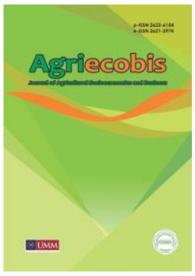
Universitas Muhammadiyah Malang, East Java, Indonesia

Agriecobis
(Journal of Agricultural Socioeconomics and Business)

p-ISSN 2662-6154, e-ISSN 2621-3974 // Vol. 7 No. 01 March 2024, pp. 12-26



Research Article

Utilizing Analytical Hierarchy Process for Evaluating the Performance of Straw Mushroom (Volvariella spp.) Farmers in North-Eastern Region of Karawang, West Java, Indonesia

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ARTICLE INFO

Article history
Received December 1, 2023
Revised March 25, 2024
Accepted March 30, 2024
Published March 31, 2024

Keywords
Analytical Hierarchy Process
Straw Mushroom
Volvariella spp.
Framers Performance

ABSTRACT

Producers of Straw Mushroom (Volvariella spp.) in the North-Eastern region of Karawang, West Java, Indonesia predominantly operate within the sub-districts of Cilamaya Kulon, Cilamaya Wetan, and Banyusari. A noticeable decline in Straw Mushroom cultivation has been observed in this region, which can be ascribed to various factors including suboptimal farming practices, diminished seed quality, and erratic weather conditions impacting production outcomes. It is imperative to enhance the efficiency of mushroom farming across multiple stages encompassing planning, procurement of raw materials, processing, Maintenance, harvesting, marketing, shipping, handling returns, and ensuring consumer satisfaction. This study aims to evaluate the productivity of mushroom farmers, with a specific focus on the top-performing farmers in the North-Eastern region of Karawang. Proportionate stratified random sampling was employed as the sampling technique, and data were collected through structured interviews utilizing a questionnaire. Quantitative analysis, employing the Analytical Hierarchy Process method, was utilized for data analysis. The findings reveal that planning criteria hold the highest priority value of 0.306, whereas satisfaction criteria have the lowest priority value of 0.018. The top-performing farmers achieved a score of 2.08, while the lowest performing farmers attained a score of 1.10.

INTRODUCTION

The agricultural sector assumes a dual function within the economy, acting as both a direct supplier of sustenance and income, and as a substantial driver of economic advancement and societal well-being (Rompas et al., 2015). It holds pivotal importance in propelling Indonesia's economic trajectory (Shodiq, 2022), providing sustenance for a substantial portion of the populace and offering avenues for income generation through various agricultural commodities (Indraningsih & Swastika, 2022). Among the agricultural sub-sectors, horticulture is presently garnering notable focus and investment within Indonesia (Sebagai et al., 2019).

Horticulture stands as a pivotal element in agricultural progress, encompassing various categories of vegetables, fruits, ornamental, and medicinal plants. These commodities often hold considerable economic significance, thereby constituting a vital income source for farmers and facilitating labor absorption. Among horticultural commodities, mushrooms are acknowledged for their substantial economic value (Ufairoh, 2022).

Mushrooms have gained increasing popularity among consumers in Indonesia (Pertanian & Padjadjaran, 2021), establishing themselves as highly coveted horticultural commodities (Lestari et al., 2018).Volvariella spp., commonly referred to as Straw Mushroom, is extensively cultivated and represents one of the most prevalent mushroom varieties. BPS (2021) reveals that mushroom production in Indonesia reached a total of 900,420 quintals in 2021. The majority of mushroom produce is marketed in its fresh form, with a particular focus on urban areas. Straw Mushroom (Volvariella spp.) holds widespread consumption appeal and is frequently incorporated as an ingredient in various culinary preparations (Dilla, 2019). West Java is emerging as a prominent hub for the cultivation of Straw Mushroom (Volvariella spp.) within Indonesia.

In 2021, data from the BPS of West Java revealed that mushroom production in the region totaled 216,257 quintals, with a cultivated area spanning 135,567 square meters. The predominant cultivated species of edible fungus is Volvariella spp., commonly known as Straw Mushroom. Production of Straw Mushroom (Volvariella spp.) is gaining prominence across various districts in West Java, including Karawang, Bandung, West Bandung, Bogor, Subang, and Majalengka. Commonly cultivated crops in these regions encompass Straw Mushroom (Volvariella spp.), long beans, cucumber, eggplant, Choy sum (Chinese flowering cabbage), water spinach, spinach, and red or cayenne pepper.

Karawang, situated in West Java, is widely acknowledged as a significant hub for Straw Mushroom (Volvariella spp.) production, as evidenced by Sasmita et al. (2022) and Widiyanto et al. (2021). Consequently, the preeminence of Straw Mushroom (Volvariella spp.) as a commodity in Karawang is not unexpected (Suhaeni et al., 2022). According to the BPS of Karawang in 2022, Straw Mushroom (Volvariella spp.) accounted for the highest seasonal vegetable production, reaching 1,176,964 quintals in 2021. The primary production regions for Straw Mushroom (Volvariella spp.) are the sub-districts of Cilamaya Kulon, Cilamaya Wetan, and Banyusari in the North-Eastern Region of Karawang. However, in 2022, the output of Straw Mushroom (Volvariella spp.) declined to 833,606 quintals, as reported by the coordinator of the Horticulture section of the Agriculture Office in Karawang (2023).

