Jurnal JEETech: Vol. 7 No. 1 Tahun 2026
Journal Of Electrical Engineering And Technology
https://ejournal.ft-undar.ac.id/index.php/jeetech
DOI: https://doi.org/10.32492/jeetech.v7i1.7106
e-ISSN: 2722-5321
p-ISSN: 2964-7320

Decision Support System For Selecting Formal Education Levels In a Violation Based Microcontroller and IOT

[1*]Sumantri, [2]Ratri Enggar Pawening, [3]Moh.Jasri, [4]Ilmirrizki Imaduddin, [5]Bambang, [6]Tijaniyah, [7]M.Fadhilur Rahman

[12357] Informatics Engineering Study Program, Faculty of Engineering, Nurul Jadid University
[46] Electrical Engineering Study Program, Faculty of Engineering, Nurul Jadid University
[1] sumantri@unuja.ac.id , [2] enggar.r@unuja.ac.id , [3]jasri@unuja.ac.id, [4]ilmi.eeunuja@gmail,com, [5]bambang@unuja.ac.id , [6]tijaniyah@unuja.ac.id , [7]fadhilurrahman88@gmail.com

Article Info

Article history:

Received March 15, 2026
Revised April 4, 2026
Accepted April 29, 2026

Keyword:

Violation
Decision
Method
Microcontroller
Internet Of Things

ABSTRACT

This study develops a decision support system to determine appropriate formal education levels based on student violations using the Multi Attribute Decision Making (MADM) method with the Simple Additive Weighting (SAW) technique. The system integrates a microcontroller and Internet of Things (IOT) technology for real time data collection and monitoring. Several criteria, including violation frequency, type, behavior, and academic performance, are evaluated and weighted to produce ranking results. The result of the SAW method calculation shows that the third alternative (Senior High School or SLTA) obtained The results of this study include the accuracy of the XAW method values, the test results of the MQ2 sensor, and the test results of the Internet of Things system with Telegram notifications. This means that the SLTA level becomes the primary category where smoking violations by students are strictly prohibited. This is because students at the SLTA level tend to exhibit more rebellious behavior, causing rules to be sometimes ignored. The microcontroller functions as the control system for cigarette smoke. The sensor used for detection is the MQ-2 gas sensor, which is also highly sensitive to air quality, including CO_2, ammonia, benzene, and cigarette smoke. The Internet of Things (IoT) is used for remote monitoring of cigarette smoke detection in a room. This system utilizes notifications from the Telegram application connected to the principal’s mobile phone. The score of 17.15 is very valid because that from the result of SAW method calculation. The step is very clear that has been explained in value result. Preference value is from the head master of pesantren that the maker of regulation

Corresponding Author:
Sumantri,
Informatics Engineering Study Program, Faculty of Engineering, Nurul Jadid University
Jl. KH. Zaini Mun'im, Tj. Lor, Karanganyar, Paiton, Probolinggo Regency, East Java 67291
Email: sumantri@unuja.ac.id

1. Introduction

The rapid development of information and communication technology has driven digital transformation in various sectors, including education [1]. The utilization of technologies such as microcontrollers and the Internet of Things (IOT) enables the creation of systems that are more effective, efficient, and integrated in data management and decision-making processes. This presents a significant opportunity for educational institutions, particularly Islamic boarding schools (pesantren), to improve the quality of student management, especially in terms of monitoring and behavioral development [2].

In the environment, student violations are one of the common issues encountered. Violation recording and management systems that are still conducted manually tend to have several limitations, such as vulnerability to recording errors, difficulties in data recapitulation, and a lack of objectivity in decision-making related to sanctions or follow up actions [3]. In addition, the selection of formal education levels for students is often not based on systematic and measurable criteria, which may lead to suboptimal decisions. The student violation referred to is smoking among male students at Nurul Jadid Islamic Boarding School. The formal education options used as alternatives in the Multi-Attribute Decision Making (MADM) method are: MINM, MTSNJ, MANJ, SMPNJ, and SMANJ.

To address these issues, a system is needed that can automatically integrate student violation data and support objective decision making. One approach that can be used is the Multi Attribute Decision Making (MADM) method, which allows decision-making processes based on multiple predefined criteria. This method can provide more rational and transparent results in determining appropriate formal education levels for students by considering factors such as violation levels, discipline, academic achievement, and other relevant aspects.

