

Developing strategic planning of green supply chain in refinery CPO company

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Abstract. We are conducted a research at the company of the manufacturing CPO into cooking oil, margarine and materials of oleochemical industries. Today palm oil based industries are facing global challenges related to environmental issues. To against these challenges, it is necessary to have an environmentally friendly supply chain. However, the limited resource owned by the company requires the integrated environmental strategy with the company's business strategy. The model is developed based on management orientation towards external pressure, internal key resources and competitive advantage that can be obtained as the decision factor. The decision-making method used is Analytical Network Process (ANP). The results obtained institutional pressure becomes the criterion with the greatest influence on green supply chain initiatives and sub criteria of customer desires and stakeholder integration having the most significant influence on green supply chain initiatives. There are five green alternative initiatives that can be done: green product design, greening upstream, greening production, greening downstream and greening post use. For green supply chain initiative, greening upstream is the best priority.

1. Introduction

Green Supply Chain Management (GSCM) is a concept of the traditional supply chain management with the environmental aspect integrated, include product design, material procurement, manufacturing activity, packaging activity, distribution activity and the post use management. The GSCM objective is for eliminating or minimizes waste (energy, gas emission, dangerous chemical, and another waste) along the supply chain network.

This company is a one of palm oil refinery industry who manufacturing Crude Palm Oil (CPO). The company has two core processes, the refinery and the fractionation. In refined process, palm oil will be processed into RBDPO and PFAD as the side product of RBDPO, after that RBDPO will go to fractionation process into RBD-OLEIN and RBD-STREARIN as end final product. Supply chain activities in this company not yet fully focused with the environmental based supply chain.

The research about green supply chain has been doing in some country. S. Maryam Masoumik (2015) in research journal "A Strategic Approach to Develop Green Supply Chains." Those study explain the external pressure from regulator, consumer, supplier, competitor, social group and media more push organization to include eco practice into their business process. In this case, supply chain manager found many list of green initiative which can be take in supply chain process. However, the



problem is limited resources are not possible do the initiative effectively. Therefore, the manager must choose an initiative strategic supply chain to get more competitive.

In another research by Hendra Saputra (2012) in research journal "Planning the measurement model of performance green supply chain pulp and paper." In that research explain the system of performance measurement of the green supply chain is necessary for managing the environment risk, improving the competitiveness with green supply chain practice and to get right strategic for the company. Mensuration performance system of the green supply chain in PT RAPP only focuses on midstream and downstream operation related manufacturing process and supplier. The objective of that research is to design conceptual model and computer program for measurement green supply chain pulp production when information of all supply chain can be controlled as well. Supply Chain Operations Reference (SCOR) matrix applied to identify key performance index (KPI). The weight of KPI defines with AHP method. Computer application designed for implemented conceptual model with basic data combine, mathematic formulates, and user interface. The result has two level and fifteen objectives and twenty-seven KPI.

With the outgrowth today and the challenges for industries to applied green supply chain, so to make research about green supply chain strategic in refinery CPO Company is necessary.

2. Research Methods

We conducted a research at Refinery Palm Oil Company in Medan. The study was conducted in July 2016 - May 2017.

2.1. Research Variables

The variables observed in this study are:

2.1.1. Independent Variables

The independent variable is a variable whose value influences the dependent variable either positively or negatively (Sinulingga, 2011). Based on researched by S. Maryam Masoumik (2015) in research journal "Strategy Approach to Develop Green Supply Chains" hence can compile independent variable for this study, that is as follows:

a. Institutional pressures

Pressures and issues faced such as regulatory rules, changes in consumer desires, community demands, and pressure from competitors.

b. Key resources

Important aspects such as, how to make sustainable improvement and integrate stakeholders become concern areas.

c. Competitive values

To be able to survive in competition, competitive values should be the company's concern.

d. Green supply chain initiative

Alternative practical initiatives were undertaken to improve the company's green supply chain.

2.1.2. Dependent Variables

The dependent variable is the dependent variable whose value is influenced by other variables. The dependent variable in this research is Green supply Chain strategies (eco-friendly supply chain strategy).

2.2. Data Processing Method

Method ANP used to processing Data. ANP calculated the weight of each variable for each green supply chain by using network linkage result from ANP method.

The steps in the ANP method:

a. Structure of green supply chain criteria and sub criteria

b. Green network supply chain design

- c. Validation of network green supply chain
- d. Pairwise comparison questionnaires
- e. The calculation of the weighted average criteria
- f. Calculation of partial weight and matrix consistency
- g. Preparation of supermatrix with superdecisions
- h. Calculate the unweighted supermatrix, weighted supermatrix and limit matrix with superdecisions software.
- i. Priority criteria and sub criteria of the green supply chain.