In the North-eastern Region of Karawang, farmers engage in the cultivation of Straw Mushroom (Volvariella spp.) primarily in the sub-districts of Cilamaya Kulon, Cilamaya Wetan, and Banyusari. A decrease in Straw Mushroom (Volvariella spp.) cultivation has been observed across these three sub-districts. Table 1 presents data on mushroom production in Cilamaya Kulon, Cilamaya Wetan, and Banyusari sub-districts, sourced from the Agriculture Office in Karawang in 2023.

Table 1. Production of Straw Mushroom (Volvariella spp.) in the sub-districts of Cilamaya Kulon, Cilamaya Wetan, and Banyusari

Sub-districts	**Production of Straw Mushroom (Volvariella spp.) (in quintals)**	
	2021	**2022**
Cilamaya Kulon	1,094.94	114
Cilamaya Wetan	2,346.65	146.5
Banyusari	860.6	510.28

Source : Agriculture Office in Karawang (2023)

The decline in Straw Mushroom (Volvariella spp.) production can be attributed to various factors such as farmers' suboptimal performance in the cultivation process, deteriorating seed quality, and unpredictable weather conditions, all of which directly influence overall production outcomes (Saikia & Bora, 2023). Cultivation of Straw Mushroom (Volvariella spp.) holds promise as a lucrative venture due to its short growth cycle and relatively high market value (Dewi, 2023; Utami, 2023), presenting significant cash generation potential (Suhaeni et al., 2021).

Farmers persistently strive to improve Straw Mushroom (Volvariella spp.) quality to enhance yields. Optimizing cultivation processes is paramount for boosting production. This entails improving performance across all stages, including planning, procurement, processing, maintenance, harvesting, marketing, shipping, material return, and ensuring farmer satisfaction.

This study aims to assess the performance of Straw Mushroom (Volvariella spp.) farmers in the North-Eastern Region of Karawang and analyze the top-performing farmers' performance within the same region. The Analytical Hierarchy Process methodology is employed to facilitate decision-making based on multiple criteria.

METHOD

Research Method

The study employs quantitative and descriptive qualitative analysis methodologies to evaluate the performance of mushroom farmers. Quantitative analysis assesses farmers' performance, while descriptive qualitative analysis provides additional insights into farmers with the highest and lowest scores. Performance indicators were developed using the Analytical Hierarchy Process methodology to evaluate mushroom farmers' performance optimally.

Situated in the North-Eastern Region of Karawang, specifically in the sub-districts of Cilamaya Kulon, Cilamaya Wetan, and Banyusari, this study's research site was chosen due to its prominence in mushroom production and the absence of prior research on mushroom growers' performance in the area. Data collection occurred during April and May 2023.

Sampling Technique

This study employs proportionate stratified random sampling as its sampling method, which is commonly used when dealing with heterogeneous populations (Swarjana & Ketut, 2012). This approach divides the population into strata based on various characteristics such as age, location, gender, education level, and income.

In this research, the proportionate stratified random sampling technique was applied to select a sample of Straw Mushroom (Volvariella spp.) farmers in the North-Eastern Region of Karawang, specifically in Cilamaya Kulon District, Cilamaya Wetan District, and Banyusari District. Each district has a different number of mushroom farmers: Cilamaya Kulon has 43, Cilamaya Wetan has 19, and Banyusari has 8, totaling 70 mushroom farmers in the region.

The determination of the sample size of mushroom producers followed the formula used in proportionate stratified random sampling. The formula*:*

$$n_i = \frac{N_i}{N}\ x\ n \quad (1)$$

Where:
n_i : number of samples by strata/level
n : total number of samples
N_i : number of populations by strata/level
N : total number of populations

- Sub-district of *Cilamaya Kulon*
  For the sample of Straw Mushroom (Volvariella spp.) farmers in Cilamaya Kulon are:

n = $\frac{43}{70}$ x 60
n = 36,85 (rounded up by the researcher to 37)

- Sub-district of *Cilamaya Wetan*
  For the sample of Straw Mushroom (Volvariella spp.) farmers in Cilamaya Wetan are:

n = $\frac{19}{70}$ x 60
n = 16,28 (rounded down by the researcher to 16)

- Sub-district of *Banyusari*
  For the sample of Straw Mushroom (Volvariella spp.) farmers in Banyusari are:

n = $\frac{8}{70}$ x 60
n = 6,85 (rounded up by the researcher to 7)

The sample size for Straw Mushroom (Volvariella spp.) farmers in Cilamaya Kulon, Cilamaya Wetan, and Banyusari was determined to be 37, 16, and 7 farmers, respectively, resulting in a total sample of 60 farmers for this study.

