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Decision-Making System for Determining Tuition Fees using the Simple Additive Weighting Method

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Abstract-This study aims to develop a decision-making system for determining tuition fees using the Simple Additive Weighting (SAW) method. The SAW method is a multi-criteria decision-making technique that calculates the weighted sum of decision alternative attributes. This system is designed to assist school administration in making decisions related to the determination of tuition fees for students, which is a crucial source of funding for school operations. The system was developed using PHP programming language and MySQL database. This study utilized descriptive research methods and data collection techniques such as interviews, observations, and documentation. The collected data were then analyzed using the SAW method to determine the weight of each attribute and rank the decision alternatives. The system's performance was evaluated using black-box testing methods, and the results indicated that the system exhibited excellent accuracy, reliability, and efficiency. The testing results showed that the developed system can assist school administration in making decisions related to the determination of tuition fees for students. The use of this system can simplify the decision-making process and reduce errors in decision-making, thereby enhancing school operational activities.

Keywords: Decision-Making System; Simple Additive Weighting; Tuition Fee; Student; Private School

1. INTRODUCTION

Tuition fees in private schools is a financial contribution required to be paid by parents or guardians to support the operational and developmental needs of the school. This fee also serves as one of the primary sources of income for private schools, typically utilized for teacher salaries, facility maintenance, procurement of educational equipment, and other school activities [1]. Due to limited financial resources, private schools often heavily rely on tuition fees from students and their parents. The quality of education and school facilities is frequently associated with the amount and punctuality of tuition fees [2].

As an educational institution, SMK KIMIA PGRI Serang City faces challenges in managing financial aspects, including the determination of the tuition fees that students must pay as a source of funding for school operations. The accurate and fair determination of tuition fees is of utmost importance to SMK KIMIA PGRI Serang City as it can impact the quality of educational services provided to students and the sustainability of school operations. However, the decision-making process regarding the determination of SPP fees is currently carried out manually and has the potential for errors and inequities.

The decision-making method used in determining tuition fees needs improvement to enhance efficiency and accuracy. One of the methods that can be employed is the Simple Additive Weighting (SAW) method. The SAW method is a multi-criteria decision-making technique that calculates the weighted sum of attributes for decision alternatives [3]. By utilizing this method, relevant attributes in the determination of tuition fees can be assigned weights and used to rank decision alternatives [4].

The implementation of a decision-making system using the SAW method can offer various benefits to SMK KIMIA PGRI Serang City. Firstly, this system can help address the issue of inequity in determining tuition fees. In the current manual process, certain crucial factors such as students' financial conditions, the level of program difficulty, and school operational costs may not be adequately considered. By employing the SAW method, weights can be assigned to each of these attributes, thus ensuring that the decision-making process for setting tuition fees is based on objective and fair criteria [5]. Secondly, this decision-making system can simplify the decision-making process for school administration. In the manual system, administrators must gather data, analyze it, and make decisions manually, which is time-consuming and prone to errors. With the automated system using the SAW method, administrators only need to input student data and relevant attributes, and the system will automatically calculate weights and rank decision alternatives [6]. Thirdly, this system can also enhance the efficiency of school financial management. With the automated system in place, administrators can easily access information about the tuition fees that each student needs to pay and make adjustments as necessary. This can reduce the potential for errors in calculations and ensure the smooth operation of the school's activities [7].

To assist the financial department and treasurer in resolving issues, the researcher has designed a system for determining tuition fees for students using the object-oriented analysis and development methodology known as the Unified Approach (UA). This methodology comprises phases of Object-Oriented Analysis (OOA) and Object-Oriented Design (OOD) and employs standard Unified Modeling Language (UML) graphical notations to model the system's requirements. The Unified Approach represents an effort to combine the best practices, processes, and workflows with UML notations and diagrams to gain a better understanding of object-oriented concepts and object-oriented system development [8].

In this research, a Multiple Attribute Decision Making (MADM) problem is addressed using the SAW method. This method was chosen because it can assign weights to each criterion, followed by a ranking process to determine the best alternative from a set of alternatives [9]. Through this ranking method, it is expected that assessments can be more precise, as they are based on predetermined criterion values and weights [10], thereby obtaining more accurate results for the annual tuition fees for each batch of students at SMK KIMIA PGRI Serang City.

The utilization of the SAW method in decision-making systems has been widely implemented across various domains, such as determining rewards for the best partners of PT. Telkom Akses [11]. The assessment of PT. Telkom Akses highlights their excellence based on criteria including Data Reconciliation, Attributes, Attendance, and Performance. Precision is crucial, aligned with the scale of criteria. Furthermore, the comparison of percentage calculations within the system can provide recommendations to PT. Telkom Akses to adopt the system, validated to perform exceptionally well and deliver fitting outcomes. Furthermore, this method has been applied in decision-making processes for selecting the best eyeglasses [12], the Simple Additive Weighting method, is employed to identify the best alternatives by evaluating and filtering various options based on criteria such as lens type, frame color, price, and brand. This method is executed using PHP programming language and MySQL database, defining that the top-rated alternative is the one with a higher ranking value. Determining employee bonuses at PT. Mayatama using the SAW method, with model development employing the waterfall approach [13], the outcomes highlighted the advantages of employing the SAW technique as a decision support system at PT. Mayatama Solusindo to streamline the process of determining employee bonuses aligned with their performance. This method aids administrators in swiftly and efficiently calculating bonuses, derived from the employee's basic salary multiplied by the ranking value percentage. The use of the Simple Additive Weighting (SAW) method can even be applied in the selection of ornamental plants [14], it simplifies their decision-making process in selecting suitable ornamental plants based on their criteria. The decision support system for plant selection has been successfully calculated, resulting in rankings to recommend stores with the desired ornamental plants that align with the customer's preferences. Additionally, It's even used in determining smartphone purchases [15]. Within this system, individuals can input their desired smartphone criteria, streamlining the purchasing process by aiding buyers in selecting smartphones aligned with their specific requirements. Based on several previous studies referenced in this research, therefore the key distinction of this research lies in the specific assessment criteria and weights used to determine the tuition fees for students.

This research will involve data collection using a descriptive method through interviews, observations, and documentation. The gathered data will be analyzed using the SAW method to determine attribute weights and rank decision alternatives. Additionally, the system's performance will be evaluated using black-box testing methods to ensure accuracy, reliability, and efficiency [16].

With the integrated and automated decision-making system in place, it is expected that SMK KIMIA PGRI Serang City can improve the tuition fee determination process, enhance fairness in fee payments, and optimize school financial management. This research can make a significant contribution to improving educational management quality at SMK KIMIA PGRI Serang City and provide insights for the development of similar systems in other educational institutions.

2. RESEARCH METHODOLOGY

To ensure that the research is conducted effectively, efficiently, systematically, and in a structured manner in accordance with applicable scientific standards, the research stages are arranged as presented in Figure 1 below.

