Selection of Superior Nile Tilapia Seeds Using Weighted Product Method

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Abstract. Nile tilapia (Oreochromis Niloticus) in Indonesia is an economical fish because of the easy way of cultivation and the popular taste so that nile tilapia is one of the fish that is often consumed in Indonesia. The great interest in public consumption of nile tilapia has made this nile tilapia cultivation business develop rapidly, both on a large and small scale. For this reason, decision support is needed in the selection of superior nile tilapia seeds to produce good nile tilapia. The decision support system uses the weighted product method by considering 6 criteria such as fish weight, fish length, fish movement, physical defects, fish color, and fish belly condition. With 15 data used in the decision support system for selecting superior nile tilapia seeds, it produces an accuracy of 86.6%.

INTRODUCTION

Nile tilapia (Oreochromis Niloticus) in Indonesia is an economical fish because of the easy cultivation method and the popular taste so that nile tilapia is one of the fish that is often consumed in Indonesia. The great interest in public consumption of nile tilapia has made this nile tilapia cultivation business develop rapidly, both on a large and small scale [1]–[3]. The magnitude of this interest can be seen from 2011 to 2015 the production of nile tilapia in Indonesia rose to 992,697 tons and nile tilapia is the fish that has the highest production in the three main fish productions, followed by catfish and milkfish [4].

The increasing demand for market share which increases every year for nile tilapia requires the selection of superior nile tilapia seeds to be able to meet demand. These superior nile tilapia seeds are expected to produce more eggs for breeding, large fish sizes, and quality meat [5], [6]. Several factors need to be considered in choosing superior seeds to be considered in cultivation by tilapia farmers. Some of these factors are the weight of the fish, the length of the fish, the movement of the fish, physical defects, the color of the fish, and the condition of the fish's stomach. This selection will be assisted by a system that can support decisions for nile tilapia farmers to determine superior nile tilapia seeds.

Decision support systems require methods to be able to produce the expected results. The Weighted Product (WP) method is one of the methods that is often used in research such as selecting superior catfish [7] and selecting a superior brood gurame soang fish [8]. And based on research, the WP method has higher accuracy and is more optimal than the SAW method [8], [9]. Therefore, the selection of superior nile tilapia seeds will use the WP method.

METHOD

DECISION SUPPORT SYSTEM

Decision Support System (DSS) is a computer-based information system by taking an approach based on the information it has to obtain several alternatives as a result of a decision. DSS is used to help certain parties to be able to provide several alternative decisions, but it is the user who still makes the decision. DSS is the result of a process based on the criteria and the weight of the criteria owned to select various alternatives to produce the best decision. The decision-making process is carried out in stages, systematically, consistently, and in every step from the beginning it has included all parties, which will give good results [7], [10], [11].

Weighted Product Method

The Weighted Product (WP) method is a part of the decision making model by multiplication in connecting an attribute rating. Weight for attributes, serves as a positive rank in the multiplication process between attributes, while the attribute rating serves as a negative rank for the cost attribute [7], [8], [11].

1) Determination of value weight W

$$Wj = \frac{Wj}{\Sigma Wj} \quad (1)$$

2) Determination of value Vector S

$$S_i = \prod_{j=1}^{n} x_{ij}^{wj} \quad (2)$$

3) Determination of value Vector V

$$V_i = \frac{\prod_{j=1}^{n} x_{ij}^{wj}}{\prod_{j=1}^{n} \left(x_j^{w}\right)^{wj}} \quad (3)$$

where:
V = Alternative preferences are analogous to vector V
W = Weight criteria / sub-criteria
j = Criteria
i = Alternative
n = Number of criteria
S = Alternative preferences are analogous to vector S.

RESULT AND DISCUSSION

Nile tilapia data was obtained from a nile tilapia fish farm in Samarinda City, East Kalimantan, Indonesia. The data was obtained in the form of criteria, criteria weights and sub-criteria values, and some nile tilapia data. The criteria weight data can be seen in Table 1 and the subcriteria data can be seen in Table 2.