Data Collection Technique

This study included both primary and secondary data sources. The researcher collected primary data by conducting interviews with farmers who cultivate Straw Mushroom (Volvariella spp.) in the north-eastern region of Karawang. The interviews were carried out using a questionnaire designed by the researcher. The secondary data was acquired through an extensive review of literature, including data from reputable government entities and institutions such as the Indonesian Statistics (BPS), the Agriculture Office, and relevant academic publications.

Data Analysis Method

The study adopted a quantitative analysis approach, employing the Analytical Hierarchy Process (AHP) method. Developed by Thomas L. Saaty, the AHP is a decision support methodology aimed at decomposing multifaceted situations involving multiple factors or criteria into a hierarchical structure (Supriadi et al., 2018). This methodology facilitates decision-making by organizing complex situations into a hierarchical framework of components and criteria. The study utilized the following criteria: K-1 for planning, K-2 for procurement, K-3 for processing, K-4 for maintenance, K-5 for harvesting, K-6 for marketing, K-7 for delivery, K-8 for return, and K-9 for satisfaction.

Advantages and disadvantages of AHP (Supriadi et al., 2018) The Analytic Hierarchy Process (AHP) encompasses various advantages and disadvantages within its analytical framework. Its advantages include:

1. Unity: AHP transforms broad and unstructured problems into a flexible and comprehensible model.
2. Complexity: AHP addresses complex problems through a systems approach and deductive integration.
3. Interdependence: AHP is applicable to system elements that are independent of each other and do not necessitate linear relationships.
4. Hierarchy structuring: AHP reflects natural thought processes by categorizing system elements into hierarchical levels, with each level containing similar elements.
5. Measurement: AHP offers a measurement scale and a methodology for deriving priorities.
6. Consistency: AHP considers logical consistency in judgments used to establish priorities.
7. Synthesis: AHP generates an overall estimate of the desirability of each alternative.
8. Trade-off: AHP assesses the relative priority of factors within the system, allowing individuals to select the best alternative based on their objectives.
9. Judgment and consensus: While not mandating consensus, AHP combines the outcomes of various assessments.
10. Process repetition: AHP enables individuals to refine problem definitions and enhance judgment and understanding through iterative processes.

The Analytic Hierarchy Process (AHP) presents several disadvantages:

1. Dependency on subjective expert input: The AHP model relies heavily on subjective impressions provided by experts. Consequently, the accuracy of the model hinges on the expert's assessment, making it vulnerable to errors if the assessment is incorrect.
2. Lack of statistical testing: As a purely mathematical technique, the AHP does not incorporate statistical testing. Thus, there is no means to ascertain the level of confidence in the accuracy of the model generated.

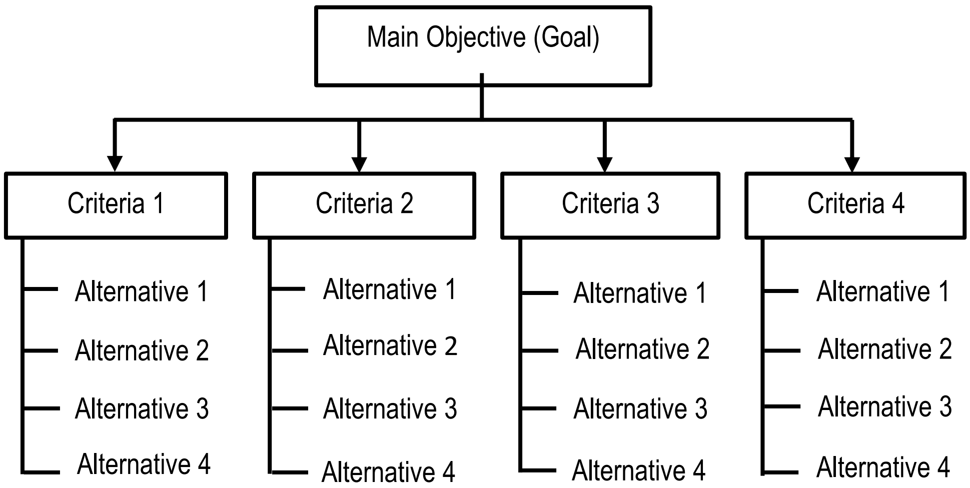
The steps involved in determining criteria weights through the Analytical Hierarchy Process approach are as follows:

1. Problem Identification:

The initial step in utilizing the AHP technique involves defining the primary objective, criteria, and alternatives to be considered.

2. Development of a Hierarchical System, Beginning with the Main Goal:

Figure 1 provides a visual representation of the hierarchical structure typically employed in this process.



Source: (Munthafa et al., 2017)

Figure 1. Hierarchical Structure of AHP

1. Creating a pairwise comparison matrix illustrating the relative contribution or effect of each element to the objective or criterion level above it.

