Analytical Hierarchy Process (AHP) for Selecting Freight Forwarder Services to Get Minimum Shipping Cost for Export Goods

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The selection of freight forwarders in the delivery of exported goods is carried out with a direct appointment system. This can affect the level of customer satisfaction, and the cost of shipping and export of goods issued by the company increases. This study aims to minimise the cost of shipping export products. The method used to select freight forwarders is the Analytical Hierarchy Process (AHP) Method. Using the AHP method, the calculation of freight forwarder services can be used to determine th type of freight forwarder services that have the highest weight and calculation of shipping costs for export goods outlined by the company. Then, it is possible to compare the costs incurred by the company of several types of freight forwarding services, using one type of goods shipment which has the highest weight in the calculation of the AHP Method. There are four steps to choosing freight forwarder services, using the AHP method. Pairwise comparisons are matrices that can compare the weights between criteria and between alternatives. Companies, in choosing freight forwarding services, are advised to use the AHP method as it can be implemented to produce an initial solution that is feasible regarding the performance of the freight forwarding company.

Key words: *AHP, Freight Forwarder, Export Shipping Costs.*

Introduction

Organisations perform all activities and operations within a framework, which is built on its vision and mission. The performance of each activity and operation can be measured using Key Performance Indicators (KPI), which indicate the organisation's success in achieving its strategic objectives (Nurcahyo, R., Wibowo, A., & Putra, R. 2015). Supplier selection is

a strategic decision that significantly influences a firm's competitive advantage. The importance of this decision is amplified when a firm seeks new markets and potentially a new supplier base (Rezaei, Jafar, et al.,2016). With increasing concern towards environmental protection, organisations have become more and more responsible for their products and overall sustainability (Deshmukh, A. J., & Vasudevan, H. 2014). Supplier selection and monitoring of ongoing supplier performance evaluation is based on operational and strategic criteria (Nair, A., Jayaram, J., & Das, A. 2015). Activities in a manufacturing company include production, warehousing, distribution and transportation activities. The company which carries out these activities must have good strategies so that the products offered are in accordance with the wishes of consumers and able to increase customer satisfaction. Distribution activities can be interpreted as the process of distributing goods or services from producers to consumers with the right products, prices, quantities, time, location, quality, and service. The process of sending exported goods is one of a company's activities whose business scope covers several countries, or of consumers of the company in several countries. The sending of export goods must consider all aspects related to the applicable export shipping regulations. The factors that most affects the smoothness of a business process, especially in the delivery of export goods, is the selection of freight forwarder services, as this will determine how quickly and precisely the company can deliver goods, and the optimality of costs incurred.

Cost is an important consideration in a company's business activities, especially shipping costs, because these can affect the smooth running of the company's business processes, such as the level of profits earned by the company, and customer satisfaction from the company. Shipping costs can increase customer satisfaction because shipping activities are a process that determines the company has good service to consumers. Shipping costs can be minimised by selecting the freight forwarder services appropriately.

Previous Literature Review

Based on previous research conducted by Cariou, P in 2018 and research conducted by Kannan, V, et all in 2009 revealed that the Analytical Hierarchy Process (AHP) Method is a method that can determine the weight of criteria owned by freight forwarders. The AHP method has the advantage of selecting freight forwarder services because the AHP method is a one that can simplify complex problems into a structured form. However, among the studies that used the AHP method, no one calculated the comparison of shipping costs incurred when making a freight forwarder service before using the AHP Method after using the AHP Method, so that this is very important by using the AHP method to minimize costs in choosing freight forwarding services.

Problems that have been explained will be corrected so that the company can choose freight forwarder services appropriately. Besides being able to choose freight forwarder services appropriately, the company can also minimize the cost of shipping exported goods.

Methods

To facilitate the present research authors have visited an water pump manufacturer in Jakarta. The company, in sending goods abroad (export) using a third party (or a freight forwarder, all aspects required in shipping export goods are handled by the chosen freight forwarder services. In determining freight forwarder services then, the company appoints responsibility? directly to the freight forwarder services that will be used. Therefore, the company needs to make improvements to the determination of freight forwarder services in the delivery of export goods. There are recommended steps to select freight forwarder services by using the AHP Method as follows:

1. Determine the alternative freight forwarder services that will be selected.
The freight forwarder service that will be selected is the service used to process export goods. Selection of alternative freight forwarder services is carried out through interviews with shipping experts in the company, namely the assistant manager and marketing staff for export marketing.

