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Selecting Goldfish Broods Use the Weighted Product and Simple Additive Weighting Methods

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ABSTRACT

Majalaya carp is a freshwater fish that has important economic value and is widespread in Indonesia. Goldfish is the most cultivated fish because it has many advantages both physiologically and genetically. Several factors of assessment in the selection of superior brood stock that can be considered in the cultivation of Goldfish cultivators are; ideal body weight, fish movement, physical deformities, scales, and the base of the tail. All of these factors can help the decision-making process for superior Goldfish. This study uses two methods, namely the Simple Additive Weighting (SAW) method and the Weighted Product (WP) method. Based on the results of research that has been carried out on 20 superior broodfish of Majalaya goldfish, the level of accuracy is obtained by comparing with existing data. The Weighted Product method gets an accuracy value of 90% while the Simple Additive Weighting method gets an accuracy value of 80%.

Corresponding Author:

Ramadiani Ramadiani

1. INTRODUCTION

Carp (Cyprinus capio) is the most widely cultivated fish because it has physical, physiological and genetic advantages. Majalaya goldfish are cultivated in swift water, which is a pond where the water flows continuously in a certain amount. For fish farmers who are just learning Mas Majalaya, they still find it difficult to determine superior brood fish. There are several alternatives and indicators in choosing superior sires of Mas Majalaya fish. Factors that can be considered in aquaculture by Majalaya carp cultivators include ideal body weight, fish movement, physical abnormalities, shape of scales, and shape of the base of the tail. The decision support system that is built is expected to provide recommendations and alternative information media options for novice carp cultivators. So that it can help Majalaya goldfish cultivators choose superior broodstock for high quality Majalaya carp cultivation [1-8].

The system that is built will produce the right decision recommendations, must be supported by the right method as well. In certain cases, such as the case of selecting superior carp broodstock. This study will compare two methods where one method will be selected based on comparative calculations for the decision-making process. The method used in this study is the Simple Additive Weighting method with the Weighted Product method. Based on the background described above, a decision support system is needed using the "WP Method and SAW Method to select Majalaya Superior carp brooders" as the best solution recommendations [9-12].

Previous studies related to this research include; Research conducted by [11] used the Weighted Product method with criteria such as size, weight, color, physical defects, and even water conditions. The results showed that the criteria for size, weight, color, physical defects, and even water conditions could help catfish cultivators in choosing superior broodstock quality. Research conducted [12], the process of making a Decision Support System for Land Selection for Chili Plants with the Weighted Product method with predetermined criteria and weights. Based on the results of testing the weighted product calculation system with manual calculations, the final results are almost the same with an accuracy of 97.6%. The research was conducted [1], using the Simple Additive Weighting method and

the Weighted Product method with the criteria of carp price, carp weight and carp health. The Weighted Product method got 80% accuracy and the Simple Additive weighting method got 60% accuracy from the total data of 10 alternative superior Gurame Soang breeds.

2. RESEARCH METHOD

2.1. Simple Additive Weighting (SAW)

The SAW method is a weighted addition method. The basic concept is to find a weighted summary of the performance ratings for each alternative on all attributes. This method normalizes the decision matrix with a scale that can be compared on all available alternative ratings. This method is grouped into various criteria, then translated from fuzzy numbers in the form of crisp numbers so that these values will be able to carry out the calculation process to find the best alternative. The following are the equations for the SAW method [1],[13–23].

The preference value for each alternative (Vi) is given as:

$$r_{ij} = \begin{cases} \frac{x_{ij}}{Max_i\,(x_{ij})} & \text{if } j \text{ is benefit attribute} \\ \frac{Min_i\,(x_{ij})}{x_{ij}} & \text{if } j \text{ is cost attribute} \end{cases} \quad (1)$$

The preference value for each alternative (Vi) is given as:

$$V_i = \sum_{j=1}^{n} \mathrm{W_j}\, \mathrm{r_{ij}} \quad (2)$$

2.2. Weighted Product (WP)

WP is a decision-making method by multiplying in a related attribute rating, where the rating of each attribute must be raised first with the weight of the attribute concerned. Attribute weight functions as a positive rating, while the cost attribute, including attribute ratings, functions negatively. This method uses multiplication as the attribute rating link, where the rating of each attribute must be increased first with the appropriate weight [1], [12], [19-24]. This process is the same as the normalization process. The weighted product is calculated based on the interest rate. The steps in calculating the Weighted Product method are as follows: The process of normalizing the criteria weights (W), w = 1.