Table 2. Pairwise Comparison Matrix

	Criteria -1	Criteria -2	Criteria -3	….	Criteria-n
Criteria -1	K11	K12	K13	….	K1n
Criteria -2	K21	K22	K23	….	K2n
Criteria -3	K31	K32	K33	….	K3n
…	…	…	…	…	…
Criteria-n	Kn1	Kn2	Kn3	….	Knn

Source: (Suhaeri & Yunita, 2023)

The pairwise comparison matrix is calculated using the following formula

$$A=\left[a_{ij}\right](n\times n)=\begin{bmatrix} 1 & a_{12} & \dots & a_{1j} & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & a_{2j} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 1/a_{1j} & 1/a_{2j} & \dots & 1 & \dots & a_{jn} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 1/a_{1n} & 1/a_{2n} & \dots & 1/a_{jn} & \dots & 1 \end{bmatrix} \quad (2)$$

where:
A : square matrix for pairwise comparisons
a_{ij} : value of i-th row and j-th column
If $a_{ij} = a$ then $a_{ji} = \frac{1}{a}$ (reciprocal value)

The sum value of each j-th column is calculated by:

$$a_{.j} = \sum_{i=1}^{n} a_{ij} \quad (3)$$

where:

$a_{.j}$: the sum value of the j-th column
j : the number of columns 1, 2, ..., n
I : the number of rows
N : the number of columns or rows

Therefore, the row matrix of the sum result is obtained as follows.

$$\begin{bmatrix} a_{.1} & a_{.2} & a_{.3} & \dots & a_{.j} & \dots & a_{.n} \end{bmatrix} \tag{4}$$

Define pairwise comparisons so that there is a total of n x [(n-1)/2] judgments, where n is the number of elements being compared.

Table 3. Rating Scale of Pairwise Comparison

Intensity of Importance	Description
1	Both elements are equally important
3	One element is slightly more important than the other
5	One element is more important than the other
7	One element is significantly more important than the other
9	One element is absolutely more important than the other
2,4,6,8	Values between two adjacent consideration values
Reverse	If activity i gets one number compared to activity j, then j has the opposite value compared to i.

Source : (Metode et al., 2023)

2. Determining the normalization matrix of the pairwise comparison matrix, using the following formula.

$$K = \left[k_{ij}\right](n \times n) = \frac{A(n \times n)}{\left[a_{.j}\right]} = \begin{bmatrix} \frac{1}{a_{.1}} & \frac{a_{12}}{a_{.2}} & \dots & \frac{a_{1j}}{a_{.j}} & \dots & \frac{a_{1n}}{a_{.n}} \\ \frac{1/a_{12}}{a_{.1}} & \frac{1}{a_{.2}} & \dots & \frac{a_{2j}}{a_{.j}} & \dots & \frac{a_{2n}}{a_{.n}} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \frac{1/a_{1j}}{a_{.1}} & \frac{1/a_{2j}}{a_{.2}} & \dots & \frac{1}{a_{.j}} & \dots & \frac{a_{jn}}{a_{.n}} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ \frac{1/a_{1n}}{a_{.1}} & \frac{1/a_{2n}}{a_{.2}} & \dots & \frac{1/a_{jn}}{a_{.j}} & \dots & \frac{1}{a_{.n}} \end{bmatrix} = \begin{bmatrix} k_{11} & k_{12} & \dots & k_{1j} & \dots & k_{1n} \\ k_{21} & k_{22} & \dots & k_{2j} & \dots & k_{2n} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ k_{i1} & k_{i2} & \dots & k_{ij} & \dots & k_{in} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ k_{n1} & k_{n2} & \dots & k_{nj} & \dots & k_{nn} \end{bmatrix} \tag{5}$$

where:
k_{ij} : the value of the i-th criterion and the j-th column of the normalization matrix result of matrix A
j : the number of columns 1, 2, ..., n
n : the number of columns or rows

Sum the values of the j-th column based on the i-th row with the following formula:

$$k_{i.} = \frac{\sum_{j=1}^{n} k_{ij}}{n} \tag{6}$$

where:
$k_{i.}$: criterion value of summing the value of the i-th row in normalization matrix
j : the number of columns
i : the number of rows 1, 2, ..., n
n : the number of columns or rows

Therefore, the matrix result of the priority column is as follows.

$$K_{prioritas} = \begin{bmatrix} k_{1.} \\ k_{2.} \\ k_{3.} \\ \dots \\ k_{i.} \\ \dots \\ k_{n.} \end{bmatrix} \quad (7)$$

where:
$k_{prioritas}$: priority value for each criterion
$k_{i.}$: criterion value of summing the value of the i-th row in normalization matrix

3. Calculating eigenvalues criteria
   The eigenvalue criteria are calculated by multiplying the comparison matrix (A) multiplied by the priority matrix.