By combining the MADM method with microcontroller and IoT technologies, a student violation control system can be designed to perform real-time monitoring, automatic data recording, and more accurate data integration. This system is expected to assist pesantren administrators in making faster, more accurate, and data-driven decisions.

Based on the above explanation, this study aims to develop a microcontroller and IoT-based student violation control system equipped with the Multi Attribute Decision Making method for selecting formal education levels. It is expected that the results of this study will contribute to improving the quality of student management and support more objective and effective decision making in the pesantren environment

2. Literature Review

2.1. Simple Additive Weighting (SAW) Method

The Simple Additive Weighting (SAW) method is one of the methods in Multi-Attribute Decision Making (MADM) used to determine the best alternative based on the weighted sum of the performance values of each alternative across all criteria [5].

The Simple Additive Weighting (SAW) method is one of the techniques in a Decision Support System (DSS) used to determine the best choice among several alternatives based on a number of criteria [13]. This method is also known as the weighted summation method because its main concept is to sum the values of each alternative after they have been multiplied by the weights of their respective criteria [5].

2.2. Microcontroller

A microcontroller is an integrated electronic device (chip) that functions as the " brain" in an automatic control system. Within a single microcontroller, there are several main components such as the CPU (Central Processing Unit), memory (RAM and ROM), and input/output (I/O) used to interact with other devices. Because all these components are contained within one chip, a microcontroller becomes a practical, efficient, and cost-effective solution for various control applications [20]. One of the advantages of a microcontroller is its ability to operate automatically and in real time. A microcontroller can respond quickly to changes in environmental conditions according to the programmed logic. In addition, it has relatively low power consumption, making it highly suitable for use in systems based on alternative energy sources such as solar panels [8].

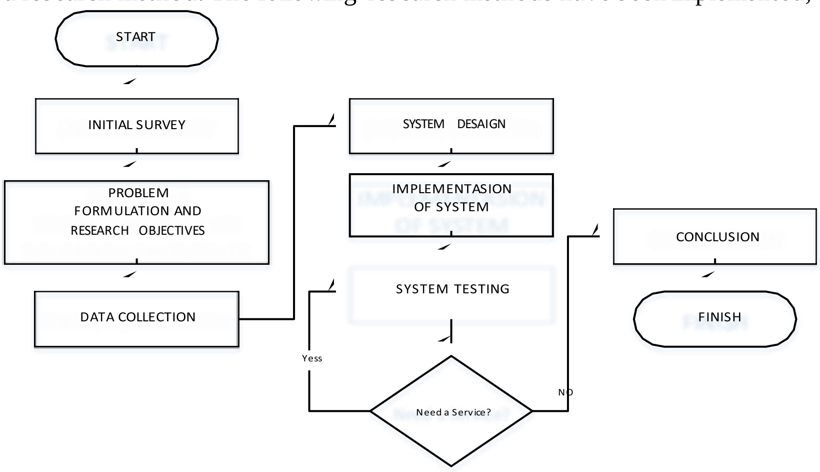
2.3. Photovoltaic

Photovoltaic is a technology that enables the direct conversion of sunlight into electrical energy through a physical process in semiconductor materials [4]. The term comes from two words: *photo* (light) and *voltaic* (electricity), so it literally means " *electricity generated from light.*" . In principle, the photovoltaic process occurs in solar cells, which are typically made of semiconductor materials such as silicon. When sunlight strikes the surface of a solar cell, particles of light (photons) transfer their energy to electrons in the material [14]. This energy causes the electrons to be released from their atomic bonds and move freely. The movement of these electrons generates a direct current (DC) electric flow Solar cells consist of two layers of semiconductor material with different electrical properties (p-type and type layers. This difference creates an internal electric field that drives the electrons in a specific direction, producing a stable electric current when exposed to sunlight. In practical applications, multiple solar cells are combined to form a solar panel to generate greater power [15]. The electrical energy produced can be used directly to operate electronic devices, stored in batteries, or converted into alternating current (AC) using an inverted [19]

3. Methodology

3.1. Research Method

This research has a research method. The following research methods have been implemented, which can be seen in



]Figure. 1. Research Methods

In this stage, the research process begins with an initial survey, followed by the formulation of the research problem and objectives based on the findings from the survey. Subsequently, the author proceeds with data collection, system design, system implementation, and system testing. If testing reveals the need for improvements, the process will revert to the system testing stage; conversely, if no improvements are required, the research will advance to the conclusion stage

3.2. System Flowchart

This research has a system flowchart. The following research methods have been implemented, which can be seen in Figure 2.

