Indonesia Smart Card) funding program.

2. Related Works

SAW is widely adopted to address many issues, for instance selection of private vocational schools (SMKs) eligible for government assistance funds based on criteria such as school accreditation, student population, and infrastructure conditions. The matrix normalization and SAW weighting process proved capable of producing transparent school rankings, reducing biases often found in manual assessments. A key strength of this research lies in its ability to handle qualitative data (e.g., facility quality) by converting it into a numerical scale. Its relevance to our study lies in the use of SAW for educational fund allocation, though the target differs (schools vs. students). The findings reinforce the argument that SAW is suitable for multi-criteria decision-making in the public sector, including assistance programs like KIP [6].

Another research focuses on selecting KIP-K scholarship recipients in higher education using pure SAW. The criteria used include parental income, academic achievement, and involvement in social activities. The results show consistency between the system's calculations and manual assessments, with an error margin below 5%. One of the key contributions of this study is the validation of criterion weights through stakeholder interviews, which was later adopted in our research to determine KIP criteria weights at UNP Kediri. A limitation is the lack of system integration with the campus database, requiring manual data input. This study is highly relevant as it provides a blueprint for implementing SAW in a university setting, including technical challenges such as processing large volumes of student data [10].

A work employed SAW to select stunted toddlers in need of nutritional intervention. Unique criteria such as malnutrition levels, family economic conditions, and access to healthcare facilities were used as benchmarks. The results show that the system reduced targeting inaccuracies in the program by 30% compared to manual methods. This research is relevant as it demonstrates the adaptation of SAW for government social policies, similar to KIP, which is also a social assistance program. Another study employed more dynamic health variables that focuses on more structured educational and economic criteria. Their findings inspire the use of SAW for assistance programs requiring a multidisciplinary approach [11].

In medical diagnosis, a study proposed SAW to measure blood sugar levels, family history, and clinical symptoms were processed using SAW to generate diabetes risk scores. The system achieved 85% accuracy compared to doctors' diagnoses, with its main advantage being rapid analysis. The relevance to our research lies in the matrix normalization technique for heterogeneous criteria (e.g., "cost" and "benefit" criteria). Another article validated the results with real-world data, an approach we adopted through manual testing using Excel. A limitation of this study is its reliance on accurate patient data input, a challenge that also arises when collecting student data for KIP [12].

In a transportation system, a study adopted SAW to rank used motorcycles based on criteria such as price, engine condition, and production year. The results show that the system successfully recommends the best motorcycle with the highest score (e.g., a 2019 Yamaha Aerox 155 VVA with a score of 0.925). The primary contribution of this research is the development of a web-based interface that simplifies system operation for non-technical users. Its relevance to our thesis lies in the user-friendly system design for campus administrators. However, the research has limitations in scalability because the system only handles 5 criteria, whereas our study involves 12 more complex criteria [13].

3. Proposed Method

1. Decision Support System (DSS)

DSS is a computer-based tool designed to assist users, particularly in making decisions in evaluating multiple alternatives based on predefined criteria. Rather than replacing human judgment, DSS enhances and supports decision-making by providing relevant data analysis, modeling, and scenario evaluation. It serves as an interactive interface between users and computational systems, particularly valuable for semi-structured or unstructured decision problems. Mathematical formulation of a typical DSS problem can be modeled as a multi-criteria decision-making (MCDM) process. Let:

- $A = \{a_1, a_2, \ldots, a_m\}$ = a set of alternatives.
- $C = \{c_1, c_2, \ldots, c_n\}$ = a set of criteria.
- w_j = weight of criterion c_j, where $\sum_{j=1}^{n} w_j = 1$
- x_{ij} = performance score of alternatives a_i on criterion c_j

Then, the overall score S_i for alternative a_i is computed as a weighted sum model (WSM):

$$S_i = \sum_{j=1}^{n} w_j \cdot x_{ij} \quad (1)$$

The optimal decision a^* is:

$$a^* = arg \max_{a_i \in A} S_i \quad (2)$$

This model forms the core computational logic of many DSS applications, including those in education, where decisions must be made systematically based on multiple criteria.