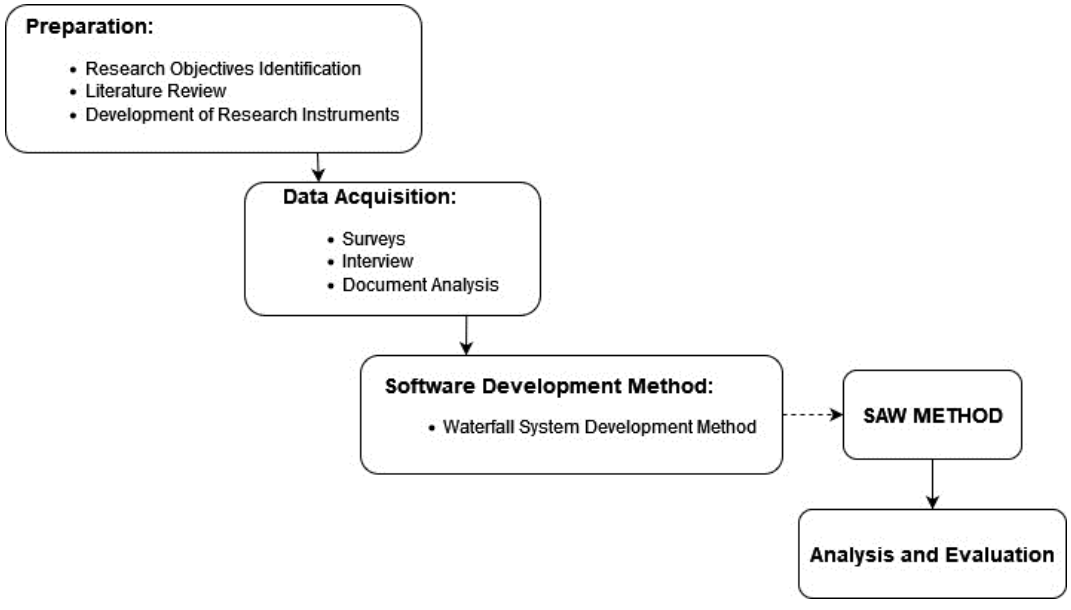

Figure 1. Research Phase

2.1 Preparation Stage

The preparation stage for this research involves several key tasks. Firstly, it entails the identification of clear and specific research objectives, defining the goals and outcomes the study aims to achieve within the context of tuition fee determination. Secondly, an extensive literature review is conducted to comprehensively understand existing research, theories, and practices related to tuition fee decision-making systems, providing valuable insights and identifying gaps in current knowledge. Lastly, during this stage, the development of research instruments, such as surveys or questionnaires, is undertaken to gather relevant data and information, ensuring that these instruments align with the research objectives and the chosen methodology. These preparatory steps lay the foundation for a structured and well-informed research process, facilitating the effective exploration of the chosen topic [17].

2.2 Data Acquisition

Data acquisition refers to the process of collecting data from various sources or relevant resources within the context of research or analysis. The data in this research was obtained using several methods. Firstly, surveys are conducted to gather structured data from a sample of stakeholders, such as students, parents, or administrators, aiming to collect quantitative information on their preferences and factors influencing tuition fee decisions. Secondly, interviews are conducted with key individuals involved in the decision-making process, including school administrators or financial experts, to obtain qualitative insights, expert opinions, and a deeper understanding of the decision-making system. Lastly, document analysis is carried out to examine relevant documents, policies, and records related to tuition fee determination, enabling the researcher to extract valuable information and historical data pertinent to the research objectives. These data acquisition methods collectively provide a comprehensive dataset for the subsequent stages of analysis and decision-making system development [18].

2.3 Development Method

The utilization of the Waterfall System Development Method in this research involves a sequential and structured approach to software development. In this method, the development process is divided into distinct phases that must be completed in a linear fashion, starting with requirements analysis, followed by system design, implementation, testing, deployment, and maintenance [19]. Each phase has its specific objectives, and progress to the next phase only occurs once the previous one is completed. This methodology provides a well-defined framework for the systematic development of the decision-making system, ensuring that each stage is thoroughly completed before moving on to the next, thereby prioritizing stability and documentation throughout the development process [20].

2.4 Simple Additive Weighting Method

The system development method utilized in this study is the Simple Additive Weighting (SAW) method, often referred to as the weighted sum method. The fundamental concept of the SAW method involves calculating the weighted sum of performance ratings for each alternative across all attributes [21]. The SAW method aids in decision-making for a given scenario; however, it ultimately selects the alternative with the highest calculated value as the best choice [22]. The calculations align with this method if the chosen alternative satisfies the predefined criteria [23]. The SAW method is more efficient due to its shorter computation time [24].

The SAW method is also commonly known as the weighted sum method. The basic concept of the SAW method is to determine the weighted sum of performance ratings for each alternative across all attributes. The steps involved in the SAW method are as follows [25]:

a. Create a decision matrix Z with a size of m x n, where m = the alternatives to be selected and n = the criteria.
b. Assign a value x to each alternative (i) on each predetermined criterion (j), where i=1,2...m and j=1,2...n in the decision matrix Z.

$$Z = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1j} \\ \vdots & & & \vdots \\ x_{i1} & x_{i2} & \cdots & x_{ij} \end{bmatrix} \quad (1)$$

c. Providing preference weight values (W) by decision-makers for each predetermined criterion

$$W = [W_1\ W_2\ W_3 \ldots\ldots W_j] \quad (2)$$

d. Perform Z decision matrix normalization by calculating the normalized performance rating value (r_{ij}) of alternative A_i on attribute C_j.

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{\underset{i}{MAX}(x_{ij})} & \text{if j is benefit attribute} \\ \dfrac{\underset{i}{MIN}(x_{ij})}{x_{ij}} & \text{if j is cost attribut atribute} \end{cases} \quad (3)$$

e. The results of the normalized performance rating values (r_{ij}) form a normalized matrix (R).

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1j} \\ \vdots & & & \vdots \\ r_{i1} & r_{i2} & \cdots & r_{ij} \end{bmatrix} \quad (4)$$

f. The final preference values (V_i) are obtained by summing the products of the row elements of the normalized matrix (R) with the corresponding column elements of the weight matrix (W).

$$V_i = \sum_{j=1}^{n} W_j r_{ij} \quad (5)$$

a larger V_i value indicates that alternative A_i is more preferred [26].

2.5 Analysis and Evaluation

This phase involves analyzing the collected data, applying the Simple Additive Weighting (SAW) method to make decisions regarding tuition fees, and evaluating the outcomes. The analysis assesses how well the decision-making system aligns with the predefined objectives and whether it efficiently considers various criteria and preferences. Additionally, it may involve comparing the SAW results with other decision-making methods to determine the superiority of the chosen approach. The evaluation process aims to identify strengths, weaknesses, and areas for improvement in the system and make recommendations for enhancements or refinements, ensuring that the system aligns with the desired goals and contributes positively to tuition fee determination.