$$A(n\times n)\times K_{prioritas}(n\times 1) = \begin{bmatrix} 1 & a_{12} & \dots & a_{1j} & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & a_{2j} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 1/a_{1j} & 1/a_{2j} & \dots & 1 & \dots & a_{jn} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 1/a_{1n} & 1/a_{2n} & \dots & 1/a_{jn} & \dots & 1 \end{bmatrix} \times \begin{bmatrix} k_{1.} \\ k_{2.} \\ k_{3.} \\ \dots \\ k_{i.} \\ \dots \\ k_{n.} \end{bmatrix} = \begin{bmatrix} e_1 \\ e_2 \\ e_3 \\ \\ e_i \\ \\ e_n \end{bmatrix} \quad (8)$$

where:
$e_{i.}$: criteria values of the 1st, 2nd, 3rd, i and n-th rows
A : square matrix of pairwise comparisons
$k_{prioritas}$: priority value for each criterion
$k_{i.}$: criterion value of summing the value of the i-th row in normalization matrix
n : the number of columns or rows

4. Calculating hierarchy consistency
   To calculate the consistency of the hierarchy, what is needed is to calculate the value λ_{max} (characteristic value) consisting of n (number of criteria), e_i (i-th eigenvalue), and k_i (number of priority values in the i-th row). Then calculate the consistency index (CI) value consisting of λ_{max} (characteristic value) and n (number of criteria). Then calculate the consistency ratio (CR) value consisting of CI (consistency index value) and RI (random consistency index value).

a. Calculating the value of λ_{max}
   The calculation of λ_max involves multiplying 1 divided by the number of criteria by the sum of the i-th eigenvalue divided by the i-th priority value, as depicted in the following formula.

$$\lambda_{\max} = \frac{1}{n}\left(\sum_{i=1}^{n}\frac{e_i}{k_i}\right) \quad (9)$$

where:
λ_{max} : characteristic value
n : the number of criteria
e_i : the i-th eigenvalue
k_i : the number of priority values in the i-th row

b. Calculating the value of the consistency index as follows.

$$CI = \frac{\lambda_{\max} - n}{n-1} \quad (10)$$

where:
CI : the value of the consistency index
λ_{max} : characteristic value
n : the number of criteria

c. Calculating the value of the consistency ratio as follows.

$$CR = \frac{CI}{RI} \quad (11)$$

where:
CR : the value of the consistency ratio
CI : the value of the consistency index
RI : the value of the random consistency index

Table 4. Random Consistency Index

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0,00	0,00	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49	1,51	1,48	1,56	1,57	1,59

Source: Saputra and Nugraha (2020)

If the consistency ratio (CR) is ≤ 0.1 (10%), the assessment results are deemed acceptable and valid (Susetyo et al., 2019), signifying consistency in the evaluation process (Rasyid & Wagola, 2021).

RESULTS AND DISCUSSION

Hierarchical Structure

The issue under examination is subdivided into various components, specifically criteria and alternatives, organized hierarchically. In this study, a total of nine criteria were utilized, including planning (K-1), procurement (K-2), processing (K-3), maintenance (K-4), harvesting (K-5), marketing (K-6), delivery (K-7), return (K-8), and satisfaction (K-9). These criteria are derived from the performance of farmers, encompassing their planning, production, and overall satisfaction in carrying out agricultural tasks. The study involved a spectrum of options, represented by farmers numbered from 1 to 60.

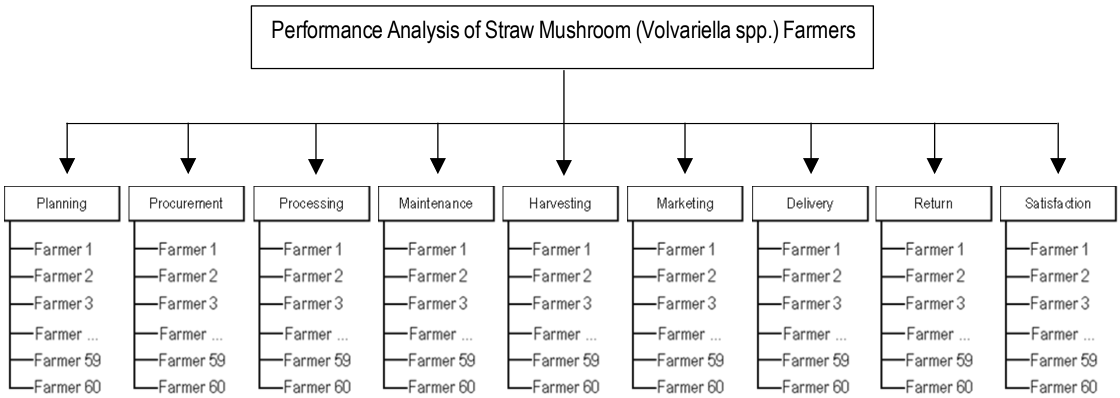


Figure 2. Hierarchical Structure of Performance Analysis of Straw Mushroom (Volvariella spp.) Farmers in North-Eastern Region of Karawang

Pairwise Comparison Matrix

At this stage, a comparative assessment is conducted between each criterion and every other criterion, resulting in a 9x9 matrix.