a. Determination of the weight value of W

$$W_j = \frac{W_j}{\sum W_j} \quad (3)$$

Description:

W_j = Attribute weight

$\sum w_j$ = Total attribute weight

b. Determination of the Vector S value

$$\mathrm{S_i} = \prod_{j=1}^{n} X_{ij}^{w_j} \quad (4)$$

Description:

$\mathrm{S_i}$ = The decision on the normalization alternative results in -i

$\mathrm{X_{ij}}$ = Attributes alternatives rating

w_j = Weight sttribute

i = Alternative

j = Attributes

$\prod_{j=1}^{n} X_{ij}^{w_j}$ = Alternate multiplication value per attribute of j = 1-n

In this alternative where $\sum w_j = 1$.

w_j is the rank of positive value to attribute profits, and negative values to attribute costs.

Relative preference of each alternative (V).

c. Determination of Vector V values

$$\mathrm{V_i} = \frac{\prod_{j=1}^{n} X_{ij}^{wj}}{\prod_{j=1}^{n} (X_j^w)_{ij}^{wj}} \quad (5)$$

Description:

$\mathrm{V_i}$ = Alternate preference result to - i

$\mathrm{X_{ij}}$ = Rating alternate per attribute

$\mathrm{W_j}$ = Weight attribute

i = Alternative
j = Attributes
$\prod_{j=1}^{n} X_{ij}^{wj}$ = Multiplication alternative value per attribute
$\prod_{j=1}^{n} (X_j^w)_{ij}^{wj}$ = the number of multiplication results per attribute alternative ranking

2.3. Majalaya Goldfish

Goldfish is a freshwater fish that is of economically important value and is widely distributed in Indonesia carp have been reared since 475 BC in China. In Indonesia, goldfish first became known in the Galuh area, Ciamis, West Java around 1810. It is one of the freshwater fishery commodities that are currently very promising and are in great demand by consumers. This fish has a high economic value from grave houses to private homes. The huge demand almost never stops especially for some local markets in Indonesia. This is certainly a profitable business opportunity for the developer of Majalaya carp aquaculture. It is the most widely cultivated carp because it has physical, physiological and genetic advantages. Majalaya Goldfish began to be widely known in 1975 through intensive aquaculture of swift water pools and is now scattered in almost every entire region Indonesia as fish consumption (Figure 1). The release of fish varieties was submitted based on the results of the research of the three institutions mentioned before [1-6]. The criteria that have been determined on the Majalaya Goldfish are C1: ideal weight, C2: fish motion, C3: physical deformity, C4: shape of scales, C5: base of tail.

Figure 1. Majalaya Goldfish or Carpfish

a. Ideal Weight

The ideal weight of fish for broodstock is 3 kg per head at the age of one and a half years. Assortment of superior broodstock has a lowest weight of 2 kg to 2.5 kg and the best weight of broodstock fish is from 2.5 kg to 3 kg. Weight measurement tool using hanging scales, look at Tabel 1.

Table 1. Fish weight

Criteria	Criteria Parameter	Criteria	Value
Fish Weight	1500 gram – 1900 gram	Less	2
	1901 gram – 2100 gram	Quite	3
	2101 gram – 2500 gram	Good	4
	2501gam – 3000gram	Very good	5

b. Physical disability

The record of goldfish can be watched from the form of the fish's body, if there are body defects, the stomach does not bulge and the fish head looks uneven following the shape of the body, then the fish is not suitable as a superior breeder because it can influence the mating progression. Choose fish with worthy body form. The way to find out is to directly observe the fish in the pond (Tabel 2).

Table 2. Physical disability

Criteria	Criteria Parameter	Criteria	Value
Physical disability	Fin Defects	Very Less	1
	Physical damage	Less	2
	Normal Physical	Very Good	5

c. Fish Movement

The movement of goldfish when seen in healthiness is agile. If the movement of the fish is not agile, then the fish may get unwell and cannot be used in the assortment of superior brooders. Seeing it is by monitoring or directly observing the movement of fish in the pond (Table 3).

Table 3. Fish motion

Criteria	Criteria Parameter	Criteria	Value
Fish Motion	Not Agile	Less	2
	Agile	Good	4
	Very Agile	Very good	5

d. Shape of Scale

The ideal form of goldfish scales is fish scales that look regular, not random and clean. The ideal form of scales for brooders has a neat and regular shape without defects. The base of the tail must be normal and strong, not

shortened or curved, the ratio of the length of the base of the tail is longer and wider than its height. All values obtained from experts are seen using goldfish available to breeders (Table 4).

