

Supplier performance analysis using the Analytical Hierarchy Process (AHP) method

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Abstract: This research aims to determine priorities in supplier selection. The determination of this supplier uses the Analytical Hierarchy Process (AHP) method by determining the criteria and sub-criteria of the supplier selection objectives. Each criterion and sub-criteria are arranged in a hierarchical structure and compared by determining the priority scale. The selection of suppliers is based on the largest global weight values. The selected supplier is PT. MMII with a global weight value of 0.280. The global weighted assessment has considered consistency in decision-making based on a consistency index, which must be below 10%. It shows that PT. MMII is selected based on existing criteria and sub-criteria compared to other suppliers. This study contributes to group decision-making involving experts to choose the most appropriate supplier.

Keywords: AHP method, global weight calculation, supplier

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Introduction

Supplier is an important line that is part of the company where the supplier can supply raw materials, both raw and semi-finished, for the company. The company is responsible for making decisions about the selection of suppliers [1]. When choosing suppliers, the company's decision is complex, considering the criteria and sub-criteria. Criteria for selecting suppliers are price, quality, delivery, quantity, and service.

Much research has been done related to choosing an object. The selection uses the Analytical Hierarchy Process as a method. Analytic Hierarchy Process (AHP) is a method or tool for multi-criteria decision making using Expert Choice software, tools in the software will simplify the function of the AHP method [2]. The selection for appropriate technical software used from 6 alternative engineering software in the company criteria is also made according to the AHP method [1]. Companies select the most suitable technology and use additional considerations based on a cost-benefit analysis [3]. Application of AHP in project management to select the best contractor. The hierarchical structure for the prequalification criteria and the contractors who qualify for the project [4]. AHP is also used in the integrated approach of the storage site selection process, where both quantitative and qualitative aspects have been considered [5]. AHP is used for provider selection of a telecommunications system. It is a complex, multi-person, multi-criteria decision problem [6]. AHP compares each criterion's importance and the candidates' values on each criterion to calculate for determining or making the best decision [7-8].

The analytical hierarchy process can be used to select an object. The AHP method is also used to measure productivity. This method is suitable because it considers the criteria and sub-criteria arranged in a hierarchical structure. This supplier selection problem has clear criteria and sub-criteria known to the company. The AHP method can support the company in selecting

suppliers from several alternatives. The supplier decision was made by considering the value of consistency in the experts' answers based on pairwise comparisons between existing criteria and sub-criteria. Experts are people who understand and understand this supplier.

Supplier is a line in which raw and finished goods are delivered to a company or store; Supplier performance reviews can be measured using the Analytical Hierarchy Process (AHP) method. AHP is a useful way to select which suppliers a company should or should not maintain. The choice of this method is considered appropriate compared to other methods since a practical and effective approach allows researchers to solve a complex problem that is not structured into several components in a hierarchical arrangement, allowing them to keep track of training existing suppliers. This method is considered appropriate because it can represent the hierarchy of the supplier itself. The AHP method can also translate or solve unstructured problems into an easy-to-understand or simpler model. This method also uses pairwise comparative assessment performed by experts to obtain a priority scale [9]. The company uses AHP's analysis to select existing suppliers.

Methodology

This study did not use test hypotheses. Instead, it implements individual axioms in a hierarchical analysis (AHP) process. AHP methods generally organize problems in the form of underlying reasoning. By dividing the existing problem into smaller parts, when using AHP, it is divided into two steps: hierarchical design and hierarchical component evaluation [10]. The Analytical Hierarchical Process (AHP) is one of the methods. The most widely used multi-criteria analysis in decision making is the basis for completing the AHP process [11]:

- a. Define the decision hierarchy with attributes (criteria) and alternatives (suppliers) representing the relationship.
- b. Comparison of Features and Alternatives Using a Dual Comparison Scale Determining the relative importance of attributes and alternatives involves comparing how well options perform with different attributes.
- c. Find the maximum eigenvalue (λ_{max}) and CI (conformity index) weights of the attribute and its alternatives.
- d. Calculate CR (Correspondence Ratio) = CI/RI where RI is (Randomly Generated Conformity Index).
- e. Follow step d, find the total weight, collect all, and perform calculations with Excel software to normalize the weight to get the best supplier. When the best supplier has been found, the company can also compare with other suppliers by adding or removing existing criteria.

A hierarchical structure has no standards or hierarchies of creation. Hierarchy is often based on a combination of ideas, experiences, and views of others that exist. Three things are opposites between one person and another. Therefore, the possibility of creating a non-standard hierarchy is very large. Due to the probability that various cases are very high, thus, the hierarchical structure tends to differ [12]. The scoring scale used in the pairwise comparison questionnaire often refers to the literature. It provides scores from one to nine with appropriate explanations [13]. The odds-scoring scale is greater between one criterion and another. Each incremental significance increases and also represents a value between two adjacent considerations. The RI value is very important for calculating the CR value. In this study, the RI value is adjusted as needed when the criterion is applied for five items. The RI value used is 1.12.