2. Determine the criteria for freight forwarder services
Determine the criteria for freight forwarder services according to Putri Fajar Wulandari and Ary Arvianto in a journal entitled "Selection of Expedition Services Using the Analytical Hierarchy Process (AHP) Method". In the book of Logistics Management Basics 2017, the criteria are determined based on the results of interviews conducted by experts authorized in the company.

3. Build hierarchy
The hierarchy in the method of AHP involves three levels. the first level is the goal of selecting freight forwarder services. The second level is the criteria that are taken into consideration in the selection of freight forwarder services. The third level is an alternative to the freight forwarder service used.

4. Do pairwise comparisons
Pairwise comparisons compare elements in pairs according to criteria and alternatives of freight forwarder services. In conducting pairwise comparisons, a matrix can be used that can compare weights between criteria and between alternatives. According to Saaty in the Logistics Management Basics book in 2017, the scale used in pairwise comparison is as follows:

Scale 1: Both elements are equally important

Scale 3: One element is slightly more important than the other

Scale 5: One element is more essential or important than the other element

Scale 7: One element is clearly more important than the other element

Scale 9: One element is absolutely more important than the other

Scale 2, 4, 6, 8 are values between two close considerations

Table 1: Pairwise Comparison Questionnaire

Kriteria	Skala																		Kriteria
	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9		

1.   Fill pairwise comparison matrix

The pairwise comparison matrix is filled using numbers that can describe the importance of one element to another. If aij is the value of an individual opinion matrix, which reflects the comparison of interests between the i-th element with the j-th element in a hierarchy of one element above another, then aij is the value of an individual opinion matrix that reflects the comparison of interests between the j-th element and the i-th element in the same hierarchy and is worth 1/aij. If i = j then the value of aij = 1.

Table 2: Pairwise Comparison Matrix

Kriteria	Perbandingan Berpasangan			
	Price	*Responsivity*	*Schedule*	*Document*
Price				
Responsivity				
Schedule				
Document				

2.   Synthesis

The results of pairwise comparison is synthesized to obtain the overall priority by adding the values of each column to the matrix, then normalizing by dividing each value from the

column by the total column. After normalization, the sum of the value of each matrix is divided by the number of elements to get an average score.

In making decisions, the calculator must pay attention to consistency. Low consistency will affect the accuracy of the results obtained from calculations. The process of reaching a decision using the AHP method must calculate several values as follows:

a. Lambda (λ) - a vector consistency average value.

b. Max lambda - the average value of lambda.

c. Consistency Index (CI) - used to measure the level of consistency in the results of calculations using the An AHP Method.

d. Consistency Ratio (CR) - a consistency test that is performed after knowing the value of the Consistency Index (CI).

According to Sutarman in the Logistics Management Basics book, the consistency ratio must be less than 10%. Steps to calculate consistency ratio:

a. Multiply the initial matrix value with the average (priority weight)

b. Divide the matrix multiplication by average (priority weight).

c. Calculate max λ by dividing the results from point b with the number of elements.

d. Calculate the Consistency Index with a formula:

$$CI = \frac{(max\ \lambda - n)}{n-1} \tag{1}$$

Description:

CI = *Consistency Index*

λ = Lambda

n = Number of elements

e. Calculate Consistency Ratio with :

$$CR = \frac{CI}{RI} \tag{2}$$

Description:

CR : *Consistency Ratio*

CI : *Consistency Index*

RI : *Random Index*

3. Calculation of Export Good's Shipping Costs

The calculation of the cost of shipping exported goods is carried out to determine the number of costs that can be minimised after calculating the selection of freight forwarders by using the AHP Method. In the calculation, using the AHP method will produce the value or weight of each freight forwarder service. The calculation of the cost of shipping exported goods is performed by adding up all shipping costs carried out for one year, then a cost

comparison can be made before calculating the weight. After calculating the weight of the freight forwarder services used by the company, calculating the cost reduction percentage in shipping costs of exported goods can be done with the following formula:

$$Cost\ reduction\ percentage = \frac{Cost\ Difference}{Total\ of\ Initial\ Cost}\ x\ 100\% \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(3)$$

4.   Analysis

Based on calculations carried out using the AHP method, it can be seen that the highest weighted freight forwarder services are freight forwarders who have the most appropriate performance to the needs of the company. By knowing the performance of each freight forwarder service used, the company can select the most appropriate freight forwarder service. The appropriate freight forwarder services can affect the company's performance in the process of shipping export goods, especially in terms of costs. Costs incurred will be lower if the company is right in selecting freight forwarder services.

