

Supplier Assessment and Order Allocation Determination for Fast Moving Consumer Goods

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Abstract— Supply chain management in manufacturing has been widely discussed by researchers and industrial engineers due to complexity of activities. One of the supply chain activities is supplier selection. Supplier selection has involved in maintaining the smoothness of process production, the dependency between suppliers has becomes a serious concern for company. This study focuses on the supplier selection problem to obtain the best supplier for Fast Moving Consumer Goods (FMCG) Company. The criteria of supplier selections for (FMCG) company were introduced. The criteria in supplier evaluations are limited to quality, price, payment term, quantity accuracy, on time accuracy, response of supplier, flexibility of supplier and completeness of document. The weights of importance level for each criteria is processed by using Analytic Hierarchy Process (AHP) approach. In obtaining information on supplier overall performance, the weights of importance level is multiplied with actual supplier score. As the result, the score of overall supplier performance could help decision maker in deciding the amount of allocation order that should be distributed for each supplier.

Keywords— Supply chain management, Supplier selection, Analytic Hierarchy Process, Order allocation, Fast Moving Consumer Goods (FCMG)

1. Introduction

In production process, the smoothness of supply chain is one of the most important things to be considered. Fast Moving Consumer Goods Company continues to improve their business and their production process. In controlling their production process, the availability and smoothness of raw material is one of the most important things to be considered, therefore purchasing division has very important role, to ensure availability and smoothness of raw material in Fast Moving Consumer Goods (FMCG) Company.

In today competitive market, purchasing division must have awareness about how importance of selecting right supplier in fulfilling their requirement of raw material with their desired quality and scheduled [1].

Purchasing divisions have a key role to involve on cost reduction, profitability and flexibility of a company by selecting the right suppliers [2]. Selecting right supplier significantly affects the total cost of product and help company improve their competitiveness [3]. As companies become more dependent on supplier, the poor decision in choosing right supplier can give affect in stability of company especially in production process [4].

Supplier selection strategy can be divided into two type of problem, first selecting only the best supplier from few supplier that can fulfil all buyer requirement such as demand, quality and delivery and etc (single sourcing) and second selecting two or more suppliers to meet the demands of company (multiple sourcing)[5]. Generally Fast Moving Consumer Goods (FMCG) Company in Indonesia decided to use the multiple sourcing. Multiple sourcing is going to be suitable for a company who has an issue in fulfilling their needs in raw material. Implementation of multiple sourcing provides company a backup plan and protection from shortage, other supplier disruptions and there is need to maintaining competitiveness between suppliers [6]. Not only advantage but also a disadvantage that may occur by using multiple sourcing, the disadvantage is more supplier owned, more difficult supplier to be maintained. In overcoming the difficulties in maintaining many suppliers, it is important to company have a skill to decide which supplier has a good performance and not, In obtaining that information, purchasing division should have an measuring instrument that called supplier evaluation. Supplier evaluation and selecting right supplier has an important role in supply chain process and also crucial in success of a manufacturing firm [7].

Currently, Fast Moving Consumer Goods (FMCG) Company has own supplier evaluation with unique characteristic. However, the existence of the supplier evaluation is used to know overall supplier performance only, there is no further action to utilize the supplier performance information in deciding the amount of supplier allocation order. Otherwise if company implement supplier evaluation well, it can effectively reduce a risk of delay in overall process production in company [8].

In supplier selection for multiple sourcing, it is important for company to balance in term of criteria weight [9]. The importance of criteria selection in supplier evaluation highly depends on the type of items and the context in which they are to be purchased [10]. The selection of criteria should be based on information that can be obtained and available about the supplier, According to [11] it seems unlikely that there will be a best of set criteria that can be applicable to all supplier selection problems [11].

At the moment, Fast Moving Consumer Goods Company in this research has some criteria in supplier evaluation such as quality of product, rate of accuracy delivery in time and rate of accuracy amount of quantity. In selecting best supplier Fast Moving Consumer Goods Company usually use price as the leading factor in deciding and distribute allocation order for each supplier. In this research the focus will be identifies what criteria that must be considered in supplier evaluation and determined the weight for every criteria, from that information purchasing division can decide amount of order allocation that should be distributed for every supplier.