This research focuses on the selection of suppliers. For companies, Suppliers can be correctly identified based on pre-defined criteria. In theory, it seems that an analytical hierarchical process approach can be used to determine priorities, alternatives, or alternatives not defined according to theory Selection is not based on clear criteria, so gaps in this research can lead companies to select suppliers the right way, i.e., an analytical hierarchical process. The novelty of this study lies in calculating the uniformity in global gross weight calculations.

The analytical hierarchical process (AHP) concept is based on a complex problem state of the world, consisting of contrasting elements and various similar elements. Where individual components are often interrelated, the analytical hierarchy method (AHP) complements and assists in making decisions based on characteristics considered representative of all. This set creates various issues related to the resources used. Therefore, a system of priorities is needed

to facilitate this. Appropriate solutions must be found later to create an efficient structure [14]. Analytical Hierarchical Processes (AHP) are among the most widely used tools for decision makers. AHP can describe or solve many criteria. AHP methods to evaluate performance are based on quality, delivery, cost, service, and performance. Features among these criteria Criteria quality is a supplier selection criterion because supplier selection models affect business continuity when analyzing supplier selection issues [15]. Other factors must also be taken into account [16]. The advantages of using the AHP method over other methods are the number of specialists and other problems. It can be managed in a hierarchy of system complexity levels from the lowest (alternative), intermediate (sub-criteria) to the highest level (general), which should be taken into account by the company as 50-90% of the cost. The company's trade was made possible through purchasing activities [17]. Sourcing AHP uses a qualitative and quantitative approach to select the best suppliers. A combination of AHP and linear programs is also useful for viewing tangible and intangible factors. The company was provided with a list of suppliers with suitable capacity and some orders [18].

Criteria that can be compared perfectly cannot be measured. If the threshold is lowered or raised, ratings do not matter. The AHP methodology has a clear principle of dividing the problem into smaller parts. It is easy to carry out such analysis to determine the goal. The most important aspect of AHP analysis is placing parts or variables in a hierarchy and assigning numerical values to each variable, and synthesizing them to select the variable with the highest priority [19]. Thus, the final decision is very accurate. Figure 1 shows the steps of the AHP method.

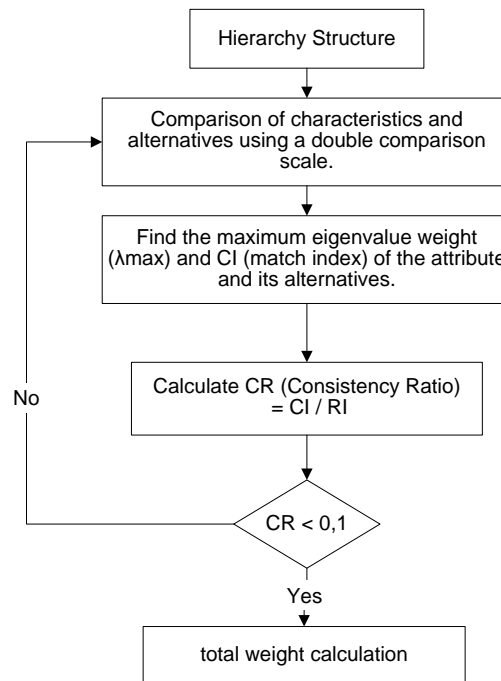


Figure 1. Step AHP method

Results and Discussions

Results

The following is a hierarchy of supplier selection criteria in Figure 2 that has been made based on the interview results.

