Decision-Making Analysis of Koi Pool Pump Selection using Analytical Hierarchy Process (AHP) Method

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Decision-Making Analysis of Koi Pool Pump Selection using Analytical Hierarchy Process (AHP) Method

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ABSTRACT

The availability of various koi pond pump products is sold with various kinds, types, and various advantages. This diversity makes it difficult for business owners to determine a koi pond pump product that suits their business needs. The consideration of the pump in question is a koi pond pump in the form of an electric submersible pump or ESP. One method that can be used for the selection of a koi pond pump is the AHP (Analytical Hierarchy Process) method. This study uses the AHP method assisted by expert choice software. From the results of the assessment of the criteria in the selection importance of suppliers, the priority scales are as follows: Priority I Brand Reputation (0.4251), Product Design (0.2661), Power Consumption (0.1102), Durability (0.1074), Ease of Maintenance (0.054), and Price (0.0409). From the results of the alternative assessment, the following priorities were generated: priority I Eheim CON12000 (0.4105), Resun PG12000 (0.2318), Yamano ACT12000 (0.2025), and Atman MP12000 (0.1551).

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1. INTRODUCTION

Business competition is getting tougher with the entry of various kinds of new competitors. To win the business competition, it needs to be innovation and continuous improvement for business continuity. A healthy business can be seen from the owner's ability to manage all incoming information to be analysed and used as a basis for decision-making. This decision-making applies to all small and medium-sized businesses[1], [2]. One of them is King Aquatik Ambarawa, a micro business which is engaged in the cultivation of freshwater ornamental fish. The key to fish farming is how a farmer maintains water quality[3][4]

To maintain water quality, a pond pump is needed which functions to pump water, produce oxygen concentrations in the water, create water waves, and reduce ammonia, nitrate, and nitrite levels[5]. The availability of various koi pond pumps on the market with various advantages is a consideration in maintaining water quality[6][7]. The need for koi pond pump is a type of *Electric Submersible Pump* (ESP)[8].

Due to the need for a koi pond pump as described above, as well as the availability of various koi pond pumps on the market with various advantages, where this diversity makes it difficult for business owners to determine the right koi pond pump according to their business needs, a problem arises, namely which koi pond pump is the best to choose? To solve the above problems, a method is needed to be used as a solution, one of which is by the way of decision-making analysis[6], [9]–[15].

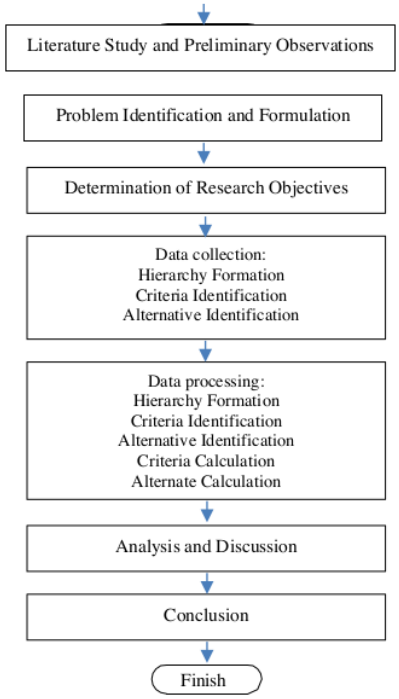
AHP is one of the decision-making analysis methods that use human perception, which understands the problem posed as the main information input [10]. The advantages of the AHP method are that it can solve multi-criteria problems with one-way absolute without any fuzziness hierarchies, rational weighting, and relatively short time.

Previous studies were very limited on the development needs and success of fish farming. Even though it is known that the success of fish farming is very much influenced by some factors. A previous study [6] used AHP to select the type of ESP pump in oil drilling on 3 factors. In addition, the research on fish farming [10]

focuses on the selection of fish suppliers, which considers price, service quality and fish specifications. This study explored expert preferences to determine the pump selection factors in koi fish farming.

2. RESEARCH METHOD

This research was developed using the AHP method. The data needed are secondary data obtained from literacy and previous research and primary data obtained from observations and questionnaires to respondents based on the volume of the pool and the required discharge. The stages of the research are as follows:



Picture 1. Flow Chart Research

2.1. Literature Study and Preliminary Observation

Conduct reference by finding the references which is related to the AHP method and submersible pump case studies.

2.2. Problem Identification and Formulation

Define the problem and describe the process to solve the problem.

2.3. Determination of Research Objectives

Determine the alternative solutions for selecting koi pond pumps based on the types of machines on the market.

2.4. Data Collection

Collect the secondary data derived from literature and primary data based on field observations and discussions.

