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Implementation of Analytic Network Process for Selecting Supplier of Aluminum at PT X

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Abstract This research is conducted to help a company select aluminum supplier that best fits its considered criteria. PT X is an aluminum-casting company in Indonesia which supplies aluminum based product for other downstream companies. Every company must pursue the best accuracy in fulfilling order to satisfy their customer. This performance is determined by how the company runs its internal processes. One of them is about selecting their raw material supplier. According to survey and interview, this process becomes a problem at PT X. There are four alternatives of suppliers at PT X. The current situation shows that there is not a proper process of selecting supplier so that seeing the result of the decision, the company often faces the fact that it isn't the right decision. In this research, a decision making model of Analytic Network Process (ANP) will be established. There are many criteria and sub-criteria considered by the company to select a supplier. These criteria often have correlations with others, so that ANP will be the appropriate method to help this multi-criteria decision making problem. Product quality, service, delivery, price, and location are found out to be criteria that PT X considers important in selecting supplier. Every possibility of criteria/sub-criteria interaction is identified to develop the model. Pairwise comparison is conducted to determine the importance of criteria and sub-criteria. The final result shows that a supplier named Manaf Logam considered as the best aluminum supplier.

Introduction

In supply chain system, there are often many parties included, i.e. supplier, manufacturer, distributor, retailer, and customer. Each party runs their business to fulfill what their customer need. Therefore, each of them has their own strategy to achieve that purpose. Customer satisfaction becomes an important key to sustain the business run well. PT X is an aluminum casting industry that serves aluminum based product for its downstream companies. Trying to cater for their customer need well, it does some efforts which are doing inspection process to make sure the quality of product, having an additional order of raw material to reach a certain production target, and so on. However, some of them are considered as impromptu actions that often cause increase on production cost.

One of several problems that causes this kind of actions relates to supplier selection. Aluminum is the main raw material for PT X manufacturing process. According to observation performed at PT X, the person in charge of this supplier selection is still doing this process without good reasoning. It is well understood because this decision actually includes many criteria which makes the decision making process hard. There are many raw material problems that the company faces in their current condition. There are quality problem, quantity, delivery problem, and so on. There are 4 aluminum suppliers for PT X, which are Yun Hok, Panca Logam, PD Heri, and Manaf Logam. Every supplier offers different quality, service, and product price. According to PT X experiences on their past decisions, sometimes they experienced that the aluminum they got from supplier was poor in aluminum purity aspect. This problem made the manufacturing process produced a lot of defective products. Actually the company can handle it by doing additional process on the product, but obviously it increases their production cost. Another problem faces by

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the company is about on-time delivery case. There are certain suppliers that offer a good aluminum product but they can't keep their promise to deliver the product on time. This problem will cause PT X unable to meet the production deadline so that it can't meet customer need on time either. This trade-off reasoning on many criteria makes decision making process more complex. Considering that a right supplier choice becomes a very important aspect to lower purchasing cost and improving a company competitiveness [1], this research is conducted to build a decision making model that will help the company to get a better decision about their aluminum supplier.

As explained before, this decision making process includes many criteria which cause the process quite hard for the decision maker. In this paper, we use Analytic Network Process (ANP) as a decision making method for aluminum supplier that will help this multi-criteria decision making. ANP can accommodate a multi-criteria decision making condition and also the dependency possibility among the criteria. First of all, the decision making criteria and sub-criteria will be identified. The dependency among criteria and sub-criteria will be identified as well. The output from these two activities will be inputs for decision making model development. Pairwise comparison will be conducted and at the end of this research there will be a list of supplier selection priority for PT X.

Methodology

There are several steps performed in this research to provide PT X with a supplier selection suggestion. It starts from criteria/sub-criteria identification through interview and literature review. Next processes will be identifying the relationship between criteria, building an ANP model, collecting data, doing data calculation and analysis, and finally recording the result. These steps can be explained as below.