Results and Discussion
Build Hierarchy

The hierarchy contains goals, criteria, and alternatives that are aspects used in the calculation using the Analytical Hierarchy Process. The goal in the hierarchy above is the selection of freight forwarder services. In the hierarchy, there are four criteria and four alternatives obtained from the interviews by experts in the field of shipping export goods in the company, namely, assistant managers and delivery staff. Four criteria are used in the hierarchy as follows:

Figure 1. Hierarchial Structure of *Freight Forwarder* Service Selection
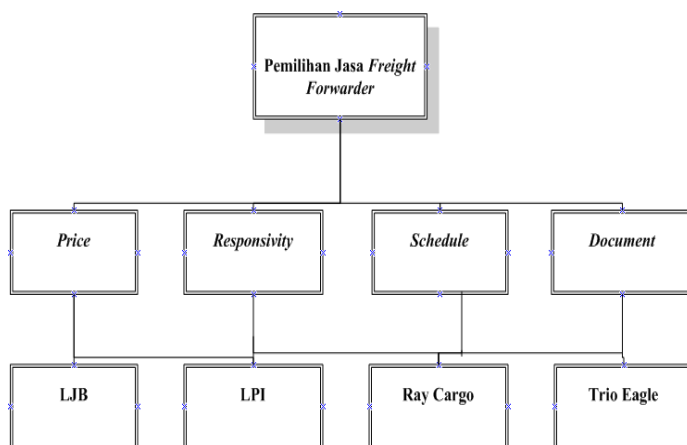
Price

Price is a criterion that affects the performance of freight forwarder services, the price is included in these criteria because it affects the costs incurred by the company to deliver exported goods. The company wants freight forwarders that provide affordable prices to help their business processes.

Responsivity

The response from freight forwarder services is something that is needed to support the export of goods, a good response from freight forwarder service companies will affect the smooth process of shipping exported goods to consumers.

Schedule

A goods delivery schedule that has been determined by freight forwarder services affects the delivery time of exported goods. Freight forwarder services that have the most frequent and appropriate shipping schedules are freight forwarders that can meet the company's needs for sending goods.

Document

Documentation is important in sending export goods. The completeness of the documents provided will affect the performance of freight forwarder services. The timeliness of sending the files needed in shipping export goods will also affect customer satisfaction.

Pairwise Comparison

The comparison is made in pairs between each criterion and each alternative. Comparative data was obtained from a questionnaire filled by two respondents, namely staff and managers of the export marketing division. The following calculations are inter-criteria pairwise comparison:

Figure 2. Inter-Criteria Pairwise Comparison

Compare the relative importance with respect to: Goal: Pemilihan Jasa Freight Forwarder

	Price	Responsiv	Schedule	Document
Price		1.0	2.0	2.0
Responsivity			1.0	1.0
Schedule				1.0
Document	Incon: 0.02			

Table 3: Priority Weight Criteria

Criteria	Price	Responsivity	Schedule	Document	Total	Average *(priority weight)*
Price	0,17	0,25	0,14	0,14	0,70	0,18
Responsivity	0,17	0,25	0,29	0,29	0,90	0,25
Schedule	0,33	0,25	0,29	0,29	1,15	0,29
Document	0,33	0,25	0,29	0,29	1,15	0,29

The average shows the priority weight value for each row. Based on the calculation of priority weight from the four criteria, it can be seen that the criteria that have the highest weight are schedule and document of 0.29, and then responsivity of 0.25. Thesmallest is the price of 0.18.

Calculate Consistency Ratio

Consistency Ratio (CR) calculation is performed after knowing the priority weight value. To find out the value of CR, a matrix calculation should first be done from the value of each pairwise comparison with the priority weight value, lambda calculation, max lambda, and Consistency Index (CI). The CR value produced was 0.02. This implies that the results of the study can be accepted because the value is less than 10% or 0.1.

