DETERMINATION OF SUPPLIER SELECTION CRITERIA USING ANALYTICAL HIERARCHY PROCESS IN THE FOOD COMPANY

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ABSTRACT

The criteria for selection is important in supplier selection. The used criteria must surely reflect supply chain strategy or characteristics of the item to be supplied. Analytical Hierarchy Process (AHP) to help solve complex problems by structuring a hierarchy of criteria, interested parties, with interesting results and considerations for developing a weight or priority. This research was conducted at a food company to to identify the supplier selection criteria, test weights and priorities relevant. The results of this study, the 4 criteria and 16 sub-criteria in supplier selection. Responsiveness criteria has weight 0.259 with the highest priority, followed by the cost criterion has a weight 0,211 with second priority, the next delivery criteria has weight 0.205 with the third and final priority quality criteria has weight 0.175 with the last priority.

Keywords*: supplier selection criteria, analytical hierarchy process.*

1. INTRODUCTION

One of succes factors of a company is supplier selection (Gencer and Gurpinar, 2007 dalam Kurniawati dkk., 2013). Proper supplier selection can guarrantee the availability of raw material to keep the production line. Supplier selection is important decision making problem in order to get a supplier that can improve the competitiveness of companies (Ghodsypour and O'Brien, 2001 dalam Kurniawati dkk., 2013). It could be argued supplier selection is one of the important activities in the procurement to achieve competitive advantage (Amid dkk., 2011).

Supplier selection is a multi criteria problem where each of the criteria used to have different interests and information about it is not precisely known. In this case the supplier selection based on the low price offer is no longer efficient. To get the maximum performance of the supply chain should incorporate other criteria relevant to the objectives of the company (Ng, 2008 dalam Kurniawati dkk., 2013).

Selection of suppliers is the decision-making problems that involve multi-persons. Input was obtained from the opinions of experts who have a point of view, responsibility, and experience as a decision maker. Assessment criteria decided by the management and the entire supply chain of production based strategy (Amid dkk., 2011). Decision-making process can be translated by a systematic and logical approach to get priority and weight (Tam and Tummala, 2001 dalam Kurniawati dkk., 2013).

PT. Ceres Meiji Indotama as one of food companies have been cooperating with several suppliers to ensure continuity of production. The company will select the suppliers that can provide its desired specifications. In practice it is often obtained from the suppliers of raw materials depends on the quantity and price required. But along with increasing competition, companies must not only take into consideration the quantity and price, but also other criteria such as flexibility, service and others. This study was aimed to raise a number of criteria in supplier selection by taking the study at the food company.

Various methods can be used in supplier selection problems involving multiple criteria such as weighting in multi-criteria supplier selection using the method of data envelopment analysis (Ng, 2008 dalam Kurniawati dkk., 2013), analytic network process (ANP) and the similarity to ideal solution to produce weight and rank

suppliers whereas linear programming is used to allocate the demand of each supplier (Lin dkk., 2011 dalam Kurniawati dkk., 2013). The SWOT analysis can be used to get a framework of criteria and indicators of supplier selection (Chen, 2011 dalam Kurniawati dkk., 2013). If the criteria will be used to evaluate suppliers have corresponding relationships then the exact method used is the ANP, but if the criteria does not have the corresponding relationships appropriate method to be used is the process Analytical Hierarchy (AHP) (Dewayana dan Budi, 2009 dalam Kurniawati dkk., 2013).

The results of observations provide information that PT. Ceres Meiji Indotama criteria used have not had corresponding relationships with each other, the appropriate method to be used is the AHP. AHP method is used to determine the weight of each criterion, where the weights will be used in the prioritization criteria in supplier selection.

This study will select the appropriate criteria in supplier selection and test weights and priorities relevant criteria. The results of this study are used as a basis for consideration or input for the company to determine the strategic policy particularly in the supply chain in terms of supplier selection.

2. *ANALYTICAL HIERARCHY PROCESS (AHP)*

AHP developed by Thomas L. Saaty during the period from 1971 to 1975. This method is a framework for effective decision making on complex issues by simplifying and speeding up the decision making process by solving the problem into parts, arranging these parts, or variables in a hierarchical arrangement, giving a numerical value on the subjective judgment of the importance of each variable and synthesize these considerations to specify which variables have the highest priority and act to affect the outcome of the situation. The AHP method helps to solve a complex problem by structuring a hierarchy of criteria, interested parties, with interesting results and considerations for developing a weight or priority. This method also combines the strength of feeling and logic concerned on various issues, and synthesizes diverse considerations into the matching results with our estimates as presented intuitively on considerations that have been made. There are three basic principles of decision-making with the AHP method:

1. The principle of the determination of the hierarchy
2. The principle of establishing priorities
3. The principle of logical consistency

The advantages of AHP in decision making are:

1. Can resolve complex problems, and its structure is irregular, unstructured problems even at all.
2. Less full written data and quantitative data on the problem does not affect the smoothness of the decision-making process because assessment is a synthesis of various viewpoints of respondents thought.
3. In accordance with the basic human ability in assessing a case to facilitate the assessment and measurement of the elements.