Criteria/Sub-criteria Identification

There will be criteria and sub-criteria in ANP model. As explained on the introduction, this supplier selection process can be classified into multi-criteria decision making process. According to initial observation, quality and delivery aspect become two important aspects/criteria considered by PT X. There will be other criteria that PT X considered. Hence, this step should be conducted to get comprehensive criteria for the ANP model. Literature review will be the first step to get the general knowledge about criteria/sub-criteria in supplier selection process. According to Tahriri et al. [2], there are 23 factors considered by steel manufacturing company in supplier evaluation and selection. Several of them are quality, delivery, performance history, price, technical capability, attitude, and impression. Literature study also includes Kotler [3] as the basic literature to identify additional criteria and sub-criteria. Based on this initial knowledge, interview is carried out to the decision maker. The decision maker is the one who is in charge of aluminum purchasing process at PT X. He has had experience in this subject for about 5 years. This interview should be run because each company must have its own consideration on the supplier, so there may be more than 23 factors considered or even less than 23. The result shows that there are 5 criteria considered by the decision maker i.e. aluminum purity, price, delivery, service, and location. There are sub-criteria considered for every criterion except aluminum purity and location. Table 1 shows sub-criteria for 3 criteria considered.

Table 1. Decision making sub-criteria

Price	Delivery	Service
Price Level	Punctuality	Responsiveness to Complaint
Discounts	Quantity Accuracy	Ease of Ordering
Payment Procedure	Delivery Responsiveness	
	Delivery Flexibility	

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Every criteria and sub-criteria above will be explained as below

1. Aluminum purity
   Aluminum purity is the essential product quality aspect for PT X. The purer the metal is, the easier the company can process it. The purity of a product could be identified by its density, while in visual aspect it can be identified by its color.
2. Price
   Price should be an aspect considered by PT X because it will affect the production cost. This criterion includes price level, discount, and payment procedure. Price level relates to how expensive the price given by the supplier for their product. The meaning of discount relates to the probability of getting a discount price on every purchasing activity. Payment procedure is talking about the procedure option that eases the company in completing a certain amount of payment. Cash payment procedure will not be a problem for PT X when the company has an enough budget. Payment procedure through installment will be more preferable for the company that has problem with their purchasing budget.
3. Delivery
   According to Kotler [3], delivery relates to punctuality, product quantity precision, cost, speed, and flexibility. There are three sub-criteria in common with Kotler [3] definition, which are punctuality, quantity accuracy, and flexibility. Another additional sub-criterion is delivery responsiveness. Punctuality and quantity accuracy have obvious and important meaning that determines performance of the company. The third aspect, which is flexibility, means the capability of supplier to fulfill irregular customer demand. The last delivery sub-criterion is delivery responsiveness. It relates to how fast the supplier sets the delivery for every customer order.
4. Service
   Service relates to quality of interaction happened between the company and the supplier. The first aspect of this criterion is responsiveness to complaint which means how fast and effective a supplier finds/gives a solution to customer problem. The second aspect is ease of ordering. This sub-criterion is talking about whether the company has to visit the supplier in every ordering activity. The responsiveness of supplier in responding customer call is also considered in this sub-criterion.

Dependency Identification

Dependency identification is performed by interviewing the decision maker. There are two kinds of dependencies in ANP model. They are inner and outer dependency. According to Saaty [4], inner dependency is relationship exist between sub-criterion within a certain criterion, whereas outer dependency is relationship between sub-criteria from different criterion. One inner dependency found out from this process is between discount and price level. With higher probability of getting discount, the company will often get the product in satisfying price. Outer dependency happens between aluminum purity and price level. Another dependency happens between service and delivery which are ease of ordering to punctuality and quantity accuracy. According to decision maker experience, the purer the aluminum is, the higher the price will be. The ease of ordering will affect how the delivery performance is. The easier the supplier to reach, the more punctual and accurate the delivery will be. This kind of relationship happens because it will be easier to give order information update to supplier so that it will influence the punctuality and quantity accuracy of delivery process.

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Model Building

According to the previous 2 steps, an ANP model will be established. Fig. 1 shows the ANP decision making model for PT X.

