The Determining Criteria in the Selection of Spare Parts Suppliers at PT.XYZ Using the Analytical Hierarchy Process (AHP) Method

Age Dirgantini Sanni[1], Jessica Olifia[2], Atiqotun Nisa[3]

{agedirgantinisanni@gmail.com[1], jessica@polibatam.ac.id[2], anis0012@student.monash.edu[3]}

Politeknik Negeri Batam, Management and Business Department, Batam City, Indonesia[12], Faculty Business and Economics, Monash Caulfield, Monash University, Australia[3]

Abstract. This research aims to develop criteria for selecting spare parts suppliers at PT XYZ using the Analytical Hierarchy Process (AHP) method. The study begins with the identification of relevant criteria in the selection of spare parts suppliers. These criteria include procurement, quality, service, price, and payment. Data for this research were obtained from the questionnaire responses distributed to respondents knowledgeable in the field of procurement of goods and services. Based on the results of the Analytical Hierarchy Process (AHP) method, it was found that supplier X (PT Wira Sembada Maju) ranked first with a weight value of (0.48), supplier Y (PT Sugih Jaya Logistik) ranked second with a weight value of (0.42), and the last priority was supplier Z (PT Cahaya Eco Indonesia) with a weight value of (0.11).

Keywords: Suppliers, Spare Parts, Analytical Hierarchy Process (AHP), Criteria.

1 Introduction

In the area of Industry 4.0, intense competition among companies has driven a strong push for improving productivity, quality, efficiency, and flexibility. Therefore, companies need access to responsible suppliers capable of providing high-quality materials through procurement. Supplier selection is a critical business strategy for companies and should be done carefully because the items or materials obtained will be used for the long term.

A decision support system is a system built to assist in providing solutions to a problem, thus aiding in decision-making. Decision-making is performed to rank several alternatives based on multiple criteria and sub-criteria. There are various decision support system methods that can be used in selecting the right supplier in the procurement process. One of them is by applying a decision support system using the Analytical Hierarchy Process (AHP) method. AHP is a decision-making method for prioritizing alternatives when multiple criteria need to be considered [1].

In a relevant article that used the same method [2], they conducted research using the Analytical Hierarchy Process (AHP) method to select the best village. This research can serve

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as an important theoretical foundation for this study, which aims to determine the best spare parts supplier for PT. XYZ.

PT. XYZ is a company engaged in providing logistic services for the flow of trade goods, as well as land and airport facilities in Batam Island. As a logistics service provider, the company strives to continually enhance customer satisfaction by providing adequate and high-quality land transportation. PT. XYZ has a general division responsible for procurement of goods and services, commonly known as the procurement division. The division often procures spare parts to support land transportation operations. The current spare parts request process is computerized, with each until filling out a request from provide. These forms are then submitted to the respective unit leaders for approval of the needed spare parts. Once approved, the forms are handed over to the procurement division for processing.

Based on the spare parts request data from November to January, despite a decline in December, it can be observed that there is a significant increase in requests in January continuing until March 2023. Thus, increase is due to the high level of operational activities in January, resulting in numerous repairs and maintenance of transportation vehicles. Therefore, the selection of the right spare parts supplier has a significant impact on the required spare parts demand to support the operational process [3].

From the above description, the problem in supplier selection at PT XYZ focuses solely on the lowest price and neglects other factors. This has led to the spare parts not meeting the expected quality standards and increased spare parts demand. According to [6], other factors such as good quality, adequate service, and production should also be considered, reducing the chances of selecting the wrong spare parts supplier. PT XYZ currently lacks appropriate method for supplier selection. Therefore, the researcher will discuss the criteria for selecting procurement suppliers who can meet the requirements in terms of quality, price, and services to ensure that the needs are well-organized. This discussion will include weighting criteria and alternatives, determining which criteria and alternatives need to be prioritized in the spare parts supplier selection process at PT XYZ.

2 Literature Review

2.1 Supply Chain Management (SCM)

Supply chain management is a strategic approach to managing the flow of goods and services from suppliers through production and distribution to end customers. The primary goal of SCM is to enhance the efficiency and effectiveness of the supply chain in achieving faster profits and greater customer satisfaction [3].

2.2 Purchasing

Purchasing, or procurement, is the activity or process of acquiring goods or services from external soureces for use I business operations. This activity falls within the procurement function in supply chain management. Purchasing is not just about buying goods or services at a low cost but also obtaining the best value for the company by considering factors such as quality, timing, delivery, supply risk, and service. Therefore, affective purchasing management is crucial in achieving desired business goals [6].

