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Supplier selection in rubber industry using analytic network process (ANP) and technique for order preference methods by similarity to ideal solution

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Abstract. The selection of suppliers of raw materials is a requirement of decision-making which is quite important because the right supplier selection can improve the performance and increase the competitiveness of the company. The main factors of concern in determining criteria for supplier companies is a necessary characteristic of rubber raw materials that have the standard SIR (Standard Indonesian Rubber). Based on expert opinions specified several criteria and subkriteria required for the selection of the supplier. Supplier selection problem resolution is done by applying the methods of Analytical Network Process (ANP). Supplier selection criteria using Dickson's Vendor Selection theory. The scale of the influence between criteria and alternatives based on the criteria relationship becomes the input in ANP to produce criteria weight. ANP analysis produces the criteria that become the best supplier performance requirements are Quality criteria (0.2918), followed by price criteria (0.1857), performance history (0.1267), delivery (0.1225) and claim policy and warranty (0,0954) Sub-criteria resulted in consistency of quality, accuracy of the number of shipments, level of disability, timeliness of delivery, price cuts, guarantee of raw materials, ability to maintain agreements, flexibility of delivery schedules, and quick response in responding to complaints.

1. Introduction

The company's success factor is influenced by the selection of the right supplier for the company. The selection of the right supplier can guarantee the availability and quality of raw materials[1]. The selection of the right supplier by the company will maintain the production line at the company. Good quality products require good quality raw materials. In addition, the speed and timeliness of material deliveries from suppliers not only allows companies to produce and deliver products to customers in a timely manner, but also can reduce the level of inventory of material that must be stored so that it will also result in cost savings[2]. Supplier selection is a matter of decision making involving multiple people. The criteria are derived from the opinions of experts who have a perspective, responsibility, and experience as decision makers. The decision making process is translated by a systematic approach and logic to get priority and weight[3].

The method will be adapted in this research is the integration of the method of Analytic Network Process (ANP). ANP is used to determine the weights of the criteria of suppliers are interconnected so

that form a network by using the criteria of dickson. Method ANP there is defedency in its use and feedback between the criteria used[4].

Supplier selection criteria using Dickson's theory. Dickson's research results are the reference for most studies that discuss suppliers or vendors[5]. The Dikcson study was based on a questionnaire sent to 273 buying agents and managers selected from members of the National Association of Purchasing Managers. Members of this association are sales agents and managers in the US and Canada. From the results of the study there are 23 important criteria for the supplier selection process which are sorted from the highest to the lowest mean rating[6]. The highest mean rating can be concluded as the most significant and most important criteria. In that year, the most significant criteria were product quality, delivery time, historical performance data, and warranty policies used by suppliers[7]. This research needs to be done to give feedback to the company in the selection of the right supplier based on the quality of each vendor.

2. Method and materials

The research was carried out on an industrial tire retreading. The type of research is a survey research that is research that aims to obtain facts from existing symptoms directly from certain people who are used as objects of research and find a solution that will be applied[8].

This research use questionnaire instrument (a questionnaire) that is filled in by the respondents who understand and become expert in the specified research object. Respond in the research is supervision, production manager and marketing manager[9].

The data used is assessment data on criteria and sub-criteria from alternatives obtained from questionnaires filled by experts[10]. Quality, delivery, claim and guarantee policy, performance history and prices are the criteria that are determined for the purpose of obtaining the best supplier for the company.

Research done by following these steps:

2.1. Determination of the criteria and Sub-criteria

This step will yield criteria and sub-criteria on the supplier company. Determination of the criteria and sub-criteria is the result of interviews with company experts in party charging the closed questionnaire for the determination of the criteria and semi-open for sub-criteria determination[11].

2.2. Determination of the relationship between criteria and sub-criteria

This step aims to find out how the relationship between criteria and sub-criteria. here are 2 relationships between criteria and sub-criteria, namely inner dependence and outer dependence.. Inner dependence relationship shows the relationship between sub-criteria in the same criteria cluster, while outer dependence shows sub-criteria relationship with other sub-criteria outside the criteria sub-criteria cluster[12].