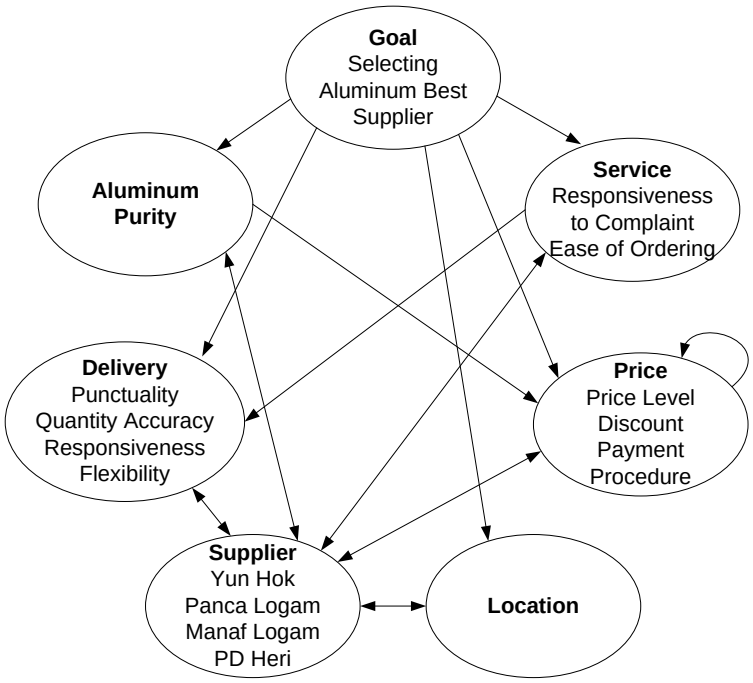

Fig. 1. ANP model for PT X

Pairwise Comparison

The data will be collected using pairwise comparison method according to ANP model in Fig 1. The respondent will be the decision maker. He will determine a certain score for every criteria/sub-criteria comparison. There will be criteria and sub-criteria comparison with respect to goal criteria. The comparison is about the level of importance of criteria/sub-criteria in achieving the goal. With 5 criteria that are compared with respect to goal, there will be ${}_5C_2$ pairwise comparisons that have to be done. One of them is shown below

Aluminum Purity 9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 **Service**

In above example, the decision maker has to determine the importance of aluminum purity criterion compared to service in selecting best aluminum supplier. Value of 1 represents that aluminum purity and service have equal importance level in selecting best aluminum supplier, while value of 9 on aluminum purity side will represent that aluminum purity absolutely more important than service criterion. There are many other comparisons beside this kind of comparison. Every criterion that comes out with more than one arrow indicates a comparison that has to be done. The comparison will also be useful to find out the strength of each supplier from every aspect/criterion considered.

Data Calculation

Every pairwise comparison will be evaluated in terms of its consistency. Only a consistent comparison could be used for the analysis. If there is an inconsistent comparison, the decision maker should do the comparison again. This consistency is evaluated based on Consistency Ratio (CR) which has to be less than 0.1 [4]. All pairwise comparisons done in this research are consistent

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so that the next calculation can be carried out. There will be cluster matrix, unweighted matrix, weighted matrix, and limiting matrix that show several steps of data calculating. Eigen vector will be extracted from every comparison and will become the input for the initial matrix, which are cluster and unweighted matrix. The limiting matrix will be the final calculation step of data and provides information about supplier selection priority for PT X.

Result and Discussion

After all comparison processes, the result shows that Manaf Logam is the best supplier for PT X. It can be identified from every supplier score in limiting matrix. There are 4 alternatives of suppliers for PT X which are Manaf Logam, Panca Logam, PD Heri, and Yun Hok. The limiting matrix score for each supplier are 0.1377, 0.0882, 0.1249, and 0.0763 respectively. Manaf Logam gets the highest score which makes it the best supplier for PT X. Actually, PT X can consider other suppliers according to descending limiting matrix score order. The analysis about this supplier order can be done by looking at criterion importance level and sub-criteria score for every supplier.

Cluster matrix is a matrix that records criteria importance level. There are 5 criteria considered in this research, which are Aluminum Purity, Price, Service, Delivery, and Location. Importance score for every criterion are 0.323, 0.398, 0.082, 0.142, and 0.054 respectively, while the detail of importance level of each sub-criterion within the criteria can be shown in Table 2 and Table 3. The highest sub-criteria score in every criterion indicates the most important sub-criterion considered by the company. This result is well understood if it is compared to the real situation at PT X. Delivery Flexibility is the most important aspect with respect to delivery criterion. It can be seen from the usual PT X practice up till now that often demands for immediate additional supply of aluminum. Another sub-criterion is Price Level. This sub-criterion is also valid and very logical to be the most important aspect considered within Price criterion. Considering that PT X often demands for immediate delivery, Ease of Ordering will obviously be the important aspect which has to be most considered by PT X in service factor. A high fluctuation of demand makes PT X needs such a fast and efficient way to reach/call supplier for an order.