3. Result and Discussion

3.1 Determinate Criteria and Sub criteria of Green Supply Chain

The used criteria are based on references to previous research. There are three performance appraisal criteria used: Pressures and issues faced, important sources, and competitive values. Determination of sub criteria also used previous research, while criterion and sub criteria used can be seen in Table 1.

Table 1. Criteria and Sub criteria

Criteria	Sub criteria
Institutional Pressure (T)	1. Regulatory Pressures
	2. Costumer Pressures
	3. Market Pressures
	4. Society Pressures
Key Resources (S)	1. Continuous Improvement
	2. Stakeholder Integration
	3. Disruptive Change
Competitive Advantages (K)	1. Cost Reduction
	2. Reputation and Legitimacy
	3. Future Positioning

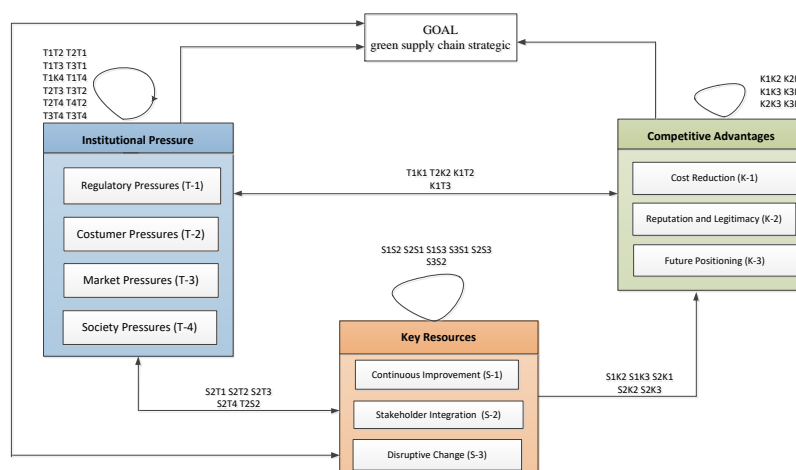


Figure 1. Network Structure (Network)

In the next stage, we made the network structure (Network). At this stage each criterion and sub criteria will be determined whether affecting each other.

Determination of influence relationship between Sub-Criteria is done by an interview with the manager. The instrument used is a closed questionnaire.

Based on the relationship between the sub criteria that have been compiled, then compiled into the network structure (network) that can be seen in Figure 1.

3.2. Paired Comparison Questionnaire

A set pairwise comparison questionnaire is used to assign weights to each of the Criteria and Sub-Criteria so that it can be determined from which perspective has the highest Criteria weight. This questionnaire has two parts namely pairwise comparison between Criteria, pairwise comparison between Sub-Criteria.

3.3. ANP Data Processing

3.3.1. An ANP calculation

The calculation of Consistency Ratio for paired matrix The Institutional Pressure Criteria is shown as follows:

- Calculate the weighted average by calculated the geometric averages. Geometric averages are calculated by the formula:

$$GM = \sqrt[n]{X_1 \cdot X_2 \dots X_n}$$

Example for the calculation of geometric mean for pairwise comparison Criteria for institutional pressure:

$$GM = \sqrt[5]{3 \times 3 \times 3 \times 3 \times 5} = 3,32370$$

- Each column element is divided by the number of columns respectively. Calculation of the normalization matrix and partial weight of the institutional pressure cluster:

$$\text{Normalize Matrix} = \text{column value} / \text{total}$$

- Calculating Consistency ratio

$$(\text{Matrix of Average Geometric Calculations}) \times (\text{Voted Weight of Each Line})$$

- Calculating Vector Consistency

$$(\text{Consistency Ratio: Vector weight of each row})$$

- Calculate the average of entries (λ_{\max})

$$\lambda_{\max} = \frac{\sum_{i=1}^n \text{Consistency Vector}}{n}$$

- Calculating Consistency Index (CI)

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

- Calculating Consistency Ratio (CR)

$$CR = \frac{CI}{\text{Random Consistency Index}}$$

Obtained CR < 0,1, then respondent answer consistent. The same calculation is performed on all elements between Criteria and Sub-Criteria.

3.3.2. An ANP calculation

Supermatrix are the result of priority vectors of comparison between clusters and sub criteria. Supermatrix consist of three stages: Unweighted Supermatrix, Weighted Supermatrix, and Supermatiks Limit (Limiting Supermatrix). To obtain these three supermatrix used Super Decision software assistance to facilitate the processing.

