IMPLEMENTATION OF AHP AND SAW METHODS ON DECISION SUPPORT INFORMATION SYSTEM OF SELECTION FOR FLEET OF GOODS DELIVERY (PT. XYZ TO OPTIMIZE SHIPPING COSTS)

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ABSTRACT

PT. XYZ is a freight forwarding company in Bandung City, where the delivery of goods is done throughout Indonesia. Delivery of goods made only from the city of Bandung alone, so that raises the risk when the process of delivery of goods, especially on the cost of delivery of goods. The process of shipping only a small amount of goods and distance is one of the problems if the delivery is done by the fleet itself, it is necessary fleet partners for cost efficiency and freight forwarding. To help the company determine the delivery fleet of goods for more efficient cost, it is necessary a decision support information system. In building this decision support information system using Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) method. The application of the AHP method to determine the weight of each criterion, while the SAW method is applied to determine the ranking of each method. Both of these methods can process the data to become a more accurate decision in the selection of fleet or fleet of goods delivery partners for more efficient shipping costs. This research is only about decision making only; there are still many business processes of the company which is not discussed in this research. If this research will be developed, it is expected to discuss other company business processes.

Keywords: Decision Support System, AHP Method, SAW Method, Shipping Fleet, Cost Efficiency

1. INTRODUCTION

The current e-commerce business advancement continues to grow rapidly in line with the increasing public demand for products and services to meet all of its needs [1]. Delivery of goods is the most important thing in the e-commerce business. Once the goods do not get into the hands of the consumer well then the good name of the e-commerce business seller will be smeared [2][3].

Most e-commerce entrepreneurs make use of shipping companies for goods to be delivered to consumers, both between cities and out of town [4]. PT XYZ is one of the freight forwarding company located in Bandung City. To maintain business continuity due to competition, the company must provide satisfaction to its customers. To provide satisfaction to customers, the company chooses delivery packages in the delivery of goods delivery package with delivery time is faster than usual. Surely the customer must pay the tariff according to his choice. But in providing maximum service for customers, the company must also pay attention to things that affect the company's own business, one of which is the cost efficiency in the delivery of goods.

The cost incurred by the company will be less efficient if the company sends goods in small quantities and long distance shipments using the company's shipping fleet [5]. Then the company must have a freight forwarder company partner [6]. In selecting the goods delivery partner, the company should pay attention to several criteria such as partner quality, partner-owned package, and of course the cost of the partner. If the company involves the partner, the company must take an appropriate decision in selecting partners [7]. The company should be able to take into account the costs incurred in deciding to use its fleet or use a corporate partner by customer orders [8].

Based on the problem, the company needs a decision support information system that can determine the delivery options of goods using its shipping fleet or involve partners by taking into account more efficient shipping costs. The methods used for decision making are the AHP and SAW methods. The criteria used in this study such as distance delivery, delivery package selection, rating partners, and the number of items sent. The resulting output is in the form of a decision that can make it easier for companies to determine whether the delivery of goods is done by their fleet or to use partners with more efficient costs [9]. If the results are out using a partner, then the partner selected is a partner that has a rating and suitability order with a more efficient cost that has been calculated by the system [10].

2. METHODS

Research methodology is a method used in this study to collect and describe the situation directly in the field. The more detailed explanation of the methods used in preparing this study as shown below:

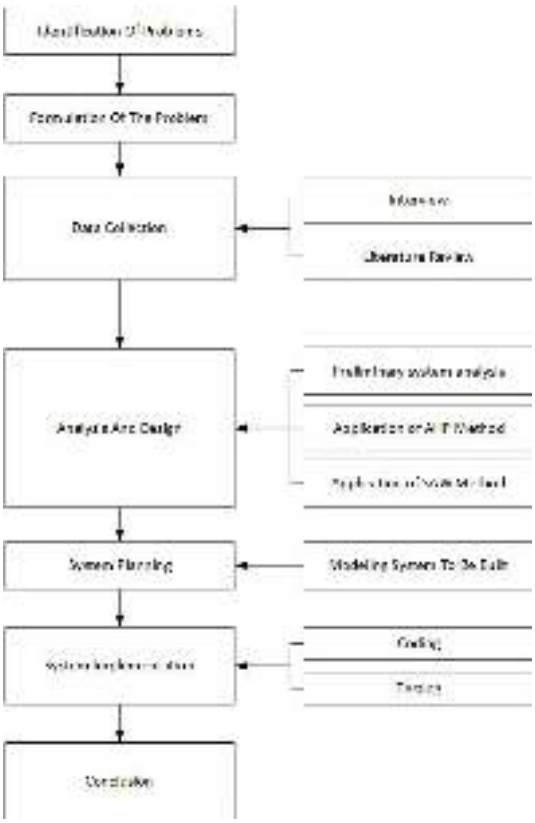


Figure 1. Research methodology

2.1. General Explanation

Based on the methodology above the first step in the research is to identify the problem which is the most important in the research because the problem will determine the quality of the research. The problem in this research is how to optimize shipping cost at the company. In sending the goods, the company must be able to determine the delivery fleet for the cost incurred by the company more efficiently. The next step is the formulation of the problem. The problem formulation is an elaboration of the problem identification which includes full and detailed questions about the scope and constraints of the problem. The next step is to collect data. In collecting

Data, the authors use interview methods. Interviews were conducted to collect data on the delivery of goods on the company used for research through several sources to determine the criteria. In addition to interviews, for complete information then the author looking for literature studies on the efficiency of freight costs. In addition to the literature, the shipment data on the company also includes one of the required literature studies. After collecting the data, the next step is analysis and design. In this first step, the author analyzes the initial system that is running on the company. Furthermore, based on the problems studied, the authors use the AHP and SAW methods to solve problems regarding the efficiency of shipping costs. The application of the AHP method is used to determine the weight of the predefined criteria. After the weight of the value of each criterion is determined then next calculate the value of Consistency Ratio (CR) to determine whether the criteria are consistent or not. If the value of CR < 0.1 then declared consistent. Once weigh the consistent CR criteria and CR values, the ranking of each alternative is determined using the SAW method. Both methods are applied in the system to determine the decision in determining the delivery fleet of goods for more efficient shipping costs. Next stage system design. At this stage will be modeling on the system to be built. Once the system is designed then the system is implemented. The algorithm used in the method applied to the system in program code. Then the system must be tested first to find if there is an error in the system. After all, steps are done then it can be concluded from this research.

2.2. Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) was developed by Thomas L. Saaty, a mathematician from the University of Pittsburgh, the USA in the 1970s. This decision support model will describe complex multi-factor or multi-criteria problems into a hierarchy [27]. A problem is said to be complex if the structure of the problem is unclear and unavailability of accurate statistical data and information so that the input used to solve this problem is human intuition [26]. Essentially, the AHP method breaks down a complex, unstructured situation into its parts, arranging that part or variable in a hierarchical order, assigning numerical values to subjective considerations about the relative importance of each variable, and synthesizing considerations and increasing reliability AHP as a decision-making tool [25].

2.3. Simple Additive Weighting (SAW)

The SAW method is often also known as the weighted summing method [29]. The basic concept of the SAW method is to find the weighted sum of performance ratings on each alternative on all attributes [30]. The SAW method requires the process of normalizing the decision matrix (X) to a scale comparable to all existing alternative ratings [31].

3. RESULTS AND DISCUSSION

In this research, the AHP method is used to determine the weight of the criteria used in the study. Then after the criteria weight is obtained, then proceed with the SAW method to determine the ranking of each alternative.

3.1. The process of AHP Method And SAW Method

3.1.1. The first stage is to define the problem and determine the desired solution.

In setting priorities, priority-setting issues should be able to decompose into goals of an activity, identify alternatives, and formulate criteria for choosing priorities. The purpose of the study is to determine the delivery fleet of goods for more efficient shipping costs. Criteria used:
C1 = Time, C2 = Results Packing, C3 = Number of Goods, C4 = Fleet Type, C5 = Shipping Cost
Alternative used:
A1 = Own Fleet, A2 = JNE, A3 = Tiki, A4 = Pos Indonesia, A5 = J & T

3.1.2. Develop a hierarchy that begins with the main purpose.

Hierarchy is a structural abstraction of a system that studies the interaction functions be-tween components and their effects on the system. Preparation of a hierarchy or decision structure is undertaken to illustrate the identified system elements or decision alternatives. A hierarchy is defined as a representation of a complex problem in a multi-level structure where the first level is the goal, followed by the factor level, criteria, sub-criteria [1].

