APPLICATION OF ANALYTIC NETWORK PROCESS IN THE PERFORMANCE EVALUATION OF LOCAL BLACK-SOYBEAN SUPPLY TO UNILEVER INDONESIA'S SOY-SAUCE PRODUCT

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ABSTRACT

Nowadays, companies are putting more concerns for neighborhood community development as part of their corporate social responsibility. Unilever Indonesia, as a subsidiary of Unilever Worldwide, also encouraged its surrounded communities to participate in production process and to get benefit of it. Through its "sustainability" mission, Unilever Indonesia developed its nearby community of farmers to supply minimum 50% of the total black-soybean for its soy-sauce product, which is named BANGO. To enhance supply performance, Unilever Indonesia controls the supply to meet the standard performance.

This study applied the Analytic Network Process (ANP) as an alternative method of measuring and evaluating the performance of supply. The criteria and sub-criteria are identified based on internal company experts in a focus group discussion. These criteria are price, availability of supply, quality, and supplier reputation, elaborated into 10 sub-criteria, i.e., supply price conformance, price stability, willingness to negotiate, supply capability meets order, supply availability continuity, supply conformance to prescribed specifications, quality consistency, seamless supply provision, supplier and supply is already widely known, and trustworthy supplier. The resulted analysis of pairwise comparison questionnaire showed a good performance of supply in the scale 82.65% out of the 100%.

Keywords: ANP, Soybean Supply Performance, Supply Chain

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1. Introduction

In today's globalized world, more and more companies are concern for the local community development as part of their corporate social responsibility. Unilever Indonesia as a subsidiary of Unilever Worldwide also encouraged its surrounded communities to participate in the production process by planting and supplying the black soybean. Black soybean is the main raw material for its soy sauce products, named "BANGO". The communities of farmers have been assisted since 2001 by the company and some leading University experts to grow the supply capacity from those local black-soybean farmers and meet the performance imposed by Unilever Indonesia. This performance improvement process is continuously monitored by the Procurement and Quality Control Team. Up until now, the quality monitoring system is still conducted conservatively and does not apply any best practice method. Therefore, finding a better method is a challenge and ANP is one of the alternatives to meet the challenge.

Supply performance measurement is a part of supply monitoring. A number of quantitative approaches have been applied to measure supplier performance as part of supply performance. Total cost ownership (TCO), analytic hierarchy process (AHP), linear programming, statistical approaches are some of those quantitative approaches (Bayazit, 2006). The ANP is a new theory that extends the AHP to cases of dependence and feedbacks (Saaty, 2001). The AHP has been extensively implemented, while the ANP has not been implemented much yet. This research aims to introduce Analytic Network Process (ANP) to the supply improvement process.

2. Literature Review

Supply and supplier performance are part of supply chain performance. Fundamental theories in this research are supply chain performance, supply and supplier performance evaluation method, and Analytic Network Process.

2.1 Supply Chain Performance

Supply chain is an integrated set of business functions, encompassing all activities from raw material acquisition to final customer delivery (Benita and Tonja, 1998). Therefore, supply as output from the supplier is part of supply chain. A successful supply chain is said to be one which delivers the right quantity and desired quality of the final product at the rights place at right time (Sarkis et al., 2002). The real results from supply chain management come from the integration processes throughout the entire supply chain from the supplier's supplier to the customer's customer (Ptak and Schragenheim, 2000).

Poor quality of materials is the most common reason for the failure of Just-in-time (JIT) logistics (Copacino, 1997). To avoid a supply bottleneck, the performance of selected suppliers must be submitted to regular controls during the supplier-buyer relationship (supplier controlling) in order to be able to recognize changes over time as well as to react appropriately (Rainer and Christian, 2005).

2.2 Supply and Supplier Performance Evaluation Method

A number of alternative approaches have been suggested that take the factors associated with late delivery times, production breaks, poor deliver goods quality, etc., into account. These are called rating models that summarize several performance indicators into one score (Chee-Cheng et al., 2004). Those several performance indicators of most previous studies include supply and supplier performance indicators.