3. RESULTS AND DISCUSSION

3.1 System Design

System design is the process of modeling and designing solutions for a business problem using information technology. This encompasses planning the data structure, algorithms, and system architecture [27]. Furthermore, Keng Siau et al explain that system design is an activity of designing and determining how to process information systems based on the results of system analysis to meet user needs, including the design of user interfaces, data, and process activities [28]. The proposed system model will be created using the Unified Modeling Language (UML). Diagrams to be generated include Use Case Diagrams and Activity Diagrams.

3.1.1 Use Case Diagram

Use Case Diagram is a type of diagram in the Unified Modeling Language (UML) used to illustrate interactions between a system and external actors that interact with the system. This diagram aids in planning, visualizing, and comprehending the various features or functions that a system will provide [29]. The design of the use case diagram that will be used in this research can be seen in Figure 2 below.

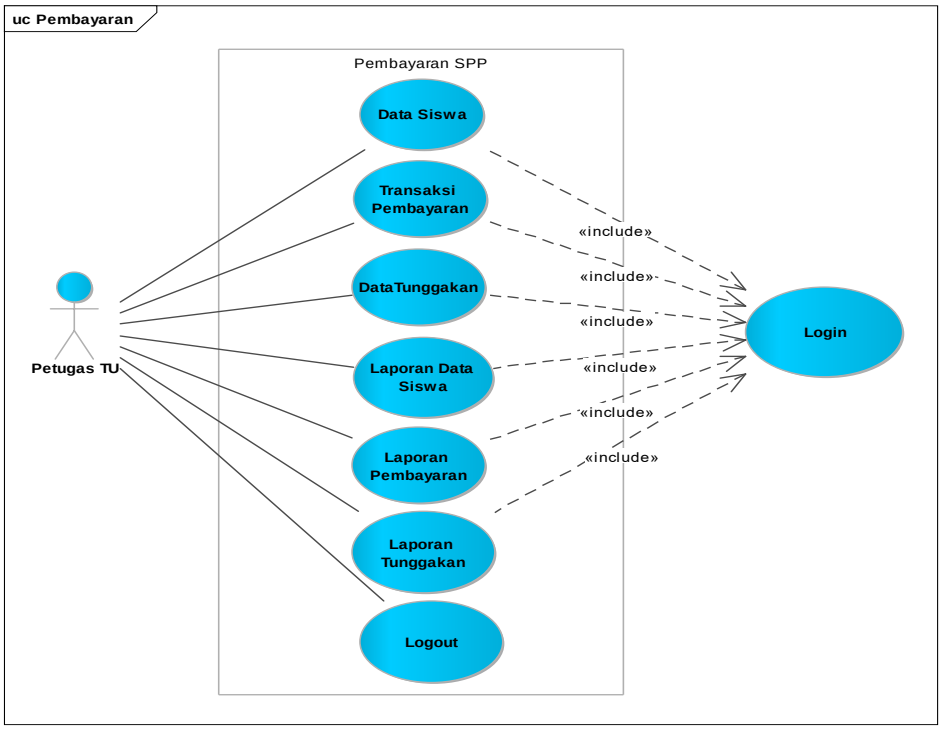

Figure 2. Use Case Diagram

From figure 2, it can be seen that the system is accessed by the User (Administrative Officer) as an actor. They have access to log into the application or system. After logging in, there are 6 menus consisting of: student data, Payment Transactions, Outstanding Data, Student Data Reports, Payment Reports, and Outstanding Reports. There is also an access to log out (Logout) from the system.

3.1.2 Activity Diagram

Activity Diagram is a type of diagram in the Unified Modeling Language (UML) used to depict activities and workflow within a process or system. This diagram visualizes the sequence of tasks, activities, decisions, and branching that occur within a business process or system [30]. The design of the activity and workflow in management criteria process for the decision-making system in determining tuition fees can be seen in Figure 3 below.

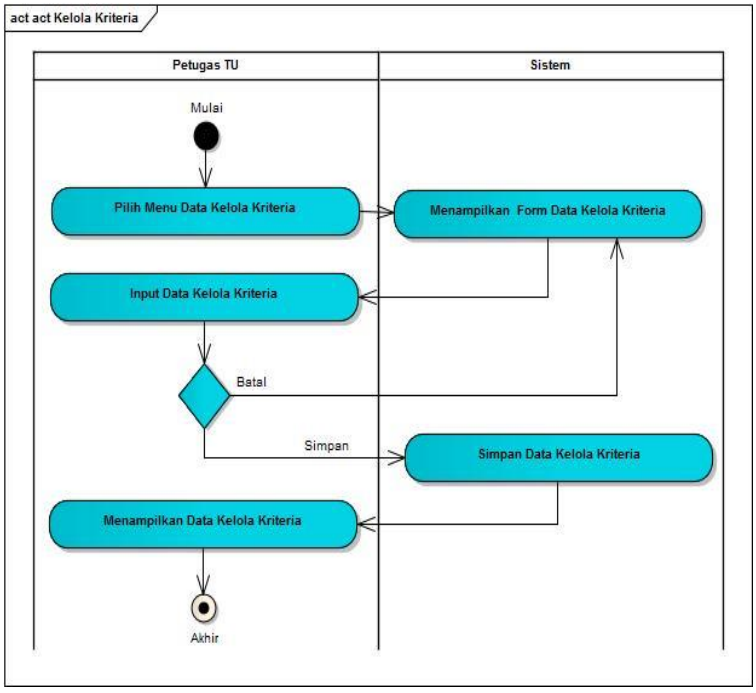

Figure 3. Activity Diagram Manage Criteria

Figure 3 above illustrates the process of management criteria, the officer will log into the system, and after entering, they will select the Manage Criteria Data menu. Then, the system will display the Manage Criteria Data form. After that, the administrative officer inputs the Manage Criteria Data. If the data is entered correctly without any input errors, the data will be saved. If there are input errors, it will revert back to filling out the Criteria Data form. Once saved, the system will display the results of the Criteria Data. The final step is to log out of the system (Logout). The activities and workflow in the process of determining the assessment of tuition fees are presented in Figure 4 below

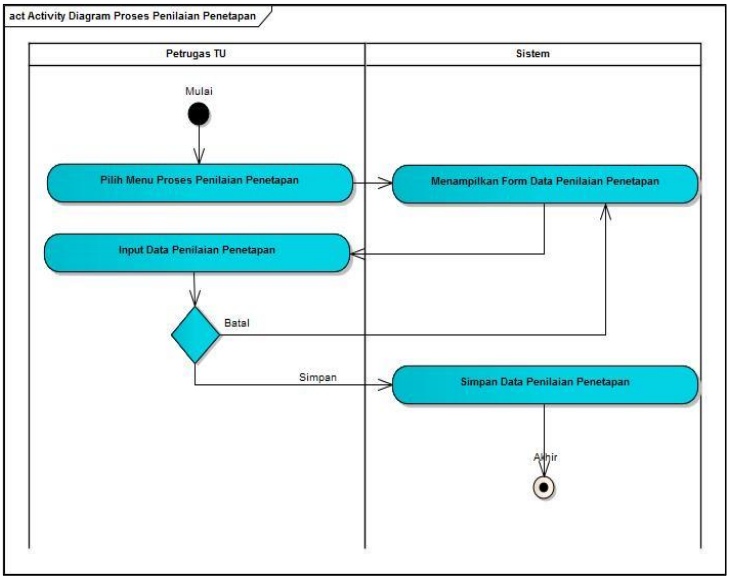

Figure 4. Activity Diagram Assesment of Determination

Figure 4 described process of the administrative officer logs into the system and then selects the assessment determination process menu. After that, they will proceed to input data into the assessment determination form. Once the input is complete, if the data is successfully entered, it will be saved. If not, it will revert back to the assessment determination data input form. Finally, the officer will log out of the system.