Table 5. Pairwise Comparison Matrix on the Performance of Straw Mushroom (Volvariella spp.) Farmers in North-Eastern Region of Karawang

Criteria	K-1	K-2	K-3	K-4	K-5	K-6	K-7	K-8	K-9
K-1	1	3	3	3	5	5	7	9	9
K-2	0.33	1	3	3	3	5	5	7	9
K-3	0.33	0.33	1	3	3	3	5	5	7
K-4	0.33	0.33	0.33	1	3	3	3	5	5
K-5	0.20	0.33	0.33	0.33	1	3	3	3	5
K-6	0.20	0.20	0.33	0.33	0.33	1	3	3	3
K-7	0.14	0.20	0.20	0.33	0.33	0.33	1	3	3
K-8	0.11	0.14	0.20	0.20	0.33	0.33	0.33	1	3
K-9	0.11	0.11	0.14	0.20	0.20	0.33	0.33	0.33	1

The data in Table 5 of the pairwise comparison matrix delineate the performance of Straw Mushroom (Volvariella spp.) Farmers in the North-Eastern Region of Karawang as follows:

a. The value of 1 in the planning criterion column and row signifies equal importance between the two elements.
b. The value of 3 in the procurement criteria column of the planning criteria row suggests a slightly higher level of importance for the planning criteria compared to procurement aspects.
c. The value of 5 in the harvesting criteria column of the planning criteria row indicates greater significance for the planning criteria element over the harvesting criteria element.
d. The value of 7 in the shipping criteria column of the planning criteria row indicates the higher importance of the planning criteria element relative to the shipping criteria element.
e. The value of 9 in the return criteria column of the planning criteria row underscores the substantial significance of the planning criteria element over the return criteria element.
f. The value of $\frac{1}{3}$ or 0.33 in the planning criteria column of the procurement criteria row represents the inverse of the value in the procurement criteria column of the planning criteria row.
g. The value of $\frac{1}{5}$ or 0.20 in the planning criteria column of the harvesting criteria row is the reciprocal of the value in the harvesting criteria column of the planning criteria row.
h. The value of $\frac{1}{7}$ or 0.14 in the planning criteria column for the delivery criteria row inversely corresponds to the value in the delivery criteria column for the planning criteria row.
i. The value of $\frac{1}{9}$ or 0.11 in the planning criteria column of the return criteria row represents the inverse of the value in the return criteria column of the planning criteria row.

The summation results for each column of criteria in the row matrix are as follows:

$$a_{.j} = [2{,}77 \quad 5{,}65 \quad 8{,}54 \quad 11{,}40 \quad 16{,}20 \quad 21{,}00 \quad 27{,}67 \quad 36{,}33 \quad 45{,}00]$$

Normalizing a Matrix

Normalizing a matrix aims to standardize each element within the matrix, ensuring uniformity across its values (Aini et al., 2022). In the normalized matrix, the criterion value in each criterion column equals 1. The summation of criterion values in the i-th row of the normalized matrix is obtained by totaling the values within that row, yielding the following outcomes:

$$k_{i.} = \begin{bmatrix} 2,75 \\ 1,91 \\ 1,36 \\ 0,99 \\ 0,71 \\ 0,50 \\ 0,36 \\ 0,25 \\ 0,17 \end{bmatrix}$$

The priority value of the i-th row of normalized matrix is calculated by dividing the sum of the i-th row by the number of criteria, so that the following results are obtained.

$$K_{prioritas} = \begin{bmatrix} 0,306 \\ 0,212 \\ 0,151 \\ 0,110 \\ 0,078 \\ 0,056 \\ 0,040 \\ 0,028 \\ 0,018 \end{bmatrix}$$

Eigenvalue of Criteria

The eigenvalue of each criterion is determined by normalizing the comparison value and then multiplying it by the priority value. This calculation is performed using the Microsoft Excel program, yielding the following outcomes. The eigenvalue of each criterion is derived from the multiplication of the values in the pairwise comparison matrix by the corresponding values in the priority matrix.

$$e_{i.} = \begin{bmatrix} 3,094 \\ 2,173 \\ 1,525 \\ 1,087 \\ 0,760 \\ 0,531 \\ 0,376 \\ 0,258 \\ 0,177 \end{bmatrix}$$

Hierarchy Consistency

Ensuring consistency in decision-making is crucial to avoid decisions based on inconsistent considerations. The level of hierarchy consistency is determined through the calculation of λ_{max}, the consistency index value, and the consistency ratio value.

