

## SUPPLIER PERFORMANCE ASSESSMENT USING ANALYTICAL HIERARCHY PROCESS METHOD

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**Abstract** -- This research was conducted in Hyundai Aluminium Co., Ltd. The company is a manufacturer and applicator for the job, especially aluminium curtain wall installation. Glass materials needed to form a curtain wall unit that these materials are not produced by Hyundai Aluminium Co., Ltd. To the researchers intend to determine the priority criteria, sub-criteria, and consistency of thought or opinion of the respondents who are staff at Hyundai Aluminium Co., Ltd. in determining the glass supplier. In this study, the authors use the method of Analytical Hierarchy Process (AHP) to determine the priority of criteria, sub-criteria that compared global priority and will test the level of consistency of answers. The order of importance of criteria on the results of this research is Quality (.290), an accuracy of delivery (0.279), price (0.238) and Service (0.193). Sequence global priority sub-criteria are H1 (0.174), K1 (0.138), D1 (0.114), K3 (0.096), H2 (0.063), K2 (0.056), L3 (0.034), D2 (0.025), L2 (0.023), L1 (0.006). Consistency Value Ratio (CR) among criteria and sub-criteria inter smaller than 0.1 (CR, 0.1) which means that the answers of the respondents consistently.

**Keyword:** Priority criteria; Analytical Hierarchy Process; Consistency Ratio

### INTRODUCTION

Decision-making is one of the main major activities in any business organization. A management system is basically managing a decision taken by the personnel inside it. As the business organizations become more dynamics in the last ten years, then the theory related to decision making continues to grow and its implementation is in various fields of the management system. In decision-making also occasionally requires supporting tools. If the decisions to be taken are complex with substantial risks such as policy formulation, decision makers often require tools in scientific, logical, and structured forms. One of the important decisions making process and often done in a company is decision making related to supplier selection (Bai, 2015). Supplier selection decisions are important, as they are one of the earliest activities of an organization's business chain. The selection of the right suppliers is a key activity in purchasing, rather than the detail purchasing activity itself. The purchase includes the purchase of components, raw materials, and any supporting materials. In making decisions to select suppliers, decision makers require analytical tools that enable them to solve complex problems so that decisions are made more qualified. Supplier selection must be done carefully because the wrong supplier selection will cause disruption of the production process and company operation (Haque et al., 2014; Kaur, 2014).

As a fairly new company, the company is trying to continuously improve the quality of its

products and services. Improved product quality is certainly driven by the improvement of process quality, including the process of purchasing or procuring. One of the things that will be pursued in the procurement process is developing a positive partnership relationship with suppliers, especially suppliers for glass products. By strengthening the relationship between contractors and suppliers through this partnership relationship it is expected that changes in the schedule and volume of material procurement do not interfere with overall project completion targets. In addition, by choosing the optimal supplier, the company can benefit either directly or indirectly. At this time, the company has identified three potential suppliers who will be selected the best.

Based on the results of customer satisfaction level data on suppliers, there are some differences that affect the criteria for supplier selection. Table 1 – Table 3 show the level of customer satisfaction.

Based on supplier data, there are differences of perception, between functions within the organization, in determining which suppliers should be selected by the company. The board of directors and management tend to select a supplier based on the lowest price, with the reasons of obtaining a large profit. While the procurement line argues that the selected suppliers must be on time in delivering their material and supplies. And the engineering department thinks that quality should be the main point in choosing a supplier.

Table 1: Supplier Data

No	Customer Response	Supplier A	Supplier B	Supplier C
1	Satisfaction with material quality	90%	90%	80%
2	Satisfaction with material price	80%	70%	70%
3	Satisfaction with the services provided	60%	50%	60%
4	Satisfaction with material delivery time	40%	50%	50%

Sources: Data from glass supplier year 2015-2016

Table 2: Data on Supplier Capacity

Supplier	Factory Area (m2)	Production Capacity (m2/day)	Number of Employees	Delivery Time (days)
PT. A	55.000	400	130	21
PT. B	30.000	500	400	7
PT. C	7200	400	117	7