3.2 SAW Method Calculation Process

The SAW method calculates scores for alternatives by combining weighted criteria, helping in decision-making by identifying the most preferred alternative.

3.2.1 Assesment and Weighting Criteria

In the SAW method, criteria are required to determine the tuition fee to be imposed on each student. Each criterion is then assigned weights determined by the school according to the existing rules. The list of criteria along with their respective weights can be seen in Table 1 below.

Table 1. Assesment and Weighting Criteria

Criteria Code	Description	Weighting	
		(Percent %)	Decimal
C1	Parent's occupation	20%	0.20
C2	Parent's income	23%	0.23
C3	Parent's dependents	10%	0.10
C4	Tools and materials	10%	0.10
C5	Distance traveled	5%	0.05
C6	Facilities and infrastructure	10%	0.10
C7	Insurance	7%	0.07
C8	School's financial assistance	15%	0.15

Based on Table 1, each criterion carries a distinct relative weight to appropriately influence the evaluation process or decision-making. Consequently, the decisions or policies made will be influenced by factors associated with these criteria at the predetermined level of significance. From the criteria, the suitability rating for each alternative was then created for each criterion using a scale of 1 to 5, The scale ranges from "Very Poor (1)," indicating extremely low performance or quality, through "Poor (2)," "Fair (3)," "Good (4)," to "Very Good (5)," signifying progressively better performance or quality, nearing excellence at its highest level.

After determining the values for each criterion, the next step is to explain the weight of each criterion that has been converted into fuzzy numbers.

a. Tuition Fee Weight

The predetermined weight of tuition fees can be viewed in Table 2 below.

Table 2. Tuition Fee Weight

Tuition Fee (Rp)	Weight
250.000	≥ 0.90
200.000	0.71 – 0.89
150.000	≤ 0.70

From Table 2 above, tuition fee weight increases with higher fees, emphasizing their greater influence on decision-making, reflecting a proportional relationship between fee amounts and their impact on the decision process.

b. Parent's Occupation, Income and Dependents

The occupation criterion is derived from the most recent job held by the student's parents, the parent's income criterion is reflected in the earnings documented in each student's parent's pay slip, and the parent's dependents criteria are observed through details provided in the student's family card. All these criteria are presented in Table 3 below.

Table 3. Parent's Occupation, Income and Dependents (C1-C3)

Job Criteria (C1)	Value	Parent’s Income (C2)	Value	Parent’s Dependents (C3)	Value
Government Employees	5	> 5.000.000	5	1 – 2	5
Private Employees	4	3.000.000 – 4.999.999	4	3	4
Businessman	3	1.000.000 – 2.999.999	3	4	3
Laborer	2	500.000 – 999.999	2	5	2
Jobless	1	< 500.000	1	> 6	1

The table 3, assesses parent's occupation, income, and dependents to determine criteria values. It ranks occupations based on income brackets and dependents' count. Government employees and high-income individuals with fewer dependents score the highest. Private employees follow with moderate income and a specific number of dependents. Businesspersons rank next, followed by laborers, while unemployed individuals with more dependents score the lowest.

The evaluation illustrates a correlation between occupation, income, and dependents, emphasizing how certain occupations align with income brackets and family size. This categorization aids in understanding financial circumstances and family support, guiding decisions in educational or assistance programs.

c. Tools and Materials, Distance Traveled, Facility and Infrastructure

The tools and materials criterion influences students' lab practicum outcomes. Distance traveled is gauged by the distance from home to school. The criterion for decision-making involves new facilities or renovations supporting students within the school environment. All these criteria are presented in Table 4 below.

Table 4. Tools and Materials, Distance Traveled, Facility and Infrastructure (C4-C6)

Material Quality (C4)	Value	Mileage (C5)	Value	Facility and Infrastructure (C6)	Value
Very Good	5	< 10 km	5	New Building	5
Good	3	10.1 – 20.9 km	3	Renovation	3
Fair	1	> 30 km	1	Still	1

Table 4 outlines criteria for tools/materials, distance traveled, and facility/infrastructure. Quality materials and proximity to school positively impact ratings, with 'Very Good' materials and shorter distances earning the highest scores. Additionally, new buildings receive the highest score for facilities, followed by renovations and existing facilities. The evaluation suggests a correlation between quality materials, shorter distances, and superior facilities, highlighting their significance in student outcomes and experiences. These criteria guide decisions related to resource allocation, emphasizing the importance of accessibility to quality materials and proximity to school, along with the continuous improvement of facilities to enhance the learning environment.

d. Insurance

The insurance criterion is taken from the need for student safety in the laboratory. These criteria are presented in Table 5 below.

Table 5. Insurance (C7)

Insurance	Information	Value
Have	Very Good	5
Do not have	Very Poor	1

Based on Table 5, possessing insurance is rated as 'Very Good,' while lacking insurance is considered 'Very Poor,' highlighting the significant contrast in evaluation based on insurance coverage within the given criteria.

e. School's Financial Assistance (BOS)

School Operational Assistance (BOS) fund criterion is taken from the amount received by the school. These criteria are presented in Table 6 below.

Table 6. School's Financial Assistance (C8)

Financial Aid	Information	Value
Full	Very Good	5
Truncated	Fair	3
Do not have	Very Poor	1

Table 6 grades financial aid: full aid as 'Very Good,' partial aid as 'Fair,' and lacking aid as 'Very Poor.' This ranking suggests a direct correlation between the extent of financial assistance provided and the rating, impacting students' opportunities and support levels.

3.2.3 Alternative Criteria

In the selection of the administration of tuition fee costs at SMK Kimia PGRI Kota Serang, what is referred to as alternatives are all the students enrolled in the school.

As a sample data for the calculation in this research, 10 students were selected. Each student was evaluated according to the predetermined criteria. The data of these 10 candidates were collected by the school administration, and the compatibility ratings for each alternative on each criterion were then formed, as seen in Table 13 below.