a. The value of λ_{max}

$$\lambda_{\max} = \frac{1}{n}\left(\sum_{i=1}^{n}\frac{e_i}{k_i}\right)$$

$$\lambda_{\max} = \frac{1}{9}\left(\frac{3,094}{0,306}+\frac{2,173}{0,212}+\frac{1,525}{0,151}+\frac{1,087}{0,110}+\frac{0,760}{0,078}+\frac{0,531}{0,056}+\frac{0,376}{0,040}+\frac{0,258}{0,028}+\frac{0,177}{0,018}\right) = 9,754$$

b. The value of the Consistency Index (CI)

$$CI = \frac{\lambda_{\max} - n}{n-1} = \frac{9,754-9}{9-1} = \frac{0,754}{8} = 0,094$$

c. The value of Consistency Ratio (CR)

$$CR = \frac{CI}{RI} = \frac{0,094}{1,45} = 0,065$$

After doing calculations, the resultant ratio value is less than 0.1. Therefore, it can be inferred that the assessment findings are acceptable and consistent with the respondents' evaluation. The calculation can proceed accordingly (Handoko et al., 2023).

The Alternative Value of Criteria on Straw Mushroom (Volvariella spp.) Farmers

The value of this criterion was derived from interviews conducted with farmers cultivating Straw Mushroom (Volvariella spp.) in the north-eastern region of Karawang. The result of row matrix $a_{.j}$ is derived from the interview findings as follows.

$$a_{.j} = [217 \quad 175 \quad 215 \quad 300 \quad 199 \quad 193 \quad 187 \quad 300 \quad 115]$$

Alternative Normalizing Matrix on Straw Mushroom (Volvariella spp.) Farmers

The alternative value in each column of the alternative normalizing matrix criteria has a uniform value of 1. The alternative value of the summation of the normalizing matrix value of the i-th row is obtained as follows.

$$k_{i.} = \begin{bmatrix} 0,165 \\ 0,155 \\ 0,132 \\ 0,161 \\ 0,141 \\ \cdots \\ 0,165 \\ 0,170 \\ 0,124 \\ 0,124 \\ 0,165 \end{bmatrix}$$

Alternative Eigenvalue

The alternative eigenvalue for Straw Mushroom (Volvariella spp.) farmers is computed by determining the eigenvalue for each farmer based on the priorities assigned to each criterion. These alternative values are derived from normalized criteria. The resulting alternative eigenvalues are as follows.

$$e_{a1} = \begin{bmatrix} 0,0056 \\ 0,0056 \\ 0,0056 \\ 0,0042 \\ 0,0056 \\ \cdots \\ 0,0056 \\ 0,0056 \\ 0,0042 \\ 0,0042 \\ 0,0056 \end{bmatrix} \quad e_{a2} = \begin{bmatrix} 0,0036 \\ 0,0036 \\ 0,0024 \\ 0,0036 \\ 0,0024 \\ \cdots \\ 0,0036 \\ 0,0036 \\ 0,0036 \\ 0,0036 \\ 0,0036 \end{bmatrix} \quad e_{a3} = \begin{bmatrix} 0,0028 \\ 0,0028 \\ 0,0028 \\ 0,0028 \\ 0,0028 \\ \cdots \\ 0,0028 \\ 0,0028 \\ 0,0014 \\ 0,0014 \\ 0,0028 \end{bmatrix}$$

$$e_{a4} = \begin{bmatrix} 0,0018 \\ 0,0018 \\ 0,0018 \\ 0,0018 \\ 0,0018 \\ \cdots \\ 0,0018 \\ 0,0018 \\ 0,0018 \\ 0,0018 \\ 0,0018 \end{bmatrix} \quad e_{a5} = \begin{bmatrix} 0,0012 \\ 0,0008 \\ 0,0008 \\ 0,0008 \\ 0,0008 \\ \cdots \\ 0,0016 \\ 0,0020 \\ 0,0008 \\ 0,0008 \\ 0,0016 \end{bmatrix} \quad e_{a6} = \begin{bmatrix} 0,0012 \\ 0,0009 \\ 0,0009 \\ 0,0012 \\ 0,0009 \\ \cdots \\ 0,0009 \\ 0,0009 \\ 0,0009 \\ 0,0009 \\ 0,0009 \end{bmatrix}$$

$$e_{a7} = \begin{bmatrix} 0,0006 \\ 0,0006 \\ 0,0006 \\ 0,0009 \\ 0,0006 \\ \cdots \\ 0,0006 \\ 0,0006 \\ 0,0006 \\ 0,0006 \\ 0,0006 \end{bmatrix} \quad e_{a8} = \begin{bmatrix} 0,0005 \\ 0,0005 \\ 0,0005 \\ 0,0005 \\ 0,0005 \\ \cdots \\ 0,0005 \\ 0,0005 \\ 0,0005 \\ 0,0005 \\ 0,0005 \end{bmatrix} \quad e_{a9} = \begin{bmatrix} 0,0005 \\ 0,0005 \\ 0,0002 \\ 0,0005 \\ 0,0003 \\ \cdots \\ 0,0005 \\ 0,0005 \\ 0,0002 \\ 0,0002 \\ 0,0005 \end{bmatrix}$$

where:
e_{a1} : alternative eigenvalue on K-1 planning
e_{a2} : alternative eigenvalue on K-2 procurement
e_{a3} : alternative eigenvalue on K-3 processing
e_{a4} : alternative eigenvalue on K-4 maintenance
e_{a5} : alternative eigenvalue on K-5 harvesting
e_{a6} : alternative eigenvalue on K-6 marketing
e_{a7} : alternative eigenvalue on K-7 delivery
e_{a8} : alternative eigenvalue on K-8 return
e_{a9} : alternative eigenvalue on K-9 satisfaction