Identification of Criteria and Alternatives

Identifying criteria and alternatives start with secondary data collection, namely research [6] regarding ESP pumps in the Zaryka field with the criteria for product durability, experience and reputation, and the amount of maintenance. The next step is the process of collecting primary data with resource persons, business owners who have been working in the field of koi enlargement since 2017, and workers who have taken care of koi ponds since 2018, to find out the suitability of the criteria in selecting a koi pond pump. On this basis, criteria and alternatives are determined according to the needs analysis based on pond volume calculations as a basis for decision-making.

Hierarchy

Based on the identification of criteria and alternatives, the next stage is a description of the problem as a decision-making hierarchical tree.

2.5. Data Processing

Calculate the primary data from the pairwise comparison questionnaire results.

Pairwise Comparison Questionnaire

At this stage, respondents were asked to assess decision preferences based on objectives, criteria, and alternatives using a pairwise comparison questionnaire. This assessment uses a Likert scale that is used for the AHP method, which has a value from 1 to 9

Table 1. Value Rating Scale

	Information
1	Criterion/Alternative A is as important as Criterion/alternative B
3	A is slightly more important than B
5	A is more important than B
7	A is clearly more important than B
9	Absolute is more important than B
2,4,6,8	When in doubt between two adjacent values
* The comparison value of B with A is 1 (one) divided by the comparison value of A or [1/A]	

Weight

In this case, the respondents involved were business owners and senior employees. Then the respondent's assessment is calculated using the Geometric Mean with the following formula: $a_{ij}=(R_1,R_2,R_3,\ldots,R_n)^{1/n}$. After that, the geometric mean calculation results are entered in each column according to the pairwise comparisons. By calculating the eigenvector values of each pairwise comparison matrix, the result of eigenvalues are the weights of each element which will be used to determine the priority of elements in the lowest hierarchical structure until it reaches the top hierarchical structure.

Consistency

Next is the consistency test to test the respondents whether in filling out pairwise comparisons are always consistent or not. A matrix is considered consistent if the Consistency Ratio (CR) value is <0.1. While it is inconsistent if the allowed value is 10%. The CR formula is below

$$CR = \frac{CI}{RI}$$

2.6. Analysis and Discussion

Determine the weight of the criteria, sub-criteria, and alternatives based on expert preferences to provide a proposed consideration in deciding on selecting a Koi pump.

2.7. Conclusion

State the hierarchical form level 1 (one) priority criteria, level 2 (two) prior sub-criteria and level 3 (three) alternative priority options.

3. RESULTS AND ANALYSIS

In the process of deciding to choose an alternative koi pond pump, it is carried out using the Analytical Hierarchy Process approach in several stages of the process as follows:

3.1. Criteria and Alternative Decision

From the results of observations and interviews, identification of criteria, sub-criteria and alternative Koi pump engines were obtained the decision making consideration.

Table 2. Criteria, Sub-criteria, and Alternatives for Koi Pump Selection

Criteria	Sub- Criteria	Preference Assessment
Product Design (Quality)	Compliance with Specifications (Q1)	

	Material Quality (Q2)	An assessment that is measured from the physical goods as the satisfaction of needs
	Safety Factor Guarantee (Q3)	
	Concise Product Design (Q4)	
Price (Price)	Compatibility with Quality (P1)	The value of the pump money unit measured in quantitative units
	Price Affordability (P2)	
Brand Reputation (Serviceability)	Ability to give guarantees (S1)	Brand's ability to serve customers from promotion to after-sales
	Spare Parts Availability (S2)	
	Ease of getting Products (S3)	
	Manufacturer Experience (S4)	
Power Consumption (Features)		The electricity consumption of a pump is measured in watts
Endurance (Durability)		The durability of the use of the pump up to a relatively long time
Ease of Maintenance (Maintenance)		Ease of maintenance of the pump for a certain time
Koi Pond Pump Alternatives		
Eheim CON 12000		The need for water debit is 12000 liters/hour
Atman MP-12000		Speed ability to decompose waste
Resun PG12000		Economical price
Yamano AC-T12000		Voltage 220V

3.2. Hierarchy

The decision-making process based on predetermined criteria, sub-criteria, and alternatives is described as a hierarchy to make it easier to compare judgments at each level of the hierarchy. The following is the Koi Pond Pump selection hierarchy.