2.1. Stages of Decision Making AHP Method

In general, the basic steps of AHP are summarized as follows:

1. Defining the problem and set goals. When AHP is used to select the alternative or alternatives prioritization, then at this stage of development alternatives.
2. Formulate the problem in a hierarchical structure. Every complex problem may be viewed from a detailed and structured.
3. Establish priorities for each element of the problem at the level of the hierarchy. This process resulted in a weight element to the achievement of the goal, so that the element with the highest weight has priority handling. The first step in this phase is to construct a pair wise comparison matrix is transformed in the form, so that the matrix is called the matrix of pair wise comparisons.
4. To test the consistency of the comparison between elements obtained at each level of the hierarchy. Consistency of

comparison in terms of per matrix comparison and the entire hierarchy to ensure that the resulting priority order obtained from a series of comparisons which are within the boundaries of the logical preference. After calculating the weight of the element, the next step is to test the consistency of the matrix.

2.2. Preparation of Structure Hierarchy Problem

Hierarchy problem is provided to assist decision-making process with regard to all the decision criteria involved in the system. Most of the problem becomes difficult to solve because the solution process is done without regard to the problem as a system with a certain structure.

At the highest level of the hierarchy, stated goals, objectives of the system are sought solution of the problem. The next level is a translation of these objectives. A hierarchy in the AHP is the elaboration of criteria that are arranged in multiple levels, with each level includes some homogeneous criteria as shown in figure 1.

2.3. Preparation of Priority

Each of the criteria contained in the hierarchy must be known relative weighting of each other. The goal is to determine the level of interest from parties interested in the problem of the criteria and hierarchical structure or the system as a whole. To determine the priority order of elements, the first step is to set up pair wise comparisons, i.e. comparing in pairs all elements at the same level based on certain elements that are one level above it in the hierarchy. The comparison is then transformed into a matrix form used in numerical analysis. The pair wise comparison matrix form is the form most desirable, because the matrix is a tool that is simple and commonly used, provide a framework to test the consistency, obtain additional information by making all possible comparisons and analyzes overall sensitivity to changing priorities in comparison.

2.4. Eigen Vector and Eigen Value

If the decision maker has included the perception or judgment for each comparison between criteria - criteria that are within one level (level) or which can then be compared to determine which criteria are most preferred or most importantly, compiled a comparison matrix at each level (levels). To fill the pair wise comparison matrix, we use the numerical values obtained from the scale comparisons made by Saaty (Saaty, 1994), in the Table 1.