Results of Final Assessment

The results of the final assessment are calculated by summing the results of the calculation of the alternatives eigenvalue - the criteria are then multiplied by 100. So that the results of the final assessment of Straw Mushroom (Volvariella spp.) farmers with the name Mr. Ahmad Baihaqi were obtained:

Final Assessment = (0,0071 + 0,0036 + 0,0035 + 0,0018 + 0,0020 + 0,0012 + 0,0006 + 0,0005 + 0,0005) (100)
= (0,0208) (100) = 2,08

Perform the same procedure for each farmer. Subsequently, conduct ranking utilizing the Microsoft Excel program to identify the top 5 farmers and the bottom 5 farmers based on their respective values, as illustrated in Table 6 below.

Table 6. Results of the Final Assessment of the Performance of St raw Mushroom (Volvariella spp.) Farmers in 2023

No	Nama	Results of the Final Assessment	Description
1	Ahmad Baihaqi	2,08	Best (Highest)
2	Katim	1,96	Best (Highest)
3	Sarwiyan	1,87	Best (Highest)
4	Karna	1,84	Best (Highest)
5	Kisel	1,82	Best (Highest)
56	Sayidi	1,47	Lowest
57	Datam	1,40	Lowest
58	Sarim	1,29	Lowest
59	Dulkarim	1,28	Lowest
60	Podil	1,10	Lowest

The analysis of Straw Mushroom (Volvariella spp.) farmers' performance in the North-Eastern Region of Karawang reveals that the planning criteria exhibit the highest significance among the evaluated criteria. Among the performance indicators for mushroom farmers, planning holds the utmost priority, with a priority value of 0.306. Following this, the procurement criteria rank second in importance, with a value of 0.212, while processing criteria occupy the third position at 0.151. Maintenance criteria are fourth in priority, scoring 0.110, whereas harvesting criteria rank fifth with a value of 0.078. Marketing criteria hold the sixth position, achieving a value of 0.056. Subsequently, delivery criteria are seventh in priority at 0.040, while return criteria follow closely behind at 0.028. Lastly, satisfaction criteria represent the least priority, with a value of 0.018.

The top-performing farmer is the one who achieves the highest score. From the pool of 60 respondents consisting of Straw Mushroom (Volvariella spp.) farmers, the analysis identifies 5 farmers with the most exemplary performance. The leading farmer exhibits the highest score of 2.08, followed by the second-best performer at 1.96. The third-best performance scores 1.87, while the fourth and fifth best performances yield values of 1.84 and 1.82, respectively.

The advantages of top-performance among Straw Mushroom (Volvariella spp.) farmers in the North and North Eastern Region of Karawang are as follows:

- Diligently participating in mushroom counseling and training activities.
- Innovating patterns of making mushroom barns, such as elongating them beyond normal sizes.
- Making innovations in media processing.
- Making innovations in spraying mushroom seedlings, such as using sugar water, jelly, and stimulating drugs.
- Producing their own mushroom seedlings.
- Regulating the room temperature in the mushroom barn.

The disadvantages of the lowest-performance among Straw Mushroom (Volvariella spp.) farmers in the North and North Eastern Region of Karawang are:

- The condition of the mushroom barn is not suitable for use.
- Lack of innovation.
- Absence of a specialized mushroom farmer group.
- Lack of a temperature measuring device, resulting in temperature setting estimations.
- Relatively few mushroom barns, failing to meet the minimum requirement of at least three units.

CONCLUSION

The performance analysis of Straw Mushroom (Volvariella spp.) farmers in the North-Eastern Region of Karawang indicates that among the nine performance criteria evaluated, planning emerges as the most pivotal aspect. Planning exhibits the highest priority value of 0.306, followed by procurement with a value of 0.212, processing with 0.151, and maintenance with 0.110. Among the 60 respondents, five farmers demonstrated the most exemplary performance. The highest-ranking farmer achieved a final score of 2.08, followed by the second, third, fourth, and fifth best performers with final scores of 1.96, 1.87, 1.84, and 1.82, respectively.

Policy interventions by the government should encompass capital allocation, training sessions, counseling, mentoring programs, and comparative studies tailored to Straw Mushroom farmers. These initiatives aim to enhance farmers' self-sufficiency, particularly in seed production. Furthermore, farmers are encouraged to maintain more than one mushroom barn, ideally a minimum of three, and to innovate in barn construction patterns, media processing techniques, mushroom seed spraying methods, and proper regulation of barn temperatures.

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