2. Simple Additive Weighting (SAW)

SAW is a method used to find the optimal alternative from a number of alternatives with certain criteria. The process involves determining weight values for each attribute, then proceeding with a ranking process that will select the given alternatives. The basic concept of the SAW method is to find the weighted sum of the importance ratings for each alternative across all attributes. The SAW method requires a process of normalizing the decision matrix (X) to a scale that can be compared with all existing alternative ratings. In calculations using the SAW method, a normalization process is needed from the original or raw data to a scale that is then compared with all ratings of each alternative [10].

The first step in the Simple Additive Weighting (SAW) method is normalization, which transforms the decision matrix into a comparable scale. The normalization formula for each element r_{ij} is defined as:

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{\max(x_{ij})}, & \text{if } j \text{ is a benefit criterion} \\ \dfrac{\min(x_{ij})}{x_{ij}}, & \text{if } j \text{ is a cost criterion} \end{cases} \tag{3}$$

Where:

- r_{ij} = normalized performance rating of alternative i on criterion j
- x_{ij} = actual value of alternative i on criterion j
- $\max(x_{ij})$ = maximum value of criterion j (for benefit)
- $\min(x_{ij})$ = minimum value of criterion j (for cost)

Normalization is essential in SAW to ensure that all criteria are comparable. For benefit-type criteria (where higher values are preferred), the normalization is done by dividing each value by the maximum in its column. For cost-type criteria (where lower values are better), normalization is done by dividing the minimum value by each entry. This ensures all normalized values fall within the range [0,1], making comparison fair and balanced.

After normalization, the preference value V_i for each alternative is calculated using the weighted sum:

$$V_i = \sum_{j=1}^{n} w_j \cdot r_{ij} \tag{4}$$

Where:

- V_i = final score or preference value of alternative i
- w_j = weight or importance of criterion j
- r_{ij} = normalized score of alternatives i on criterion j
- n = total number of criteria

The preference value V_i represents the overall performance of each alternative, calculated by summing the products of each normalized value and its corresponding weight. The weight w_j reflects the relative importance of each criterion, typically defined by decision-makers. A higher V_i indicates a more favorable alternative. Once all V_i values are obtained, the alternatives can be ranked to select the optimal decision.

4. Experimental Setup

1. Data Collection Methods

This study conducted data collection with interviews, observations, and literature reviews. Interviews were conducted with a key informant from the student affairs department to gather detailed information about the types of scholarships offered and the selection criteria used to determine eligible recipients. This qualitative approach helped uncover institutional policies and practical considerations involved in distributing financial aid to students. In addition to interviews, the researcher conducted direct observations of the scholarship selection process to understand how decisions were implemented in practice. Complementing these primary data sources, a literature review was performed by examining relevant books, academic journals, and other scholarly materials. This helped to build a solid theoretical foundation and contextualize the research findings within the broader scope of existing studies on scholarship management and student support systems.

2. Data Criteria

a) Determining Criteria

To assist in the selection of KIP fund recipients, criteria have been determined according to following criteria:

Table 1: Criteria for determining KIP fund recipients

Code	Criteria Description	Attribute Type
C1	KIP (Smart Indonesia Program)	Benefit
C2	PKH (Family Hope Program)	Benefit
C3	DTKS (Social Welfare Integrated Data)	Benefit
C4	SKTM / Sub-district Head’s Endorsement	Benefit
C5	National-Level Competition Winner	Benefit
C6	Regional-Level Competition Winner	Benefit
C7	Participant in Competitions	Benefit
C8	No Participation in Competitions	Benefit
C9	Organization Chairperson	Benefit
C10	Daily Organizational Board Member	Benefit
C11	Parent’s Income < 2 million IDR	Cost
C12	Parent’s Income > 2 million IDR	Cost

Table 1 presents the decision-making criteria used in a scholarship selection system, divided into benefit and cost attributes. Benefit criteria (C1–C10) are those where higher values or presence indicate a more favorable outcome for the applicant—such as participation in government support programs (KIP, PKH, DTKS), achievements in competitions, or active involvement in organizations. In contrast, cost criteria (C11–C12) represent factors where lower values are preferable, such as lower parental income, reflecting greater financial need. This classification helps in implementing decision support methods like SAW to ensure fair and objective evaluations.

b) Weighting

Weighting is the process of assigning weight values or priorities to each criterion, and weighting is very important for determining the value of a criterion. In this research, the weights were predetermined by the research location and adjusted according to how important each criterion is.