From problem statement above, motivates the authors to propose a new approach in selecting the best supplier based on their performance. In this research there are some research question, the research question are:

1. What criteria can fulfil the needs of Fast Moving Consumer Goods Company in assessing their supplier performance?
2. How much weight should be distributed into every criteria to balancing supplier performance evaluation?
3. What supplier that have best performance according to supplier evaluation?
4. How much order allocation should be distributed for every supplier?

The scope of this observation is limited to raw material of product "W" in Fast Moving Consumer Goods Company in Indonesia. This study aim to contribute in make a new approach of supplier evaluation and make company have a standard decision in supplier selection to allocated their distribution order into specific supplier, because currently purchasing division in Fast Moving Consumer Goods company that become the subject of research do not have

a standard decision and specific method in allocated their distribution order into specific supplier. Currently, the process of deciding the amount of allocation order only decided by the judgment of the decision maker (where price become leading factor and the cheapest supplier is selected to obtain all the order or obtain most of the allocation order). Criteria in supplier evaluation are limited to quality, price, payment term, quantity Accuracy, on time accuracy, response of supplier, flexibility of supplier and completeness of document.

2. Literature Review

2.1 Purchasing

Purchasing refers to all activities involved with obtaining items from a supplier; manage the logistics such as transportation, goods-in and warehousing before the item is used by user [12]. Purchasing also has focused attention on supplier, to ensure the smoothness of manufacturing process and capacity utilization [13]. The key purchasing activities flows are shown in Figure 1.

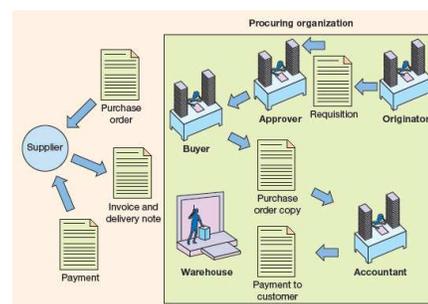


Figure 1. Purchasing activities flows [12]

Strategy of supplier selection divided into 2 strategies they are [14]:

1. *Single Supplier*
This strategy decides to only choose single supplier to fulfil all the needs of one or more item. Company will decided best supplier in fulfilling the needs.
2. *Multiple Supplier*
This strategy decides to choose more than one supplier in fulfilling the company needs. This strategy is used after a lot of consideration has been determined, such as production capacity of supplier, service and price

Purchasing processes in supplier evaluation are analyzed in two stages [15]:

1. First is the selection of suppliers by filtering them through an evaluation process that considering both qualitative and quantitative analyzed measurement.

2. Second stage is decide order amounts for each supplier are determined (order allocation).

In supplier selection there are some phase that made by De Boer, there are [16]:

1. Problem definition
Finding out exactly what the purpose and what want to be achieved by selecting a supplier
2. Formulation of selection criteria
Defining the criteria that related in supplier evaluation
3. Pre-qualification
Re-check on criteria and compare into previous historical data
4. Final choice
Making a final choice in selecting supplier

In a competitive market in industry, supplier evaluation now become more specific, where at the beginning only financial perspective that become the key to assess supplier performance, nowadays there are more than one perspective to be considered in assessing supplier performance [1]. In supplier Evaluation there are some criteria to be considered, such as [4]:

1. Price
2. Quality of product
3. Technical capabilities
4. Suppler service and etc.

Beside that the previous performance of supplier, guarantee, and financial position is also one of criteria to be considered in supplier evaluation [17].

2.2 Multi-criteria decision-making methods

In decision making, more than one criterion is usually needed to reach a decision, therefore it is important for decision maker to structure the problem and assess the criteria before the decision is made. There are many methods in solving multi criteria problem. Multi criteria decision making method usually helping decision maker by assess each criteria and on how they combine the evaluation of criteria to make a general evaluation [18].

2.2.1 AHP

AHP is one of a well known multi-criteria decision-making method. This method offers a useful and systematic approach in making a decision [19]. AHP provide a methodology to calibrate the numeric scale of measurement of quantitative as well as qualitative measurement. In deciding the level of important, AHP has a range from 1-9 least valued and 1-9 for absolutely more [20]. AHP provides decision makers with way to transform subjective measurement into objective

measurement [21]. This method also can produce the priority of criteria and distributed the weight of every criteria [22].Some key and basic steps involved in this methodology are [20]:

1. State the main problem
2. Determine the objectives of the main problem
3. Identify the criteria and sub criteria.
4. Structure the problem in a hierarchy of different levels constituting Objective/goal, criteria, sub-criteria and alternatives. Example of AHP hierarchy is shown in Figure 2.