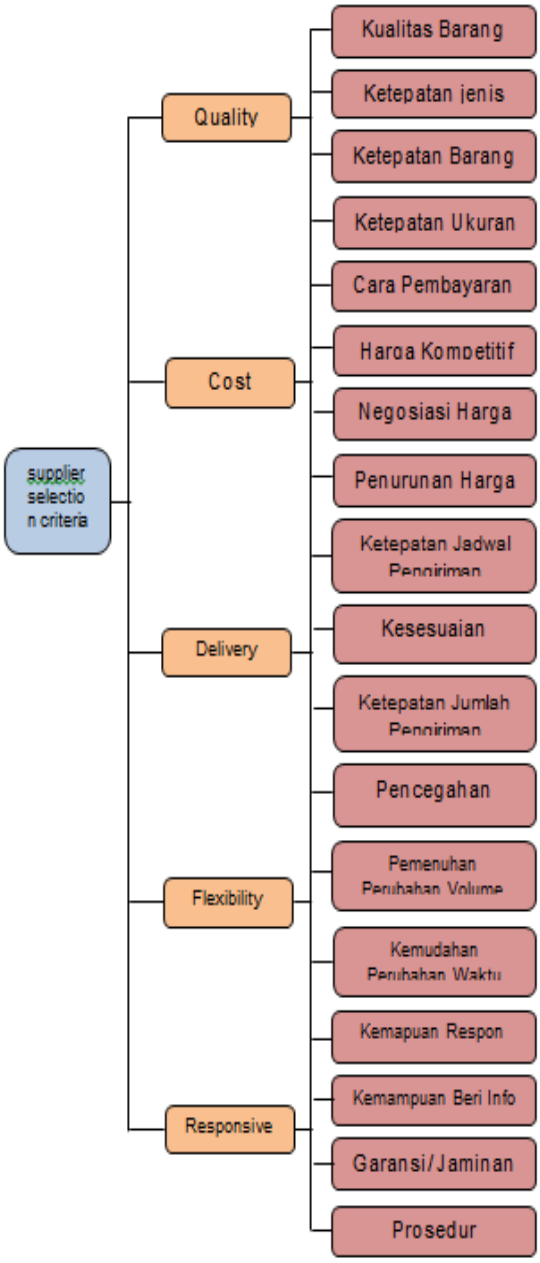

Figure 1. Supplier Selection Criteria Hierarchy Structure

Table 1. Rating Scale Comparison

Interest level	Variable Definition	Description
1	Both elements are equally important	Both elements have the same influence the importance of
3	An important element of a little more than the other elements	Opinions bit partial to an element other than the elements
5	An element is more important thann other element	Opinions are very partial to an element other than the elements
7	A much more important element than the other elements	An element is strongly favored and its dominance appears in practice
9	An absolute element is more important than any other element	One element of the absolute proved preferable to his partner, at a high confidence level
2,4,6,8	The midpoint between two adjacent consideration	If there is doubt between two adjacent rating
Contrary / Reciprocal	If the element A has one of the above values when compared with the element B, then element B has the opposite value when compared with the element A	

2.5. Consistency Index and the Ratio Test

One of the main AHP model that distinguishes it from the model - other models of decision-making is the lack of absolute consistency requirement. With the AHP model that uses input perception of the decision maker as the inconsistencies may occur because humans have limitations in their perception expressed consistently, especially if you have to compare a lot of criteria. Under these conditions, the decision maker can express the perception will be consistent or not.

Consistency of a measurement matrix itself is based on the maximum eigen value. Thomas L. Saaty has shown that the consistency of the matrix berordo index n can be obtained by the following formula:

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

CI = *Consistency Index*
λmaks = Largest eigen value of the matrix vector n
N = Ordo of Matrix

If the CI is zero, then the pair-wise comparison matrix is consistent. Limit inconsistency (inconsistency) as determined by Thomas L. Saaty determined using Consistency Ratio (CR), which is the ratio of consistency index with a value of the Random Index (RI) were obtained from an experiment by the Oak Ridge National Laboratory later developed by the Wharton School and is shown as Table 2 of this value depends on the matrix order n. Thus, consistency ratio can be formulated as follows:

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

CR = *Consistency Ratio*
RI = *Random Indeks*

Table 2. Random Index

n	1	2	3	4	5	6	7	8
RI	0,00	0,00	0,58	0,90	1,12	1,24	1,32	1,41

n	9	10	11	12	13	14	15
RI	1,45	0,00	0,00	0,58	0,90	1,12	1,24

(Saaty, 1996)

If the matrix pair - wise comparison with the value of CR is less than 0,100 then the opinion of the decision maker inconsistency is acceptable if it does not then need to be repeated assessment.

3. RESEARCH METHOD

1. Identify the Problem
   This stage is the initial stage of the study, and consists of several parts. The parts of this phase will explain the background of the problem, purpose of the study, and review of the literature.
2. Data Collection and Processing
   This stage is an important stage in determining the criteria which consists of several parts which are the steps of determining supplier selection criteria, priorities and weights using the method of Analytical Hierarchy Process (AHP), to determine the respondents and questionnaires.
3. Stage Analysis and Conclusions
   This stage is the final stage in the form of the results of the rank order of criteria.

4. RESULT AND DISCUSSION

To get the data were spread two questionnaires. The first questionnaire aimed to determine the criteria and sub-criteria. The second questionnaire was taken to perform pair wise comparisons (pairwise comparison) comparing each element with other elements. At each level of hierarchy in

pair in order to get the value of the interest rate element in the form of qualitative opinion. The pair wise comparisons made by decision-makers, namely the head of production, QC, R&D, Purchasing, PPIC and head of the warehouse.

To quantify the qualitative opinion of the grading scale used Saaty opinion of the value that will be obtained in the form of numbers that can be compared according to predetermined assessment at PT. Ceres Meiji Indotama based AHP then obtained the data in the Table 3.