2.3 Supplier Selection

Supplier selection is the process of choosing or evaluating suppliers who will provide the raw materials, products, or services needed by a company. The goal of supplier selection is to ensure that the chosen suppliers have the capability to meet the company's needs effectively and efficiently [4].

2.4 Decision Support System (DSS)

An information system that supports decision-making by providing the necessary information, data, and analysis tools. Its purpose is to assist users or companies in identifying problems, selecting alternative solutions, and evaluating the consequences of each alternative solution [5].

2.5 Analytical Hierarchy Process (AHP)

A decision-making method developed by Thomas Saaty in. AHP is used to assist in decision-making in complex situations involving interconnected factors with varying levels of importance. The stages of the AHP method are as follows:

a. Hierarchy structuring
b. Creating pairwise comparison matrices
c. Calculating weights/priorities
d. Selecting the optimal supplier
e. Testing for consistency

3 Research Methodology

This research employs a quantitative methodology, which is a type of research focused on the collection and analysis of numeric data to explain, measure, and control the phenomena of interest. In this study, a questionnaire was distributed to 5 individuals who are knowledgeable or understand the spare parts procurement process and those who make decisions when selecting spare parts suppliers in the company.

Quantitative research emphasizes the analysis of numerical data processed using statistical methods. In brief, the conceptual framework for this research can be illustrated in fig.1.

3.1 Operational Variables and Their Measurement

Operational definitions are used by researchers to make it easier to collect relevant and accurate data for existing criteria. The following is the operational definition of the criteria in this research:

1 Delivery
  Delivery accuracy includes 3 sub criteria:
  a. Ability to meet delivery quantities
  b. Accuracy of quantity of goods
  c. On time delivery
2 Quality

Quality here includes 3 sub criteria:

a. Provision of goods without defects
b. Quality of goods guaranteed (original)
c. Ability to provide consistent quality.

3 Service

Services here include 3 sub-criteria:

a. Ability in communication
b. Ability to provide a wide range of spare parts
c. Immediately replace if there is a mismatch of spare parts

4 Price

The price here includes 3 sub-criteria:

a. Ability to provide competitive prices
b. Ability to provide discounts on orders of a certain amount
c. Providing discounts on certain days

5 Payment

Payment here includes 3 sub-criteria

a. Payment deadline
b. Advance payment
c. Suspension of payment

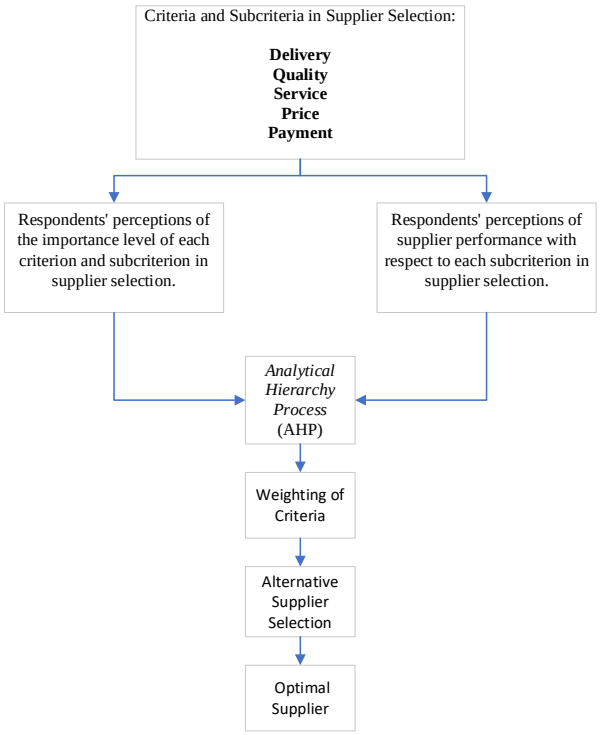

Fig. 1. Conceptual Framework.

3.2 Data Analysis Technique

This research utilizes data analysis through the Analytical hierarchy Process (AHP) method. Calculations are performed manually using Microsoft Excel. The steps in supplier selection are as follows:

1. Establishing the problem hierarchy structure
   Creating a hierarchy to describe a complex problem, making it clearer for decision-making based on expert input and experience in the field. The following is the hierarchy in the supplier selection research at PT XYZ:

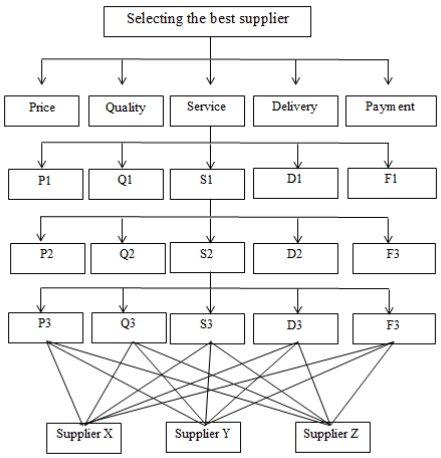

Fig. 2. Hierarchical structure.