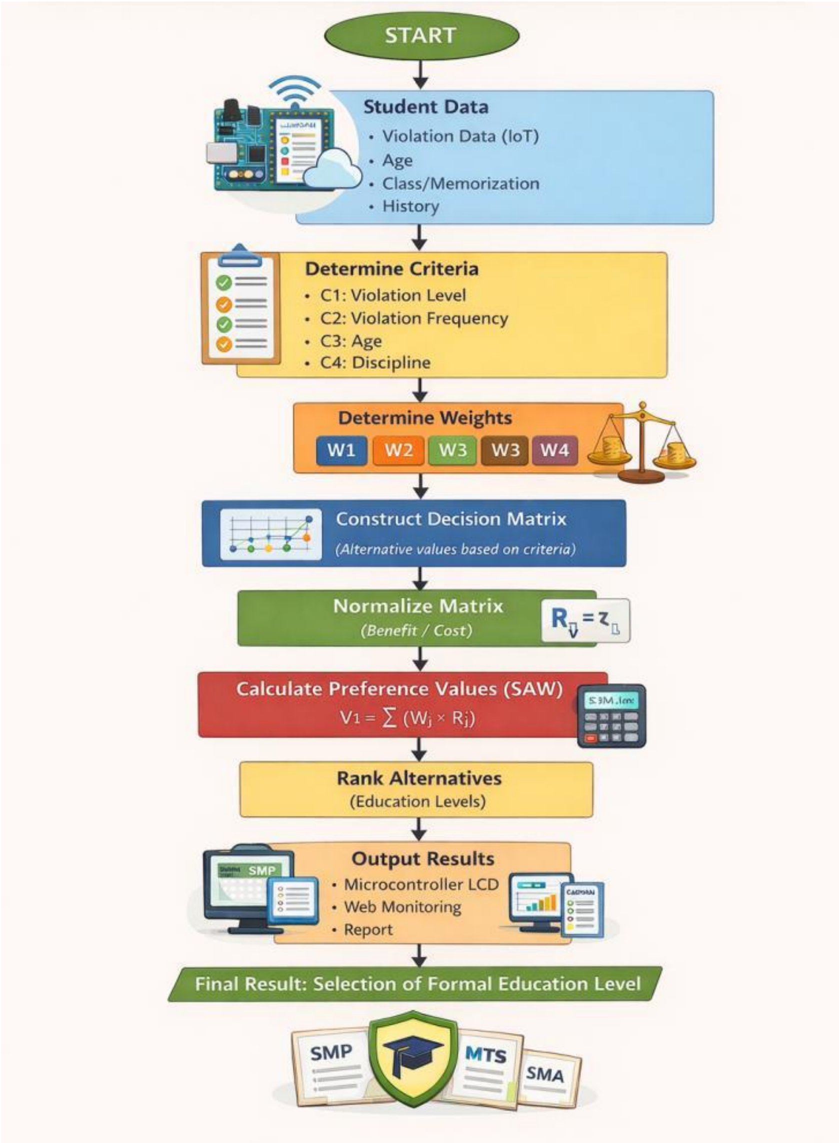


Figure 2. System Flowchart

The diagram illustrates the working process of a Multi Attribute Decision Making (MADM) method integrated with a microcontroller and IOT based student violation control system to determine the appropriate formal education level. The process begins with the input of student data, which includes violation data collected through IoT devices, as well as supporting information such as age, class or memorization level, and violation history. This data serves as the foundation for decision-making.

Next, the system proceeds to determine the evaluation criteria, which typically include violation level, frequency of violations, age, and discipline. Each of these criteria represents an important factor in assessing the student' s condition. After defining the criteria, the system assigns weights to each criterion based on their level of importance. These weights (W1, W2, W3, W4) ensure that more significant criteria have a greater influence on the final decision. The system then constructs a decision matrix, which contains the values of each student (alternative) against the defined criteria. To ensure fair comparison, the matrix is processed through a normalization stage, distinguishing between benefit and cost criteria.

Following normalization, the system calculates the preference value using the Simple Additive Weighting (SAW) method, where each normalized value is multiplied by its corresponding weight and summed to produce a final score for each alternative. Based on these scores, the system performs ranking of alternatives, ordering students or possible education levels from the most suitable to the least suitable.

The results are then output through the system, which may include a microcontroller display (LCD), web-based monitoring via IOT, and generated reports for administrators. Finally, the system produces the final decision, which is the selection of the most appropriate formal education level for the student. This entire process enables automated, objective, and efficient decision-making in managing student violations and educational placement.