Sources: Glass from supplier data

Table 3: Data of Quotation Price and number of shipments per day by supplier

Supplier	Glass Specification	Quotation Price (Rp/M2)	Quality of Delivery (sheet)
PT. A	Euro Grey 8 mm Heat Strengthen + 12 mm AS + 6 mm low E clear	700.000	20 - 25
PT. B	Euro Grey 8 mm Heat Strengthen + 12 mm AS + 6 mm low E clear	725.000	20 - 30
PT. C	Euro Grey 8 mm Heat Strengthen + 12 mm AS + 6 mm low E clear	830.000	20 - 30

Sources: Data from Glass Supplier Data

Understanding the above description, then the formulation of problems in research is as follows: what is the order of priority criteria in supplier selection in Hyundai Aluminium and what is the global priority of sub-criteria in supplier selection in Hyundai Aluminium?

**MATERIAL AND METHOD**

Some of the key aspects of the procurement process are the selection of suppliers, the purchase of the goods themselves, the services and support provided by suppliers to the company. This is important because the buying activity is one of the main parts of business management. In today's competitive environment, it is highly unlikely to be successful at low cost production, and produce quality products without satisfactory suppliers. Therefore, one of the most important decisions in procurement is the selection activity and maintaining good relationships with eligible suppliers/suppliers (Heriansyah & Ikatrinasari, 2017). Thus, the selection of a competent supplier is one of the most important functions that the purchasing department should do.

The supplier selection process stems from the need for suppliers, determines and formulates the decision criteria, pre-qualifies (initial screening and prepares a shortlist of potential suppliers from a supplier list), chooses final suppliers, and

monitoring of selected suppliers, i.e. evaluation and the assessment continues.

The criteria used in the selection of suppliers from some literature are as follow:

1. Criteria for supplier selection according to Dickson based on ranking/order of importance level is as follows (Weber et al., 1991):
  - a. Quality
  - b. Delivery
  - c. Past Performance
  - d. Warranties & Claims Policies
  - e. Production Facilities and Capacity
  - f. Price
  - g. Technical Capability
  - h. Financial Position
  - i. Procedural Compliance
  - j. Communication System
  - k. Reputation and Position in Industry
  - l. Desire for Business
  - m. Management and Organization
  - n. Operating Controls
  - o. Repair Service
  - p. Attitude
  - q. Impression
  - r. Packaging Ability
  - s. Labour Relations Record
  - t. Geographical Location
  - u. Amount of Past Business
  - v. Training Aids
  - w. Reciprocal Arrangements

2. Supplier selection criteria (Nydick and Hill, 1992):
  - a. Quality
  - b. Price
  - c. Service
  - d. Delivery
3. Supplier selection criteria can also be grouped into several sub-groups (Surjasa, 2016)
  - a. Price Criteria  
Sub-criteria that include in the price criteria are price appropriateness with the quality of goods produced and quantity discount: Any discount scheme for certain orders made
  - b. Quality Criteria  
Sub-criteria that include the quality criteria are:
    - 1) Conformity of goods with specified specifications
    - 2) Provision of goods without defects
    - 3) Ability to provide consistent quality
  - c. On time Delivery Criteria  
Sub-criteria that include in the ontime Delivery criteria are:
    - 1) Ability to deliver the goods based on the agreed date
    - 2) Ability in handling transportation system
  - d. Quantity Accuracy Criteria  
Sub-criteria that include the Quantity Accuracy Criteria are:
    - 1) Accuracy and suitability quantity in shipping
    - 2) Suitability packaging contents
  - e. Customer Care Criteria  
Sub-criteria that include the Customer Care Criteria are:
    - 1) Easiness to be contacted
    - 2) Ability to provide information clearly and easily understood
    - 3) Speed in response to customer inquiries
    - 4) Quick response to resolving customer complaints
4. Using the information in step 3, make a comparison of the relative importance of the supplier/supplier against the criteria, and calculate the priority.
5. Use the results in steps 2 and 4, then calculate the priority or the weight of the supplier for the purpose of the hierarchy.

### Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) was developed by Thomas L. Saaty in the 1988. This method is one of the multi-criteria decision-making models that can help the human mindset in which logic, experience, knowledge, emotion, and sense factors are optimized into a systematic process (Zhang and Zhu, 2015; Li, 2014; Adianto et al. 2014; Ikatrinasari et al., 2011).

AHP is a decision-making method developed to prioritize several alternatives when several criteria must be considered, and allow decision makers to construct complex problems into a hierarchy or set of integrated levels. Essentially, AHP is a method used to solve complex and unstructured problems into its groups, by organizing the group into a hierarchy, then entering numerical values instead of human perceptions of relative comparison. With a synthesis, it will be able to determine which element has the highest priority.

### Use of AHP

AHP is widely used for decision making in solving problems in terms of planning, alternative determination, prioritization, policy selection, resource allocation, needs determination, results in forecasting, outcome planning, system planning, performance measurement, optimization, and conflict resolution.

The advantages of AHP methods in problem solving and decision making are:

- a. Unity: AHP gives a single, easy-to-understand, flexible model for a variety of unstructured issues.
- b. Complexity: AHP integrates deductive and system-based approaches to solving complex problems.
- c. Interdependence: AHP can handle the interdependence of elements in a system and not impose linear thinking.
- d. Hierarchical composition: AHP reflects the natural tendency of the mind to sort elements of a system at different levels and group similar elements in each level.
- e. Measurement: AHP gives a scale to measure things and the shape of a model to set priorities.
- f. Consistency: AHP keeps track of the logical consistency of the considerations used in

### Supplier Selection Stage

The stages of supplier selection using the AHP method (Nydick and Hill, 1992) are as follows:

1. Identify the criteria to be used in supplier selection.
2. Make a pairwise comparison of the relative importance of the criteria to the goal, and calculate the priority or weighting criteria based on the information obtained.
3. Measure / assess suppliers in meeting the criteria.

- determining priorities.
- g. Synthesis: AHP leads to an overall assessment of the good of each alternative.
  - h. Bargain: AHP takes into account the relative priorities of various system factors and allows people to choose the best alternative based on their goals.
  - i. Assessment and consensus: AHP does not impose consensus but synthesizes a representative outcome of different judgments.
  - j. Process repetition: AHP allows people to refine their definition of a problem and improve their considerations and understanding through repetition.

Besides the above advantages, there are some difficulties during the AHP methods implementations. In many cases, if these difficulties cannot be solved, then it can become a weakness of the AHP method in decision making.

- a. AHP cannot be applied to a very sharp / an extreme point of view among the respondents.
- b. This method requires dependence on a group of experts according to the type of specialist involved in decision making.
- c. The respondents involved should have sufficient knowledge and experience on AHP issues and methods.

#### *The Principles of AHP*

Decision-making in the AHP methodology is based on 4 basic principles, namely: Decomposition, Comparative Judgement, Synthesis of Priority and Logical Consistency.

Once the problem is defined, the step that needs to be done in decomposition is to break the whole problems into its elements. If you want to get accurate results, the breakdown is also done to the elements, so that some problem level is obtained. That is why the process of analysis is called a hierarchy. There are two types of hierarchy, one is complete and another one is incomplete. It is called a complete hierarchy if all elements exist are at the next level, otherwise, the hierarchy called as an incomplete hierarchy.

This principle means making an assessment of the relative importance of two elements at a certain level in relation to the above criteria. This assessment is at the core of the AHP, as it will influence in determining the priorities of the existing elements as a basis for decision-making. The results of this assessment are presented in matrix form named pairwise comparison matrices

From each pairwise comparison, a matrix is searched eigenvector of each matrix, to get local priority. This is because pairwise comparison matrices are at every level, so to obtain global priority synthesis must be done between local

priorities. The procedure for synthesis differs according to the hierarchy. Sorting elements according to relative importance through a synthesis procedure is called priority setting. Global priority is the priority/weight of sub-criteria and alternatives to the overall hierarchy goal / highest level in the hierarchy. To get global priority is by multiplying local priority sub-criteria and alternatives with the priority of parent criterion (upper-level criterion).