Table 4. Shape of scale

Criteria	Criteria Parameter	Criteria	Value
Scale Shape	Irregular	Less	2
	Regular	Good	4

e. Base of the Tail

The base of the tail must be normal and strong, not shortened or curved, the ratio of the length of the base of the tail is longer and wider than its height, look at Tabel 5. The ratio of the length of the base of the tail is longer and wider than its height. All values obtained from experts are seen using goldfish to breeders.

Table 5. Base of the tail

Criteria	Criteria Parameter	Criteria	Value
Base of Tail	Abnormal	Less	2
	Normal	Good	4

The explanation in Table 6 is the result of interviews with experts with several assessments in determining the weight value. The highest weight value determined was 5, with very important information, 4 with important information, 3 with moderately important information and 2 with less important information.Table 6. Criteria Weight Value

No.	Weight	Criteria
1	Ideal Weight	3
2	Physical Disability	5
3	Fish Move	4
4	Shape Scales	3
5	Base of Tail	3

The weight value was obtained from the results of interviews with experts from the Faculty of Fisheries. The main criteria obtained are ideal weight, fish movement, physical disability, scale shape, tail base shape. the value of the weight of the physical form of the fish gets a value of 5, the largest weight because it greatly affects the selection of superior brooders, and affects the mating process. The criteria for the movement of fish are in the second largest criterion (4), the movement indicates the fish are alive, healthy and good to be spawned immediately. The criteria for ideal body weight, shape of scales, base of tail are three (3). Fish weight has an effect because good fish growth affects fish quality. The shape of the scales on a goldfish has an effect because if the scales are regular then the fish is good. The base of the fish's tail will have an effect because if the fish's growth is not normal when it is young, then the fish's tail will look abnormal.

The system built for the recommendation of superior goldfish broodstock is desktop-based. System recommendations in the form of an alternative choice of superior carp broodstock are expected to help novice sighters. They may not understand how to choose goldfish with superior broodstock criteria. The initial system display will provide information about the usability of the system in the initial form [25-30]. The initial form contains some goldfish broodstock data, goldfish weight data, and WP calculations. The goldfish data form is the goldfish data that has been previously inputted. The weight data form contains alternative goldfish data that has been converted into a weight value according to the criteria. Next is the WP calculation form and SAW calculation. The data on the weighting criteria for the modified carp brooders are immediately calculated. After getting the results of the normalization of weights, then proceed with calculating the vector S. After getting the results of the vector S then calculating the value of the vector V. Implementation is the realization of the process of making an application system based on the design that has been done (Table 7).

Table 7. Results values

No	Fish code	Weight	Physical	Fish Motion	Shape	FishTail
1	F01	1	5	5	4	4
2	F02	3	5	5	2	4
3	F03	1	2	4	4	4
4	F04	1	5	5	4	4
5	F05	5	5	2	4	4
6	F06	5	2	5	4	4
7	F07	1	5	5	4	4
8	F08	2	2	4	4	4
9	F09	5	5	5	2	4
10	F10	1	5	4	4	4

2.5. WP Manual Calculation

The first step in the WP method is to create a decision matrix, which is to make a weight for each criterion first. then each criterion weight is normalized by calculating the number of criteria weights divided by the total number of criteria weights. Stages of the process of normalizing the calculation of the weight of the criteria using equation 3.

$$W_1 = \frac{3}{Total\ Weight} = \frac{3}{18} = 0{,}1667$$

$$W_2 = \frac{5}{Total\ Weight} = \frac{5}{18} = 0{,}2778$$

Normalization vector S is calculated based on the equation 4. Here one vector calculation S multiplying matrices decisions that have been raised to the value of improvements weights. The above calculation obtained calculation results as shown in Table 8.

$S_1 = (1^{0{,}1667}) \times (5^{0{,}2778}) \times (5^{0{,}2222}) \times (4^{0{,}1667}) \times (4^{0{,}1667}) = 3.5495$

$S_{20} = (1^{0{,}1667}) \times (5^{0{,}2778}) \times (5^{0{,}2222}) \times (4^{0{,}1667}) \times (4^{0{,}1667}) = 3{,}5495$