Tabel 7. Alternative Criteria

Alternative	Criteria							
	C1	C2	C3	C4	C5	C6	C7	C8
Abizar Febrilyan	Private Employees	3.000.000 – 4.999.999	1	Good	< 10 km	Renovation	Have	Truncated
Achmad Aditya	Laborer	3.000.000 – 4.999.999	1	Good	10.1 – 20.9 km	Renovation	Have	Truncated

Ahmad Destian Imanullah	Businessman	3.000.000 – 4.999.999	1	Good	< 10 km	Renovation	Have	Truncated
Arief Hidayatullah	Private Employees	3.000.000 – 4.999.999	1	Good	> 30 km	Renovation	Have	Truncated
Aulia Widyatanti	Laborer	3.000.000 – 4.999.999	2	Good	10.1 – 20.9 km	Renovation	Have	Truncated
Christine Pariang Vanesia Tampubolon	Laborer	3.000.000 – 4.999.999	1	Good	10.1 – 20.9 km	Renovation	Have	Truncated
Dimas Aditiya	Laborer	3.000.000 – 4.999.999	1	Good	< 10 km	Renovation	Have	Truncated
Djenar Al-Gibraltar	Private Employees	3.000.000 – 4.999.999	2	Good	10.1 – 20.9 km	Renovation	Have	Truncated
Eka Putra Munandar	Private Employees	3.000.000 – 4.999.999	1	Good	10.1 – 20.9 km	Renovation	Have	Truncated
Galih Ramadhan	Laborer	3.000.000 – 4.999.999	1	Good	> 30 km	Renovation	Have	Truncated

Table 7 presents a dataset of students along with their corresponding criteria. Students are categorized based on their parents' occupations, income, dependents, quality of tools and materials, distance traveled, facility and infrastructure, insurance, and school financial aid. Most students have parents employed in the private sector with an income ranging from 3 to 5 million Indonesian Rupiah. They generally have one dependent and fall into the 'Good' category concerning practical tools and materials, with a majority traveling less than 20 kilometers to school. School facilities largely underwent renovations. All students in this table possess insurance, indicating a high level of coverage availability. Financial aid from the school predominantly takes the form of limited or partial assistance, falling short of full aid. This suggests that most students might receive financial assistance that does not cover all their educational expenses. However, there's variance in the distance traveled to school and the number of dependents, affecting certain criteria assessments. Students with longer commutes or more dependents tend to receive slightly lower ratings in distance and dependent-related criteria. The data analysis indicates that the majority of students in the table share similarities in income, parents' occupation, and the quality of tools and materials. However, discrepancies arise in the distance traveled, impacting accessibility and potential fatigue factors for students. The assessment of insurance and school financial aid reveals that all students have insurance coverage but might receive limited financial aid. This underscores the significant role of school financial assistance in meeting students' educational needs, especially for those with more constrained financial conditions.

From the data presented in Table 7, subsequently assessed based on the predetermined weights, the results of the assessment can be seen in Table 8 below

Table 8. Match Rating on Each Alternative

Alternative	Criteria							
	C1	C2	C3	C4	C5	C6	C7	C8
Student 1	4	4	5	3	5	3	5	3
Student 2	2	4	5	3	3	3	5	3
Student 3	4	4	5	3	5	3	5	3
Student 4	4	4	5	3	1	3	5	3
Student 5	2	4	5	3	3	3	5	3
Student 6	2	4	5	3	3	3	5	3
Student 7	2	4	5	3	5	3	5	3
Student 8	4	4	5	3	3	3	5	3
Student 9	4	4	5	3	3	3	5	3
Student 10	2	4	5	3	1	3	5	3

Table 8 showcases match ratings for each student across various criteria. Students exhibit consistency in most criteria, displaying similar ratings in C1, C2, C3, C4, C6, C7, and C8. However, variability arises in C5, highlighting differences, potentially in the distance traveled, influencing specific assessments. This consistency across multiple criteria suggests alignment in several aspects among the students, signifying commonalities in parental occupation, income, dependents, facilities, insurance, and financial aid, except for distinctions in travel distance.

3.2.4 Completion of SAW Method

From the assessment results of the school students above, the highest value for each criterion (Max Xij) was determined, as shown in Table 9.

Table 9. Criteria Largest Value

Criteria		Max Value (X_{ij})
Code	Name	
C1	Parent's occupation	4
C2	Parent's income	4
C3	Parent's dependents	5
C4	Tools and materials	3
C5	Distance traveled	5
C6	Facilities and infrastructure	3
C7	Insurance	5
C8	School's financial assistance	3

Table 9 identifies the criteria with the highest values across students. Parent's dependents (C3), distance traveled (C5), and insurance (C7) received the maximum ratings of 5, signifying their significant impact on evaluations. Meanwhile, parent's occupation (C1) and income (C2) both obtained a maximum value of 4. Tools and materials (C4), facilities (C6), and school financial assistance (C8) garnered lower maximum values, indicating their comparatively lesser influence on the overall evaluations or decision-making process.

The next step is to normalize the X matrix to calculate the value of each criterion based on whether it is assumed to be a benefit or a cost criterion. The calculation is as follows:

Student 1	Student 2	Student 3	Student 4	Student 5
R11 = 4/4 = 1	R21 = 2/4 = 0,5	R31 = 4/4 = 1	R41 = 4/4 = 1	R51 = 2/4 = 0.5
R12 = 4/4 = 1	R22 = 4/4 = 1	R32 = 4/4 = 1	R42 = 4/4 = 1	R52 = 4/4 = 1
R13 = 3/5 = 1	R23 = 5/5 = 1	R33 = 5/5 = 1	R43 = 5/5 = 1	R53 = 5/5 = 1
R14 = 3/3 = 1	R24 = 3/3 = 1	R34 = 3/3 = 1	R44 = 3/3 = 1	R14 = 3/3 = 1
R15 = 5/5 = 1	R25 = 3/5 = 0.6	R35 = 5/5 = 1	R45 = 1/5 = 0,2	R55 = 3/5 = 0.6
R16 = 3/3 = 1	R26 = 3/3 = 1	R36 = 3/3 = 1	R46 = 3/3 = 1	R56 = 3/3 = 1
R17 = 5/5 = 1	R27 = 5/5 = 1	R37 = 5/5 = 1	R47 = 5/5 = 1	R57 = 5/5 = 1
R18 = 3/3 = 1	R28 = 3/3 = 1	R38 = 3/3 = 1	R48 = 3/3 = 1	R58 = 3/3 = 1
Student 6	Student 7	Student 8	Student 9	Student 10
R61 = 2/4 = 0.5	R71 = 2/4 = 0.5	R81 = 4/4 = 1	R91 = 4/4 = 1	R101 = 2/4 = 0.5
R62 = 4/4 = 1	R72 = 4/4 = 1	R82 = 4/4 = 1	R92 = 4/4 = 1	R102 = 4/4 = 1
R63 = 5/5 = 1	R73 = 5/5 = 1	R83 = 5/5 = 1	R93 = 5/5 = 1	R103 = 5/5 = 1
R64 = 3/3 = 1	R74 = 3/3 = 1	R84 = 3/3 = 1	R94 = 3/3 = 1	R104 = 3/3 = 1
R65 = 3/5 = 0,6	R75 = 5/5 = 1	R85 = 3/5 = 0.6	R95 = 3/5 = 0.6	R105 = 1/5 = 0,2
R66 = 3/3 = 1	R76 = 3/3 = 1	R86 = 3/3 = 1	R96 = 3/3 = 1	R106 = 3/3 = 1
R67 = 5/5 = 1	R77 = 5/5 = 1	R87 = 5/5 = 1	R97 = 5/5 = 1	R107 = 5/5 = 1
R68 = 3/3 = 1	R78 = 3/3 = 1	R88 = 3/3 = 1	R98 = 5/3 = 1	R108 = 3/3 = 1

