Jurnal Teknik Elektro dan Komputer (JEECOM)
Vol. 07, No. 2 (2025), DOI: 10.33650/jeecom.v4i2
p-ISSN: 2715-0410; e-ISSN: 2715-6427

MADM Method for Flower Type Selection in Ornamental Plant Watering Based on Microcontroller and Solar Panels

Tijaniyah [1] , M. Syarif Hidayatullah [2] , Nauval Sya'bani Ibn Fahlan [3]

[1] Nurul Jadid University; Jl PP Nurul Jadid Dusun Tj Lor, Karanganyar, Kec. Paiton, Probolinggo Regency, East Java; 67291, No. Tel. (0335) 771732

Article Info

Article history:

Received Okt 22, 2025
Revision Okt 29, 2025
Received Okt 30, 2025

Keywords:

Control, Automatic, Watering, Ornamental, Plants.

ABSTRACT

This research aims to develop an automatic watering system based on a microcontroller and solar panels, using the Multi-Attribute Decision Making (MADM) method to determine the type of flower that is suitable for the watering system. Solar panels are used as the main energy source to increase the efficiency and sustainability of the system. The Multi-Attribute Decision Making (MADM) method with the SAW technique uses the highest ranking calculation. The types of ornamental plants are Bougainvillea, Monstera, Peace Lily (Spathiphyllum) and pothos. The highest ranking for the type of flower is the monstera flower with a weight value of 11.95. With this system, ornamental plant owners can more easily determine plants and care for their plants without the need for regular manual watering. In addition, the use of solar panels makes this system more energy efficient and environmentally friendly. The owner of the flower shop really welcomed this control system tool because it can save Rp. 36,000 per month for electricity costs for watering ornamental plants because all power can be generated by solar panels, namely 250 Watts per day with a panel size of 120 WP. The total power usage of the ornamental plant watering control system is 35.25 Watts. Solar panels produce less power in the morning, at 9-10 watts, and 96-99 watts in the afternoon. During hot weather, solar panels produce more power.

Corresponding author:
Tijaniyah
Nurul Jadid University; Jl PP Nurul Jadid Dusun Tj Lor, Karanganyar, Kec. Paiton, Probolinggo Regency, East Java; 67291
Email: tijaniyah@unuja.ac.id

1. INTRODUCTION

Technological advances in agriculture and horticulture are rapidly developing, including automated systems for watering ornamental plants. Optimal plant watering depends heavily on the plant type, soil moisture level, and environmental conditions. However, many ornamental plant owners still water plants manually, which can result in over- or under-watering. Therefore, it is important to determine which flower types are best suited to a microcontroller- and solar-panel-based automatic watering system. [1]

Ornamental plants play a vital role in environmental aesthetics and ecosystem balance. However, one of the main challenges in their care is proper watering, as each type of plant has different water requirements. Overwatering can cause root rot, while underwatering can stunt plant growth. Therefore, a smart and efficient watering system is necessary for optimal plant growth. [2.]

Along with technological developments, microcontroller-based automation systems are increasingly being applied in agriculture and horticulture. Microcontrollers can be used to automatically control plant watering based on data from soil moisture sensors, temperature sensors, and light sensors. Furthermore, the use of solar panels as a power source in these systems can increase energy efficiency and support environmentally friendly technologies [3.]

MADM is a method that can assist in decision-making by considering various criteria, such as water requirements, light intensity, soil type, and air humidity. With this method, it is hoped that the system can automatically adjust the optimal watering pattern for each type of flower. With a microcontroller-based watering system supported by solar panels, it is hoped that it can help ornamental plant owners in caring for their plants more effectively and efficiently, as well as reducing dependence on human labor in watering plants. Therefore, this study was conducted to develop and test an automatic watering system that is able to select the optimal type of flower using the MADM method, so that it can provide a smarter and more sustainable solution in ornamental plant care [4.]

2. METHOD

This research uses a *mixed methods paradigm* with a sequential combination approach. A quantitative approach is used to measure the effectiveness of a microcontroller- and solar-panel-based ornamental plant watering system based on the water requirements of several flower types. Meanwhile, a qualitative approach is used to explore user perceptions of ease of use, system efficiency, and preferences for certain flower types. By combining these two approaches, the research is expected to produce more comprehensive, valid, and applicable conclusions [5.]