Table 3. The main criteria for pairwise comparisons after taking the average value of 6 respondents

Kriteria	Quality	Cost	Delivery	Flexibility	Responsiveness
Quality	1,000	1,000	1,000	2,667	0,854
Cost	1,000	1,000	2,333	2,167	1,000
Delivery	1,000	0,852	1,000	4,833	1,021
Flexibility	0,724	0,774	0,558	1,000	1,706
Responsiveness	2,167	1,000	2,019	3,357	1,000
Total	5,890	4,626	6,910	14,024	5,581

Table 4 Normalization and Weight Determination Key Criteria

Kriteria	Quality	Cost	Delivery	Flexibility	Responsiveness	*Eigen Vector*
Quality	0,170	0,216	0,145	0,190	0,153	0,175
Cost	0,170	0,216	0,338	0,154	0,179	0,211
Delivery	0,170	0,184	0,145	0,345	0,183	0,205
Flexibility	0,123	0,167	0,081	0,071	0,306	0,150
Responsiveness	0,368	0,216	0,292	0,239	0,179	0,259
Total	1,000	1,000	1,000	1,000	1,000	1,000

Table 5 Determination λ maximum Key Criteria

Kriteria	*Eigen Vector*		*Lambda*
Quality	0,175	5,890	1,030
Cost	0,211	4,626	0,978
Delivery	0,205	6,910	1,418
Flexibility	0,150	14,024	2,098
Responsiveness	0,259	5,581	1,445
Total	1,000		6,969

CI = (λmaks – n) / (n-1)
CI = (2,098 – 5) / (5-1) = -0,726
CR = CI / CR
RI = *Random Indeks* (Look table 2)
CR = -0,7255 / 1,12 = - 0,648

Because the results of the main criteria for CR <0.1, the consistent assessment and processing of data can be submitted the next calculation. Here are the results of testing the consistency of the main criteria sub criteria as Table 6.

Table 6 Consistency Key Test Criteria and Sub criteria

Matriks	CI	RI	CR	Ket.
Kriteria Utama	-0,726	1,120	-0,648	Konsisten
Quality	-0,832	0,900	-0,924	Konsisten
Cost	-0,896		-0,996	Konsisten
Delivery	-0,816		-0,907	Konsisten
Flexibility	0,502		0,558	Tidak Konsisten
Responsiveness	-0,830		-0,922	Konsisten

Based on the above table it can be seen that all the criteria and sub-criteria are consistent except for the sub criteria flexibility, it is necessary to re questionnaire. However, in this study the results are ignored. So the results obtained weights and priorities as the following table.

Table 7 Results and Priority weighting of Key Criteria and Sub Criteria

No.	Kriteria dan Sub Kriteria		Bobot		% Bobot		Prioritas
	Responsiveness	Rs					
	Kemampuan Memberi Informasi Jelas	Kmi		0,316		31,6%	I
1	Prosedur Pengaduan	Pp	**0,259**	0,244	**25,9%**	24,4%	**I** II
	Garansi / Jaminan	Gr		0,242		24,2%	III
	Kemampuan Respon Komplain	Krk		0,199		19,9%	IV
	Cost	Co					
2	Negosiasi Harga	Nh		0,387		38,7%	I
	Cara Pembayaran	Cb	**0,211**	0,235	**21,1%**	23,5%	**II** II
	Harga Kompetitif	Hk		0,194		19,4%	III
	Penurunan Harga	Ph		0,185		18,5%	IV
	Delivery	Dr					
	Ketepatan Jadwal Pengiriman	Kjp		0,269		26,9%	I
3	Kesesuaian Pesanan	Kp	**0,205**	0,269	**20,5%**	26,9%	**III** II
	Ketepatan Jumlah Pengiriman	Kjk		0,264		26,4%	III
	Pencegahan Kerusakan	Pk		0,198		19,8%	IV
	Quality	Qu					
	Ketepatan Jenis Barang	Kjb		0,276		27,6%	I
4	Kualitas Barang	Kb	**0,175**	0,262	**17,5%**	26,2%	**IV** II
	Kekuatan Barang	Kkb		0,259		25,9%	III
	Ketepatan Ukuran	Ku		0,203		20,3%	IV

Based on Table 7 it can be seen that the responsiveness has first priority with 0,259 weight, has a cost to the weight of 0,211 second priority, third priority delivery has the fourth priority weight of 0.205 and quality with a weight of 0.175.

5. CONCLUSION

Based on the processing and data analysis, the conclusions that can be drawn is that supplier selection criteria according to the needs of the company is responsiveness, cost, delivery and quality.

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