TABLE 1. Criteria weight

Code	Criteria	Weight	Description
C1	Fish weight	4	Benefits
C2	Fish length	5	Benefits
C3	Fish move	3	Benefits
C4	Physical disability	3	Benefits
C5	Fish color	3	Benefits
C6	Stomach condition	4	Benefits

TABLE 2. Subcriteria value

Criteria	Subcriteria	Value
Fish weight (C1)	250 – 500 g	1
	501 – 750 g	2
	751 – 1000 g	3
Fish length (C2)	10 – 15 cm	1
	16 – 20 cm	2
	21 – 25 cm	3
Fish move (C3)	Not agile	1
	Agile	2
	Very agile	3
Physical disability (C4)	Yes	1
	No	2
Fish color (C5)	Dark	1
	Light	2
Stomach condition (C6)	Fluid	1
	No fluid	2

TABLE 3. Nile nile tilapia data

No	Code	Fish weight (gr) (C1)	Fish length (cm) (C2)	Fish movement (C3)	Physical disability (C4)	Fish color (C5)	Stomach condition (C6)
1	IK01	605	20	Agile	No	Light	No fluid
2	IK02	650	23	Very agile	No	Light	No fluid
3	IK03	740	23	Very agile	No	Light	No fluid
4	IK04	655	22	Very agile	No	Light	No fluid
5	IK05	600	21	Agile	No	Light	No fluid
6	IK06	650	22	Agile	No	Light	No fluid
7	IK07	635	21	Very agile	No	Light	No fluid
8	IK08	700	23	Agile	No	Light	No fluid
9	IK09	715	23	Not agile	No	Light	No fluid
10	IK10	580	19	Not agile	No	Light	No fluid
11	IK11	750	23	Very agile	No	Light	No fluid
12	IK12	725	23	Agile	No	Light	No fluid
13	IK13	680	22	Very agile	No	Light	No fluid
14	IK14	630	23	Very agile	No	Light	No fluid
15	IK15	805	24	Agile	No	Light	No fluid

Fish data obtained from nile tilapia cultivation in Samarinda City, East Kalimantan, Indonesia based on criteria, namely fish weight, fish length, fish movement, physical disability, fish color, stomach condition as shown in table 1. Nile tilapia data was obtained as in table 3, then changed according to table 2 so that it can be input data to the system. The converted data can be seen in table 4.

TABLE 4. Nile nile tilapia fish data conversion results

No	Code	Fish weight (gr) (C1)	Fish length (cm) (C2)	Fish movement (C3)	Physical disability (C4)	Fish color (C5)	Stomach condition (C6)
1	IK01	2	2	2	2	2	2
2	IK02	2	3	3	2	2	2
3	IK03	2	3	3	2	2	2
4	IK04	2	3	3	2	2	2
5	IK05	2	3	2	2	2	2
6	IK06	2	3	2	2	2	2

7	IK07	2	3	3	2	2	2
8	IK08	2	3	2	2	2	2
9	IK09	2	3	1	2	2	2
10	IK10	2	2	1	2	2	2
11	IK11	2	3	3	2	2	2
12	IK12	2	3	2	2	2	2
13	IK13	2	3	3	2	2	2
14	IK14	2	3	3	2	2	2
15	IK15	3	3	2	2	2	2

The first step in the WP method is to normalize the weights first. The weights of the existing criteria in table 1 are normalized using equation 1.

$$W_1 = \frac{4}{total\ weight} = \frac{4}{22} = 0{,}181$$
$$W_2 = \frac{5}{total\ weight} = \frac{5}{22} = 0{,}227$$
$$W_3 = \frac{3}{total\ weight} = \frac{3}{22} = 0{,}136$$
$$W_4 = \frac{3}{total\ weight} = \frac{3}{22} = 0{,}136$$
$$W_5 = \frac{3}{total\ weight} = \frac{3}{22} = 0{,}136$$
$$W_6 = \frac{4}{total\ weight} = \frac{4}{22} = 0{,}181$$

After getting the normalized weights, then calculate the preference value for each alternative based on the decision matrix using equation 2.

$$S1 = (2^{0,181}) \text{ x } (2^{0,227}) \text{ x } (2^{0,136}) \text{ x } (2^{0,136}) \text{ x } (2^{0,136}) \text{ x } (2^{0,181}) = 6.734$$
$$S2 = (2^{0,181}) \text{ x } (3^{0,227}) \text{ x } (3^{0,136}) \text{ x } (2^{0,136}) \text{ x } (2^{0,136}) \text{ x } (2^{0,181}) = 6.909$$
.
$$S15 = (3^{0,181}) \text{ x } (3^{0,227}) \text{ x } (2^{0,136}) \text{ x } (2^{0,136}) \text{ x } (2^{0,136}) \text{ x } (2^{0,181}) = 6.933$$

From the calculation based on the decision matrix and the normalized weights, the decision normalization values for each alternative can be seen in table 5.

