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APPLICATION OF GDSS USING AHP AND BORDA METHODS IN HYDROPONIC PLANT QUALITY DETERMINATION

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Abstract — *Hydroponic cultivation in Gowa Regency, South Sulawesi, experienced serious failure. This failure occurred during the seeding process, caused by the use of poor quality seeds and a lack of consistent attention and control over the environmental conditions of plant growth. The aim of this research is to apply the AHP and Borda methods in a group decision support system to contribute to determining the best plant quality for hydroponic cultivation. In evaluating plant quality, assessment criteria are used which include leaf growth, stem strength, stem quality, planting media, and use of vitamins. There are also 6 alternative plants being evaluated, namely lettuce, bok choy, kale, kale, spinach and celery leaves. The AHP method is used to outline the hierarchical evaluation of hydroponic plant quality, facilitating priority-based decision making through determining relative weights between criteria. Meanwhile, the Borda method is used to integrate the ratings of the three decision makers, producing reference values for each alternative and helping determine the overall quality of hydroponic plants. The calculation results show that the selected alternative, namely spinach, was ranked first with a value of 10.23, while the alternative lettuce plant was ranked sixth or last with a value of 3.69 as the best quality plant. With these findings, spinach plants are considered an effective solution for hydroponic cultivation in Gowa Regency and can be applied more widely in the context of modern agriculture. So that it can increase the yield and sustainability of hydroponic cultivation in Gowa Regency.*

Keywords*: AHP, BORDA, hydroponics, group decision support system.*

Intisari — *Budidaya hidroponik di Kabupaten Gowa, Sulawesi Selatan, mengalami kegagalan yang cukup serius. Kegagalan tersebut terjadi dalam proses semai, disebabkan oleh penggunaan bibit yang kurang berkualitas dan kurangnya perhatian serta pengendalian yang konsisten terhadap kondisi lingkungan pertumbuhan tanaman. Tujuan dari penelitian ini adalah menerapkan metode AHP dan Borda dalam group decision support system untuk memberikan kontribusi dalam menentukan kualitas tanaman terbaik untuk budidaya hidroponik. Dalam mengevaluasi kualitas tanaman, digunakan kriteria penilaian yang meliputi pertumbuhan daun, kekuatan batang, kualitas batang, media tanam, dan penggunaan vitamin. Serta terdapat 6 alternatif tanaman yang dievaluasi yaitu selada, pakcoy, kale, kangkung, bayam, dan daun seledri. Pada metode AHP digunakan untuk menguraikan evaluasi hirarki kualitas tanaman hidroponik, memfasilitasi pengambilan keputusan berbasis prioritas melalui penentuan bobot relatif antar kriteria. Sementara itu, metode Borda digunakan untuk mengintegrasikan peringkat dari tiga decision maker, menghasilkan nilai referensi pada setiap alternatif dan membantu menentukan kualitas tanaman hidroponik secara menyeluruh. Hasil perhitungan menunjukkan bahwa alternatif terpilih yaitu tanaman bayam menduduki peringkat pertama dengan nilai 10.23, sementara alternatif tanaman selada menduduki peringkat keenam atau terakhir dengan nilai 3.69 sebagai kualitas tanaman terbaik. Dengan temuan ini, tanaman bayam dianggap sebagai solusi yang efektif untuk budidaya hidroponik di Kabupaten Gowa dan dapat diaplikasikan secara lebih luas dalam konteks pertanian modern. Sehingga dapat meningkatkan hasil dan keberlanjutan budidaya hidroponik di Kabupaten Gowa.*

Kata Kunci*: AHP, BORDA, hidroponik, pengambilan keputusan kelompok.*

INTRODUCTION

Indonesia with its tropical climate consisting of rainy and hot seasons, facilitates hydroponic cultivation. Introduced in 1980 by Bob Sadino, this technique is increasingly popular in Indonesia[1] including in South Sulawesi. Hydroponic farming has become a popular choice for people who have the concept of gardening in a small area[2]. Hydroponics is an agricultural system that utilizes nutrient-rich water rather than soil[3]. This method is an effective solution for growing plants around the house, with less water requirements compared to plant cultivation using soil media. Plant maintenance becomes simpler thanks to the relatively clean growing medium, and allows monitoring of plant nutrients and roots.