2.3. Creation of a network stucture

The relationship between criteria and sub criteria obtained from the results of interviews with experts is made into an image of the structure of the network[13].

2.4. Calculation of criteria and sub-criteria weights

The granting of the weighting on each of the criteria was conducted to know the priority on each criterion. The assessment weighting is performed by means of a detailed questionnaire by the experts at the company[14].

3. Results and discussion
3.1. Analysis of criteria and sub-criteria
Criteria and sub criteria obtained are the result of discussion with the experts at the company by conducting a questionnaire filling. Criteria and subkriteria obtained can be seen in table 1.

Tabel 1. Criteria dan Sub-Criteria

Criteria	Sub-Criteria
Quality (Q)	Suitability of Quality raw materials (Q-1)
	The number of rejected raw materials (Q-2)
	Quality consistency of raw materials (Q-3)
Delivery (D)	On Time Delivery (D-1)
	Accuracy of Delivery Amount (D-2)
	Delivery schedule flexibility(D-3)
Policy Claims & Guarantee (PCG)	Providing Guarantee or Guarantee on Raw Materials (PCG-1)
	Fast response in responding to complaints (PCG-2)
Performance History (PH)	Ability to fulfill order quantities (PH-1)
	To be contacted(PH-2)
	Ability to maintain agreement(PH-3)
	Ability to communicate with customers (PH-4)
Price (P)	The suitability of the raw material price (P-1)
	The granting of discounts (P-2)
	Ways Of Payment (P-3)

Table 1 shows the criteria and sub-criteria for the selection of suppliers and influential supplier best made for company.
1. Determination of the relationship criteria and sub criteria and the establishment of network
2. Determination of criteria and sub-criteria weights

Criteria and sub-criteria achieved is the result of interviews with experts with instruments questionnaires. From an assessment that was done will be retrieved each weighting criteria and sub-criteria. Ranking of criteria weight can be seen in Table 2.

Table 2. Criteria weight rating

Criteria	Weight
Quality (Q)	0,2918
Price(P)	0,1857
Performance History(PH)	0,1267
Delivery(D)	0,1225
Policy Claims & Guarantee(PCG)	0,0954

Table 3 shows the ranking of the weight criteria where the most dominant criteria for supplier selection is quality with a weight of 0.2918. The sub-criteria weight is sorted by rank which can be seen in Table 3.

Table 3. Subcriteria

Sub-Criteria	Weight
Suitability of quality raw materials	0,1162
The number of rejected raw materials	0,1080
Warranties or guarantees against raw materials	0,0717
The consistency of quality of raw material	0,0677
The suitability of the raw material price	0,0648
The granting of discounts	0,0640
Ways of Payment	0,0563
The accuracy of the number of shipments	0,0406

Ability to maintain agreement	0,0408
Delivery schedule flexibility	0,0408
On time delivery	0,0389
The ability to communicate with customers	0,0371
Ability to Fulfill Order Quantities	0,0364
Fast Response in Responding to Complaints	0,0237
Easy to be Contacted	0,0126

Table 3. shows the ranking of weights subkriteria to choose supplier there is sub-dominant criteria are suitability of quality raw materials with weights 0.1162.

4. Conclusion

To keep the company performance criteria required of suppliers who supply the raw material of rubber. Standard criteria required the company, based on the analysis of ANP conclusion as follows:

1. Criteria that most affect the performance of the supplier to maintain and improve the performance of the company is Quality criteria (0.2918), followed by the price criterion (0.1857), performance history (0.1267), shipping (0.1225) and policy (warranty claims and 0.0954).

