Priority of Selection Suppliers with Fuzzy ANP COPRAS-G

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Abstract. The company which is engaged in spring bed production is located in Medan city. Procurement of raw materials is the main activity in ensuring the clear production. Delivery delayed by suppliers of raw materials affects the clear production and impacts on order delivery to customers. Delivery delay of the company happened in raw materials foam and wire by each supplier with a frequency of 66% from the total delivery made. Therefore, supplier evaluation needed done and the company take an appropriate decision based on the priority suppliers. Integration of Fuzzy Analytical Network Process (FANP) and Complex Proportional Assessment with Grey Theory (COPRAS-G) is used in the evaluation of the supplier where the scale of influence among criteria and assessment of suppliers of the criteria obtained using a questionnaire distributed to five managers to gain weight, weight criteria which is serves as in inputs for priority suppliers. Results priorities foam raw material suppliers are HI, PF, MF, and DCI which is the priority sequence obtained suppliers of wire raw materials supplier are BUWI, AJ, and GGS.

1. Introduction

Economic competition in the market era of ASEAN and Economic Community currently requires company to compete in domestic and international markets. In an atmosphere of intense competition, customer satisfaction is the key for companies to win the competition, because satisfied consumers will return to the company, loyal to company products and spread the good image of the company products to other customers. One of the strengths for consumer satisfaction determines the intensity of competition in the industry is the bargaining power of suppliers. Companies are competing to improve their performance and resources.

Raw materials are the main problem for companies because very potential in improving the products offered. Purchasing of raw materials in the company is inseparable from the role of suppliers and the selection of suppliers is a strategic activity, especially if the supplier will supply the main raw material [1]. This condition affects consumer trust and satisfaction. Therefore, evaluation of suppliers must be done and companies take a right decisions. The selection of the right supplier influences the quality of the product produced and has a major impact on customer satisfaction. Importance of customer satisfaction in today dynamic corporate environment is obvious as it greatly influences customers repurchase intentions whereas dissatisfaction has been a primary reason for customers intentions to switch. Satisfied customers are most likely to share their experiences with other five or
six people around them [2]. The relationship between consumer and supplier and the ability of the supplier affects the quality, timeliness of delivery and the purchase cost [3].

Companies that produce spring bed work together with several different local suppliers to supply foam and wire raw materials to ensure the availability of raw materials and smooth production to demand order completed on time. In addition to having collaboration for a long time, the cost factor offered is also a consideration of the company in collaborating with suppliers of raw materials for foam and wire at this time. In practice, companies always place orders first in anticipating the possibility of delivery delays. However, shortages or unavailability of raw materials continue to happen due to improper delivery of raw materials by suppliers. The transfer frequency of raw material from suppliers reaches 66% of the total delivery of raw materials. The delay in raw materials distribution by suppliers encourages companies to rush orders to the other suppliers to get a shortage of raw materials in making production. The consequence of rush orders made is the emergence of additional costs for the company, namely saving costs, demand costs and opportunity costs. In addition, the production schedule also disrupted which affects the delivery of orders to consumers. The problem of delay delivery of raw materials by suppliers is important to discuss because it affects delivery which is a function in customer satisfaction needed. The accumulation of the inability to fulfill customer satisfaction have an impact on consumer confidence loss which is results in the loss of consumers. Therefore, evaluation of suppliers must be done to obtain supplier ratings with good and poor performance.

One method can be used to analyze the problem of supplier priority is to use Fuzzy Analytical Network Process, Chang Approach and Chopras G method. The ANP is the most comprehensive framework for the analysis of corporate decisions. It allows both dependence within clusters of elements (inner dependence) and between clusters (outer dependence). The elements in a cluster may influence other elements in the same cluster and those in other clusters with respect to each of several properties [4]. This ANP method is able to overcome the problem of interdependence and feedback between alternatives or criteria making it easier in a more systematic analysis [5]. Extent analysis from Chang (1996) is a concept used in the development of fuzzy AHP [6]. The complex proportional assessment (COPRAS) method assumes direct and proportional dependences of the significance and utility degree of the available alternatives under the presence of mutually conflicting criteria. It takes into account the performance of the alternatives with respect to different criteria and also the corresponding criteria weights. The COPRAS method which is used here for decision-making in manufacturing environment adopts a six stage procedure for ranking and evaluating alternatives in terms of their significance and utility degree. COPRAS has the ability to account for both positive (beneficial) and negative (non-beneficial) criteria, which can be assessed separately within the evaluation process [7]. Method COPRAS is most commonly used in Lithuania, its main characteristics and properties have not been clearly defined and demonstrated. However, the awareness of these properties allows us to show the benefits of the method’s application, to predict the influence of minimizing criteria values on the final result (estimate), to check the calculations and to take into account possible instability of estimates yielded by the method due to the specific character of the actual data [8].