3.1.3. Assessment of priority of criterion and alternative elements.

Once the problem decomposes, then there are two stages of assessment or comparing elements between the comparison between criteria and comparison between alternatives for each criterion. Comparison between criteria is intended to determine the weight for each criterion. On the other hand, the comparison between alternatives for each criterion is intended to look at the weight of an alternative for a criterion. In other words, this assessment is intended to see how important an option is seen from certain criteria. We need to make the conversion table from the priority statement into the numbers. For various issues, a scale of 1 to 9 is the best scale for expressing opinions [20].

3.1.4. Develop criteria with pairwise matrices.

Table 1 Matched paired matrices

Criteria	Time	Results Packing	Number of Goods	Fleet Type	Shipping Cost
Time	1	0.33	0.25	0.17	0.14
Results Packing	3	1	0.75	0.50	0.43
Number of Goods	4	1.3	1	0.67	0.57
Fleet Type	6	2	1.5	1	0.86
Shipping Cost	7	2.30	1.75	1.17	1

3.1.5. Summing the element value of each column of the criteria matrix element values above.

3.1.6. Dividing each element in the column by the appropriate number of columns from the values of the element of Martic table 2 and the sum of each column above, it can be calculated the normalization matrix by dividing each element in the column by the number of appropriate fields.

Table 3 Result matrix normalization criteria

Criteria	Time	Results Packing	Number of Goods	Fleet Type	Shipping Cost
Time	1/21 = 0,05	0,33/6,95 = 0,05	0,25/5,25 = 0,05	0,17/3,51 = 0,05	0,14/3 = 0,05
Results Packing	3/21 = 0,14	1/6,95 = 0,14	0,75/5,25 = 0,14	0,50/3,51 = 0,14	0,43/3 = 0,14
Number of Goods	4/21 = 0,19	1,3/6,95 = 0,19	1/5,25 = 0,19	0,67/3,51 = 0,19	0,57/3 = 0,19
Fleet Type	6/21 = 0,29	2/6,95 = 0,29	1,5/5,25 = 0,29	1/3,51 = 0,29	0,86/3 = 0,29
Shipping Cost	7/21 = 0,33	2,30/6,95 = 0,33	1,75/5,25 = 0,33	1,17/3,51 = 0,33	1/3 = 0,33

3.1.7. The next step sums up each row of the matrix. After obtaining the number of each line, then counted the priority value of criteria by dividing each number of rows by the number of elements or number of criteria (n = 4), so the priority value of each criterion can be calculated. So if in percent form can be seen in table 4.

Table 4 Percentage of Criteria Value

Criteria	Weight	Percentage
Time	0,05	5%
Results Packing	0,14	14%
Number of Goods	0,19	19%
Fleet Type	0,29	29%
Shipping Cost	0,33	33%
Total	1	100%

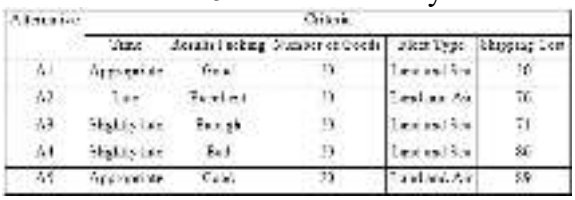
3.1.8. Testing Consistency

The pairwise comparison is said to be consistent when the value of CR $\leq$ 0,1. Since the consistency ratio value is -0.0082 < 0.1, then the above matrix is consistent.

3.1.9. After the weight value of each criterion is obtained and the consistency ratio test results are consistent, then the next

process is to use the SAW method. For data used is data delivery of goods from Bandung to Padang, here are the data used:

Table 5 Data of delivery



3.1.10. Creating Criteria Value

Criteria value contains the code of criteria, the name of the criteria, the weight of the value, and the optional description that is as a limitation of the value of each criterion. Determining the criteria values can be selected from several measurement scales, such as 1-4, 1-5, 1-10 and 1-100 scales.