Figure 2 Example of AHP hierarchies [23]

5. Compare each element in the corresponding level and calibrate them on the numerical scale. In this step we can determine the relationship weight between one element to other. It is required $n(n-1)/2$ comparisons, where n is the number of elements with the considerations that diagonal elements are equal or "1" and the other elements will simply be the reciprocals of the earlier comparisons. In comparing each element expert has to assess one element to the other based on the pair wise comparison scale (the pair wise comparison scale is show in Table 1.

Table 1. Pair wise comparison scale

Intensity	Level of importance	Explanation
1	Equal	Two activities has equally level to the object
3	Moderate	Slightly favours one over another
5	Strong	Strongly favours one over another
7	Very strong	Dominance of the demonstrated in practice
9	Extreme	Evidence favouring one over another of the highest possible order of affirmation
2,4,6,8	Intermediate level	When compromise is needed

Source: [24]

6. Perform calculations to find the maximum Eigen value, consistency index (CI), consistency ratio

(CR), and normalized values for each criteria/alternative.

- If the maximum Eigen value, CI, and CR are satisfactory then decision is taken based on the normalized values; else the procedure is repeated until these values lie in a desired range.

3. Methodology

First step in making a propose supplier evaluation is by deciding the main purpose of the observation, after observation is done, and it is found that the main problem in purchasing division in Fast Moving Consumer Goods is unavailability of standard base or specific method in allocated their distribution order into specific supplier. The existence of this supplier evaluation in Fast Moving Consumer Goods company is used only to know supplier performance without further action that may be useful in minimizing miss allocation in allocating order and protection from shortage, strikes and other supplier disruptions can be avoided. After the problem has been decided, next step is decide the scope of observation because Fast Moving Consumer Goods have a wide business so the focus of observation should be simplify, after that, AHP method is implemented which start from determine criteria of selection supplier and after processing data is processed, it will produce the optimal weight of every criteria, next step is multiply the weight with score of supplier for every criteria, after the final total score is known, we can summary overall score of supplier and assign the amount of order should be distributed for every supplier

4. Data Collection

In term to obtain data, there are two methods that used, first is direct data collection and second is indirect data collection. For primary data, such as price, quality and delivery data of supplier, the author obtained directly from purchasing division in Fast Moving Consumer Goods Company, for indirect data collection the method is implemented by observing, interviewing and questioner. Example data that obtain by indirect method is selection of criteria and level of importance of criteria of supplier performance that obtained through questioner.

5. Data Processing

Purchasing division in Fast Moving Consumer Goods company is divided into 3 sectors such as raw material, packaging and supporting. Distribution of fund that expense from Fast Moving Consumer Goods company into 3 sector is show in Figure.4

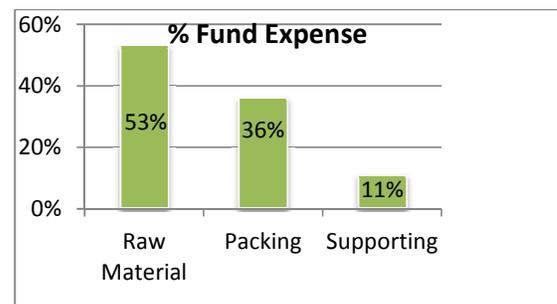


Figure 4. Fund Expense in Fast Moving Consumer Goods

From Figure.4 it is conclude that raw material sector is the highest fund expense compare to other sector. Based on that, raw material division will become the focus of the research. After the focus of raw material sector has been chosen, next step is deciding what raw material product will be the focus of this observation, it is important because Fast Moving Consumer Goods is a company who has a lot of products and every product has their own characteristic and specific of raw material. Distribution of fund that expense for every product is show in Figure 5.