Based on research conducted by Ilyas Renreng, hydroponic techniques are efficient and effective in urban farming, provide better yields compared to conventional techniques, and can be used for personal consumption or shared with others in densely populated areas[4]. Hydroponics is an effective solution to overcome household economic problems, because its growing media allows the utilization of narrow land to grow economically valuable vegetables. Hydroponic systems can be designed cheaply, easily, practically, and economically, contributing positively to the economic stability of families[5]. Therefore, it is important to ensure the optimal quality of hydroponic plants, especially in order to fulfill food needs. Ijohidroponik, Mjfarm, and Salman Hidroponik are hydroponic farmers in Gowa Regency, South Sulawesi. They cultivate various crops such as lettuce, pak choi, spinach, mustard greens, water spinach, and celery using hydroponic technology. The monthly income generated from hydroponic cultivation ranges from 4 to 6 million Indonesian Rupiah, based on the information gathered through interviews with the farmers.

The problem often faced by hydroponic farmers is that they experience failure in the seeding process due to the poor quality of the seeds used and the lack of consistent attention and control over the environmental conditions of plant growth. As a result, the quality of vegetables produced is not in line with market requirements. The process of evaluating the quality of hydroponic crops requires a systematic and objective approach that considers a number of factors such as growth rate, nutrient quality and plant health.

Success in hydroponic farming depends not only on technology and infrastructure, but also on proper plant selection and careful cultivation management. The quality of hydroponic plants is a key factor in achieving optimal and sustainable yields. Therefore, in order for crop yields in hydroponic plant cultivation to reach their maximum potential, it is important for hydroponic farmers to have specialized knowledge about quality hydroponic plants. As well as utilizing a decision support system that can provide information and guidance regarding the selection of quality plants that have optimal yield potential. In determining the 6 alternative types, it is determined based on 5 criteria, including the condition of leaf growth, stem strength, root quality, planting media used, and vitamins[6] needed which have an important role in maintaining the successful growth of hydroponic plants.

Analytic Hierarchy Process (AHP) is a decision making method that decomposes multi-criteria problems into a hierarchy which is defined as a complex problem in a structure of objectives, criteria, sub criteria and alternatives[7]. making it possible to synthesize the various factors involved in the decision-making process. Apart from that, the AHP method is a decision making method that can solve problems or multi-criteria where it prioritizes alternatives through a pairwise comparison matrix and is part of multi-attribute decision making [8][9]. The AHP method is used by decision makers to assess the relative importance of each criterion which helps in determining the quality of hydroponic plants.

In assessing the quality of hydroponic plants, the role of hydroponic farmers as decision makers who have diverse knowledge and experience is very important. Borda method is used for group voting in the decision-making process. The Borda method is one of the group decision-making methods in which the selection process is based on the frequent assessment of the selected alternatives[10]. Borda is an approach in group decision making that involves a number of raters and utilizes the multiplication between the reference value of each alternative and the weight of its ranking[11][12].

The Borda method is the right choice to combine the rankings made by each decision maker with the previous AHP method, because this method is able to integrate the assessment of ranking results in determining the quality of hydroponic plants[13] from various different views regarding a decision that can be combined into a collective decision, so that the resulting decisions can be accepted by all group members[14].

This research analyzes the quality of hydroponic plant seeds in hydroponic farming businesses in South Sulawesi using the AHP method. There are 3 criteria and several sub-criteria with three plant alternatives evaluated. The calculation

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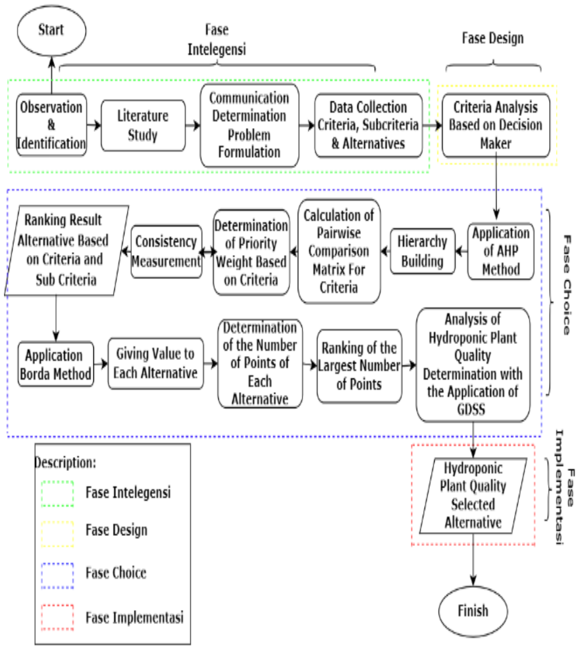
results show that the best quality seeds are pak choy (77%), followed by spinach (74%) and lettuce (43%) [15]. The next study is the result of research on the feasibility evaluation of Integrated Social Welfare Data (DTKS) using the AHP and Borda methods involving three Decision Makers (DM) and ten criteria. The AHP method identifies feasibility only for RT users with a feasibility value above 0.29. Meanwhile, the Borda method determined the minimum feasibility based on the smallest value of each DM, focusing on the Score values of RT, PMS, and Kelurahan[16].