Table 2. Price & delivery sub-criteria importance level

Price	Importance	Delivery	Importance
Price Level	0.66775	Punctuality	0.30968
Discounts	0.19918	Quantity Accuracy	0.22568
Payment Procedure	0.13307	Delivery Responsiveness	0.14741
		Delivery Flexibility	0.31723

Table 3. Service sub-criteria importance level

Service	Importance
Responsiveness to Complaint	0.3868
Ease of Ordering	0.6132

After looking at every criterion/sub-criterion importance level, we also have to know the strength of each supplier so that we can have ideas about how Manaf Logam can come out as the best supplier for PT X. Table 3 shows the supplier score for every sub-criterion.

Table 3. Sub-criteria comparison among suppliers

Aspect		Manaf Logam	Panca Logam	PD Heri	Yun Hok
Price	Price Level	0.1920	0.0991	0.1298	0.2180
	Discount	0.1677	0.1982	0.1030	0.0952
	Payment Procedure	0.0366	0.0991	0.1635	0.0831
Service	Ease of Ordering	0.0638	0.0153	0.0638	0.0250
	Responsiveness to Complaint	0.0127	0.0612	0.0127	0.051
Delivery	Punctuality	0.0329	0.0218	0.0308	0.0368
	Quantity Accuracy	0.0301	0.0390	0.0267	0.0399
	Delivery Responsiveness	0.0231	0.0443	0.0172	0.0128
	Delivery Flexibility	0.0527	0.0337	0.0641	0.0493
	Aluminum Purity	0.3337	0.3337	0.3337	0.3337
	Location	0.0542	0.0542	0.0542	0.0542

According to Table 3, we can see that Manaf Logam gets the second position for Price Level after Yun Hok, while PD Heri as the second recommended supplier is on the third position. Although it is on the third position for PD Heri, it has the best payment procedure. Manaf Logam also gets the second position in the discount aspect. Looking at aluminum purity and location criterion, every supplier has the same score. The third important criterion for this selection process is delivery. In this criterion, Manaf Logam gets the second position for 3 out of 4 sub-criteria, while in service aspect Manaf Logam is placed on the first position for ease of ordering which is the same as PD Hery. On average, Manaf Logam always gets the second position in every criterion compared to other suppliers which sometimes could get the worst position, especially in several high importance criteria. This is the reason why eventually Manaf Logam is the supplier suggested to be the best aluminum supplier for the company.

Summary

According to the result and analysis, Manaf Logam is suggested to be the best supplier for PT X, while the second alternative of supplier will be PD Heri. However, the condition of aluminum market could change so that this decision should not be valid anymore. There may be innovation in aluminum processing technology, transportation, new metal design, and so on which will affect how the decision maker chooses the supplier. The ANP decision making model should be revised whenever there are new factors or new dependencies identified. This activity will keep the decision meet company requirement. More literature review should be conducted to enrich this decision making model so that the model and also the decision will last for a longer time. Considering that this kind of business will continually grow, PT X should consider more alternatives for its supplier. PT X should actively find another supplier which can give a better offer.

References

[1] Xia, W. and Wu, Z., Supplier Selection with Multiple Criteria in Volume Discount Environments, The International of Management Science 35 (2007) 494–504.
[2] Tahriri, F., Osman, M.R., Ali, A. , Yusuf, R.D., and Esfandiary, A., AHP Approach for Supplier Evaluation and Selection in a Steel Manufacturing Company, Journal of Industrial Engineering and Management (2008) 54-76.
[3] Kotler, P., Manajemen Pemasaran, Jakarta : Erlangga, 2009
[4] Saaty, T.L., Decision Making with Dependence and Feedback: The Analytical Network Process 2nd ed, RWS Publications, Pittsburgh, 2001.