The result of the normalized performance rating values (r_{ij}) forms the normalized matrix (R).

$$\begin{pmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0,5 & 1 & 1 & 1 & 0,6 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 0,2 & 1 & 1 & 1 \\ 0,5 & 1 & 1 & 1 & 0,6 & 1 & 1 & 1 \\ 0,5 & 1 & 1 & 1 & 0,6 & 1 & 1 & 1 \end{pmatrix}$$

The next step is to perform the ranking process by multiplying the normalized matrix (R) with the preference weight values (W) and determining the preference values for each alternative (V_i) by summing the products of the normalized matrix (R) with the preference weight values (W). The preference weight values/vector weights (W) are assigned by decision-makers for each predefined criterion.

W = [0.2 0.23 0.1 0.1 0.05 0.1 0.07 0.15]

Thus, the value is obtained:

V1 = 0.2 (1) + 0.23 (1) + 0.1 (1) + 0,1 (1) + 0,05 (1) + 0,1 (1) + 0,07 (1) + 0.15 (1) = 1

V2 = 0.2 (0.5) + 0.23 (1) + 0.1 (1) + 0,1 (1) + 0,05 (0,6) + 0,1 (1) + 0,07 (1) + 0.15 (1) = 0.88

V3 = 0.2 (1) + 0.23 (1) + 0.1 (1) + 0,1 (1) + 0,05 (1) + 0,1 (1) + 0,07 (1) + 0.15 (1) = 1

V4 = 0.2 (1) + 0.23 (0.8) + 0.1 (0,8) + 0,1 (1) + 0,05 (0.2) + 0,1 (1) + 0,07 (1) + 0.15 (1) = 0.96
V5 = 0.2 (0.5) + 0.23 (1) + 0.1 (1) + 0,1 (1) + 0,05 (0,6) + 0,1 (1) + 0,07 (1) + 0.15 (1) = 0.88
V6 = 0.2 (0.5)+ 0.23 (1) +0.1 (1)+ 0,1 (1) +0,05 (0,6) + 0.1 (1) + 0,07 (1) + 0.15 (0,1) = 0.88
V7 = 0.2 (0.5) + 0.23 (1) + 0.1 (1) + 0,1 (1) + 0,05 (1) + 0,1 (1) + 0,07 (1) + 0.15 (1) = 0,9
V8 = 0.2 (1) + 0.23 (1) + 0.1 (1) + 0,1 (1) + 0,05 (0.6) + 0,1 (1) + 0,07 (1) + 0.15 (1) = 0.98
V9 = 0.2 (1) + 0.23 (1) + 0.1 (1) + 0,1 (1) + 0,05 (0.6) + 0,1 (1) + 0,07 (1) + 0.15 (1) = 0.98
V10 = 0.2 (0.5) + 0.23 (1) + 0.1 (1) + 0,1 (1) + 0,05 (0.2) + 0,1 (1) + 0,07 (1) + 0.15 (1) = 0.86

From the calculation above, the ranking results are obtained as shown in table 10 below:

Table 10. Result of V_i Calculation

Alternative	Value of V_i	Tuition Fee (Rp)
V1	1	250.000
V2	0,88	200.000
V3	1	250.000
V4	0,96	250.000
V5	0,88	200.000
V6	0,88	200.000
V7	0,9	250.000
V8	0,98	250.000
V9	0,98	250.000
V10	0,86	200.000

The table 10, presents the results of Vi (preference value) calculations for each alternative, along with their associated tuition fees (in Indonesian Rupiah). In the context of classification or decision-making, this table illustrates the extent to which each alternative is assessed or ranked based on predefined criteria. Here is the interpretation of the table:

a. **V1** has a preference value (Vi) of 1, which is the highest among all alternatives. This indicates that V1 is the most preferred or the most suitable alternative based on the utilized criteria, with a tuition fee of 250,000 Indonesian Rupiah.
b. **V3** also has a preference value (Vi) of 1, the same as V1. This means that V3 shares the same preference level as V1 and also has a tuition fee of 250,000 Indonesian Rupiah.
c. **V8** and **V9** both have a preference value (Vi) of 0.98, which is quite high. This suggests that V8 and V9 are excellent alternatives and nearly equivalent to V1 and V3 in terms of preference. Their tuition fees are 250,000 Indonesian Rupiah.
d. **V4** has a preference value (Vi) of 0.96, also high. This indicates that V4 is nearly equivalent to V8 and V9 in terms of preference, with a tuition fee of 250,000 Indonesian Rupiah.
e. **V2**, **V5**, **V6**, and **V10** have lower preference values, specifically 0.88 and 0.86. This implies that these alternatives are less preferred or less suitable compared to others in the classification based on the predefined criteria. Their tuition fees range from 200,000 to 250,000 Indonesian Rupiah.

So, in the context of the classification results, V1, V3, V8, and V9 can be considered as alternatives with stronger financial capabilities, while V2, V5, V6, and V10 exhibit lower preferences in deciding the monthly tuition fee payment for students.

3.3 System Implementation

a. Main Page

This page contains menus to access all functions available in the application. The screenshot of the main page can be seen in Figure 5 below.

Figure 5. Main Page

b. Manage Criteria Page

The manage criteria page is used to modify or manage the criteria data in determining the tuition fee. The screenshot of the criteria page can be seen in Figure 6 below.

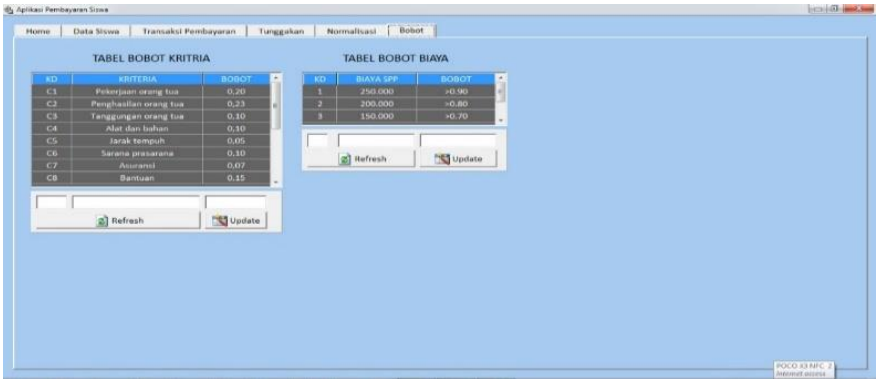

Figure 6. Manage Criteria Page

c. Tuition Fee Assessment Page

This page contains the calculation and results of the assessment for Tuition funding. The screenshot of the tuition fees assessment page can be seen in Figure 7 below.