A cost-based system provides a justifiable and rational method for evaluating key supplier performance factors, identifying supplier non-performance costs and accurately reflecting the actual cost of doing business with suppliers (Monczka and Trecha, 1988). Another technique is the analytical hierarchy process method in which the relative positions of suppliers with respect to a given criterion are determined during pairwise comparison (Narasimhan, 1983). The most common approach is the

weighted-point plan, which consists of a stipulating number of criteria, giving them different weights and selecting the supplier with the best weighted total score (Gregory, 1986; Wind and Robinson, 1968).

In most previous studies, quality and delivery were always present as criteria. While in the majority of the scorecard factors and criteria included total cost and service (Stueland, 2004). Sim et al. (2010) stated in general, the three criteria, which were rated considerable importance and extremely importance by Dickson (1966), and ranked top three by Weber (1991) and Zhang (2004) are price, delivery, and quality. Companies commonly use one of the three basic supplier measurement and evaluation techniques or systems, including the categorical system, weighted-point system and cost-based system. These different systems are usually compared based on their ease of use, level of decision subjectivity, required resources to use the system and implementation costs (Dobler and Burt, 1996; Monczka et al., 1998).

2.3 Analytic Network Process (ANP)

The ANP is the generalization of the AHP. ANP deals with uncertainty and complexity and provides insights that other traditional methods could miss. The power of the ANP lies on its use of ratio scales to capture all kinds of interactions and make accurate predictions, and, even further, to make better decisions. The ANP enabled us to incorporate both quantitative and qualitative factors, which are very important in assessing factors affecting supplier evaluation (Bayazit, 2006).

ANP consists of a network of criteria and sub-criteria that control the interactions in the system under study. It is a network of influences among the elements and clusters (Saaty, 2001). A decision problem that is analyzed with the ANP is often studied through a control of hierarchy or network. A decision network is structured of clusters, elements, and links. A cluster is a collection of relevant elements within a network or sub-network. For each control criterion, the clusters of the system with their elements are determined. All interactions and feedbacks within the clusters are called inner dependencies whereas interactions and feedbacks between the clusters are called outer dependencies (Saaty, 1999). Inner and outer dependencies are the best way decision-makers can capture and represent the concepts of influencing or being influenced, between clusters and between elements with respect to a specific element. Then pairwise comparisons are made systematically including all the combinations of element/cluster relationships. ANP uses the same fundamental comparison scale (1-9) as the AHP.

The ANP leads additional insights not possible with traditional AHP. Interdependencies exist in most of real world supplier selection problem (SSP). In a decision problem, decision makers might feel that some factors are more important than the others affecting final preference of the alternatives. If there are some feedbacks and interdependencies among the factors, an unimportant factor may turn out to be far more important that even the most important one (Bayazit, 2006).

Basic versions of AHP and ANP are still widely used in the literature to deal with the supplier selection problem (SSP), to apply the methodology as its simplest level and not take into account any kind of constraint about suppliers. To rank the suppliers, pair-wise comparisons among suppliers themselves are utilized. The adopted hierarchical schema is composed by four hierarchical levels i.e., main goal; attributes; characteristics; alternatives (Bruno, 2009).

3. ANP Model Construction

This study adapted the ANP methodology of supplier selection problem (SSP) which has been widely used. The proposed model can be used by organizations for evaluation of supply performance that involves various criteria and interactions with some modifications.

The steps in developing the ANP model construction of this study adopted from Herawan (2011), which consists of: (a) develop of a theoretical model; (b) review of the theoretical model by a focus group

discussion (FGD) of experts, company division in charge of local black-soybean farmers supply; (c) implement the model on SuperDecisions® software tool; (d) test the model and questionnaire on limited respondents and adjust them based on test results; (e) conduct expert judgment on the questionnaire with 10 selected respondents from the team who coach local black-soybean farmers; (f) analyze the result; and (g) confirm the result with the internal company experts.