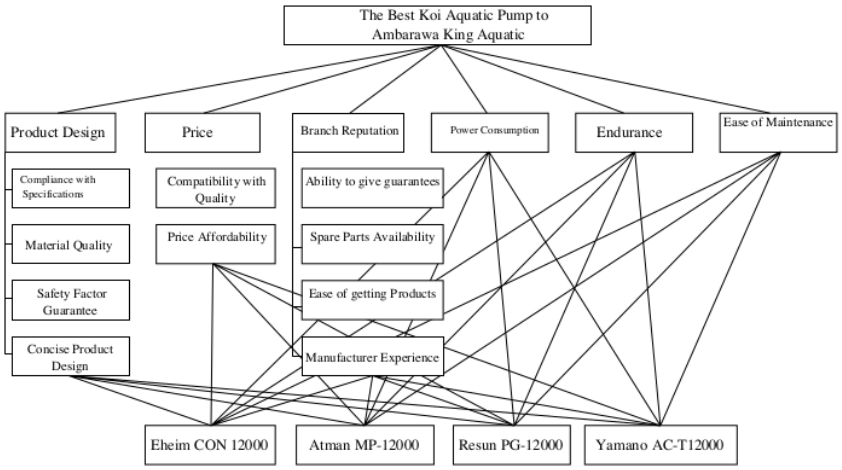


Figure 2. Decision Making Hierarchy

In the hierarchy above, you can see the relationship of each criterion to the sub-criteria and the alternatives that are decided to be material for consideration in selecting a koi pond pump.

3.3. Level Priority

Local priority is the result of pairwise comparisons from level 1 (between criteria), level 2 (between sub-criteria), and level 3 (alternative to sub-criteria). The following is an overall table of these local priorities:

Table 3. Local Priorities

Level 0 (Goal)	Level 1 (Criteria)	Weight	Level 2 (Sub-Criteria)	Weight	Alternatives	Weight

Selection of the Best Koi Pond Pump	Product Design	0,2661	Q1	0,5634	Eheim CON12000	0,5560
					Atman MP12000	0,2059
					Resun PG12000	0,0661
					Yamano ACT12000	0,1720
			Q2	0,1354	Eheim CON12000	0,6944
					Atman MP12000	0,1752
					Resun PG12000	0,0598
					Yamano ACT12000	0,0706
			Q3	0,2582	Eheim CON12000	0,7113
					Atman MP12000	0,0920
					Resun PG12000	0,1310
					Yamano ACT12000	0,0657
			Q4	0,0430	Eheim CON12000	0,2784
					Atman MP12000	0,2186
					Resun PG12000	0,1379
					Yamano ACT12000	0,3652
	Price	0,0409	P1	0,8964	Eheim CON12000	0,7065
					Atman MP12000	0,1264
					Resun PG12000	0,0537
					Yamano ACT12000	0,1134
			P2	0,1036	Eheim CON12000	0,0367
					Atman MP12000	0,1103
					Resun PG12000	0,5711
					Yamano ACT12000	0,2818
	Brand Reputation	0,4215	S1	0,1436	Eheim CON12000	0,4396
					Atman MP12000	0,2584
					Resun PG12000	0,2309
					Yamano ACT12000	0,0710
			S2	0,2672	Eheim CON12000	0,1499
					Atman MP12000	0,1022
					Resun PG12000	0,4718
					Yamano ACT12000	0,2762
			S3	0,4096	Eheim CON12000	0,0485
					Atman MP12000	0,0841
					Resun PG12000	0,3939
					Yamano ACT12000	0,4736
			S4	0,1796	Eheim CON12000	0,6030
					Atman MP12000	0,1435
					Resun PG12000	0,1343
					Yamano ACT12000	0,1192
	Power Consumption	0,1102			Eheim CON12000	0,4837
					Atman MP12000	0,3074
					Resun PG12000	0,1514
					Yamano ACT12000	0,0574
	Endurance	0,1074			Eheim CON12000	0,6071
					Atman MP12000	0,1342
					Resun PG12000	0,1648
					Yamano ACT12000	0,0939
	Ease of				Eheim CON12000	0,1495
					Atman MP12000	0,0598

	Maintenance	0,0540		Resun PG12000	0,4653
				Yamano ACT12000	0,3254

The results in table 3 are the weight of the comparison of each criterion level, the sub-criteria level to the criteria and the alternative level to the sub-criteria level. This weight value indicates the level of importance at each level of expert preference.

3.4. Overall Priority

From the local priority data, the overall priority is weighted by multiplying the local priority by the priority level above it. Here is the overall priority table.