This research intersects automation technology, Multiple Attribute Decision Making (MADM)-based decision-making, and renewable energy for optimizing ornamental plant care. It offers novel contributions in the following ways:

1. Integration of the MADM method for selecting ornamental flower types based on water requirements, environmental resistance, and beauty.
2. Implementation of flower selection results into an automatic watering system based on a microcontroller and solar panels.
3. Optimizing energy and water use with applied technology approaches and intelligent decision making [6.]

In general, many automatic watering systems and the use of the MADM method have been developed in agricultural contexts. However, there has been no research that comprehensively combines: flower selection based on the MADM method, microcontroller-based automatic watering, and energy efficiency through solar panels. Therefore, this research is in an innovative and applicable position, and has great potential to meet the needs of modern urban gardening in an efficient and environmentally friendly manner [7.]

2.1. Research Data Sources

This research has data sources, namely

a. Flower Type Data : Bougainvillea, Rose, Aglonema, Lily, Pothos, Bonsai
b. Component Data : Microcontroller (Arduino Uno / ESP32), Soil Moisture Sensor, Mini DC 3V–12V Water Pump, Relay Module, Solar Panel (Solar Panel 10W or 20W), Solar Charge Controller, 12V Battery (or 7.4V Li-ion), Voltage Regulator Module (Step Down), Water Hose / Irrigation Pipe, Solenoid Valve (optional), Breadboard and Jumper Cables, LED or Buzzer (optional), LCD / OLED Display (optional).
c. Data on Electrical Power Generated by Solar Panels
d. Data on the Results of Calculating Interest Types Using the SAW Method

2.2. Research Stages

The research stages used were the *Waterfall Method* . The *Waterfall* Method is a sequential software development process, where progress is viewed as flowing continuously downward (like a waterfall *)* through the phases of planning, modeling, implementation (construction), and testing. The advantage of using the waterfall method is that it allows for departmentalization and control. The development process model is phased *one by one* . The following are the research stages in the waterfall method, as seen in the following figure:

ISSN: 2715-6427

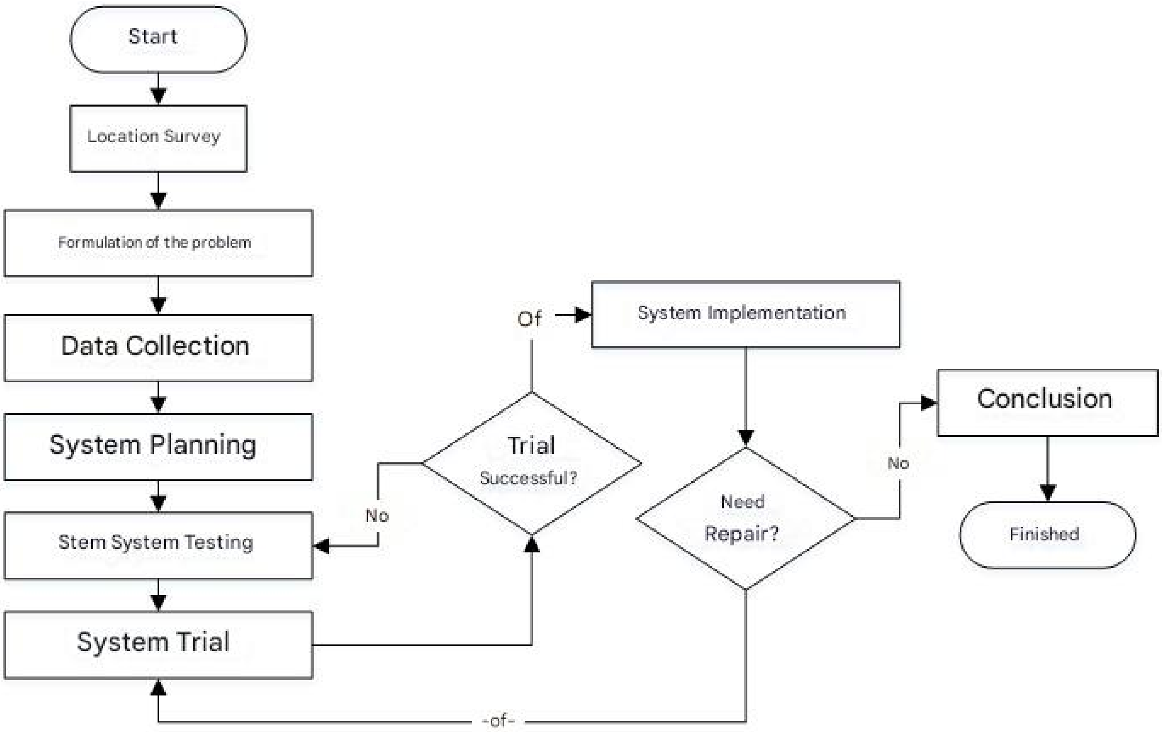

Figure 1. Research Method and Design

3. RESULTS AND DISCUSSION

A. Design Results and Control System Plan

The design of an automatic watering control system using a microcontroller and solar panels consists of components of a microcontroller (Arduino Uno / ESP32), a soil moisture sensor, a mini DC 3V–12V water pump, a relay module, a solar panel (Solar Panel 120WP), a solar charge controller, a 12V battery (or 7.4V Li-ion), a voltage regulator module (step down), a water hose / irrigation pipe, a solenoid valve (optional), a breadboard and jumper cables, an LED or buzzer (optional), an LCD / OLED display (optional) [8.] This can be seen in Figure 2.

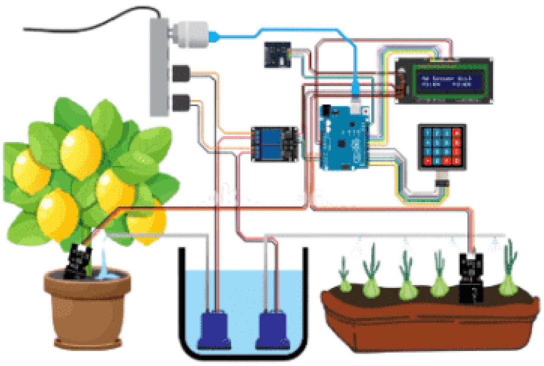

Figure 2. Design of an Automatic Ornamental Plant Watering Control System

The following are the results of the team's research into the types of flowers that will be used as an alternative calculation method for the SAW method and selected directly at Mr. Rohim's flower shop and can be seen in Figure 3 below [9.]

Figure 3. Equipment installation activities at the “Kamila Garden” flower stand

The estimated power usage of the ornamental plant watering control system based on microcontrollers and solar panels can be seen in Table 1 below :

Table 1. Estimation of Power Usage in Control System

No	Component Name	Power Consumption (Watts)	Information
1	ESP32 microcontroller	0.8 – 1.5 watts	Active only part of the time
2	Soil moisture sensor	0.05 watts	Can be disabled when idle
3	Relay	0.2 watts	Used only when the pump is on
4	Mini water pump	5 – 18 watt	Turn on 5–15 minutes per day
5	WiFi / Bluetooth Module	0.5 – 1 watt	IoT System
6	Solar Panels	15 Watt	On for 4 Hours
Total Power Per Day		**35.25 Watt**	

cost formula : Cost = Power (watt) × Duration of use (hours) × Tariff per kWh / 1000. PLN electricity tariff: ±Rp 1,444.70 per kWh (household customers R-1 1300 VA – 2200 VA) total power usage is 35.25 Watt. Daily consumption is 35.25 watts × 24 hours / 1000 = 0.846 kWh. Cost per day 0.846 kWh × Rp 1,444.70 ≈ Rp 1,222 if 1 month then Rp, 1,222 x 30 = Rp. 36,000. With a 120 WP solar panel, the cost to be paid is Rp. 0 because all power in the control system is supported by solar panels that produce 200-250 Watts per day [10.]