The research applies the Group Decision Support System (AHP and Borda) to select suppliers from 5 candidates. The 5th supplier received the highest score of 14, evaluated by the cooperative chairman, deputy chairman and treasurer. The results of this calculation show the best alternative based on the ranking method[17].From several research results, the GDSS process by applying the AHP and Borda methods can determine the quality of seed plants according to the criteria and sub-criteria provided by decision makers in groups. So the aim of this research is to apply the AHP and Borda methods as a way to help farmer groups maximize the process of cultivating hydroponic plants so as to produce good quality plants.

MATERIALS AND METHODS

A. Research Design



Source: (Research Results, 2024)

Figure 1. Research design

Figure 1 shows the research stages carried out in accordance with the system development method which applies the AHP and Borda methods which consist of 4 research phases, namely:

1. Phase Intelligence

The Intelligence phase consists of 4 phases, namely:

a. Observation and identification

At this stage, the author made direct visits to three hydroponic cultivation sites, namely mjfarm, ijohydroponics, and salman hydroponics, with the aim of making direct observations and identification. With this visit, the data and information obtained will be more accurate and come directly from the source.

b. Study of literature

At this stage, a literature study step is carried out to expand understanding regarding hydroponic plant cultivation, methods for assessing plant quality, as well as reference sources relevant to the research to be carried out. These reference sources include books, national journals and international journals.

c. Communication for determining problem formulation

The author communicated directly with 3 hydroponic farmers located in Gowa Regency, South Sulawesi, with the aim of finding out the problems they faced in the process of cultivating hydroponic plants.

d. Data collection on criteria, sub-criteria and alternatives

Carrying out data collection on criteria, sub-criteria and alternatives based on the results of interviews with hydroponic farmers.

2. Phase Design

In this stage, researchers analyze the criteria used in determining the quality of hydroponic plants by interacting directly with decision makers.

3. Phase Choice

The Choice phase consists of four phases, namely:

a. Application of the AHP method

At this stage, the AHP method is applied by arranging a hierarchy starting from the objectives, criteria, sub-criteria and alternatives that have been determined. The next step is to calculate the pairwise comparison matrix for the criteria, evaluate the consistency of the ratios, and rank the alternatives based on the criteria and sub-criteria from the three decision makers.

b. Application of the Borda Method

At this stage, the Borda method is applied which involves assigning a value to each alternative and then determining the number of points for each alternative. After that, the number of points is sorted from largest to smallest to analyze the quality of hydroponic plants using GDSS.

4. Implementation Phase

At this stage, the output is the alternative selected as a result of all the research and evaluation processes that have been carried out previously.

B. Data Source

The author conducted research related to determining plant quality in hydroponic cultivators using two data sources, namely primary data and secondary data. Where primary data was obtained based on the results of direct interviews with several farmers who cultivate hydroponics. Based on the results of the interview, 5 criteria were obtained including leaves (K1), stems (K2), roots (K3), planting media (K4) and vitamins (K5). Meanwhile, secondary data was obtained from articles from journals which provide an in-depth understanding of the context of hydroponic cultivation.

C. Data Collection Technique

In this research, 3 (three) research stages were carried out, namely:

1. Observation

The author made direct observations at hydroponic cultivation locations, such as KahfiFarm, Ijo Hydroponics, and Salman Hydroponics, in order to obtain data directly from the source.

2. Interview

Interviews were conducted with direct questions and answers to several farmers who cultivate hydroponic plants to complete the data needed by the author.

3. Questionnaire

The author distributed questionnaires to respondents who cultivated hydroponic plants. The data obtained will be processed as primary data in this research. In terms of filling out this weighting questionnaire, it is carried out using pairwise comparisons based on 5 criteria.