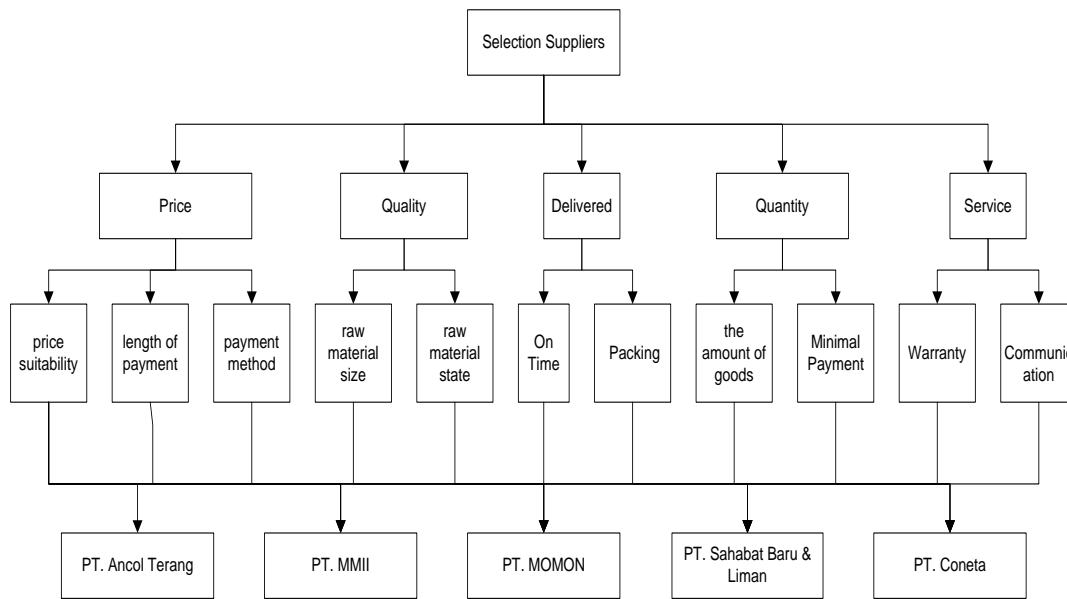


Figure 2. Hierarchy of supplier selection criteria

The criteria and sub-criteria for supplier selection are obtained from direct interviews with the company. After conducting interviews, five main criteria for supplier selection are obtained and 11 sub-criteria. Next, pairwise comparisons are made between the criteria with other criteria and the criteria with their respective sub-criteria. Finally, consistency measurements are made with the criteria below 10% by calculating index random. Decision-making by leaders is often faced with difficult problems because of the variety of decision-making criteria, the weight of considerations, and choices.

Discussions

After the consistency test has been completed, the next step is to calculate a global weight. The global weight calculation is obtained by multiplying all the weights on the criteria, sub-criteria, and alternatives. This calculation aims to see the ranking of the five existing suppliers to select these suppliers. Therefore, the global weight calculation focuses on the multiplication performed on each aspect of the hierarchy. The final result is the sum of each criterion and sub-criteria according to the supplier company (see Table 1). Table 1 shows the total ranking of each supplier where the supplier who got the first rank is PT MMII with a global weight of 0.280. Code S1-S5 are the five companies (alternative), and SK1-SK11 are the sub-criteria suppliers. The following is the order of the five companies, described using a bar chart in Figure 3. The ranking process was conducted by applying the analytic hierarchy process (AHP) method.

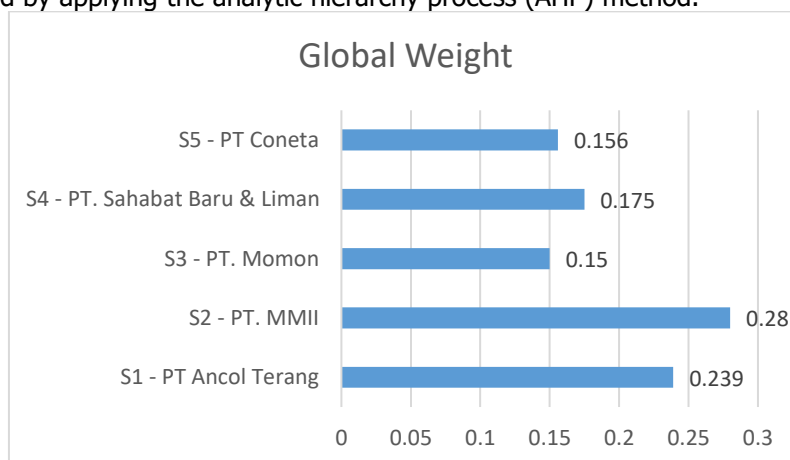


Figure 3. Global weight score

Table 1. Overall global weight

Criteria		Sub criteria		Corporate alternative				
				S1	S2	S3	S4	S5
K1	0.30	SK1	0.13	0.041	0.032	0.014	0.016	0.024
		SK2	0.11	0.037	0.029	0.013	0.015	0.021
		SK3	0.06	0.018	0.014	0.006	0.007	0.010
K2	0.30	SK4	0.08	0.018	0.027	0.015	0.009	0.007
		SK5	0.22	0.053	0.079	0.044	0.027	0.020
K3	0.12	SK6	0.10	0.020	0.034	0.017	0.019	0.010
		SK7	0.02	0.004	0.007	0.004	0.004	0.002
K4	0.13	SK8	0.11	0.016	0.016	0.016	0.031	0.030
		SK9	0.02	0.003	0.003	0.003	0.006	0.006
K5	0.15	SK10	0.04	0.007	0.010	0.005	0.010	0.006
		SK11	0.11	0.021	0.029	0.014	0.031	0.018
Total				0.239	0.280	0.150	0.175	0.156

Conclusion

AHP can be used in the method for making decisions to choose suppliers. The company can choose a supplier based on several prices, quality, delivery, quantity, and service criteria. The results show in the total weight calculation that PT MMII (S2) is the top-performing supplier company with a total score of 0.280. The resulting score is based on the sum of the criteria, sub-criteria, and alternative providers, the total weight calculated. The results of global weight calculations in PT Ancol Terang (S1) with a total score of 0.239. PT MOMON (S3) with a total score of 0.150, PT Central Sahabat Baru & Liman (S4) with a total score of 0.175, and PT CONETA (S5) with an overall score of 0.156.

Suppliers also have advantages on each criterion, so some suppliers have advantages on certain criteria in the company's pricing criteria. Other suppliers can improve and improve the quality, service, quantity, and delivery in providing services to the company. One of the supplier selections can be approached with the Analytical Hierarchy Process method.

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