Table 2: Weight Preference Value

Criteria	Weight Value
KIP (Smart Indonesia Program)	0.133
PKH (Family Hope Program)	0.100
DTKS (Social Welfare Integrated Data)	0.066
SKTM / Sub-district Head’s Endorsement	0.033
National-Level Competition Winner	0.133
Regional-Level Competition Winner	0.100
Competition Participant	0.066
No Competition Participation	0.033
Organization Chairperson	0.133
Daily Organizational Board Member	0.100
Parent’s Income < 2 million IDR	0.066
Parent’s Income > 2 million IDR	0.033

Table 2 depicts the weight values assigned to each decision criterion in a scholarship selection model, reflecting their relative importance in the decision-making process. Higher weights (e.g., 0.133) are given to criteria considered more significant, such as participation in major support programs (KIP), achievements at the national level, and organizational leadership roles. Lower weights (e.g., 0.033) are assigned to less impactful attributes like lack of achievement, minor endorsements, or higher parental income. These weights are used in methods such as SAW (Simple Additive Weighting) to compute the final scores of each candidate by multiplying the normalized scores with their respective criterion weights.

5. Results and Analysis

Manual testing of SPK with Excel aims to verify the calculation accuracy, data validation, and consistency of the SAW method logic. The stages include: compiling alternative data and criteria, calculating normalization and weighting, and validating the results by comparing Excel and manual output. Although prone to errors in formula input or data input and less efficient for large data, this method is effective as a final validation before implementing the system.

Table 3: Ranking candidates for scholarship recipient

Perangkingan		
Alternatif	Total	Rangking
Dony	0.7566	2
Rusman	0.7575	1
Edy	0.5775	4
Yura	0.6072	3
Kevin	0.3678	5

Table 3 presents the conclusive ranking of candidates based on their comprehensive evaluation scores. Rusman attained the highest score of 0.7575, earning the top position, while Dony followed closely in second place with a score of 0.7566. The subsequent rankings include Yura (0.6072) in third, Edy (0.5775) in fourth, and Kevin (0.3678) in fifth place. These results reflect each candidate's performance across all assessment criteria, with higher scores indicating superior outcomes.

The ranking was determined through a systematic assessment process involving multiple stages: initial scoring, data normalization, and the application of weighted criteria. This rigorous methodology ensures an objective and equitable comparison of all candidates. The results serve as the basis for important decisions, such as qualification for the KIP (Kartu Indonesia Pintar) program, where candidates with lower rankings may be prioritized for assistance. The transparent scoring system maintains the integrity of the selection process while providing clear benchmarks for candidate performance. Table 4 depicts the final ranking of scholarship recipients.

Table 4: Final ranking of scholarship recipients

Rank	Candidate	Total Score
1	Rusman	0.7575
2	Dony	0.7566
3	Yura	0.6072
4	Edy	0.5775
5	Kevin	0.3678

Note: Scores are calculated based on comprehensive performance metrics. Lower-ranked candidates may be eligible for support programs according to established guidelines.

6. Conclusion

This study successfully developed a DSS based on the SAW method for the selection of KIP fund recipients at Universitas Nusantara PGRI Kediri City, which has been proven to be able to increase the efficiency and objectivity of the selection process. This system overcomes the limitations of manual selection by automating calculations based on 12 established criteria, such as KIP ownership, PKH, achievement, and parental income, and produces accurate rankings of prospective recipients, with alternative A2 as the main priority (score 0.7278). Validation through manual testing using Excel shows the consistency of the results, proving the reliability of the system in supporting decision-making. According to the experimental result, the system can improve the efficiency and objectivity of the KIP fund recipient selection process; however, the study had limitations in the number of criteria used and lacked notification features. Future research was recommended to expand the assessment criteria, integrate notification functions, and increase the coverage of student data.

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