Consistency has two meanings. Firstly, similar objects can be grouped according to uniformity and relevance. For example, grapes and marbles can be grouped according to a uniform set if "round" is the criterion. But cannot if "taste" as a criterion. The second meaning is about the degree of relationship between objects based on certain criteria. For example, if sweet is a criterion and honey are considered 5 times sweeter than sugar, and sugar 2 times sweeter than syrup, honey should be considered 10 times sweeter than syrup. If honey is rated 4 times sweeter than syrup, the assessment is inconsistent and the process should be repeated if a more accurate assessment is to be obtained.

In using those four principles, AHP brings together two aspects of decision making:

- a. Qualitatively, the AHP identify and the problems and assessments, in order to find the problem solutions, and
- b. Quantitatively, the AHP performs numerical comparisons and assessments in order to find the problem solutions.

#### **Methodology**

This research was conducted using qualitative and quantitative methods. Qualitative method is to determine criteria and sub-criteria in supplier selection. While the quantitative method, based on data processing techniques using computer software, which then produces weight on each criterion. A descriptive approach used in this study, to explain the relationship between research dimensions of research variables. The variable in this research is 'supplier performance appraisal variable'. The population in this study is staff perception of Hyundai Aluminum Co., Ltd. In this study, data were collected from 9 respondents including directors, technical directors, managers, purchasing heads.

Data were collected through interviews and questionnaires to the managing director, technical director, manager, purchasing department head. The type of data used in this study is secondary data from Hyundai Aluminum. Data analysis technique in this research is Analytical Hierarchy Process Method with the support of Microsoft Excel application.

## RESULTS AND DISCUSSION

### Hierarchy Structure Problems

In using the AHP method, the most important thing is to set the problem hierarchy. Where based on the hierarchy of this problem, the priority weight at each level will be described. In

this research, the problem hierarchy consists of 3 levels. Level 0 is the goal to be achieved, level 1 is the criteria in general and level 2 is the sub-criteria that will compare specifically and more detail. The systematic hierarchy can be seen in Fig. 1.

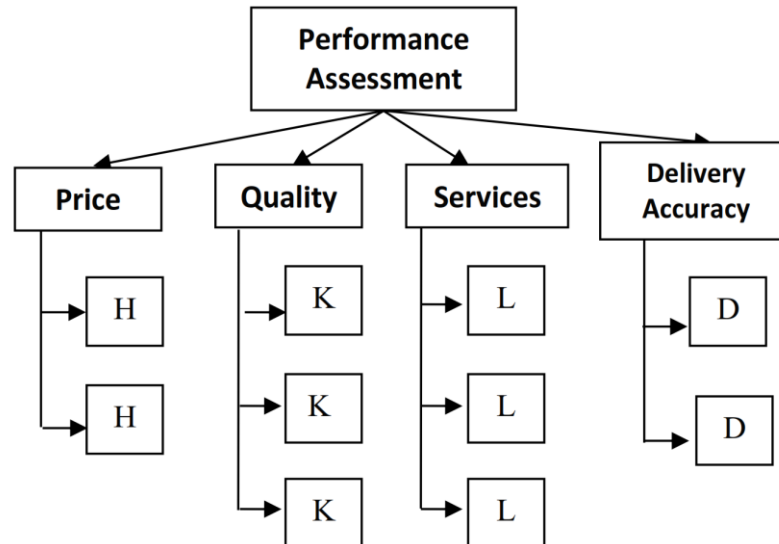


Figure 1. Structure of the Hierarchy of Problems (Saaty, 1988)

### Results from Weighting Criteria in Supplier Selection at Hyundai Aluminium Co. Ltd.

Based on the assessment of 9 respondents, the average value is measured using the

geometric mean formula. This is because AHP requires only one answer for a comparison matrix. The results are shown in Table 4.

Table 4. Priority assessment on importance criteria in supplier selection.

Criteria	Price	Quality	Services	Accuracy Delivery
Price	1	1,444	3,778	2,778
Quality	5,444	1	2,333	3,111
Service	2,111	1,889	1	2,111
On-Time Delivery	3,444	2,778	3,444	1

Sources: AHP Processing Results

The above data is the result of AHP. From the calculation of pairwise comparison between variables in choosing the above suppliers, the weight is shown in Table 5.