2. Creating a pairwise comparison matrix that illustrates the relative contribution of each element to the criteria objectives one level above it. The following is the pairwise comparison rating scale:
3. Calculating the weights/priorities of each variable at level 1 (criteria), namely delivery, quality, service, price, and payment, with the following steps:
   a. Using pairwise comparisons for each criterion, the assessment results from supplier selection respondents are then averaged using the geometric mean or geometric average formula as follows:
      $G = \sqrt{(X1) \times (X2) \ldots (Xn)}$. ``(1)
   b. The result is then normalized to obtain the eigenvalue matrix by equalizing the sum of rows the five criteria.
   c. Calculating λMax by summing the multiplication results and then dividing by n criteria.
   d. Calculating the consistency index using the following formula:
      $CI = (\lambda Max - n) / (n-1)$ (2)
   e. Calculating the consistency ratio

$$CR = CI/RI \quad (3)$$

The measurement of consistency aims to assess the inconsistency of response provided by respondents. If CR < 0.1, then the pairwise comparison values are considered consistent. Conversely, if CR > 0.1, then the pairwise comparison values are deemed inconsistent, and the values in the pairwise matrix should be revised.

f. Calculating the weights/priorities of each variable 2 (sub-criteria) for each criterion, and then global priorities are determined by multiplying the local priority of each criterion.

g. Calculating the weights/priorities of variables at level 3 (alternatives), the weights for each supplier compared to each sub-criterion.

h. After obtaining the weights for each sub-criterion and the of each supplier, the selected supplier is determined. The overall value for each supplier is the sum of the products of the supplier's weight and the sub-criterion's weight. The selected supplier is the one with the highest value.

4 Results and Discussion

4.1 Creating Pairwise Comparison Matrices

In this stage, a pairwise comparison is conducted between on criterion and another criterion. The results of the comparison between criteria can be seen in Table 1 below:

Table 1. Pairwise Comparison Matrix.

Criteria	Delivery	Quality	Service	Price	Payment
Delivery	1,00	0,12	0,32	1,52	1,38
Quality	8,39	1,00	6,72	6,12	6,28
Service	3,11	0,14	1,00	0,52	2,29
Price	0,66	0,16	1,93	1,00	2,37
Payment	0,72	0,16	0,44	0,42	1,00

4.2 Performing normalization on the pairwise comparison table

At this stage, normalization is carried out on the criteria that have been assigned comparison values. The results of the normalization on the comparison table can be observed in Table 2 below:

Table 2. Pairwise Comparison Normalozation Aming Criteria.

Critera	Delivery	Quality	Servie	Pricce	Payment	Average
Delivery	0,07	0,07	0,03	0,16	0,10	0,09
Quality	0,60	0,63	0,65	0,64	0,47	0,60
Service	0,22	0,09	0,10	0,05	0,17	0,13
Price	0,05	0,10	0,19	0,10	0,18	0,12
Payment	0,05	0,10	0,04	0,04	0,08	0,06
					Eigen Vector	1

Based on the normalization calculations in Table 2, the priority of criteria used in supplier selection can be seen in the following Table 3:

Table 3. Priority Order of Criteria.

Criteria	Value	Priority
Delivery	0,09	IV
Quality	0,60	I
Service	0,13	II
Price	0,12	III
Payment	0,06	V

From the table, it can be seen that in selecting spare parts suppliers, PT XYZ'S top priority is quality criteria with a weight of 0.598, the second priority is service criteria with a weight of 0.128, the third priority is a price criteria with a weight of 0.124, the next priority is delivery criteria with a weight of 0.088, and the last priority is the payment criteria with a weight of 0.063.

4.3 Performing consistency test

a. That the λMax value = 0.052 (4)

b. Consistency index

CI = (0.052-5)/95-1)

= 0.013 (5)

c. Consistency ratio

IR is the random index with a value of 1.12 because in the case, the matrix has a size of 5

CR = CI/IR

= 0.013/IR

= 0.001 (6)

Because the consistency ratio value of 0.001 < 0.1, the matrix above is consistent. Consistency for intercriteria and subcriteria is shown in the following table:

Table 4. Consistency Ratio Of Respondent Assesments.