Table 4: Consistency Ratio Criteria

Criteria	Rata-rata *(priority weight)*	Matrix	Lambda (ʎ)	Lambda Maks	CI	CR
Price	0,18	0,71	4,05			
Responsivity	0,25	1,00	4,05	4,06	0,02	0,02
Schedule	0,29	1,18	4,07			
Document	0,29	1,18	4,07			

Calculate Pairwise Comparison and CR for Alternative

Comparison is made in pairs between each criterion and each alternative. Comparative data was obtained from questionnaires filled by expert sources. What follows are the calculation of pairs between alternatives:

1. Alternative Pairwise Comprison of Price Criteria

Figure 3. Inter-Criteria Pairwise Comparison

Table 5: Criteria weight suppliers

Alternative	LJB	LPI	Ray Cargo	Trio Eagle	Total	Average *(priority weight)*
LJB	0,29	0,20	0,20	0,36	1,14	0,29
LPI	0,29	0,20	0,20	0,36	1,14	0,29
Alternative	LJB	LPI	Ray Cargo	Trio Eagle	Total	Average *(priority weight)*
Ray Cargo	0,29	0,20	0,20	0,09	0,86	0,22
Trio Eagle	0,14	0,14	0,40	0,18	0,87	0,22

2. Calculate Alternative *Consistency Ratio* (CR) of Price Criteria

Consistency Ratio (CR) calculation is performed after knowing the priority weight value,. To determine the value of CR a matrix calculation should first be performed of the value of each pairwise pair with the priority weight value, lambda calculation, max lambda, and Consistency Index (CI). The CR value of 0.09 states that the results of the research can be accepted because the value is less than 10% or 0.1.

Table 6: Consistency Ratio Kriteria Price

Alternative	Rata-rata *(priority weight)*	Matrix	Lambda (ʎ)	Lambda Maks	CI	CR
LJB	0,29	1,23	4,24			
LPI	0,29	1,23	4,24			
Ray Cargo	0,22	0,90	4,19	4,25	0,08	0,09
Trio Eagle	0,22	0,94	4,33			

3. Alternative Pairwise Comparison of Responsivity Criteria

The values contained in the pairwise comparison table for alternatives are the values generated from the questionnaire. Alternative comparisons of the same value are one. The alternative comparison of PT Lintasnuansa Jaya Bersama (LJB) with PT Link Pasipik Indonusa (LPI) is three. This means that PT Lintasnuansa Jaya Bersama (LJB) is a bit more important than PT Link Pasipik Indonusa (LPI). Ray Cargo's alternative comparison with Trio Eagle is worth three and in a three-value system, it shows that Ray Cargo is more important than the Trio Eagle.

Figure 4. Pairwise Comparison of Responsivity Criteria
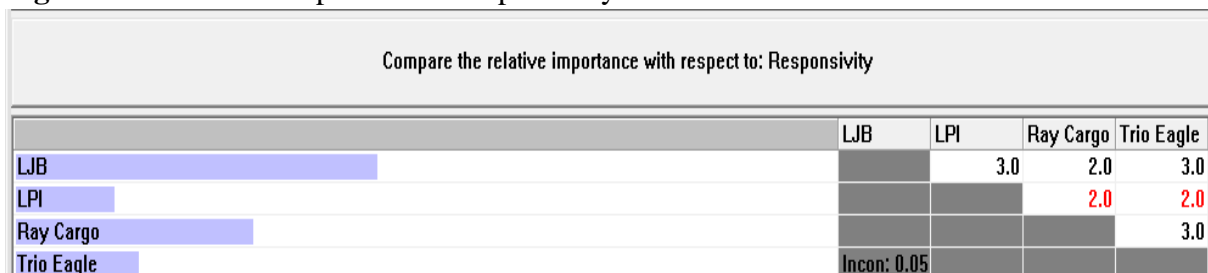
Table 7: Priority Weight of Responsivity Criteria

Alternative	LJB	LPI	Ray Cargo	Trio Eagle	Jumlah	Average (priority weight)
LJB	0,46	0,38	0,52	0,40	1,76	0,44
LPI	0,15	0,13	0,13	0,07	0,48	0,12
Ray Cargo	0,23	0,25	0,26	0,40	1,14	0,29
Trio Eagle	0,15	0,25	0,09	0,13	0,62	0,16

4. Calculate Alternatie *Consistency Ratio* (CR) of Responsivity Criteria

Consistency Ratio (CR) calculation is performed after knowing the priority weight value, to determine the value of CR, a matrix calculation should first be performed of the value of each pairwise pair with the priority weight value, lambda calculation, max lambda, and Consistency Index (CI). The CR value of 0.05 which stated that the results of the research can be accepted because the value is less than 10% or 0.1.