D. Research Methods

1. AHP method

The steps in the AHP method are as follows:

a) Determine the types of criteria used.

b) Arrange these criteria in the form of a pairwise matrix.

$$aij = \frac{wi}{wj}, i, j = 1,2 \quad (1)$$

Where *n* is the number of criteria compared *wi* the weights for the *i* and *j criteria* .

c) Normalize each column by dividing each value in the to-*i* column *and* to-*j* row by the largest value in column *i*.

$$a_{ij} = \frac{a_{ij}}{\max a_{ij}} \quad (2)$$

d) Add up the values from each column i, namely:

$$a_{ij} = \sum_i a_{ij} \quad (3)$$

e) Determine the priority weight of each to-*i* criterion, by dividing each value a by the number of criteria being compared (n), namely:

$$Wi = \frac{ai}{n} \quad (4)$$

f) Calculate the lambda max value (*eigen value)* with the formula:

$$\lambda\, max = \frac{\sum a}{n} \quad (5)$$

g) Calculating consistency index (CI)

Consistency calculation is calculating the deviation from the consistency of the value, this deviation is called the consistency index with the equation.

$$CI = \frac{\lambda maks - n}{n - 1} \quad (6)$$

Information:

CI = Consistency Index

λ max = largest eigenvalue of a matrix of order n

n = number of criteria

h) Calculating the Consistency Ratio (CR) with the formula.

$$CR = \frac{CI}{RI} \quad (7)$$

2. Borda method

After obtaining the calculation results by applying the AHP method. Next, the Borda method calculation was carried out to process the ranking of results from various agreements with three decision makers, namely hydroponic farmers, to determine the final result.

RESULTS AND DISCUSSION

In this research, the author applies group decision support system using the AHP method and Borda method to assess the quality of hydroponic plants. The criteria used to determine the quality of hydroponic plants are leaf growth conditions, stem strength, root quality, planting media and vitamins. There are 6 types of plants that are used as alternatives, such as lettuce, pakcoy, spinach, Curly cabbage, kale and celery leaves. Figure 2 shows the

Accredited Rank 2 (Sinta 2) based on the Decree of the Dirjen Penguatan RisBang Kemenristekdikti No.225/E/KPT/2022, December 07, 2022. Published by LPPM Universitas Nusa Mandiri

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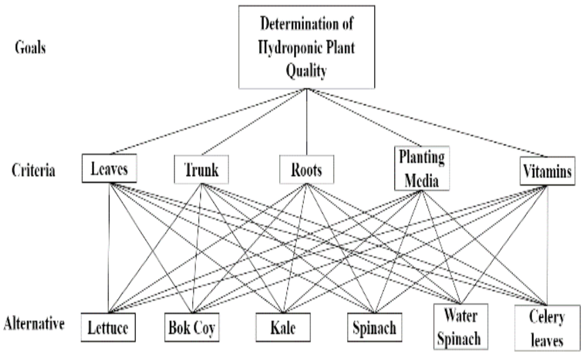
hierarchical structure of criteria in assessing the quality of hydroponic plants.



Source: (Research Results, 2024)

Figure 2. Hierarchical Structure for Determining the Quality of Hydroponic Plants

A. Determining Priority of Main Criteria

The results of distributing questionnaires are based on guidelines from hydroponic farmers who assess the level of importance of one element over another. This data is then processed into a pairwise comparison matrix to produce criterion values. The results of the pairwise comparison matrix for assessing the quality of hydroponic plants are displayed in a simple table listed in table 1.

Table 1. Pairwise Comparison Based on Main Criteria

Criteria	K1	K2	K3	K4	K5
K1	1.00	0.33	5.00	3.00	3.00
K2	3.00	1.00	4.00	7.00	4.00
K3	0.20	0.25	1.00	3.00	0.33
K4	0.33	0.14	0.33	1.00	0.25
K5	0.33	0.25	3.00	4.00	1.00
Sum	4.87	1.98	13.33	18.00	8.58

Source: (Research Results, 2024)

Table description:
K1: Leaves
K2: Stem
K3: Root
K4: Planting Media
K5: Vitamins

Step next determine priority value for each criterion. This is done by dividing the values in the pairwise comparison matrix by the corresponding number of columns. Then add them up row by row. Next, the results of this sum are divided by the total number of criteria, so that priority weights can be determined. Table 2 shows the priority results on the main criteria.