The selection and involvement of experts is critically important to the development of the model and the output (Herawan, 2011). This study involved internal Unilever experts, who supervise local black-soybean farmers and are responsible for the supply program, in ANP model construction process and pairwise comparison process.

Based on food industry evaluation criteria used in previous study (Triyanti and Gadis, 2008) and FGD with experts of Unilever Indonesia, this study used criteria that consists of four components and ten elements. The four components of criteria are namely: price (P), availability (A), quality (Q), and supplier reputation (R). The ten elements within the components are supply price conformance (P-1), price stability (P-2), willingness to negotiate (P-3), supply capability meets order (A-1), supply availability continuity (A-2), supply conformance to prescribed specifications (Q-1), quality consistency (Q-2), seamless supply provision (Q-3), supplier and supply is already widely known (R-1), and trustworthy supplier (R-2). As this ANP model is applied to measure the performance of supply, then the elements of alternative are choices of good performance and poor performance.

The factors (criteria and sub-criteria) affecting supply performance evaluation could be quantitative as well as qualitative. Those four criteria which consist of ten sub-criteria are referred to evaluate supply resulted and supplier capability to supply. There are some of qualitative concerns in sub-criteria which included in this study model, i.e., willingness to negotiate (P-3), supplier and its supply is widely known (R-1), and supplier trustworthy (R-2), while other sub-criteria are quantitative concerns based on historical data of supply result and supplier capability to supply toward company's supply standards and specifications.

The supply price (P) is important for the consideration of the performance evaluation because of the high demand and limited supply of black soybean in Indonesia which greatly affect its market price. The set price must comply with the black soybean quality (P-1). Furthermore, supply price stability becomes an important part in the stability criteria as it relates to the costs incurred by the company (P-2). Negotiation willingness to determine the price of approved supply is also required by the company (P-3).

Regarding criteria of availability (A), suppliers must be able to provide supplies as demanded specifications (A-1). Besides, supply should meet the expected time regularly and continuously so it does not interfere with the production process (A-2).

Production of Unilever Indonesia's soy-sauce requires certain quality specifications which must be met by the suppliers (Q). Black soybeans which do not meet the quality standards will not be accepted (Q-1). The company expects the lack of disability supply (Q-3) and the stable supply quality from time to time (Q-2).

Supplier reputation is the ability of a supplier in building a good image to be credible to supply the supplies (R). Supplier reputation is important n the performance evaluation because the local farmers can not be trusted to violate the agreement such as to sell the black soybeans supply that have been agreed to be planted and paid upon prior to the company's competitors. Therefore suppliers and their supplies which are well-known (R-1) and the trustworthy supplier (R-2) are approved to be the sub-criteria.