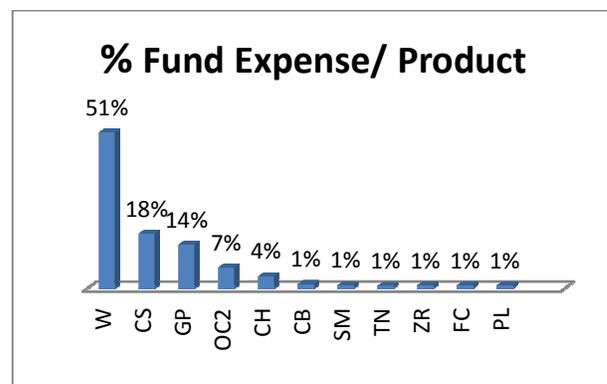
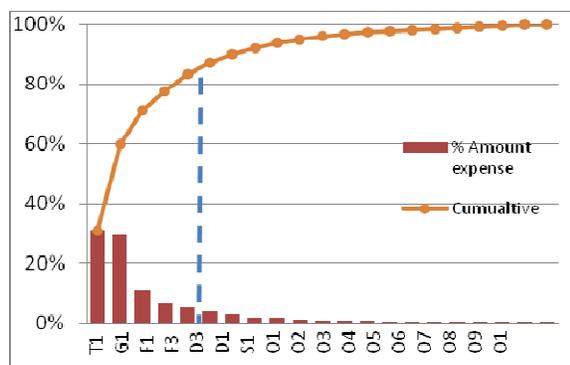


Figure 5. Fund Expense on product

From the Figure 5, it is concluded that product of "W" is the biggest contribution fund expense than the other product, from that consideration raw material of "W" product will become the focus of this observation. After type of product in raw material is decided, the next step is deciding what type of raw material in "W" product will become focus in this observation, because in producing "W" there are 21 types of raw material, by considering the number of raw material in this product, so the next step is make the object of observation become more narrow. In deciding what raw material that become focus on this observation, Pareto chart is used to identify what raw material that have a biggest contribution of total amount expense. The distribution of total fund expense in raw material of product "W" is explained in Table 2.

Table 2. Distribution of total fund expense in raw material of product “W”

NO	Item	% Amount Expense	Cumulative
1	T1	30.74%	30.74%
2	G1	29.33%	60.07%
3	F1	11.00%	71.07%
4	F3	6.50%	77.57%
5	D3	5.52%	83.09%
6	D1	4.00%	87.09%
7	S1	2.90%	89.99%
8	O1	1.99%	91.98%
9	O2	1.83%	93.82%
10	O3	1.25%	95.07%
11	O4	0.94%	96.01%
12	O5	0.66%	96.67%
13	O6	0.63%	97.30%
14	O7	0.41%	97.71%
15	O8	0.43%	98.14%
16	O9	0.39%	98.53%
17	O10	0.37%	98.90%
18	O11	0.36%	99.26%
19	O12	0.29%	99.55%
20	O13	0.24%	99.80%
21	O14	0.20%	100.00%

**Figure 6.** Pareto Chart

Based on Pareto chart in Figure 6, it is shown that item G1, T1, F1, F3 and D3 are represent the overall of fund expense in “W” product, based on that G1, T1, F1, F3 and D3 item will become the focus in supplier evaluation in this observation.

5.1 Application of AHP

In AHP implementation, the first step is started by deciding the main purpose of this model. Based on observation and interview in purchasing division, the main purpose in this model is deciding the best supplier. From supplier performance, which observed, company can be decided the amount of order allocation to every supplier. The next step after main purpose is decide, it is determined the criteria and sub criteria of the model. Based on interview, brainstorming and literature research, the criteria and sub criteria is shown on table 3.

Table 3. Criteria and Sub criteria in AHP

NO	Criteria	Sub criteria	Code
1	Quality	Quality Product	Q1
2	Financial	Price	F1
3		Payment term	F2
4	Delivery	Quantity Accuracy	D1
5		On time Accuracy	D2
6	Service	Response	S1
7		flexibility	S2
8	Document	completeness of document	KD1

After the criteria and sub criteria has been determined, next step determines the alternative solution that can be selected according to criteria and sub criteria. Based on the selected criteria and sub criteria, the alternative supplier solution is shown in Table 4.