Table 8. Vector S calculation results

Alternative	Value Vector S	Alternative	Value Vector S
S_1	3.549537	S_{11}	3.304859
S_2	3.797696	S_{12}	2.895613
S_3	2.618769	S_{13}	4.641589
S_4	3.549537	S_{14}	2.895613
S_5	3.786479	S_{15}	3.98422
S_6	3.598552	S_{16}	3.299442
S_7	3.549537	S_{17}	3.549537
S_8	2.939469	S_{18}	2.333058
S_9	4.135186	S_{19}	4.641589
S_{10}	3.377817	S_{20}	3.549537

$$V_1 = \frac{3{,}5495}{3{,}5495 + 3{,}7976 + 2{,}618 + 3{,}5495 + 3{,}786 + 3{,}598 + 3{,}5495 + 2{,}9394 + 4{,}1351 + \ldots + 3{,}549} = \frac{3{,}5495}{69{,}9976} = 0{.}0507$$

$$V_2 = \frac{3{,}5495}{3{,}5495 + 3{,}7976 + 2{,}618 + 3{,}5495 + 3{,}786 + 3{,}598 + 3{,}5495 + 2{,}9394 + 4{,}1351 + \ldots + 3{,}549} = \frac{3{,}7976}{69{,}9976} = 0{.}0542$$

The calculation above is carried out from V1 to V10 the results of the V vector values are obtained (Table 9).

Table 9. Vector V calculation results

Alternative	Value Vector V	Alternative	Value Vector V
V_1	0.050709	V_{11}	0.047214
V_2	0.054255	V_{12}	0.041367
V_3	0.037412	V_{13}	0.066311
V_4	0.050709	V_{14}	0.041367
V_5	0.054094	V_{15}	0.056919
V_6	0.05141	V_{16}	0.047136
V_7	0.050709	V_{17}	0.050709
V_8	0.041994	V_{18}	0.033331
V_9	0.059076	V_{19}	0.066311
V_{10}	0.048256	V_{20}	0.050709

2.6. SAW Manual Calculation

The final calculation is using the SAW method. The first step is to normalize the matrix first. by finding the max value in the column for each criterion. After obtaining the value from the normalization results, the calculation and ranking of alternative data is then carried out based on the results of the summation equation of the method. Figure 2 is the result of the matrix normalization calculation, which is then multiplied by the weight of each criterion using the SAW method.

$$\begin{bmatrix} 1/5 & 5/5 & 5/5 & 4/4 & 4/4 \\ 3/5 & 5/5 & 5/5 & 2/4 & 4/4 \\ 1/5 & 2/5 & 4/5 & 4/4 & 4/4 \\ 1/5 & 5/5 & 5/5 & 4/4 & 4/4 \\ 5/5 & 5/5 & 2/5 & 4/4 & 4/4 \\ 5/5 & 2/5 & 5/5 & 4/4 & 4/4 \\ 1/5 & 5/5 & 5/5 & 4/4 & 4/4 \\ 2/5 & 2/5 & 4/5 & 4/4 & 4/4 \\ 5/5 & 5/5 & 5/5 & 2/4 & 4/4 \\ 1/5 & 5/5 & 4/5 & 4/4 & 4/4 \end{bmatrix} = \begin{Bmatrix} 0{,}2 & 1 & 1 & 1 & 1 \\ 0{,}6 & 1 & 1 & 0{,}5 & 1 \\ 0{,}2 & 0{,}4 & 0{,}8 & 1 & 1 \\ 0{,}2 & 1 & 1 & 1 & 1 \\ 1 & 1 & 0{,}4 & 1 & 1 \\ 1 & 0{,}4 & 1 & 1 & 1 \\ 0{,}2 & 1 & 1 & 1 & 1 \\ 0{,}4 & 0{,}4 & 0{,}8 & 1 & 1 \\ 1 & 1 & 1 & 0{,}5 & 1 \\ 0{,}2 & 1 & 0{,}8 & 1 & 1 \end{Bmatrix}$$

Figure 2. SAW matrix normalization

$(0{,}2.3) + (1.5) + (1.4) + (1.3) + (1.3) = 0{,}6 + 5 + 4 + 3 + 3 = 15{,}6$

$(0{,}6.3) + (1.5) + (1.4) + (0{,}5.3) + (1.3) = 1{,}8 + 5 + 4 + 1{,}5 + 3 = 15{,}3$

Multiplying the matrix with each criterion weight then adding up all the results per row 1 that the results are obtained that become a reference for recommendations for superior broodstock of carp (Table 10).

Table 10. SAW calculation results

Alternative	Value Vector V	Alternative	Value Vector V
V_1	15.6	V_{11}	13.8
V_2	15.3	V_{12}	13.2
V_3	11.8	V_{13}	18
V_4	15.6	V_{14}	13.2
V_5	15.6	V_{15}	16.2
V_6	15	V_{16}	13.6
V_7	15.6	V_{17}	15.6
V_8	12.4	V_{18}	10.3
V_9	16.5	V_{19}	18
V_{10}	14.8	V_{20}	15.6

3. RESEARCH RESULTS

Users can see alternative goldfish brood stock, and view alternative conversions into weights. Users can also process calculated data for the WP method and the SAW method, as well as processing the recommended data after completing the calculation of data processing in Figure 3.