Figure 7. Tuition Fee Assessment Page

3.3.1 System Testing

System Testing aims to test all elements in the application, whether they meet the expected requirements. The testing method used is the black box method, which is a testing method that only observes the execution results through test data and checks the functional aspects of the application. The system tested using the black box method is as follows:

a. Main Page Testing

All tests were completed without errors, confirming the proper functionality and reliability of the main page. Summary of the test results can be seen in Table 11 below.

Table 11. Main Page Testing Result

Action	Expectation	Result	Conclusion
When the "Student Data" tab menu is pressed	The student data page will appear	Student data page appears	[x] Success [ ] Failure
When the "Payment Transaction" tab menu is pressed	The payment transaction page will appear	Payment transaction page appears	[x] Success [ ] Failure
When the "Payment Arrears" tab menu is pressed	The payment arrears page will appear	Payment arrears page appears	[x] Success [ ] Failure
When the "Logout" button is pressed	The system will log out and the login page will reappear	Log out and return to login page	[x] Success [ ] Failure

Table 11 presents the expected and actual results of main page testing for different tab menu actions. The analysis indicates successful outcomes for the appearance of the student data, payment transaction, and payment arrears pages

upon clicking their respective tabs. Additionally, logging out successfully returns to the login page, showcasing the system's successful functionality.

b. Add Student Data Page Testing

All tests passed smoothly, affirming the successful functionality and reliability of the page. Summary of the test results can be seen in Table 12 below.

Table 12. Add Student Data Page Testing Result

Action	Expectation	Result	Conclusion
If the "Save" button is pressed	The input data will be saved into the database	The input has been saved to the database	[x] Success [ ] Failure
If the "Cancel" button is pressed	The student data input process will be cancelled	The input process has been cancelled	[x] Success [ ] Failure

Table 12 records testing results for the add student data page. Clicking 'Save' successfully saves input to the database, marked as a successful outcome. Similarly, clicking 'Cancel' effectively cancels the input process, denoting a successful operation. Both functionalities work as expected, showcasing the system's success in managing data input and cancellation processes.

c. Criteria Page Testing

All tests were completed without issues, confirming the successful functionality and reliability of the criteria page. Summary of the test results can be seen in Table 13 below.

Table 13. Criteria Page Testing Result

Action	Expectation	Result	Conclusion
If the "Save" button is pressed	It will save the input data into the database	The input is saved into the database	[x] Success [ ] Failure
If the "Cancel" button is pressed	It will cancel the payment transaction input process	The input process is cancelled	[x] Success [ ] Failure
If the "Edit" button is pressed	It will edit the input data in the database	The process of editing data criteria	[x] Success [ ] Failure

Table 13 documents criteria page testing outcomes. Pressing 'Save' successfully saves input to the database, marked as a successful action. Additionally, clicking 'Cancel' effectively cancels the payment transaction input process, denoting success. Pressing 'Edit' successfully initiates the data editing process in the criteria, showcasing the system's functional success in these essential operations.

d. Calculation Page Testing

All tests were completed without any issues, affirming the successful functionality and reliability of the calculation page. Summary of the test results can be seen in Table 14 below.

Table 14. Calculation Page Testing Result

Action	Expectation	Result	Conclusion
If the "Process" button is pressed	It will process the input data into the database	The process of calculating criteria data	[x] Success [ ] Failure

Table 14 outlines the testing for the calculation page. Pressing the "Process" button successfully initiates the calculation of criteria data, marked as a successful action. This confirms the system's capability to execute data processing operations effectively, meeting the expected outcome for calculating criteria data.

From the test results as seen in the tables above, all the menus in the system are functioning properly with a status of "success." Therefore, the overall tuition fee decision-making system is working effectively.

4. CONCLUSION

The introduction of the decision-making system for tuition fee determination using the Simple Additive Weighting method at SMK KIMIA PGRI Serang City has emerged as a successful and forward-looking endeavor. This SAW-based approach enhances the process of tuition fee determination by taking into account a multitude of criteria. This comprehensive evaluation guarantees impartial and just fee calculations. The research advocates transparency by grounding criterion weights on the preferences of decision-makers. This transparency fosters trust among stakeholders, including students and parents, who gain a more lucid comprehension of the fee calculation procedure. The SAW system permits the creation of personalized fee structures tailored to the unique profiles of individual students. Exceptional students can benefit from fee reductions, while those in need of financial assistance receive suitable support, promoting inclusivity and accessibility. The system streamlines resource allocation by considering factors like facility availability and their influence on the learning environment, ultimately resulting in an enhanced educational experience and greater student satisfaction. The

adaptability of the SAW method ensures that the fee determination process remains flexible. As institutional dynamics shift and the significance of criteria changes, the system can be adjusted to accommodate evolving requirements.

REFERENCES

[1] K. Czarnecki, T. Korpi, and K. Nelson, "Student support and tuition fee systems in comparative perspective," *Stud. High. Educ.*, vol. 46, no. 11, pp. 2152–2166, Nov. 2021, doi: 10.1080/03075079.2020.1716316.

[2] A. Mushthofa, A., Munastiwi, E. Dinana, "Manajemen pembiayaan pendidikan berbasis bebas sumbangan pembinaan pendidikan," *J. Akuntabilitas Manaj. Pendidik.*, vol. 10, no. No. 1, pp. 64–76, 2022.

[3] C. N. Siruru and A. Nugroho, "Pengambilan Keputusan Dengan Mengunakan Metode Simple Additive Weighting (SAW) Untuk Menentukan Pembelian Mesin Tempel," *J. Indones. Manaj. Inform. dan Komun.*, vol. 4, no. 2, pp. 788–794, May 2023, doi: 10.35870/jimik.v4i2.276.

[4] N. Vafaei, R. A. Ribeiro, and L. M. Camarinha-Matos, "Assessing Normalization Techniques for Simple Additive Weighting Method," *Procedia Comput. Sci.*, vol. 199, pp. 1229–1236, 2022, doi: 10.1016/j.procs.2022.01.156.

[5] N. A. Khaliq, A. Josi, and L. Fujiyanti, "Sistem Informasi Pendukung Keputusan Seleksi Beasiswa Menggunakan Metode SAW," *JSITIK J. Sist. Inf. dan Teknol. Inf. Komput.*, vol. 1, no. 2, pp. 94–108, 2023, doi: 10.53624/jsitik.v1i2.162.

[6] F. S. Amalia, "Application of SAW Method in Decision Support System for Determination of Exemplary Students," *J. Inf. Technol. Softw. Eng. Comput. Sci.*, vol. 1, no. 1, pp. 14–21, Dec. 2022, doi: 10.58602/itsecs.v1i1.9.

[7] M. M. Neumann, J. L. Anthony, N. A. Erazo, and D. L. Neumann, "Assessment and Technology: Mapping Future Directions in the Early Childhood Classroom," *Front. Educ.*, vol. 4, Oct. 2019, doi: 10.3389/feduc.2019.00116.