Table 5. The weight and priority of the importance criteria in supplier selection

Criteria	Weight	Priority
Price	0,238	III
Quality	0,290	I
Services	0,193	IV
On-Time Delivery	0,279	II

Sources: AHP Processing Results

Table 5 shows that in choosing a glass supplier, Hyundai Aluminum Co., Ltd.'s first priority is the quality criterion with a weight of 0.290, the second priority is the on-time delivery

criteria with the weight of 0.279, the third priority is price criteria with the weight of 0.238, next priority is the service with the weight 0.193.

### Global Priority and Consistency of Criteria and Sub-criteria in Supplier Selection at Hyundai Aluminum Co., Ltd

#### Global Priority

After the weight of each criterion and sub-criteria obtained, then the synthesis to get the overall weight of the criteria and sub-criteria was carried out. Before local priority calculated, we must be identified the global value (global priority) first. To gain global priority by multiplying local priority with one priority level above (parent criterion). In detail, the results of the criteria and sub criteria weighting can be seen in Table 6.

Table 6. Global Priority

Level 0 (Objective)	Level 1 (Criteria)	Level 2 (Sub-criteria)
Performance Measurement of Supplier	Price (0,238)	H1(0,174) H2(0,063) K1(0,138)
	Quality (0,290)	K2(0,056) K3(0,096) L1(0,006)
	Services (0,193)	L2(0,023) L3(0,034)
	On-Time Delivery (0,279)	D1(0,114) D2(0,025)

Sources: AHP Processing Results

Consistency

The use of AHP models with inputs derived from human perceptions has a disadvantage that inconsistencies may occur. This is because humans have limitations in expressing their perceptions consistently, especially if they have to compare many criteria. Based on this condition then, in the end, people will be able to state the perception is consistent or not.

This consistency measurement aims are to see the inconsistency of response given by the respondent. If  $CR < 0.1$  then the pairwise comparison value on the given criterion matrix is consistent. If  $CR > 0.1$  then the pairwise comparison value on the given criterion matrix is inconsistent. So, if it is not consistent, then the filling of the values in the matrix paired with the criterion and alternate elements must be carried out again. In general, it can be seen the results of the calculation of consistency ratio in Table 7.

Table 7. Consistency Ratio (CR) Assessment of Respondents

No	Pairwise comparison	CR	Note
1	Among criteria	0,048	Consistent
2	Among sub-criteria Price	0,000	Consistent
3	Among sub-criteria Quality	0,033	Consistent
4	Among sub-criteria Services	0,006	On sistem
5	Among sub-criteria On-Time Delivery	0,000	Consistent

Sources: AHP Processing Results

Discussion

From the results of AHP analysis above, the most influential criteria in supplier selection at Hyundai Aluminium Co., Ltd. is the quality criteria with a weight of 0.290. The next influenced criterion is the criteria of the accuracy of delivery with a weight of 0.279, price criteria with a weight of 0.238, and service criteria with a weight of 0.193. With the high value of quality in supplier selection indicates that Hyundai Aluminium Co., Ltd. prioritizes high quality for glass products to be

used. This is because the glass is the outer appearance of a building that can be directly seen by everyone. And glass also has the highest risk of changes in shape and colour due to weather change effects. This result is also supported by research from Taufik and Sumantri (2014) in the titles of Research Application of Supplier Selection of Readymix Raw Material Based on Integration of AHP and Topic Methods. Where in the study quality criteria ranks, first is with a weight of 24.7%. There are three sub-criteria in the quality criteria that was used in this research, namely: conformity of goods with the predefined specification (K1), provision of goods without defect (K2), and ability to provide consistent quality (K3). Of the three sub-criteria, the sub-criteria of conformity of goods with the specified specifications is considered most important by the respondent (weight value 0.476). Next is the sub-criteria of the ability to provide consistent quality (weighted value 0.331), and the last sub-criteria is the sub-criteria of conformity of the goods with the specified specification (weight value 0.193).