Figure 1 illustrates the ANP model of performance evaluation of local black-soybean farmer supply to Unilever Indonesia's BANGO Product. Nodes inter criteria (components and elements) shows the inner and outer dependencies in ANP model construction of this study.
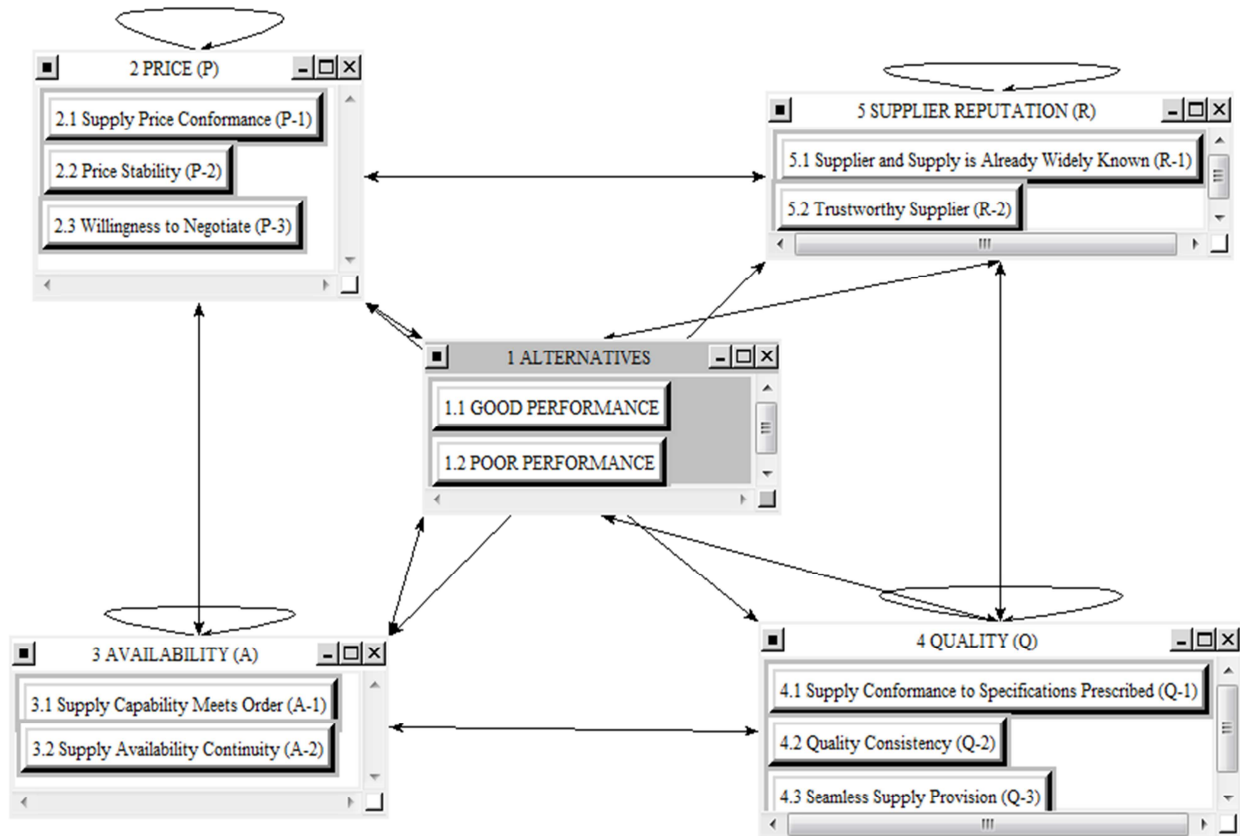
Figure1.
ANP Model Construction of Local Black-soybean Farmer Supply Performance Evaluation

4. Result Analysis

After pairwise comparisons were completed by expert respondents, calculations were performed by SuperDecisions® software. Then, the ranks of the alternatives are obtained which shows the performance measure of the supply.

The priorities or value of the criteria (component) which influence local black-soybean farmer performance are obtained according to pairwise comparisons result which consist of unweighted supermatrix, weighted supermatrix, limiting supermatrix, and cluster supermatrix.

Table 1 and figure 2 show cluster matrix in this study. Criteria quality (Q) becomes the first priority for 0.31977, followed by price (P) with 0.265697 and availability (A) with 0.170551. Supplier reputation becomes the last priority for 0.074514. The inconsistency index of pair-wise comparison assessment was 0.01716 (less than 0.1), which meant that the respondent judgments was done consistently.