[8] E. Ridhawati, E. Erlangga, and Y. Syafitri, "Digitalisasi Sistem Marketing Minyak Nilam Dengan Model Perancangan Berbasis Unified Approach Method," *J. Sains dan Inform.*, vol. 7, no. 1, pp. 29–35, 2021, doi: 10.22216/jsi.v7i1.304.

[9] F. Febriyanto and I. Rusi, "Penerapan Metode Simple Additive Weighting Dalam Sistem Pendukung Keputusan Pemilihan Smartphones," *IJCIT (Indonesian J. Comput. Inf. Technol.*, vol. 5, no. 1, pp. 67–74, 2020, doi: 10.31294/ijcit.v5i1.6674.

[10] Z.-G. Zhang, X. Hu, Z.-T. Liu, and L.-T. Zhao, "Multi-attribute decision making: An innovative method based on the dynamic credibility of experts," *Appl. Math. Comput.*, vol. 393, p. 125816, Mar. 2021, doi: 10.1016/j.amc.2020.125816.

[11] Fandi Aziz and A. S. Purnomo, "Sistem Penunjang Keputusan Penentuan Reward Bagi Mitra Terbaik Menggunakan Metode Simple Additive Weighting (SAW) (Studi Kasus : PT. Telkom Akses)," *J. Fasilkom*, vol. 11, no. 2, pp. 91–96, 2021, doi: 10.37859/jf.v11i2.2715.

[12] D. R. Dwiki Putri and M. R. Fahlevi, "Penerapan Metode Simple Additive Weighting(SAW) Dalam Pemilihan Kacamata," *Infosys (Information Syst. J.*, vol. 5, no. 2, p. 113, 2021, doi: 10.22303/infosys.5.2.2021.113-122.

[13] Y. Irawan, "Decision Support System for Employee Bonus Determination With Web-Based Simple Additive Weighting (Saw) Method in Pt. Mayatama Solusindo," *J. Appl. Eng. Technol. Sci.*, vol. 2, no. 1, pp. 7–13, 2020, doi: 10.37385/jaets.v2i1.162.

[14] E. Erlangga, Y. Yolandari, T. Thamrin, and A. K. Puspa, "Analisis Penerapan Metode Simple Additive Weighting (SAW) Pemilihan Tanaman Hias," *Explor. Sist. Inf. dan Telemat.*, vol. 12, no. 1, 2021, doi: 10.36448/jsit.v12i1.2010.

[15] S. Andini, R. Angraini, and S. Enggari, "Sistem Pendukung Keputusan Rekomendasi Smartphone Terbaik Menggunakan Metode Simple Additive Weighting (SAW)," *J. KomtekInfo*, vol. 8, no. 3, 2021.

[16] L. Liao *et al.*, "Using black-box performance models to detect performance regressions under varying workloads: an empirical study," *Empir. Softw. Eng.*, vol. 25, no. 5, pp. 4130–4160, Sep. 2020, doi: 10.1007/s10664-020-09866-z.

[17] H. Snyder, "Literature review as a research methodology: An overview and guidelines," *J. Bus. Res.*, vol. 104, pp. 333–339, Nov. 2019, doi: 10.1016/j.jbusres.2019.07.039.

[18] C. Li, Y. Chen, and Y. Shang, "A review of industrial big data for decision making in intelligent manufacturing," *Eng. Sci. Technol. an Int. J.*, vol. 29, p. 101021, May 2022, doi: 10.1016/j.jestch.2021.06.001.

[19] C. A. Crespo-Santiago and S. de la C. Dávila-Cosme, "Waterfall method: a necessary tool for implementing library projects," *HETS Online J.*, vol. 1, no. 2, pp. 81–92, Nov. 2022, doi: 10.55420/2693.9193.v1.n2.91.

[20] T. Thesing, C. Feldmann, and M. Burchardt, "Agile versus Waterfall Project Management: Decision Model for Selecting the Appropriate Approach to a Project," *Procedia Comput. Sci.*, vol. 181, pp. 746–756, 2021, doi: 10.1016/j.procs.2021.01.227.

[21] N. Vafaei, R. A. Ribeiro, and L. M. Camarinha-Matos, "Assessing Normalization Techniques for Simple Additive Weighting Method," *Procedia Comput. Sci.*, vol. 199, pp. 1229–1236, 2021, doi: 10.1016/j.procs.2022.01.156.

[22] J. Attieh and J. Tekli, "Supervised term-category feature weighting for improved text classification," *Knowledge-Based Syst.*, vol. 261, p. 110215, 2023, doi: 10.1016/j.knosys.2022.110215.

[23] Y. J. Wang, "Interval-valued fuzzy multi-criteria decision-making based on simple additive weighting and relative preference relation," *Inf. Sci. (Ny).*, vol. 503, pp. 319–335, 2019, doi: 10.1016/j.ins.2019.07.012.

[24] M. Grdinić-Rakonjac and V. Pajković, "The influence of different weighting schemes on the construction of the composite behaviour index," *Transp. Res. Procedia*, vol. 69, no. 2022, pp. 85–90, 2023, doi: 10.1016/j.trpro.2023.02.148.

[25] A. Ibrahim and R. A. Surya, "The Implementation of Simple Additive Weighting (SAW) Method in Decision Support System for the Best School Selection in Jambi," *J. Phys. Conf. Ser.*, vol. 1338, no. 1, 2019, doi: 10.1088/1742-6596/1338/1/012054.

[26] R. K. Dewi, K. C. Brata, T. Afirianto, and E. N. Candra, "Comparison between SAW and Knowledge based SAW in Recipe Recommendation System," *J. Inf. Technol. Comput. Sci.*, vol. 6, no. 3, pp. 273–280, 2021, doi: 10.25126/jitecs.202163363.

[27] S. Cronholm and H. Göbel, "Action design research: integration of method support," *Int. J. Manag. Proj. Bus.*, vol. 15, no. 8, pp. 19–47, Dec. 2022, doi: 10.1108/IJMPB-07-2021-0196.

[28] K. Siau, C. Woo, V. C. Storey, R. H. L. Chiang, C. E. H. Chua, and J. W. Beard, "Information Systems Analysis and Design: Past Revolutions, Present Challenges, and Future Research Directions," *Commun. Assoc. Inf. Syst.*, vol. 50, no. 1, pp. 835–856, 2022, doi: 10.17705/1CAIS.05037.

[29] H. Koç, A. M. Erdoğan, Y. Barjakly, and S. Peker, "UML Diagrams in Software Engineering Research: A Systematic Literature Review," p. 13, 2021, doi: 10.3390/proceedings2021074013.

[30] T. Ahmad, J. Iqbal, A. Ashraf, D. Truscan, and I. Porres, "Model-based testing using UML activity diagrams: A systematic mapping study," *Comput. Sci. Rev.*, vol. 33, pp. 98–112, Aug. 2019, doi: 10.1016/j.cosrev.2019.07.001.