Delivery accuracy criteria were ranked in second with a weight of 0.279. This criterion also contributes greatly to the company's profits in running a project. If the glass delivery is done on time, then the process of project work will also be completed according to the schedule agreed by the contractor. However, if the glass delivery process is late and not on the schedule, it will also affect the project completion schedule. In other words, the contractor will incur a loss due to a fine imposed by the owner. And this will make the profit the company does not match the expected. The results of this study are similar to the results of research conducted by Taufik and Sumantri (2014) and Haque et al. (2014).

On delivery criteria, there are two sub criteria that are an ability to deliver goods according to an agreed schedule (D1) with weight value 0,409, and ability in handling transportation system (D2) with weight value 0,091.

The third price criterion in the supplier selection (weighted value 0.238) has an important role because the purchase of glass represents a substantial portion of the value of the sale of the finished product. With cheaper glass prices, it is expected that the company can increase profit in glass installing items in a project.

But basically, the price provided by the suppliers is not too much difference. It can be seen in Table 1, the price given by each supplier is not too significant difference. This condition makes the perception of employees and top management in Hyundai Aluminium not too prioritize this criterion.

Price criteria in this study include two sub-criteria that are price appropriateness with the quality of goods produced (H1), and ability to give a discount on the order in a certain amount (H2). Of the two sub-criteria, the sub-criteria of price appropriateness with the quality of goods produced has a higher weight value of 0.733, while the sub-criteria ability to give discounts on orders in a certain amount has a weight value of 0.267.

Service criteria rank fourth in the supplier selection with a weight value of 0.193. In this research, there are three sub-criteria on service criteria: ease of contact (L1), ability to provide information clearly and easily understood (L2), speed in response to customer demand (L3).

Service criteria are not very influential in the supplier selection process. The services provided by some suppliers mostly comply with the standard procedures related to material purchases. Therefore, Hyundai Aluminium does not prioritize these criteria. The results of this study are supported by research from Shahroodi (2012) where service criteria rank fourth from several criteria that are compared. L3 sub-criteria is considered most important with a weight of 0.178. The second highest weighted sub-criteria are L2 with a weight of 0.121. While the last sub-criteria are L1 with a weight of 0.034.

## CONCLUSION

Based on research objectives and research results it can be concluded the following points. First is based on the results of literature studies and forum discussions, supplier selection criteria at Hyundai Aluminium consist of Price, Quality, Service and Delivery accuracy. After assessing using the AHP method, the order of criteria that has the most important priority in Hyundai Aluminium is as follows: Quality (0.290), Delivery accuracy (0.279), Price (0.238) and Services (0.193). Quality criteria and delivery accuracy are important points in the work of a project. If the quality of glass from suppliers is not good, can lead to discoloration of glass and can affect the strength of glass. This will affect contractors such as Hyundai Aluminium. The accuracy of delivery also has a great influence on contractor performance. In the event of late delivery, the contractor will be imposed a fine by the assignor. This results in a decrease in corporate profits.

Then, the global priority is done by multiplying the local priority with the priority of the relevant criteria at the top level and adding it to each element in the criterion-affected level. The result is a combination or known with global priority which is then used to weight the local priorities of the element at the lowest level according to the criteria. In this research, the order

of global priority in the price sub-criteria has the highest weight. Followed by quality sub-criteria, delivery accuracy, and service. This global priority does not depend on the priority criteria at level 1. This is because, at level 2, the statements are compared in more detail and include the technicalities of the criteria at level 1.

Based on research objectives and research results it can be concluded the following points. The importance criteria level in the selection of glass suppliers in Hyundai Aluminium successively is quality, delivery accuracy, price, and service. In the future, companies may also use AHP analysis to solve other multi-criteria problems as decision support tools. Finally, for further research, relevant new criteria or sub criteria or new policies within the company may change the criteria and sub criteria currently used. In addition, to reduce the subjective subjectivity of respondents, in particular, to reduce the inaccuracy and uncertainty of respondents in mapping their perceptions into numerical numbers, similar research can also use the AHP fuzzy method

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