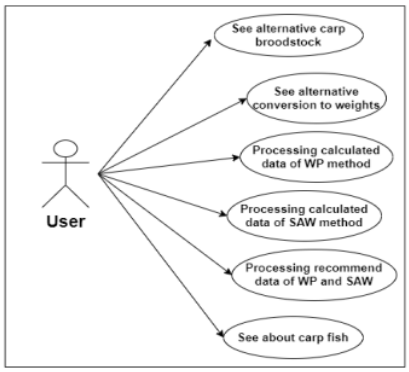

Figure 3. Use case of superior goldfish brood stock recommendation

Research using the SAW method found that from 20 alternative data for carp, there were 4 data that did not match the results of the breeder's data. Alternatives that match the results of the farmer's data are 16 data, so the level of data accuracy is 16/20 x100% = 80%. Meanwhile, using the WP method from 20 alternative goldfish data, there are 2 data that do not match the results of the breeder's data. Alternatives that match the results of the farmer's data are 18 data, so the data accuracy rate is 18/20 x100% = 90%.

Activity diagram explains the activity paths that can be done to the system that has been built, there are five forms, namely the main page, superior goldfish brood stock data, criteria weight data, WP and SAW calculations. The main page is the initial view. Select the Goldfish broodstock data menu, which is a form that displays the broodstock data that has been inputted. Weight data is a place to store data that has been normalized to criteria weights. WP calculation and SAW calculation is part of calculating the value of superior broodstock. The last process is the recommendation menu that has been ranked in the top 10 data to be used as superior breeders. The menu about carp is a menu to view information from carp and information about the explanation of the criteria (Figure 4).

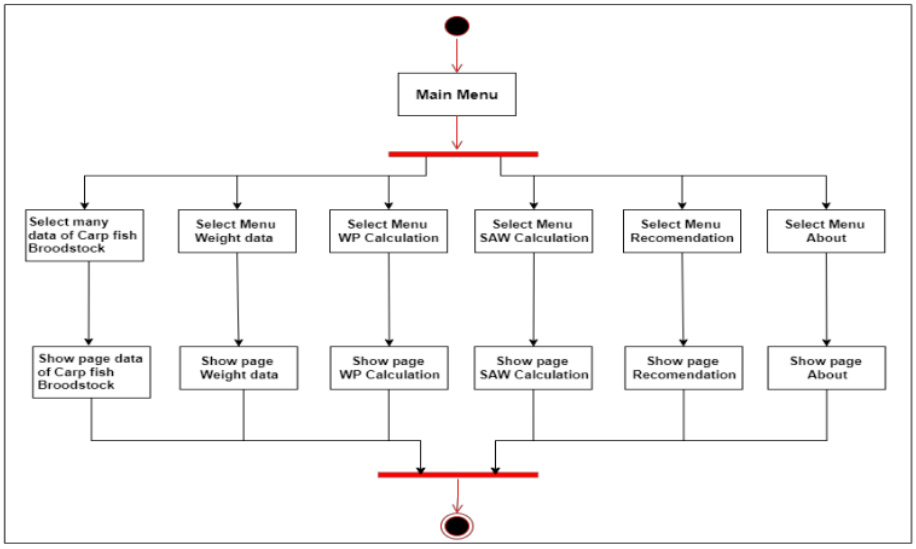

Figure.4. Activity diagram of superior goldfish brood stock recommendation

4. CONCLUSION

Design and Development of a Decision Support System for the selection of Majalaya carp broodstock to seek alternative superior broodstock as a solution for fish cultivators. This system uses the WP method and the SAW method. Factors that influence the selection of superior broodstock are ideal body weight, fish movement, physical abnormalities, scale shape, and tail base shape. All of these assessment criteria are expected to assist in selecting superior Majalaya carp brooders. Of the 20 superior broodstock of Majalaya carp selected by the observers, there were 2 brood fish that did not comply with the WP method. If using the SAW method there are 4 brood fish that do not match the results of the breeder data. So it can be concluded that the WP method gets a better accuracy value of 90% compared to the SAW method which gets an accuracy value of 80%.

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BIOGRAPHIES OF AUTHORS

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Surya Adithama

Muhammad Labib Jundillah

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