Table 2. Calculation of Priority Criteria Values

Criteria	K1	K2	K3	K4	K5	Sum	Prio Rita
K1	0.21	0.17	0.38	0.17	0.35	1.27	0.25
K2	0.62	0.51	0.30	0.39	0.47	2.28	0.46
K3	0.04	0.13	0.08	0.17	0.04	0.45	0.09
K4	0.07	0.07	0.03	0.06	0.03	0.25	0.05
K5	0.07	0.13	0.23	0.22	0.12	0.76	0.15

Source: (Research Results, 2024)

The consistency matrix is obtained by multiplying the priority values in the criteria matrix table with the pairwise comparison matrix. The results of this multiplication are shown in table 3.

Table 3. Consistency Matrix Calculation

Krite fun	K1	K2	K3	K4	K5	Sum
K1	0.25	0.15	0.45	0.15	0.46	1.46
K2	0.76	0.46	0.36	0.35	0.61	2.53
K3	0.05	0.11	0.09	0.15	0.05	0.45
K4	0.08	0.11	0.03	0.05	0.04	0.32
K5	0.08	0.11	0.27	0.20	0.15	0.82

Source: (Research Results, 2024)

The next step is determining consistency ratio (CR) value to ensure that the CR value is less than or equal to 0.1. If the CR value exceeds 0.1, it is necessary to make improvements to the pairwise comparison matrix. CR calculations for criteria are carried out as stated in table 4.

Table 4. Calculation of the Consistency Ratio (CR) Criteria Value

Criteria	Number of Rows	Priority	Results
K1	1.46	0.25	5.76
K2	2.53	0.46	5.56
K3	0.45	0.09	5.08
K4	0.32	0.05	6.31
K5	0.82	0.15	5.40
	Amount		28.11

Source: (Research Results, 2024)

The number of columns per row is calculated based on the sum of each row in table 3 , while the priority column is taken from the priority column in the criterion value matrix table. The results of these values are found from table 2.
Is known :
Number of criteria (n) = 5
The IR value can be seen in table 5 where the IR for the matrix size used is 5, so the IR value is 1.12.

Table 5. Random Index

N	1	2	3	4	5	6	7	8	9	10
I	0	0	0.8	0.	1.1	1.2	1.3	1.4	1.4	1.4
R			5	9	2	4	2	1	5	9

Source: (Research Results, 2024)

$$\lambda maks = \frac{Number\ of\ Results}{Number\ of\ Criteria} = \frac{28.11}{5} = 5.621$$

Then the value of the consistency ratio:

$$CR = \frac{CI}{IR} = \frac{-0.876}{1.12} = -0.78$$

Based on the calculation results, the CR value for the criteria factor used is -0. 7 8, indicating that the value obtained is below the threshold of 0.1 (10%). Thus, the consistency assessment is considered acceptable.

B. Determination of Sub Criteria Priority Values

In determining the priority of sub-criteria, the steps are similar to determining the priority of the main criteria. Sub-criteria are analyzed for each main criterion, compared to determine the importance of each, given a relative value, and their relative weights calculated. Symbols are used in table 6 to facilitate identification of sub-criteria.

Table 6. Sub Criteria Symbols

No.	Criteria	Sub Criteria	Symbol
1	Leaf	Yellow	WK
		Green color	WH
		Brown	WC
2	Stem	Big	B
		Normal	N
		Small	K
3	Root	White	P
		Clean	B
		Blackish Brown	CK
4	Growing media	Cocopeat	C
		Sponge	S
		Malang Sands	PM
		Rockwool	R
5	Vitamin	AB Mix	AB
		Organic	O
		Gandasil	G

Source: (Research Results, 2024)

Pairwise Comparison Matrix on Sub Criteria begins by comparing the relative importance of each sub criterion. This process helps identify differences and dominance between these aspects, providing a basis for more informed decisions. The results of the comparison of sub-criteria for leaves, stems, roots, planting media and vitamins to assess the quality of hydroponic plants can be seen in table 7-11.

Table 7. Leaf Sub Criteria

Leaf	WK	WH	WC
WK	1.00	0.33	2.00
WH	3.00	1.00	3.00
WC	0.50	0.33	1.00
Total	4.50	1.67	6.00

Source: (Research Results, 2024)

Table 8. Bar Sub Criteria

Stem	B	N	K
B	1.00	3.00	5.00
N	0.33	1.00	3.00
K	0.20	0.33	1.00
Total	1.53	4.33	9.00

Source: (Research Results, 2024)

Table 9. Root Sub Criteria

Root	P	B	CK
P	1.00	3.00	5.00
B	0.33	1.00	3.00
CK	0.20	0.33	1.00
Total	1.53	4.33	9.00

Source: (Research Results, 2024)