4. Results and Discussion

4.1. Result Of Simple Additive Weigthing (SAW)

This research has the results of calculations using the SAW method. The SAW method must consist of decision criteria, alternatives, the weight values of each criterion for every available alternative, the normalized values of each alternative, and finally the ranking values. The highest value will determine which type of formal education becomes the main subject receiving sanctions in the smoking prohibition policy. This will be explained in the description Table 1 below :

Table 1. The Criteria of Calculation of the SAW method

Code	Criteria
C1	Regulations Prohibiting Smoking
C2	Environment
C3	Enforcement of Sanction
C4	Health Education Programs
C5	Supervision By Teachers
C6	Age

This method has reference value. The value are : {5, 4, 3, 3, 5, 1} or {W1, W2, W3, W4, W5, W6}. This reference value consists of five numbers based on the decision criteria. The value of preference is from the head master of pesantren. This value join the total of criteria.

The weight values in the SAW method calculation are determined by the discipline teacher. This can be seen in Table 2 below.

Table 2. The Alternative of Calculation of the SAW method

Code	Criteria
A1	Students OF SD
A2	Students OF SLTP
A3	Students OF SLTA

A4	Students OF DINIYAH
A5	Students OF PAUD
A6	Students OF UNIVERSITY

After determining the criteria and alternatives, the next step is to assign weight values to all criteria for each available alternative. these weights are applied consistently to all alternatives. This means every alternative is evaluated using the same set of criteria, but the impact of each criterion depends on its assigned weight. This can be seen in Table 3.

Table 3. The Alternatif of Calculation of the SAW method

Code Of Criteria	Name Of Criteria	Code Of Alternative					
		A1	A2	A3	A4	A5	A6
C1	Regulations Prohibiting Smoking	3	4	4	5	5	2
C2	Environment	1	3	3	5	5	4
C3	Enforcement of Sanctions	3	5	5	5	5	3
C4	Health Education Programs	5	3	3	4	4	3
C5	Supervision By Teachers	5	4	4	4	4	3
C6	Age	1	2	2	3	3	4

Before calculating the final score, the values of each alternative must be normalized. This process ensures that all criteria are comparable, especially when they have different measurement scales, In SAW. After that, a matrix is constructed from the weighted values of the criteria for each alternative.

$$X = \begin{bmatrix} 3 & 4 & 4 & 5 & 5 & 2 \\ 1 & 3 & 3 & 5 & 5 & 4 \\ 3 & 5 & 5 & 5 & 5 & 3 \\ 5 & 3 & 3 & 4 & 4 & 3 \\ 5 & 4 & 4 & 4 & 4 & 3 \\ 1 & 2 & 2 & 3 & 3 & 4 \end{bmatrix}$$

After make the matrix value, next step is making the normalization of matrix X. Below are the results of the normalization calculation of matrix X. Notmalization of matrix X are consist that R11 until R61. The value are same as the total of matrix X

$$R_{11} = \frac{3}{Max\ \{3;1;3;5;5\}} = \frac{3}{5} = 0{,}6$$

$$R_{21} = \frac{1}{Max\ \{3;1;3;5;5\}} = \frac{1}{4} = 0{,}2$$

$$R_{31} = \frac{3}{Max\ \{3;1;3;5;5\}} = \frac{4}{5} = 0{,}8$$

$$R_{41} = \frac{5}{\text{Max}\{3;1;3;5;5\}} = \frac{5}{5} = 1$$
$$R_{51} = \frac{5}{\text{Max}\{3;1;3;5;5\}} = \frac{5}{5} = 1$$
$$R_{12} = \frac{4}{Max\{4;3;5;3;4\}} = \frac{4}{5} = 0{,}8$$
$$R_{22} = \frac{3}{Max\{4;3;5;3;4\}} = \frac{3}{5} = 0{,}6$$
$$R_{32} = \frac{5}{Max\{4;3;5;3;4\}} = \frac{5}{5} = 1$$
$$R_{42} = \frac{3}{\text{Max}\{4;3;5;3;4\}} = \frac{3}{5} = 0{,}6$$
$$R_{52} = \frac{4}{\text{Max}\{4;3;5;3;4\}} = \frac{4}{5} = 0{,}8$$