Unweighted Supermatrix is a translation of the weight of each cluster and sub criteria that is inputted into a complex matrix table. Weighted Supermatrix is obtained by multiplying all elements in

the unweighted supermatrix with the values contained in the cluster matrix so that the value of each column is one. The Weighted Supermatrix that has been obtained is then multiplied by itself in several iterations. This iteration aims to keep the weight of supermatrix stable, meaning that the row value of each element becomes the same. When the weight of each column has the same value, then Limiting Supermatrix has been obtained.

Based on the results of processing with Analytic Network Process method above we get the weight for each sub criteria that can be seen in Table 2.

Table 2. Global Weights Sub criteria

Criteria	Sub criteria	Weight
Institutional Pressure (T)	T-1 Regulatory Pressures	0.140383
	T-2 Costumer Pressures	0.237714
	T-3 Market Pressures	0.085612
	T-4 Society Pressures	0.10236
Key Resources (S)	S-1 Continuous Improvement	0.066989
	S-2 Stakeholder Integration	0.222708
	S-3 Disruptive Change	0.03889
Competitive Advantages (K)	K-1 Cost Reduction	0.06749
	K-2 Reputation and Legitimacy	0.023337
	K-3 Future Positioning	0.014517

3.4. Prioritization of Green Supply Chain Initiative

The priority setting of green supply chain initiatives is done by using ANP method. The required data at this stage is the priority value of the sub criteria and the global weighting value of the previous ANP stages as the weighted value.

3.4.1. Data Criteria and Alternative Green Supply Chain Initiative

Alternatives used based on previous research references. There are 5 (five) alternative initiatives that are used are green product design, greening upstream, greening production, greening downstream and greening post use.

The criteria used to assess alternative green initiatives are institutional pressure, core resources, competitive advantage and green strategy capabilities. The sub criteria of green capability strategic used are pollution prevention, product stewardship and clean technology.

3.4.2. Determination of Green Supply Chain Initiative Network Structure

Determination of influence relationship between Sub-Criteria is done by the interview with the previous manager in the determination of the criteria weighting. At this stage, the influence relationship used based on previous research and validating by the company. After that, we determined the relationship between sub criteria. So obtained network structure (Network) as follows.

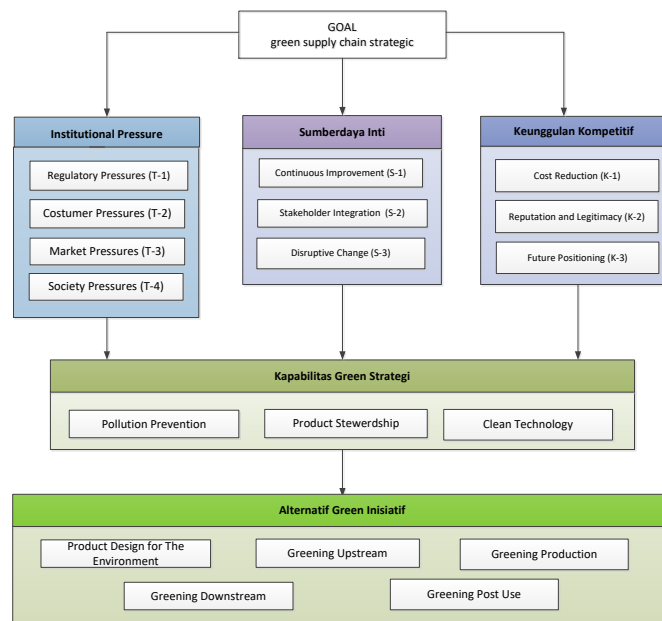


Figure 2. Network Structure (Network) Alternative Green Initiative.

3.4.3. Calculation of ANP Green Initiative

At this stage, we weigh the alternatives that have been prepared. Weighting is done in pairs according to the relationship.

The recapitulation obtained is then calculated by the ANP method as in the previous step. The software Superdecisions used to calculations of supermatrix. So the green priority is obtained as follow.

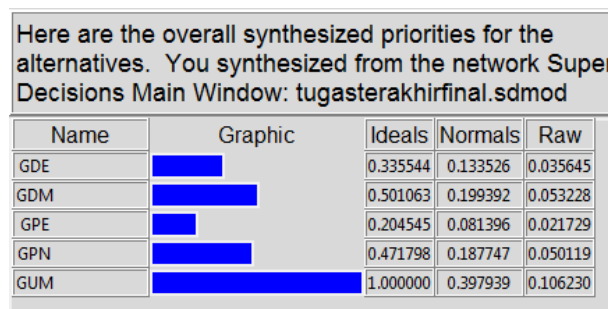


Figure 3. Priority Green Supply Chain.