Table 10. Planting Media Sub Criteria

Growing media	C	S	PM	R
C	1.00	3.00	5.00	2.00
S	0.33	1.00	3.00	2.00
PM	0.20	0.33	1.00	0.33
R	0.50	3.03	3.03	1.00
Total	2.03	7.36	12.03	5.33

Source: (Research Results, 2024)

Table 11. Vitamin Sub Criteria

Vitamin	AB	O	G
AB	1.00	3.00	5.00
O	0.33	1.00	3.00
G	0.20	0.33	1.00
Total	0.53	1.33	4.00

Source: (Research Results, 2024)

The next step in determining the sub-criteria matrix involves calculating the relative weight of each sub-criterion based on the comparison matrix. Table 12 shows the results of sub-criteria priorities.

Table 12. Leaf Sub-criteria Priority Values

	WK	WH	WC	V	Prio rity	Priority Sub Criteria
WK	0.22	0.20	0.33	0.76	0.25	0.43
WH	0.67	0.60	0.50	1.77	0.59	1.00
WC	0.11	0.20	0.17	0.48	0.16	0.27

Source: (Research Results, 2024)

The calculation process to determine the priority values for the stem, root, planting medium and vitamin sub-criteria follows the steps in equation 4.

Then determining the consistency matrix is obtained by multiplying the priority values in the criteria matrix table with the pairwise comparison matrix. The calculation results can be seen in table 13.

Table 13. Calculation of Leaf Sub-Criteria Consistency Matrix

	WK	WH	WC	Amount
WK	0.25	0.20	0.32	0.77
WH	0.76	0.59	0.48	1.82
WC	0.13	0.20	0.16	0.48

Source: (Research Results, 2024)

The calculation process to determine the sub-criteria consistency matrix values for stems, roots, planting media and vitamins is by multiplying the sub-criteria comparison matrix values by the priority values.

Furthermore determine the consistency ratio (CR) value to ensure that the CR value is less than or

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equal to 0.1. If the CR value exceeds 0.1, it is necessary to make improvements to the pairwise comparison matrix. CR calculations for sub-criteria are carried out according to those listed in table 23.

Table 14. Calculation of CR Values for Leaf Sub-Criteria

Leaf	Amount Line up	Priority	Results
WK	0.77	0.25	3.04
WH	1.82	0.59	3.09
WC	0.48	0.16	3.02
	Total		9.16

Source: (Research Results, 2024)

Table 15. Leaf Sub-Criteria CR Value

Leaf	
n	3
IR	0.58
λ max	3.053904
CI	-0.982032
CR	-1.69

Source: (Research Results, 2024)

The calculation process to determine the CR value for the sub-criteria for stems, roots, planting media and vitamins follows equation 7. Can be seen at table from the 15 calculation results obtained, the CR value for the sub-criteria shows that the value obtained is below 0.1. Where the consistency assessment is considered acceptable.

In determining the priority and sub-priority value results, the step is to integrate the relative weights of the criteria and sub-criteria. This allows an assessment of the relative priority value of each sub-criterion within the framework of the overall objective or main criterion. The combination of relative weights clarifies the contribution of each sub-criterion to the main objective, providing focus on the most influential aspects in the decision-making process.

Table 16. Relative Priority Value of Sub Criteria

Criteria	Sub Criteria	Priority Criteria	Sub Criteria Priority
	WK		0.43
Leaf	WH	0.25	1.00
	WC		0.27
	B		1.00
Stem	N	0.46	0.41
	K		0.17
	P		1.00
Root	B	0.09	0.41
	CK		0.17
	C		1.00
Media Plant	S	0.05	0.55
	PM		0.17
	R		0.65
	AB		1.00
Vitamin	O	0.15	0.40
	G		0.16

Source: (Research Results, 2024)

C. Alternative Value Based on Decision Maker

Table 17-25 displays data preferences from decision makers (DM1, DM2, and DM3) regarding the 6 alternatives tested in 5 criteria. This data refers to plant production from hydroponic farmers in Gowa Regency, South Sulawesi.