The value of normalization matrix step is R1 until R61. After normalization, next step is making a matrix value. Matrix value is consisting of normalization value, this is

$$S = \begin{bmatrix} 0.6 & 0.8 & 0.8 & 0.8 & 0.5 \\ 0.2 & 0.6 & 0.6 & 0.8 & 1 \\ 0.8 & 1 & 1 & 0.8 & 0.75 \\ 1 & 0.6 & 0.6 & 0.6 & 0.75 \\ 1 & 0.8 & 0.8 & 0.6 & 0.75 \\ 0.25 & 0.5 & 0.5 & 0.75 & 1 \end{bmatrix}$$

After obtaining the normalized decision matrix, each value is multiplied by the corresponding criterion weight. This step reflects the importance level of each criterion in the evaluation process. Next, the weighted values for each alternative are summed to produce a final preference score. This score represents the overall performance of each alternative across all criteria. The process is below

$A1 = (5)(0.6) + (4)(0.8) + (3)(0.8) + (3)(0.8) + (5)(0.5) = 13.5$
$A2 = (5)(0.8) + (4)(0.6) + (3)(0.6) + (3)(0.8) + (5)(1) = 15.6$
$\mathbf{A3 = (5)(0.8) + (4)(1) + (3)(1) + (3)(0.8) + (5)(0.75) = 17.15}$
$A4 = (5)(1) + (4)(0.6) + (3)(0.6) + (3)(0.6) + (5)(0.75) = 14.75$
$A5 = (5)(1) + (4)(0.8) + (3)(0.8) + (3)(0.6) + (5)(0.75) = 16.15$
$A6 = (5)(0.25) + (4)(0.5) + (3)(0.5) + (3)(0.75) + (5)(1) = 12$

The result of the SAW method calculation shows that the third alternative (Senior High School/SLTA) obtained a score of 17.15. This value is the highest compared to the other alternatives. This means that the SLTA level becomes the primary category where smoking violations by students are strictly prohibited. This is because students at the SLTA level tend to exhibit more rebellious behavior and higher ego, causing rules to be sometimes ignored. Determining appropriate formal education levels based on student violations using the Multi Attribute Decision Making (MADM) method with the Simple Additive Weighting (SAW) technique. The system integrates a microcontroller and Internet of Things (IOT) technology for real time data collection and monitoring. Several criteria, including violation frequency, type, behavior, and academic performance, are evaluated and weighted to produce ranking results

4.2. Result Of Control System

The test results of the MQ-2 gas sensor show that it can detect cigarette smoke and is also highly sensitive to air quality, including CO_2, ammonia, benzene, and cigarette smoke. It is therefore suitable for indoor air quality monitoring. The test results can be seen in Table 4.

Tabel 4. Test Result MQ 2 Sensor

No	Date	Safe	Dangerous	PPM Value
1	22 March 2026	✓		20 ppm
2	23 March 2026		✓	45 ppm
3	24 March 2026		✓	50 ppm
4	25 March 2026	✓		13 ppm
5	26 March 2026		✓	68 ppm
6	28 March 2026		✓	50 ppm
7	29 March 2026	✓		12 ppm
8	01 April 2026		✓	40 ppm
9	02 April 2026		✓	55 ppm

Below are the test results of the Internet of Things (IOT) system using Telegram application notifications sent to the head of the Islamic boarding school, who oversees student smoking violations. This can be seen in Table 5.

Tabel 5. Test Result Internet Of Thing By Telegram Notification

No	Date	Safe Notification	Dangerous Notification	Description
1	22 March 2026	✓		Successful sent
2	23 March 2026		✓	Successful sent
3	24 March 2026		✓	Successful sent
4	25 March 2026	✓		Successful sent
5	26 March 2026		✓	Successful sent
6	28 March 2026		✓	Successful sent
7	29 March 2026	✓		Successful sent
8	01 April 2026		✓	Successful sent
9	02 April 2026		✓	Successful sent

Below is an illustration of the performance of a cigarette smoke detection control system using the MQ-2 gas sensor and Telegram notifications to alert the head of the Islamic boarding school when cigarette smoke is detected in a room. It can be seen in Figure 3