B. Results of Calculation of Decorative Flower Type Selection Using the SAW Method

This section is the result of the calculation of the types of ornamental flowers used as alternative decision support using the Simple Additive Weighting (SAW) method. The resulting weight value (w) is used to indicate the relative importance of each sub-attribute. The first step in the SAW method is to calculate the normalized performance rating value of alternative Ai on attribute Cj using formula 1. This value is then entered into formula 2 to obtain the preference value for each alternative (Vi). These Vi values are then sorted in ascending order. A larger Vi value indicates that alternative Ai is more preferred. The following is a list of alternative types of ornamental flowers in Table 2 [11.]

Table 2. Alternatives (A) Types of Ornamental Flowers

No	Alternative Code (A)	Alternative Name
1	A1	Bougainvillea flowers
2	A2	Monstera Flower
3	A3	Peace Lily (Spathiphyllum)

ISSN: 2715-6427

4	A4	Pothos Flower

The criteria for selecting ornamental flower types for SAW method calculations can be seen in Table 3 below [12.]

Table 3. Criteria (K) for Flower Types

No	Criteria Code (K)	Criteria Name
1	K1	Wide and Thin Leaves
2	K2	Continuous Flowering
3	K3	Grows in tropical climates
4	K4	Has a Dry Structure

The decision maker assigns preference weights as follows: W = (5, 3, 4, 2). The suitability rating of each alternative for each criterion can be seen in Table 4 below [13.]

Table 4. Alternative Suitability Ratings

Alternative	Criteria			
	K1	K2	K3	K4
A1	4	4	2	2
A2	3	5	4	4
A3	4	3	5	4
A4	2	4	2	4

The decision matrix is formed from a table of alternative suitability ratings for each criterion. The following is the decision matrix [14.]

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

The normalization value of matrix x is:

$R_{11} = \frac{4}{Max\,\{4;3;4;2\}} = \frac{4}{4} = 1$

$R_{21} = \frac{3}{Max\,\{4;3;4;2\}} = \frac{3}{4} = 0{,}75$

$R_{31} = \frac{4}{Max\,\{4;3;4;2\}} = \frac{4}{4} = 1$

$\mathbf{R}_{41} = \frac{2}{\text{Max}\,\{4;3;4;2\}} = \frac{2}{4} = 0{,}5$

And so on to obtain the normalized matrix value R as follows:

$$R = \begin{bmatrix} 1 & 0.8 & 0.4 & 0.5 \\ 0.75 & 1 & 0.8 & 1 \\ 1 & 0.6 & 1 & 1 \\ 0.5 & 0.8 & 0.4 & 1 \end{bmatrix}$$

The ranking calculation after the normalized matrix process R then the ranking value results for each alternative are known as follows:

A1 = (5)(1) + (3)(0.8) + (4)(0.4) + (2)(0.5) = 10
A2 = (5)(0.75) + (3)(1) + (4)(0.8) + (2)(1) =11.95
A3 = (5)(1) + (3)(0.6) + (4)(1) + (2)(1) = 12.8
A4 = (5)(0.5) + (3)(0.8) + (4)(0.4) + (2)(1) =8.5

The highest value in the alternative ranking value for all criteria is A2 with a value of 11.95 for the Monstera flower type . This means that this type of flower requires very intensive watering. The Monstera flower can be seen in Figure 4 below [15.]

Figure 4. Monstera flower

C. Control Tool Test Results

1. Results of Soil Temperature Tests on Flowers

These results represent the temperature test results generated by the temperature sensor. This test was conducted over three days. The temperature was cold at 6:00 a.m. WIB, hot at 12:00 p.m. WIB, cool at 6:00 p.m. WIB, and cold at 11:00 p.m. WIB. This can be seen in Table 5 below.

Table 5. Results of Soil Temperature Measurement Trial

No	Date	O'clock	Test to-	Sensor	Thermometer	Accuracy	Information
1	09/05/25	06.00 WIB	1	22.11°c	22°c	100%	Cold
2	09/05/25	12.00 WIB	1	28.16°c	28°c	100%	Hot
3	09/05/25	6:00 PM WIB	1	25.32°c	25°c	100%	A little cold
4	09/05/25	11:00 PM WIB	1	23.54°c	23°c	100%	Cold
5	10/05/25	06.00 WIB	2	27.32°c	27°c	100%	Hot
6	10/05/25	12.00 WIB	2	24.21°c	24°c	100%	Cold
7	10/05/25	6:00 PM WIB	2	22.21°c	22°c	100%	A little cold
8	10/05/25	11:00 PM WIB	2	22.11°c	21°c	100%	Cold

2. Control System Component Test Results

This section presents the results of a test run of the components of an automatic ornamental plant watering control system using a microcontroller and solar panels. The test run consisted of successful operational processes of the control system, including the switch, temperature sensor, solar panel, and microcontroller. This can be seen in Table 6.