2. The sub-criteria that influence are the conformity of the quality of the raw material (Q-1) (0.1162), followed by the subcriteria of the rejected raw material (Q-2) (0.1080), providing guarantees or guarantees for raw materials (PCG-1) (0.0717), consistency of raw material quality (Q-3) (0.0677), conformity of raw material prices (P-1) (0.0648), Giving discounts (P-2) (0.0640) , Method of payment (P-3) (0.0563), accuracy of number of shipments (D-2) (0.0406), ability to maintain agreement (PH-3) (0.0408), Flexibility of delivery schedule (D-3) (0.0408), Timeliness of Delivery (D-1) (0.0389), Ability to communicate with customers (PH-4) (0.0371), Ability to fulfill order quantities (PH-1) (0.0364), Fast response in responding to complaints (PCG-2) (0.0237) and Easy to be contact (PH-2) (0.0126).

5. References

[1]   Gencer, Cevriye. 2007. *Analytic network process in supplier selection: A case study in an electronic firm*. Applied Mathematical Modelling **31** (2007) 2475–2486.

[2]   Dou, Yijie, Qinghua Zhu, and Joseph Sarkis. 2013. *Evaluating green supplier development programs with a grey-analytical network process-based methodology*. European Journal of Operational Research xxx (2013) xxx–xxx.

[3]   Kone, Aylin Cigdem, and Tayfun Buke. 2007. *An Analytical Network Process (ANP) evaluation of alternative fuels for electricity generation in Turkey*. Energy Policy **35** (2007) 5220–5228.

[4]   Bayazita Ozden, and Birsen Karpak. *An analytical network process-based framework for successful total quality management (TQM): An assessment of Turkish manufacturing industry readiness*. Int. J. Production Economics 105 (2007) 79–96.

[5]   Felice, Fabio De, Mostafa H. Deldoost, Mohsen Faizollahi and Antonella Petrillo. 2015. *Performance Measurement Model for the Supplier Selection Based on AHP*. Int J Eng Bus Manag, 2015, 7:17.

[6]   Meade, Laura M, and Adrien Presley. 2002. *R&D Project Selection Using the Analytic Network Process*. IEEE Transactions on Engineering Management, VOL. 49, NO. 1, February 2002.

[7]   Wu, Hsin-Hung. 2002. *A Comparative Study of Using Grey Relational Analysis in Multiple Attribute Decision Making Problems*. Quality Engineering Vol. 15, No. 2, pp. 209–217, 2002–03.

[8]   Wang, Endong. 2015. *Benchmarking whole-building energy performance with multi-criteria technique for order preference by similarity to ideal solution using a selective objective-weighting approach*. Applied Energy 146 (2015) 92–103.

[9]   Lin, Jeng- Hsiang, Chien Jou Yang. 2016. *Applying Analytic Network Process to the Selection of Construction Projects*. Open Journal of Social Sciences, **4**, 41-47.

[10]   Yuksel, Ihsan, Metin Dagdeviren. 2010. *Using the fuzzy analytic network process (ANP) for Balanced Scorecard (BSC): A case study for a manufacturing firm*. Expert Systems with Applications 37 (2010) 1270–1278.

[11]   Saaty, Thomas L. 2016. *Analytic Hierarchy Process. Springer*, 978-1-4419-1153-7.

[12]   Saaty, Thomas L. 2008. *Relative Measurement and Its Generalization in Decision Making Why Pairwise Comparisons are Central in Mathematics for the Measurement of Intangible Factors The Analytic Hierarchy/Network Process*. *Rev. R. Acad. Cien. Serie A. Mat.* VOL. 102 (2), 2008, pp. 251–318.

[13]   Arai, Kohei and Tran Xuan Sang. 2011. *Fuzzy Genetic Algorithm for Prioritization Determination with Technique for Order Preference by Similarity to Ideal Solution*. IJCSNS International Journal of Computer Science and Network Security, VOL.11 No.5, May 2011.

[14]   Alonso, José Antonio, M. Teresa Lamata. 2006. *Consistency In The Analytic Hierarchy Process: A New Approach*. International Journal of Uncertainty, Fuzziness and Knowledge-B ds 1. 4, N. 4 (2006) 445-459