Many previous studies have been done in overcoming the problem of supplier selection. Dargi et al. (2014) used the Fuzzy Analytic Network Process (FANP) method with Chang's approach to develop a supplier selection framework at an automotive plant in Iran. FANP is used to calculate the weights of 7 criteria evaluating the selection of suppliers used. Interrelation relationships between criteria are defined and then illustrated on an ANP network diagram. Data collection was obtained from a team of four experts [9]. Another study was also conducted by Ghorabae (2014), the method of the Complex Proportional Assessment (CORPRAS) Type 2 Fuzzy Set in conducting supplier selection in a manufacturing company. This method uses a stepwise procedure to rank and evaluate alternatives, which are considered from the degree of utility and significance in choosing the best solution. There are 5 criteria from 6 candidate suppliers assessed. The advantages of the CORPRAS method are for simple calculation methods and considerations of beneficial and non-beneficial criteria [10]. The
application used of FAHP and CORPRAS-G methods about selecting suppliers in Iranian manufacturing companies (Mobin, et al 2015). The use of these methods involves qualitative and quantitative factors which are modeled as Multi Criteria Decision Making (MCDM) which involves 5 expert opinion people to decide which are suppliers are potentially used as an alternatives by 4 supplier criteria consideration, namely price, quality, flexibility and technical capability. The advantage of this model is first discussing the weight of attributes when evaluating alternatives with FAHP, second, the number of pairwise comparisons is reduced and calculation of consistency ratio. Finally, COPRAS-G solve problems with a large number of alternatives [11]. The application of the FANP method, Chang Approach and CORPRAS-G method in increasing supplier selection problems is the best method to use. Based on that, this study aims to improve the quality of distribution and overcome lose public and consumer confidence.

2. Methodology
The study was conducted on one of the springbed industries Medan city where the objects studied were each supplier of raw materials for wire and foam at the company. The high frequency of delays in orders to consumers distribution needed for a method provides an appropriate decision in suppliers evaluation based on supplier priority results. The results of supplier criteria and subcriteria are based on the results of FGD. After the criteria and subcriteria are determined then the relationship between criteria and subcriteria determined by the results of the FGD. Fuzzy ANP is used to get the weight of each suppliers criteria and then calculated using the Chang's Extent Analysis approach. The conventional ANP gives crisp decision making, but it is unstable and unable to deal with subjective judgment. Therefore, the concept of fuzzy ANP is recommended due to the inheritance of tentative decision making with conventional ANP [12]. Processing data using the CORPRAS-G method results in normalization of the decision matrix, calculating the number of weighted averages for all alternatives, calculating alternative weights, and sorting alternatives. Data analysis in the form of choosing the best alternative suppliers according to the results of weighting calculations from data processing. Data analysis also includes when there are disadvantage of each supplier in the study and it can be improved by knowing the rankings, advantages and disadvantages of each supplier.

3. Result and Discussion
3.1. Determination of Sub criteria Weight
Fuzzy ANP is used to get the weight of each supplier criteria and then calculated the Chang’s Extent Analysis Approach. The results of sub criteria weight can be seen in Table 1.

| Criteria | Weight |
|----------|--------|
| K-1      | 0.0958 |
| K-2      | 0.0443 |
| K-3      | 0.0701 |
| K-4      | 0.0394 |
| H-1      | 0.0812 |
| H-2      | 0.0279 |
| H-3      | 0.0361 |
| H-4      | 0.0275 |
| KP-1     | 0.0843 |
| KP-2     | 0.0373 |
| KP-3     | 0.0514 |
| P-1      | 0.0275 |

Table 1. shows that specification conformity is an important consideration because it has the highest weight while reputation has the lowest weight on supplier evaluation.
3.2. Determination of Supplier Priority
COPRAS generate priority for foam suppliers based on utility degrees. Table 2. shows the results of weights calculation and sequences of foam suppliers. Results of weight calculation and sequence of wire suppliers can be seen in Table 3.

Table 2. The Result of COPRAS Foam Supplier.

| Category | HI  | PF  | DCI | MF  |
|----------|-----|-----|-----|-----|
| Weight (Q_i) | 0.2681 | 0.2477 | 0.2417 | 0.2427 |
| Utility Degree (N_i) | 100.00% | 92.38% | 90.16% | 90.53% |

Table 2. shows the results of utility degree for foam supplier sequences namely HI (100%), PF (92.38%), DCI (90.16%) and MF (90.53).

Table 3. The Result of COPRAS Wire Supplier.

| Category | GGS | BUWI | AJ |
|----------|-----|------|----|
| Weight (Q_i) | 0.3303 | 0.3353 | 0.3345 |
| Utility Degree (N_i) | 98.49% | 100.00% | 99.74% |

Table 3. shows the results of utility degrees for order of wire suppliers, namely GGS (98.49%), BUWI (100%) and AJ (99.74%).

3.3. Determination of Raw Material Delay Reduction
Reduction of raw material delays can be done by calculating at each alternative supplier. The total alternative is 2. The results of the reduction calculation in raw material delays can be seen in Table 4.

Table 4. Raw Material Delay Reduction.

| Supplier (Alternative 1) | HI  | PF  | MF  |
|--------------------------|-----|-----|-----|
| Raw Material Delay       | 2 days | 3 days | 4 days |
| Total of Raw Material Delay is 9 days |

| Supplier (Alternative 2) | HI  | PF  | DCI |
|--------------------------|-----|-----|-----|
| Raw Material Delay       | 2 days | 3 days | 5 days |
| Total of Raw Material Delay is 10 days |

Table 5 shows that alternative 1 results in a reduction in delivery delays is better than alternative 2 where the initial delay of 14 days decreases to 9 days.

4. Conclusion
The most influential criteria for supplier evaluation are conformity to desired specifications, timeliness of delivery, product cost, ease of communication and technical support. The priority results of suppliers in foam raw materials are HI, PF, MF, DCI, while the priority sequence of suppliers of wire raw materials are BUWI, AJ, GGS. Companies need to make commitments in working with better suppliers such as a system of fines submission, building a real time information system and creating high human resources and this research can be realized.

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