Table 17. DM1 Alternative Weights

Alternative	K1	K2	K3	K4	K5
Lettuce	KH	N	B	R	O
Pakcoy	WH	N	B	R	AB
Spinach	WH	K	P	C	AB
Curly cabbage	WH	K	B	R	AB
Kale	WH	N	B	R	AB
Celery leaves	WH	N	CK	S	AB

Source: (Research Results, 2024)

Table 18. DM1 Alternative Weights

Alternative	K1	K2	K3	K4	K5
Lettuce	1.00	0.41	0.41	0.65	0.40
Pakcoy	1.00	0.41	0.41	0.65	1.00
Spinach	1.00	0.17	1.00	1.00	1.00
Curly cabbage	1.00	0.17	1.00	0.65	1.00
Kale	1.00	0.41	1.00	0.65	1.00
Celery leaves	1.00	0.41	0.17	0.41	1.00

Source: (Research Results, 2024)

Table 19. DM1 Alternative Weights

Alternative	K1	K2	K3	K4	K5	V	Rank
Lettuce	0.25	0.19	0.04	0.03	0.06	0.57	6
Pakcoy	0.25	0.19	0.04	0.03	0.15	0.66	2
Spinach	0.25	0.08	0.09	0.05	0.15	0.62	4
Curly Cabbage	0.25	0.08	0.09	0.03	0.15	0.60	5
Spinach	0.25	0.19	0.09	0.03	0.15	0.71	1
Celery leaves	0.25	0.19	0.02	0.02	0.15	0.63	3

Source: (Research Results, 2024)

Table 20. DM2 Alternative Weights

Alternative	K1	K2	K3	K4	K5
Lettuce	WK	K	B	R	AB
Pakcoy	WH	N	CK	R	AB
Spinach	WK	B	B	C	AB
Curly cabbage	WH	K	B	R	AB
Kale	WH	K	B	PM	AB
Celery leaves	WH	N	P	R	AB

Source: (Research Results, 2024)

Table 21. DM2 Alternative Weights

Alternative	K1	K2	K3	K4	K5
Lettuce	0.43	0.17	0.41	0.65	1.00
Pakcoy	1.00	0.41	0.17	0.65	1.00
Spinach	0.43	1.00	0.41	1.00	1.00
Curly cabbage	1.00	0.17	0.41	0.65	1.00
kale	1.00	0.17	0.41	0.17	1.00
Celery leaves	1.00	0.41	1.00	0.65	1.00

Source: (Research Results, 2024)

Table 22. DM2 Alternative Weights

Alternative	K1	K2	K3	K4	K5	V	Rank
Lettuce	0.11	0.08	0.04	0.03	0.15	0.41	6
Pakcoy	0.25	0.19	0.02	0.03	0.15	0.64	3
Spinach	0.11	0.46	0.04	0.05	0.15	0.80	1

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Alternative	K1	K2	K3	K4	K5	V	Rank
Curly cabbage	0.25	0.08	0.04	0.03	0.15	0.55	4
Kale	0.25	0.08	0.04	0.01	0.15	0.53	5
Celery leaves	0.25	0.19	0.09	0.03	0.15	0.71	2

Source: (Research Results, 2024)

Table 23. DM3 Alternative Weights

Alternative	K1	K2	K3	K4	K5
Lettuce	WH	N	B	C	AB
Pakcoy	WH	K	CK	C	AB
Spinach	WK	B	B	C	O
Curly cabbage	WH	N	B	C	AB
Kale	WK	K	B	PM	AB
Celery leaves	WH	K	P	C	O

Source: (Research Results, 2024)

Table 24. DM3 Alternative Weights

Alternative	K1	K2	K3	K4	K5
Lettuce	1.00	0.41	0.41	1.00	1.00
Pakcoy	1.00	0.17	0.17	1.00	1.00
Spinach	0.43	1.00	0.41	1.00	0.40
Curly cabbage	1.00	0.41	1.00	1.00	1.00
Kale	0.43	0.17	0.41	0.17	1.00
Celery leaves	1.00	0.17	1.00	1.00	0.40

Source: (Research Results, 2024)

Table 25. DM3 Alternative Weights

Alternative	K1	K2	K3	K4	K5	V	Rank
Lettuce	0.25	0.19	0.04	0.05	0.15	0.68	3
Pakcoy	0.25	0.17	0.02	0.05	0.15	0.64	4
Spinach	0.11	0.46	0.04	0.05	0.06	0.71	2
Curly cabbage	0.25	0.19	0.09	0.05	0.15	0.73	1
Kale	0.11	0.08	0.04	0.01	0.15	0.38	6
Celery leaves	0.25	0.08	0.09	0.05	0.06	0.53	5

Source: (Research Results, 2024)

Table 26 shows the preferences of each decision maker for 6 alternative crops showing differences in assessment. There are interesting variations in preferences between decision makers in evaluating types of vegetables.