Table 4. Supplier mapping table

NO	Supplier	Item
1	KJ	D3
2	HG	
3	SD	F1
4	SI	
5	WI	
6	SI	F3
7	WC	
8	SL	G1
9	SU	
10	BS	T1
11	KJ	

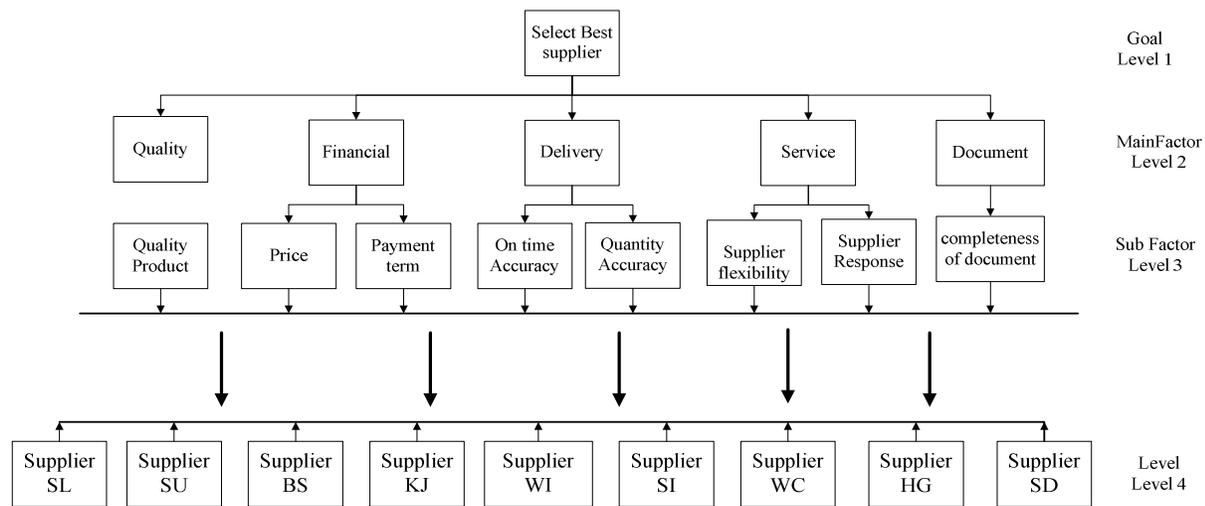


Figure 7. Hierarchies Structure

Based on Table 4, the amount of alternative solution is nine suppliers for five item of raw material. In supplier mapping in table 4 there are 2 suppliers that have a capabilities to provide 2 type of raw materials, such as KJ where not only provide D3 but also T1, It also happened in SI supplier where can provide F1 and F3 item at once. After determine of main purpose, criteria, sub criteria and alternative have been done, so the last step is make a hierarchies structure. The hierarchy structure is show in figure 7.

Table 5. Pair wise comparison of criteria

	Q1	F1	F2	D1	D2	S1	S2	KD1
F1	2	1	6	4	3	5	5	7
F2	0.2	0.2	1	0.3	0.3	0.5	0.5	3
D1	0.3	0.3	3	1	0.5	3	3	4
D2	0.5	0.3	4	2	1	4	4	5
S1	0.3	0.2	2	0.3	0.3	1	1	3
S2	0.3	0.2	2	0.3	0.3	1	1	4
KD1	0.2	0.1	0.3	0.3	0.2	0.3	0.3	1
TOTAL	4.7	2.8	23	11	7.5	19	19	34

The next step is to generate the pair wise comparison of each criteria. In this step we will see the level of importance from one criteria to other, data the level of importance from one criteria to other is obtained from questioner that have been collected before from the expert. In this model the experts are

come from two experts, first expert is Manager purchasing analyst in and Manager of raw material in Fast Moving Consumer Goods company. The election of two experts is based on consideration that both of them are the one who has an understanding and experience in supplier evaluation and allocation order in Fast Moving Consumer Goods company. Information from two experts is important because their information will decided the level of importance of each criterion than others. After the expert compares each sub criteria by filling the questioner, the result is show in Table 5.

Based on this Table of table 5, the highest total column score has achieved by KD 1 and S2 with 36 and 28.5 score. It is found that completeness of document and Term of Payment (TOP) are criteria that made less effect to supplier performance in this model.