Table 8: Consistency Ratio of Responsivity Criteria

Alternative	Rata-rata (priority weight)	Perbaikan Matriks	Lambda (ʎ)	Lambda Maks	CI	CR
LJB	0,44	1,84	4,18	4,14	0,05	0,05
LPI	0,12	0,49	4,09			
Ray Cargo	0,29	1,21	4,24			
Trio Eagle	0,16	0,64	4,07			

Decision making

The decision-making phase is the last step in the calculation of the selection of freight forwarder services by using the AHP Method. Alternative Weight Evaluation is the result that shows the weight value of each alternative. From the results of these weights, it can be seen that the highest alternative weight was PT Lintasnuansa Jaya Bersama (LJB) which was equal to 0.37 with the calculation of Alternative Weight Evaluation:

Table 9: Alternative Weight Calculation (Decision Making)

Criteria	Price	Responsivity	Schedule	Document	Alt. Weight Evaluation
Weight	0,18	0,25	0,29	0,29	
Alternative	*Priority Weight*				
LJB	0,29	0,44	0,25	0,47	**0,37**
LPI	0,29	0,12	0,25	0,16	0,20
Criteria	Price	Responsivity	Schedule	Document	Alt. Weight Evaluation
Weight	0,18	0,25	0,29	0,29	
Alternative	*Priority Weight*				
Ray Cargo	0,22	0,29	0,25	0,29	0,27
Trio Eagle	0,22	0,16	0,25	0,08	0,17

Calculation of shipping costs of exported goods is carried out in order to find out the comparison or decrease in shipping costs of exported goods issued by the company before making a selection of freight forwarders after selecting and knowing the weight of the freight forwarder services used.

1. Calculation of Export Goods Shipping Costs After Selecting Freight Forwarder Services

Shipping costs for exported goods in 2017, if only using PT Lintasnuansa Jaya Bersama (LJB), would require the company to pay a fee of Rp 2,037,840,000 with the same size and container as shipping by using four freight forwarder services. Calculation of the cost of shipping exported goods by using PT Lintasnuansa Jaya Bersama (LJB) as follows:

a. Container shiping costs 1 x 20' = 21,500,000 x 30 = 645,000

b. Container shipping costs 1 x 40' = 26.,280,000 x 53 = 1,392,840,000

Table 10: Shipping Costs of Exported Goods After Making Selection of Freight Forwarder Services

Freight Forwarder	Container size	Total Container	Cost delivery/Container	Total Cost delivery
LJB	1x20'	30	Rp. 21.500.000	Rp. 645.000.000
	1x40'	53	Rp. 26.280.000	Rp. 1.392.840.000
Total		83	Rp. 47.780.000	Rp. 2.037.840.000

2. Comparison of Prior Costs and Costs After Selecting Freight Forwarder Services

The selection of freight forwarder services affected the costs incurred when the company delivered export goods. Shipping costs by using some freight forwarder services cost Rp.

2,286,220,000, while using one freight forwarder service will cost Rp. 2,037,840,000. Shipping of exported goods using a freight forwarder service will minimize costs by Rp 248,380,000 or by 11% in 2017. Difference calculation and cost reduction percentage in costs as follows:

a. Difference = 2,286,220,000 – 2,037,840,000 = 248,380,000

b. Cost reduction percentage $= \frac{248.380.000}{2.286.220.000} \ x \ 100\% = 11\%$

Conclusion

Based on the results of the calculation of the selection of freight forwarder services using the Analytical Hierarchy Process (AHP) Method, the highest weighted freight forwarder service was PT Lintasnuansa Jaya Bersama (LJB) which is equal to 0.37. It can be interpreted that PT Lintasnuansa Jaya Bersama (LJB) is a freight forwarder service that has the most effective performance, meeting the needs of the company. The proper selection of freight forwarder services will affect the cost of shipping exported goods made by the company. The cost of shipping exported goods, if using the freight forwarder service that has the highest weight, namely PT Lintasnuansa Jaya Bersama (LJB) will be reduced by Rp 248,380,000, with a percentage reduction in costs of 11%. This can provide benefits for the company in terms of the costs incurred in the process of sending export goods. This work is an experimental study which considered the main criteria of the problem such as cost, delivery and delay. However other complex sub-criteria can also be considered to make this work more realistic. Future work can be achieved by using this technique in the issue of more complex freight forwarder selection by including criteria and sub-criteria that are more contradictory. Consideration of risk factors or freight forwarder profiles, and other related issues would be a possible extension of this research.

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