Pairwise Comparison	CR	Description
Between criteria (level 1)	0,01	Consistent
Between delivery sub-criteria	-0,05	Consistent
Between quality sub-citeria	0,01	Consistent
Between service sub-criteria	0,05	Consistent
Between price sub-citeria	0,10	Consistent
Between payment sub-criteria	-0,11	Consistent
Among alternatives for sub-criteria D1	0,10	Consistent
Among alternatives for sub-criteria D2	0,09	Consistent
Among alternatives for sub-criteria D3	0,09	Consistent
Among alternatives for sub-criteria Q1	-0,20	Consistent
Among alternatives for sub-criteria Q2	-0,02	Consistent
Among alternatives for sub-criteria Q3	-0,03	Consistent
Among alternatives for sub-criteria S1	-0,25	Consistent
Among alternatives for sub-criteria S2	-0,29	Consistent
Among alternatives for sub-criteria S3	-0,06	Consistent
Among alternatives for sub-criteria H1	-0,03	Consistent
Among alternatives for sub-criteria H2	0,00	Consistent
Among alternatives for sub-criteria H3	0,05	Consistent
Among alternatives for sub-criteria P1	-0,23	Consistent
Among alternatives for sub-criteria P2	-0,14	Consistent
Among alternatives for sub-criteria P3	-0,21	Consistent

After calculating for all criteria, subcriteria, and alternatives, the next step is to calculate the overall weights of alternatives based on the specified criteria by computing the global values first. After obtaining the global priority values, the overall weights of each alternative can be calculated by summing the overall values (global priority) for each supplier, as shown in Table 5 below:

Table 5. Order Of Priority.

Alternative	Value	Priority
Supplier X	0,48	I
Supplier Y	0,42	II
Supplier z	0,11	III

From the above AHP analysis results, the most influential criterion in selecting a supplier at PT. XYZ is the quality criterion with a weight of 0.598. The next influential criteria are service with a weight of 0.128, price with a weight of 0.124, delivery with a weight of 0.088, and payment criteria with a weight of 0.063. Looking at the values above, the quality criterion is in the first priority in the selection of spare parts suppliers. This indicates that PT. XYZ prioritizes high-quality spare parts procurement for the repair or maintenance of company-operated vehicles. This is because high-quality spare parts will have an impact on the long-term use of the parts, whereas lower quality parts may lead to shorter usage lifespan.

The service criterion, which ranks second in supplier selection with a weight of 0.128, plays a crucial role because good service makes it easier for customers to place orders with the supplier and ensures their comfort.
The price criterion ranks third in supplier selection with a weight of 0.124, as purchasing spare parts at a lower cost is expected to reduce the company's expenses.
Based on these criteria in selecting spare parts suppliers, the one who gets first priority as the best supplier is supplier is supplier Z with weight (0.11). This is because supplier X meets the criteria used as a reference by the company in selecting suppliers to provide spare parts and supplier XYZ.
By choosing the right supplier, the company benefits from obtaining the best quality and quantity, ensuring that repairs or maintenance of operational vehicles are completed on time and with high quality.

5 Conclusions and Suggestion

5.1 Conclusions

Based on the data processing and discussion using the Analytical Hierarchy Process (AHP) method for the selection of the best spare parts supplier at PT XYZ, the conclusions are as follows:

a. The most influential criterion in the selection of spare parts suppliers at PT XYZ is the quality criterion with a weight of 0.598. The second priority criterion is service with a weight of 0.128. The third priority is price with a weight of 0.124. The fourth priority is delivery with a weight of 0.088, and the fifth or last priority is the payment criterion with a weight of 0.063.
b. Based on the criteria and subcriteria in supplier selection, Supplier X can be considered the best supplier overall with a weight of 0.48. The next priority is Supplier Z with a weight of 0.42, and the last priority is Supplier Y with a weight of 0.11. This indicates that overall, the best spare parts supplier for the company to establish a long-term partnership with is Supplier X, as this supplier has the highest overall score compared to the other two suppliers.

5.2 Suggestion

Based on the analysis and conclusions above, the author recommends to the company and relevant parties the following:

a. The company, in meeting its spare parts needs, should focus on different criteria. To do so, the company can combine these criteria to find a supplier that matches the company's demands or needs. By selecting the right supplier, the company benefits from obtaining the best quality and quantity, ensuring that repairs or maintenance of operational vehicles are completed on time and with high quality.
b. Future research can expand on the research criteria and use other methods to verify the accuracy of respondent data, ensuring the validity of the results provided.

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