Table 26. Calculation Results from Each Decision Maker

Alternative	DM 1	DM2	DM3
Lettuce	0.57	0.41	0.68
Pakcoy	0.66	0.64	0.64
Spinach	0.62	0.80	0.71
Curly cabbage	0.60	0.55	0.73
Kale	0.71	0.53	0.38
Celery leaves	0.63	0.71	0.53

Source: (Research Results, 2024)

D. Calculations Borda Method

Next calculation, combining the ranking results obtained in each DM using Borda to determine the ranking and value for each alternative in each DM. The number and ranking of alternatives can be adjusted to the border point values as in table 27.

Table 27. Borda Points

Ranking	Mark
1	6
2	5
3	4
4	3
5	2
6	1

Source: (Research Results, 2024)

The first rank gets the greatest value and vice versa. The values obtained from each alternative are multiplied by the Borda point value to obtain a total value which will be converted into a ranking result. The following is the assessment for ranking using the Borda method in table 28-30.

Table 28. DM1 value

Alternative	Amount	Rank	Mark	Results
Lettuce	0.57	6	1	0.57
Pakcoy	0.66	2	5	3.31
Spinach	0.62	4	3	1.86
Curly cabbage	0.60	5	2	1.21
Kale	0.71	1	6	4.29
Celery leaves	0.63	3	4	2.51

Source: (Research Results, 2024)

Table 29. DM2 value

Alternative	Amount	Rank	Mark	Results
Lettuce	0.41	6	1	0.41
Pakcoy	0.64	3	4	2.56
Spinach	0.80	1	6	4.81
Curly cabbage	0.55	4	3	1.65
Kale	0.53	5	2	1.05
Celery leaves	0.71	2	5	3.57

Source: (Research Results, 2024)

Table 30. DM3 Value

Alternative	Amount	Rank	Mark	Results
Lettuce	0.68	3	4	2.72
Pakcoy	0.64	4	3	1.91
Spinach	0.71	2	5	3.55
Curly cabbage	0.73	1	6	4.39
Kale	0.38	6	1	0.38
Celery leaves	0.53	5	2	1.06

Source: (Research Results, 2024)

Then the values obtained from each alternative are added up and this value will be the final result of the alternative. The calculations are shown in table 31.

Table 31. Total Value for Each DM

Alternative	DM 1	DM 2	DM 3	The final result
Lettuce	0.57	0.41	2.72	3.69
Pakcoy	3.31	2.56	1.91	7.78
Spinach	1.86	4.81	3.55	10.23
Curly cabbage	1.21	1.65	4.39	7.25
Kale	4.29	1.05	0.38	5.72
Celery leaves	2.51	3.57	1. 06	7.14

Source: (Research Results, 2024)

Continue ranking the final result values of the alternatives where the highest value gets first place and vice versa. The ranking results can be seen in table 32.

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Table 32. Final Results Ranking

Alternative	The final result	Rank
Lettuce	3.69	6
Pakcoy	7.78	2
Spinach	10.23	1
Curly cabbage	7.25	3
Kale	5.72	5
Celery leaves	7.14	4

Source: (Research Results, 2024)

The calculation results show that the alternative spinach plant is ranked first with a value of 10.23 as the plant with the best quality for hydroponic cultivation. While the lettuce plant alternative was ranked sixth or last with a score of 3.69.

CONCLUSION

This research shows that the application of a group decision support system with the Analytic Hierarchy Process and Borda methods can be effective in determining the quality of hydroponic plants. Where in the AHP method, the calculation of a pairwise comparison matrix for criteria is carried out, evaluating the consistency ratio, and ranking alternatives based on sub-criteria. This involves three Decision Maker (DM). Meanwhile, the Borda Method is used to integrate the rankings of the three Decision Makers (DM). The calculation results of the two methods show that of the 5 criteria, namely leaf growth, stem strength, root quality, growing media and vitamins used, the spinach alternative is ranked the highest with a value of 10.23. Meanwhile, lettuce is ranked last with a value of 3.69 as the best quality plant. From these results, spinach is the solution to be cultivated by hydroponic farmers, especially in the area of Gowa Regency, South Sulawesi.

The suggestions from the results of this research can be developed for further research, namely by using the TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) method. This method can evaluate alternative hydroponic plants based on a number of criteria. By involving this approach, it is hoped that further research can produce a deeper understanding and comprehensive comparison regarding determining the quality of hydroponic plants.

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