After the pair wise comparison has been made the next step is to generate the consistent test. This step is important to ensure the judgments from the experts are consistence between one criteria to other. The consistence of can be determine by finding the consistency ratio (CR). To determined consistency ratio (CR) calculation must be made,

Table 6. Table of weight of sub criteria and total consistency vector

Weight	Consistency Vector
0.2216	8.651
0.3171	8.616
0.0437	8.166
0.1102	8.546
0.1602	8.654
0.0585	8.245
0.0622	8.181
0.0263	8.281
TOTAL	67.34

After consistency vector is obtained, the next step is determined Eigen value maximum, Consistency index and consistency ratio. From those three values, the consistency test is conducted to examine the weight of each criteria.

Determine Eigen value maximum (λ max)

$$\lambda \max = \frac{\text{Total Consistency vector}}{\text{Number of Sub criteria}} \quad (1)$$

$$= \frac{67.34}{8} = 8.417$$

Determine Consistency Index (CI)

$$CI = \frac{(\lambda \max - n)}{(n-1)} \quad (2)$$

$$= \frac{(8.417 - 8)}{(8-1)}$$

$$= \frac{0.417}{7} = 0.059$$

Table 7. Table Matrix sequence / Random index (RI)

N	1	2	3	4	5	6	7	8	9	10
(RI)	8	0	0.6	0.9	1.1	1.2	1.3	1.4	1.5	1.5

Source: [24]

Determine Consistency Ratio (CR)

$$CR = \frac{CI}{RI} \quad (3)$$

$$= \frac{0.059}{1.41} = 0.042$$

After consistency test is conducted, it is concluded that the CR value is less than 0.1, it is due to experts judgment is acceptable and the data of score weight is consistent. The score of weight for each criteria is shown in table 8

Table 8. Score of weight

Criteria	Score of weight
Q1	22%
F1	32%
F2	4%
D1	11%
D2	16%
S1	6%
S2	6%
KD1	3%

After weight of every criteria is determined, next step is calculating the score of supplier for each sub criteria. Summary of supplier score in every sub criteria is explained in Table 9

Table 9. Supplier score for each criteria

Item	Supplier	Q1	F1	F2	D1	D2	S1	S2	KD1
D3	KJ	91	0	55	94	80	61	80	95
	HG	100	100	0	100	100	91	100	100
F1	SD	100	85	55	92	85	76	83	83
	SI	100	85	70	94	83	92	89	92
	WI	100	100	55	81	86	95	93	98
F3	SI	100	100	70	94	87	92	92	92
	WC	100	70	40	60	88	84	94	100
G1	SL	100	100	100	75	70	89	0	77
	SU	100	55	86	100	100	92	88	92
T1	BS	100	100	55	96	87	95	92	58
	KJ	100	85	55	92	78	61	80	95

After score of each supplier is obtained, next step will be multiplying the weight with score of each supplier, from that we can summary the overall supplier performance. Table 10 shows the summary of supplier score and order allocation.

Table 10. Supplier score and order allocation

Item	Supplier	Total Score	Order allocation
D3	KJ	56.72	37%
	HG	95.11	63%
F1	SD	87.21	32%
	SI	89.14	33%
	WI	92.8	34%
F3	SI	94.75	54%
	WC	80.21	46%
G1	SL	84.94	50%
	SU	83.74	50%
T1	BS	93.66	52%
	KJ	85.24	48%

In addition based on multiplying score of weight and score of supplier performance, the best suppliers are HG, WI, SI, SL and BS for item D3, F1, F3, G1 and T1. Supplier score are shown in table 11

Table 11. Best supplier per item

Item	Supplier	Total Score
D3	HG	95.11
F1	WI	92.8
F3	SI	94.75
G1	SL	84.94
T1	BS	93.66

6. Conclusion

The Criteria and Sub Criteria of supplier selection for Fast Moving Consumer Goods (FCMG) were proposed. As a result, AHP approach shows that the criteria F1 (financial) is the most important criteria in supplier selection, followed by Q1 (Quality) as the second selection and D2 (accuracy on time delivery) as the third selection. Furthermore, the decision maker could focus on the three of criteria as the main consideration in selecting the suppliers to allocate the amount of order allocation for each supplier.

The novelty of this paper is to determine the criteria such as financial, quality, and accuracy on time delivery to be required for selecting supplier and order allocation. Those criteria suits for fast moving consumer goods company in Indonesia.

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