Table 4. Overall Priority Table

Level 0 (Goal)	Level 1 (Criteria)	Weight	Level 2 (Sub-Criteria)	Weight	Alternatives	Weight
Selection of the Best Koi Pond Pump	Product Design	0,2661	Q1	0,1499	Eheim CON12000	0,0833
					Atman MP12000	0,0309
					Resun PG12000	0,0099
					Yamano ACT12000	0,0258
			Q2	0,0360	Eheim CON12000	0,0250
					Atman MP12000	0,0063
					Resun PG12000	0,0022
					Yamano ACT12000	0,0025
			Q3	0,0687	Eheim CON12000	0,0489
					Atman MP12000	0,0063
					Resun PG12000	0,0090
					Yamano ACT12000	0,0045
			Q4	0,0114	Eheim CON12000	0,0032
					Atman MP12000	0,0025
					Resun PG12000	0,0016
					Yamano ACT12000	0,0042
	Price	0,0409	P1	0,0367	Eheim CON12000	0,6333
					Atman MP12000	0,1133
					Resun PG12000	0,0481
					Yamano ACT12000	0,1017
			P2	0,0042	Eheim CON12000	0,0038
					Atman MP12000	0,0114
					Resun PG12000	0,0592
					Yamano ACT12000	0,0292
	Brand Reputation	0,4215	S1	0,0605	Eheim CON12000	0,0631
					Atman MP12000	0,0371
					Resun PG12000	0,0332
					Yamano ACT12000	0,0102
			S2	0,1126	Eheim CON12000	0,0401
					Atman MP12000	0,0273
					Resun PG12000	0,1261
					Yamano ACT12000	0,0738
			S3	0,1726	Eheim CON12000	0,0199
					Atman MP12000	0,0344
					Resun PG12000	0,1613
					Yamano ACT12000	0,1940
			S4	0,0757	Eheim CON12000	0,1083
					Atman MP12000	0,0258
					Resun PG12000	0,0241

				Yamano ACT12000	0,0214
	Power Consumption	0,1102		Eheim CON12000	0,0533
				Atman MP12000	0,0339
				Resun PG12000	0,0167
				Yamano ACT12000	0,0063
	Endurance	0,1074		Eheim CON12000	0,0652
				Atman MP12000	0,0144
				Resun PG12000	0,0177
				Yamano ACT12000	0,0101
	Ease of Maintenance	0,0540		Eheim CON12000	0,0081
				Atman MP12000	0,0032
				Resun PG12000	0,0251
				Yamano ACT12000	0,0176

From these results, it can be said that brand reputation has the most influence on the selection of koi pond pumps with a weight value of 0.4215. The results of previous research[8] indicate that there is a positive influence on brand reputation and product quality on repeat purchases (repurchase intention).

3.5. Alternative and Criteria Weight

Determining the weight of each overall alternative can be calculated by adding up all the weights for each alternative koi pond pump, resulting in weights and ranks as shown in the table below:

Table 5. Alternative Weights and Ranks

Alternatives	Weight	Rank
Eheim CON12000	0,4105	1
Resun PG12000	0,2318	2
Yamano ACT12000	0,2025	3
Atman MP12000	0,1551	4

These results provide information that the best koi pond pump to be chosen by King Aquatic Ambarawa is Eheim CON12000 because overall the criteria and sub-criteria for this koi pond pump have the highest value compared to the other three koi pond pumps. In addition, Eheim CON12000 is believed to be superior among koi cultivators. It is because due to the comparable quality and price, the ability to perform low electric power with a high water flow rate, and good product durability due to the use of high-quality materials.

The selection of koi pond pumps based on each criterion can be analyzed in the table below:

Table 6. Alternative Weight Based on Criteria

Criteria	Eheim CON12000	Atman MP12000	Resun PG12000	Yamano ACT12000
Product Design	**0,1604**	0,0460	0,0226	0,0370
Price	**0,0261**	0,0051	0,0044	0,0054
Brand Reputaion	0,0975	0,0525	**0,3447**	0,1262
Power Consumption	**0,0533**	0,0339	0,0167	0,0063
Daya Tahan	**0,0652**	0,0144	0,0177	0,0101
Kem. Perawatan	0,0081	0,0032	**0,0251**	0,0176

Table 5 and 6 are the results of the overall weight of alternatives and criteria. Brand reputation criteria have the highest weight. It shows that the preference experts believe the brand is still an important point in decision-making 12 ponds for the purpose of growing koi fish, a land area of about 20m^2 and a total capacity of 300 koi fish measuring 10 to 15 cm, then in the case of choosing a koi pond pump for Aquatic Ambarawa, the Eheim CONI2000 is the choice with the highest weight of 0.4105. Eheim CON12000 is believed to be superior in koi cultivation circles because of its comparable quality and price, as well as its ability to perform low electric power with high water flow rates, as well as good product durability because it uses high-quality materials.

4. CONCLUSION

Koi pond pump criteria weight sequentially is Brand Reputation (0.4251), Product Design (0.2661), Power Consumption (0.1102), Durability (0.1074), Ease of Maintenance (0.054), and Price (0 .0409). The best alternative weight for choosing a koi pond pump for a case study on Ambarawa King Aquatic Micro Business in first place is Eheim CON12000 with a weight of 0.4105, the second place is Resun PG12000 with a weight

of 0.2318, the third place is Yamano ACT12000 with a weight of 0.2025, and the fourth place is Atman MP12000 with a weight of 0.1551.

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