Table 6 The value of each alternative on each criterion

Alternative	Criteria				
	C1	C2	C3	C4	C5
A1	100	75	20	40	20
A2	50	100	20	60	76
A3	75	50	20	40	71
A4	75	25	20	40	86
A5	100	75	20	60	89

3.1.11. Determine the criteria of benefits (benefits) and cost (cost).

A criterion is said to be a benefit criterion if the value on the criterion will give an advantage when the value is greater. Conversely, the criterion is said to be the cost criterion (cost) if the value of the criterion will give the cost or the loss when the value is greater. From the criteria, the first, second, third, and fourth criteria are the benefit criteria, while the fifth criterion is the cost criterion.

3.1.12. Normalization of the matrix

For the normalization of benefit criteria using the criteria value formula divided by the largest criteria value. As for the normalization of cost criteria using the formula of the smallest value criteria divided by the criteria value.

$$R_{ij} = \begin{cases} \frac{xij}{Max\,xj} & \text{jika j adalah atribut keuntungan } (benefit) \\ \frac{Min\,xij}{xij} & \text{jika j adalah atribut biaya } (cost) \end{cases} \quad (1)$$

And this is the result of normalization :

Table 7 Result of normalization

r	1	0.75	1	0.67	1
	0.50	1	1	1	0.26
	0.75	0.50	1	0.67	0.28
	0.75	0.25	1	0.67	0.23
	1	0.75	1	1	0.22

3.1.13. Ranking process using specified weights for each criterion

V1 = (1 x 5) + (0.75 x 14) + (1 x 19) + (0.67 x 29) + (1 x 33) = 85.83

V2 = (0.5 x 5) + (1 x 14) + (1 x 19) + (1 x 29) + (0.26 x 33) = 72.68

V3 = (0.75 x 5) + (0.5 x 14) + (1 x 19) + (0.67 x 29) + (0.28 x 33) = 57.63

V4 = (0,75 x 5) + (0.25 x 14) + (1 x 19) + (0.67 x 29) + (0.23 x 33) = 52.21

V5 = (1 x 5) + (0.75 x 14) + (1 x 19) + (1 x 29) + (0.22 x 33) = 69.92

Each alternative is sorted by the largest value of the calculation results to be:

Table 8 Alternative Ranking

Ranking	Alternative	Description	Final Value
1	A1	Own Fleet	85,83
2	A2	JNE	72,68
3	A5	J & T	57,63
4	A3	Tiki	52,51
5	A4	Pos Indonesia	69,92

3.2. Results

In the process of the AHP method, the weighted criteria obtained are listed in table 4. And the result of consistency test is got the value of consistency ratio of -0,0082. The value of -0.0082 is smaller than 0.1 then; the criterion is expressed consistently. After obtained the value of weight criteria,

then is the calculation by SAW method. The criteria used are determined whether the criteria are the benefit or cost criteria. These criteria are the first, second, third and fourth criteria which are the benefit criteria, while the fifth criterion is the cost criterion. Then the value of each criterion is normalized. Once normalized, can be done the ranking process. Ranking process using specified weights for each criterion. In this process, the normalized yield criterion value is multiplied by the weight of the criterion. The ranking of each alternative is sorted by the largest value of the calculation results. The result is the greatest value on V1, so the alternative A1 (Own Fleet) is the alternative selected as the best alternative based on the data delivery, and for the alternative rank listed in table 8.

4. CONCLUSION

Research has proven that hypotheses that arise to solve problems arising in freight for-warding companies using decision-making methods to determine the delivery fleet of goods for more efficient shipping costs have proven true. Using the AHP method to determine the weight of SAW criteria and methods for ranking the ranking of each alternative and presented in a decision-making information system, it has proven that the results obtained can help the company decide to determine the delivery fleet.

5. Acknowledgment

Based on the problems that arise in the company of cost efficiency in determining the delivery fleet, the decision-making method is used. The method of decision making used in the research is the AHP method and SAW method. By using both decision-making methods, it is expected that the results obtained will be able to help companies to determine the delivery fleet of goods. This study has proved that using both methods of retrieval can result in significant decisions to determine the delivery fleet of goods compared with without using decision-making methods.

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