TABLE 5. Decision normalization value

Alternative	Si
S_1	6.734
S_2	6.909
S_3	6.909
S_4	6.909
S_5	6.847
S_6	6.847
S_7	6.909
S_8	6.847
S_9	6.748
S_{10}	6.635
S_{11}	6.909
S_{12}	6.847
S_{13}	6.909
S_{14}	6.909
S_{15}	6.933

The next stage is to find the relative preference value of each alternative by using equation 3 based on table 5.

$$V_1 = \frac{6.734}{6.734+6.909+6.909+6.909+6.847+6.847+6.909+6.847+6.748+6.635+6.909+6.847+6.909+6.909+6.933} = \frac{6.734}{102.801} = 0.0655$$
$$V_2 = \frac{6.909}{6.734+6.909+6.909+6.909+6.847+6.847+6.909+6.847+6.748+6.635+6.909+6.847+6.909+6.909+6.933} = \frac{6.909}{102.801} = 0.0672$$
.

$$V_{15} = \frac{6.933}{6.734+6.909+6.909+6.909+6.847+6.847+6.909+6.847+6.748+6.635+6.909+6.847+6.909+6.909+6.933} = \frac{6.933}{102.801} = 0.0674$$

TABLE 6. Relative preference value

Alternative	Vi
V_1	0.0655
V_2	0.0672
V_3	0.0672
V_4	0.0672
V_5	0.0666
V_6	0.0666
V_7	0.0672
V_8	0.0666
V_9	0.0656
V_{10}	0.0645
V_{11}	0.0672
V_{12}	0.0666
V_{13}	0.0672
V_{14}	0.0672
V_{15}	0.0674

Based on table 6, it was found that the superior fish seeds with the highest relative preference value were in V15 with a value of 0.0674, namely nile tilapia with code IK15. Then followed by nile tilapia with codes IK02, IK03, IK04, IK07, IK11, IK13, and IK14 with a relative preference value of 0.0672. The results from table 6 will be sorted from the largest value to the smallest to get a recommendation for superior nile tilapia seeds. First, the minimum value of preference obtained to be selected as the superior fish seed is determined, which is 0.067. this value was obtained after consulting with fish farmers in Samarinda City, East Kalimantan, Indonesia.

TABLE 7. Result comparison

No	Alternative	Vi	Code	System result	Farm result	Description
1	V_{15}	0.0674	IK15	Selected	Selected	Same
2	V_2	0.0672	IK02	Selected	Selected	Same
3	V_3	0.0672	IK03	Selected	Selected	Same
4	V_4	0.0672	IK04	Selected	Selected	Same
5	V_7	0.0672	IK07	Selected	Not elected	Not same
6	V_{11}	0.0672	IK11	Selected	Selected	Same
7	V_{13}	0.0672	IK13	Selected	Selected	Same
8	V_{14}	0.0672	IK14	Selected	Not elected	Not same
9	V_5	0.0666	IK05	Not elected	Not elected	Same
10	V_6	0.0666	IK06	Not elected	Not elected	Same
11	V_8	0.0666	IK08	Not elected	Not elected	Same
12	V_{12}	0.0666	IK12	Not elected	Not elected	Same
13	V_9	0.0656	IK09	Not elected	Not elected	Same
14	V_1	0.0655	IK01	Not elected	Not elected	Same
15	V_{10}	0.0645	IK10	Not elected	Not elected	Same

$$accuracy = \frac{same\ amount\ of\ data}{amount\ of\ data}\ x\ 100\% = \frac{13}{15}\ x\ 100\% = 86.6\%$$

The results of superior fish seeds, the value obtained from the system will be compared with the results in fish farms. In 15 nile tilapia data, there are 13 nile tilapia data whose results are the same as fish farms and produce an accuracy value of 86.6%, which can be seen in table 7. In 15 data there are 2 different data results, namely, in IK07 and IK14, this difference in data is confirmed again to fish farmers. Based on the information, this difference in results was because the weight and length of the fish did not match their standards, so they did not choose nile tilapia with codes IK07 and IK14 as superior nile tilapia seeds.

CONCLUSION

The results of a decision support system using the weighted product method can provide recommendations for superior nile tilapia seeds for nile tilapia farmers in Samarinda City, East Kalimantan, Indonesia. Based on the test results from 15 nile tilapia data, fish with the IK15 code got the highest value of 0.674 and the accuracy of 86.6%.

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