Table 1.
Cluster Matrix

| Criteria	Priorities
PRICE (P)	0.265697
AVALABILITY (A)	0.170551
QUALITY (Q)	0.319777
SUPPLIER REPUTATION (R)	0.074514
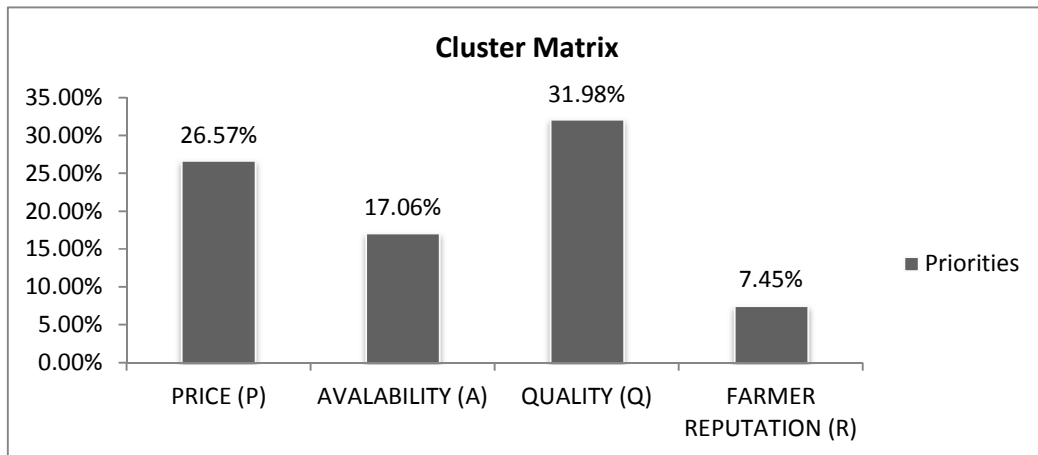
Figure2.
Result of Cluster Matrix

Table 2 and figure 3 capture the result of sub-criteria (element) priorities which are based on limiting matrix in each cluster (criteria). In criteria price (P), sub-criteria supply price conformance (P-1) is the first priority. Sub-criteria price stability (P-2) has same priority percentage with sub-criteria willingness to negotiate (P-3). Sub-criteria supply capability meets order (A-1) has highest priority percentage than sub-criteria supply availability continuity (A-2) for criteria availability (A). The highest sub-criteria priority percentage in criteria quality (Q) is sub-criteria supply must be conform to prescribed supply specification (Q-1). Sub-criteria supply quality consistency (Q-2) and seamless supply provision (Q-3) becomes the second and the third priority respectively. In criteria supplier reputation (R), sub-criteria trustworthy supplier (R-2) has higher priority percentage than sub-criteria supplier & supply is already widely known (R-1).

Table 2.
Limiting Matrix in Each Cluster (Criteria)

Criteria: PRICE (P)	
Supply price conformance (P-1)	0.15942
Price stability (P-2)	0.05314
Willingness to negotiate (P-3)	0.05314

Table 2.
Limiting Matrix in Each Cluster (Criteria)

Criteria: AVAILABILITY (A)	
Supply capability meets order (A-1)	0.11370
Supply availability continuity (A-2)	0.05685

Criteria: QUALITY (Q)	
Supply conformance to prescribed specifications (Q-1)	0.25300
Quality consistency (Q-2)	0.17542
Seamless supply provision (Q-3)	0.06082