3.5. ANP Weighting Analysis

The highest weight for criteria is the institutional pressure with the weight of 0.5661, and the lowest weight of criterion is Competitive Advantages with the weight of 0.1053.

Table 3. Weight of Institutional Pressure Sub-Criteria

Priority	Weight
Regulatory Pressures	0.1404
Costumer Pressures	0.2377
Market Pressures	0.1024
Society Pressures	0.0856
Total	0.5661

At criterion of institutional pressure, sub criteria customer pressures has the highest weight that is customer pressures equal to 0.2377, followed by subcriteria of regulation pressures and social pressures. This is influenced by the influence and relationship of customer pressures with the core resource is stakeholder integration, in this case, is the integration between customer and company. The desire of the customers also gives effect to the criteria of competitive advantage in this case that is the reputation and legitimacy of the corporation.

Table 4. Weight of Sub-Criteria of Key Resources

Priority	Weight
Disruptive Change	0.0145
Stakeholder Integration	0.2227
Continuous Improvement	0.067
Total	0.3286

From the above table obtained the highest weight of stakeholder integration is 0.2227. The weight of the sub criteria of stakeholder integration is influenced by the integration of stakeholder relations with all other sub criteria. By conducting stakeholder integration, external pressure on the company can be managed and can provide a positive influence on corporate excellence.

Table 5. Weight of Sub-Criteria of Competitive Advantage

Priority	Weight
Reputation and Legitimacy	0.0233
Cost Reduction	0.0675
Future Positioning	0.0145
Total	0.1053

In the competitive advantage criteria, sub criteria cost reduction obtains the highest weight among other competitive advantage sub criteria with 0.0675. This occurs because of the effect of cost reduction on the institutional pressure that occurs.

3.6. Pareto Analysis

In the Pareto diagram can be seen subcriteria very weak influence on the network structure (network), this can be seen from the global weight of each subcriteria that has been obtained. Here is a Pareto chart of sub criteria.

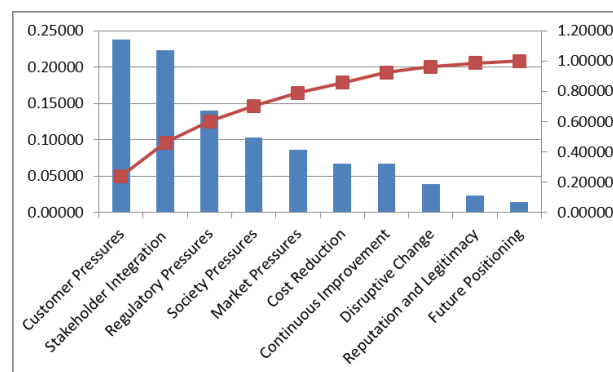


Figure 4. Pareto Diagram of Sub criteria.

Based on the above Pareto diagram it can be seen that the sub criteria that make up the cumulative total weight of more than 20% of the total weight of the whole sub criteria are the Customer pressures and Stakeholder Integration.

3.7. Results Analyze of Alternative Priorities Green Supply Chain

Based on the above Pareto diagram it can be seen that the subcriteria that make up the cumulative total weight of more than 20% of the total weight of the whole sub criteria are the Customer pressures and Stakeholder Integration.

Greening Upstream (GUM) obtained the highest score of 0.397939, following greening downstream (GDM) get score 0.199392, greening production (GPN) obtained score 0.181396, green product design (GDE) get score 0.133526, and greening post use (GPU) obtained score 0.081396. Then to improve supply chain performances become green supply chain performance, corporation should make optimization directed at Greening Upstream practice.

4. Conclusion

From this research can be concluded that There are three perspectives in designing the company's green supply chain strategy, namely: institutional pressure from outside to the firm, the core resources owned by the company and the competitive advantage expected by the corporation.

The most dominant criteria affecting the company's effort in designing the green supply chain strategy of ANP method are institutional pressure criteria (0.5661), followed by key resource criterion (0.3286), and criteria of competitive advantage (0.1053).

The most dominant sub-criteria based on the calculation method of the ANP is a sub-criteria customer pressures (0.2377), followed by sub-criteria Integration of stakeholders (0.2227), Regulatory pressures (0.1404), Social pressures (0.1024), competition pressures (0.0856), cost reduction(0.0675), Continuous improvement (0.067), Disruption change (0.0389), reputation and legitimacy (0.0233), and Position in the future (0.145).

There are five (5) alternative initiatives in strategic efforts to increase green supply chain is product design for the environment (PDE), Greening Upstream (GUM), Greening Production (GPN), Greening Downstream (GDM), and Greening post-Use (GPU). Of the five alternatives are obtained Greening Upstream (GUM) as the best priority to increase the green supply chain.

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