Table 6. Tool Trial Results

No	Date	Test of	Tool Name	Trial Results	Information

ISSN: 2715-6427

				Succeed	Not successful		Condition
1	09/05/25	1	Arduino	✓	-	Normal	Fluent
2	09/05/25	1	Solar Panels	✓	-	Normal	Fluent
3	09/05/25	1	Water Pipe Spray	-	✓	Error	Little Water
4	09/05/25	1	Temperature Sensor	✓	-	Normal	Fluent
5	09/05/25	1	Irrigation Pipes	✓	-	Normal	Fluent
6	09/05/25	1	Water pump	✓	-	Normal	Fluent
7	10/05/25	2	Arduino	✓	-	Normal	Fluent
8	10/05/25	2	Solar Panels	-	✓	Error	Error Power
9	10/05/25	2	Water Pipe Spray	✓	-	Normal	Fluent
10	10/05/25	2	Temperature Sensor	✓	-	Normal	Fluent
11	10/05/25	2	Irrigation Pipes	✓	-	Normal	Fluent
12	10/05/25	2	Water pump	✓	-	Normal	Fluent

3. Power Measurement Results on Solar Panels

These results represent the power output of the solar panel over three days, or three tests at different times. Normal means the power never drops below 30 watts. The power required to power the control system as a whole per day requires 35.25 watts. The power generated by the solar panel per day is 200-230 watts. The solar panel measures 120 watts and can produce 300 watts. This can be seen in Table 7 below.

Table 7. Solar Panel Test Results

No	Date	O'clock	Test to-	Power	Thermo meter	Weather	Information
1	09/05/25	06.00 WIB	1	10 Watt	22°c	Overcast	Abnormal
2	09/05/25	10.00 WIB	1	95 Watt	25°c	Hot	Normal
3	09/05/25	1:00 PM WIB	1	98 Watt	26°c	Hot	Normal
4	09/05/25	17.00 WIB	1	12 Watts	20°C	Thought	Not normal.
5	10/05/25	06.00 WIB	2	9 Watts	22°c	Thought	Not normal.
6	10/05/25	10.00 WIB	2	94 Watts	25°c	Without	Normal
7	10/05/25	13.00 WIB	2	97 Watts	26°c	Without	Normal
8	10/05/25	17.00 WIB	2	19 Watts	20°C	Thought	Not normal.
9	11/05/25	06.00 WIB	3	10 Watts	22°c	Thought	Not normal.
10	11/05/25	10.00 WIB	3	98 Watts	25°c	Panas	Normal

11	11/05/25	13.00 WIB	3	99 Watts	26°c	Panas	Normal
12	11/05/25	17.00 WIB	3	20 Watt	20°c	Overcast	Abnormal

4. CONCLUSION

Based on the results of the research trials conducted three times on different days, from May 9 to 11, 2025, it was explained that: The SAW calculation results show that A2 has the highest ranking, at 11.95, based on four criteria. A2 refers to Monstera flowers, meaning this type of flower requires intensive watering. The results of the trial of the temporary control device components showed errors in the water spray and solar panels that emit power when exposed to the sun. The results of the solar panel power measurement test at 6:00 a.m. showed a relatively low power output of 9-10 watts. At 1:00 p.m., the power output was very high, reaching 96-99 watts. The power generated by solar panels per day is 200-230 Watts with a solar panel size of 120WP. The power consumption of the control system is 95-100 Watts for 9 hours of active operation, meaning that using solar panels can save 100-200 Watts of power per day. The flower shop owner can save Rp. 36,000 per month on electricity costs for this control system.