Criteria: SUPPLIER REPUTATION (R)	
Supplier & supply is already widely known (R-1)	0.01242
Trustworthy supplier (R-2)	0.06209
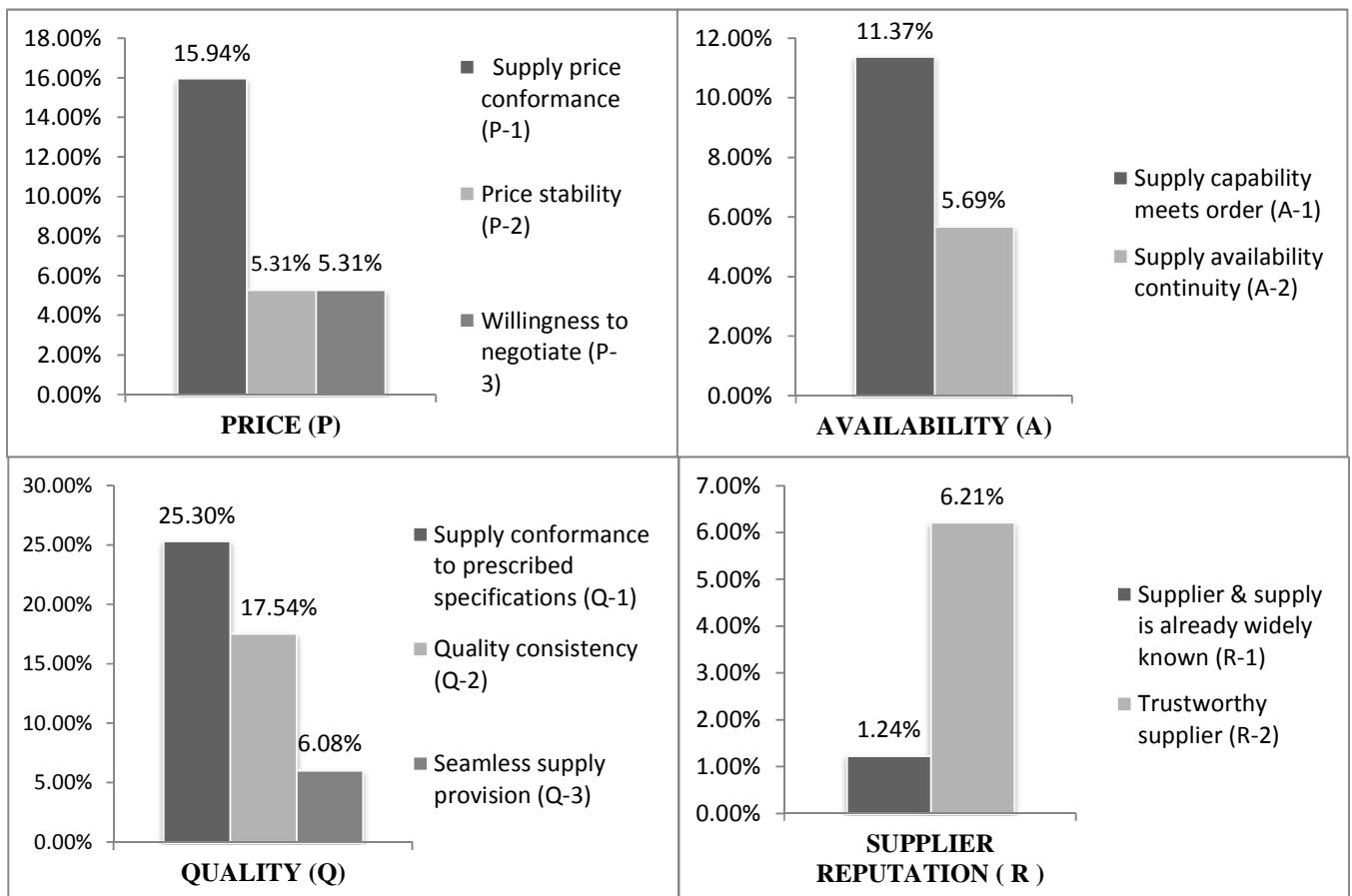
Figure 3.
Result of Limiting Matrix in Each Cluster (Criteria)

Entire analysis, which considered aspects (criteria and sub-criteria) to measure and evaluate the local black-soybean farmer supply to Unilever Indonesia, are focused to supply capability to meet current quality and quantity specification. Therefore sub-criteria that have high priority percentages must conform to prescribed supply specifications (Q-1), supply quality consistency (Q-2), supply price conformance (P-1), and supply capability to meet order (A-1). Furthermore, supply continuity performance becomes additional aspects (criteria and sub-criteria) i.e., price stability (P-2), supply availability continuity (A-2), seamless supply provision (Q-3), willingness to negotiate (P-3), and trustworthy supplier (R-2). However, to have a good supply performance, suppliers (farmers) and their supplies are not widely known (R-1).