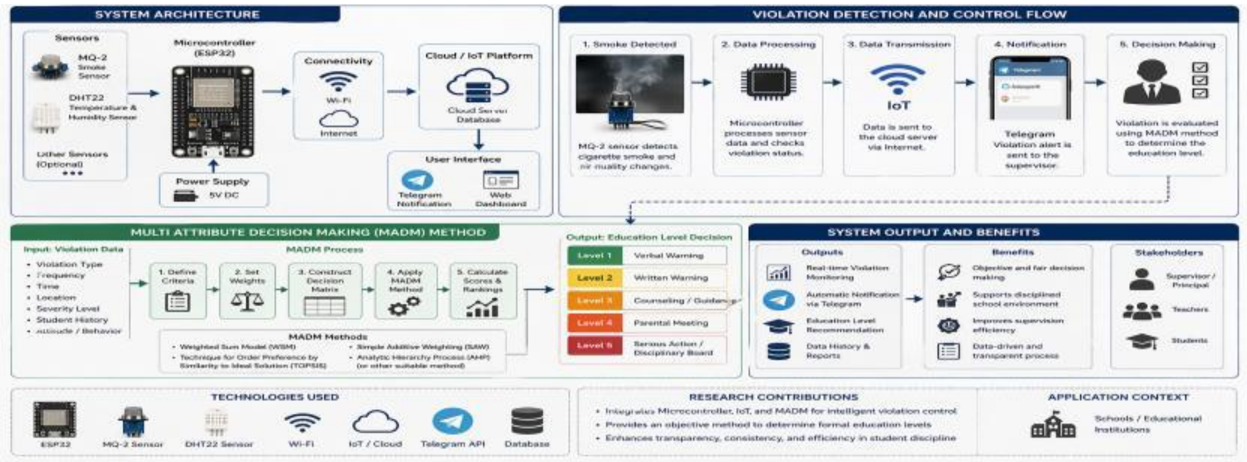


Figure 3. Architecture Control System By Microcontroller

The figure illustrates a research system for monitoring student violations using a microcontroller and IoT technology integrated with a Multi Attribute Decision Making (MADM) method. The system begins with sensors, such as the MQ-2 gas sensor, which detect cigarette smoke and environmental conditions. The collected data are processed by a microcontroller (e.g., ESP32) and transmitted via Wi-Fi to a cloud-based IoT platform. Next, the system evaluates violation data using the MADM approach, particularly the Simple Additive Weighting (SAW) method, by considering criteria such as violation type, frequency, and student behavior. The results generate a ranking that determines the appropriate formal education level or disciplinary action. Finally, notifications are sent through Telegram to school authorities for real-time monitoring. This system improves decision accuracy, transparency, and efficiency in managing student discipline.

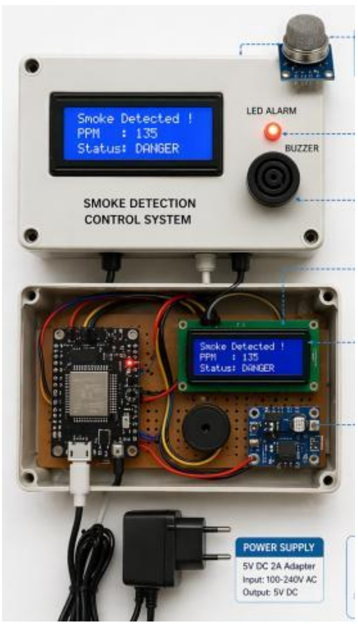


Figure 3. Control System

The system uses an MQ-2 gas sensor to detect smoke, an ESP32 microcontroller for processing, an LCD display for output, a buzzer and LED as alarms, a Wi-Fi module for IoT communication, and a 5V power supply to operate all components.

5. Conclusion

This study developed a microcontroller and IoT-based student violation control system integrated with the Multi Attribute Decision Making (MADM) method using the Simple Additive Weighting (SAW) technique. The system processes real-time data and provides objective, accurate decisions based on criteria such as violation type, frequency, and behavior. IoT integration enables monitoring and Telegram notifications for timely responses. Overall, the system improves efficiency, transparency, and effectiveness in managing student discipline through a data-driven and technology-based approach. The result of the SAW method calculation shows that the third alternative (Senior High School or SLTA) obtained a score of 17.15. This value is the highest compared to the other alternatives. This means that the SLTA level becomes the primary category where smoking violations by students are strictly prohibited. This is because students at the SLTA level tend to exhibit more rebellious behavior and higher ego, causing rules to be sometimes ignored. The score of 17.15 is very valid because that from the result of SAW method calculation. The step is very clear that has been explained in value result. Preference value is from the head master of pesantren that the maker of regulation.

Research that can be further developed includes cigarette smoke detection based on solar panels, and the microcontroller used can be upgraded using Raspberry.

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