ACKNOWLEDGEMENTS

I would like to express my gratitude to all parties who have supported this research, especially the supervisors and owners of the flower shop "KAMILA GARDEN" Karanganyar Paiton Village. And the support and input provided are very valuable in completing the research "MDAM METHOD FOR SELECTION OF FLOWER TYPES IN ORNAMENTAL PLANTS WATERING BASED ON MICROCONTROLLERS AND SOLAR PANELS". Hopefully the results of this research will be useful for the development of renewable energy and make it easier for the general public.

REFERENCE

[1] Bagaskara, K., Mahmudi, A., & Agus Pranoto, Y. (2023). IoT-Based Control and Monitoring System for Shallot Plants. *JATI (Informatics Engineering Student Journal)* , *7* (1), 873–880. https://doi.org/10.36040/jati.v7i1.6177

[2] Christioko, BV, Indriyawati, H., & Hidayati, N. (2017). Fuzzy Multi-Attribute Decision Making (Fuzzy Madm) Using the Saw Method for Selecting High-Achieving Students. *Transformatika Journal* , *14* (2), 82. https://doi.org/10.26623/transformatika.v14i2.441

[3] Nadzif, ZNZ (2021). Design and Construction of Automatic Watering for Ornamental Plants Based on the ESP8266 Microcontroller. *JATISI (Journal of Informatics Engineering and Information Systems)* , *8* (4), 2119–2130. https://doi.org/10.35957/jatisi.v8i4.1083

[4] Putri, AR, Suroso, & Nasron. (2019). Design of an Automatic Plant Watering Tool. *National Seminar on Innovation and Application of Technology in Industry (SENIATI)* , *5* (2), 155–159.

[5] Rahardjo, P. (2022). Automatic Watering System Using Soil Moisture Sensor Based on Arduino Mega 2560 Microcontroller on Harum Manis Mango Plants in Buleleng, Bali. *Scientific Journal of Electrical Technology* , *21* (1), 31. https://doi.org/10.24843/mite.2022.v21i01.p05

[6] Robi, AN, & Khoir, AS (2022). *202-Article Text-558-2-10-20230922* . 96–101.

[7] Samsugi, S., Mardiyansyah, Z., & Nurkholis, A. (2020). Automatic Irrigation Control System Using Arduino Uno Microcontroller. *Journal of Embedded Technology and Systems* , *1* (1), 17. https://doi.org/10.33365/jtst.v1i1.719

[8] Sokop, SJ, Mamahit, DJ, Eng, M., & Sompie, SRUA (2016). Peripheral Interface Trainer Based on Arduino Uno Microcontroller. *Journal of Electrical and Computer Engineering* , *5* (3), 13–23. https://ejournal.unsrat.ac.id/index.php/elekdankom/article/view/11999

[9] Sulistiyanto, Setyobudi, R., & Tijaniyah. (2023). Utilization of Tds Sensors for Water Quality Monitoring and Water Filtering of Carp Pools Using Iot. *EUREKA, Physics and Engineering* , *2023* (6), 69–77. https://doi.org/10.21303/2461-4262.2023.002865

[10] Wibowo, H. (2010). Madm-Tool: Sensitivity Test Application for Madm Models Using Saw and Topsis Methods. *National Seminar on Information Technology Applications* , *2010* (Snati), 1907–5022.

[11] YR, KP, Suppa, R., & Muhallim, M. (2021). Arduino-Based Automatic Plant Watering System. *Jurasik (Journal of Information Systems and Informatics Engineering Research)* , *6* (1), 1. https://doi.org/10.30645/jurasik.v6i1.266

[12] A Systematic Review of Multi-Attribute Decision Making Methods for Modern Decision Science (Azimi & Chen, 2023)

[13] Multi-Attribute Decision-Making Methods in Additive Manufacturing: The State of the Art (Qin et al., 2023)

[14] Selection of the Best Craftsman Using Multi-Attribute Decision Making (MADM) Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) (Case Study: PT. Sinjaraga Santika Sport, Majalengka) (Maulida et al., 2015)

[15] Fuzzy Multi-Attribute Decision Making (Fuzzy MADM) with SAW Method for Selecting Outstanding Students — Application of MADM + fuzzy approach for decision making in education. (USM Journals., 2021).