In this study, ANP could capture the realistic result of supply performance evaluation. It found four factors of criteria which consist of ten sub-criteria affecting the evaluation of supply performance with quality (Q) is the factor most affecting supply performance. In addition, it also found that supplier reputation (R) is the factor least affecting supply performance. Those could give implication for next research of this study to consider supplier reputation (R) to be one of evaluation criteria in supply performance or not.

Based on those criteria characteristics and priority, table 6 and figure 4 show that alternative which has highest score is good performance. Therefore, performance measurement result shows that local black-soybean farmer supply to Unilever Indonesia has good performance.

Table 6.
Numerical Result of Supply Performance Evaluation

Alternatives	Result
GOOD PERFORMANCE	0.826504
POOR PERFORMANCE	0.173496
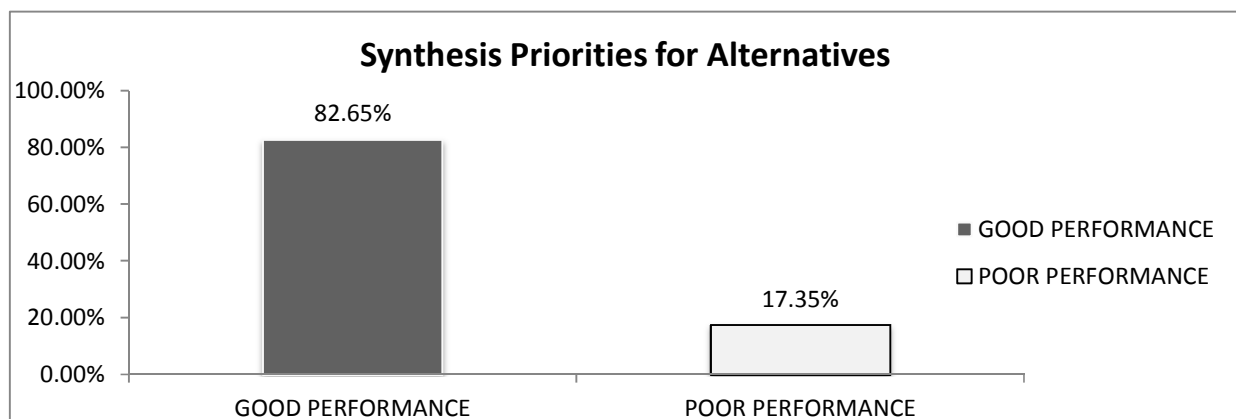
Figure 4.
Result of Performance Evaluation

5. Conclusion

The ANP model developed in this study was successfully applied as a new analytical tool to measure performance of local black-soybean supply to Unilever Indonesia. Even though ANP as generalization of AHP is not a new method, the implementation in the industry, especially food industry in Indonesia, is relatively new. The model was easily understood by the Unilever Indonesia soybean supply staffs. They were involved when asked to decide suitable criteria and sub-criteria (components and elements) of the measurement. The chosen criteria and sub-criteria were adopted from both Unilever global supply performance and local black-soybean farmer characteristics.

The ANP enabled to incorporate both quantitative and qualitative factors (criteria and sub-criteria) in this study of supply performance evaluation. The supply performance result of this study showed that local black-soybean farmer supply to Unilever Indonesia's BANGO production has good performance of 82.65% based on four criteria with ten sub-criteria included the factors most and least affecting supply performance evaluation. This result could help company in monitoring the black-soybean farmer supply with its quality standard and in increasing capacity.

6. Implications and Recommendation for Future Research

Through three basic principles of ANP, the constructed model was successfully applied in a performance evaluation process. To enrich the ANP function in this study, the ANP could be used to forecast its supply capacity increase trend. The ANP forecasting model could help Unilever Indonesia sustainability program for local black-soybean farmer.

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