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RESEARCH ARTICLE

**SUPPLY CHAIN PERFORMANCE ANALYSIS OF OIL PALM BIOMASS FOR COMMUNITY
 ELECTRICITY IN INDONESIA.**

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Abstract

The design of the oil palm biomass supply chain model, is an important step in assessing the balance of added value and performance among actors, particularly in efforts to utilization renewable energy for community electricity. In the oil palm biomass supply chain, there are three main actors that become key elements, namely oil palm farmers, palm oil agroindustry and bioenergy companies. This study aims to measure the added value and performance of the three actors based on the input and output factors of each actor. The Hayami method has been used to measure the added value of each actor, while the SCOR method has also been used to measure supply chain performance. The results of this study indicate that there has not been a balance of added value on each actor. While performance measurement results found that in general the performance of the three actors is still below average.

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Introduction:-

Population growth has significantly affected the community's energy needs. On the one hand, the availability of fossil energy has decreased. Therefore, it is necessary to develop and utilize various renewable energy sources. One of them is through the utilization of the remaining agricultural products, plantations or waste of forest products in the form of biomass, as well as oil palm biomass. Oil palm is one of the potential commodities as a source of bioenergy. The crude palm oil produced is the main raw material to produce biofuels in the form of biodiesel. While waste oil palm plantations such as empty bunches, fiber, shell and liquid waste, is a potential biomass to be utilized as a source of electrical energy (Hambali 2010).

Currently, biomass has become the most important energy source in every region of the world (Thran et al, 2010). Biomass has the potential to become one of the major sources of energy in the future, and the modernization of bioenergy systems is suggested as an important contributor to future sustainable energy development, particularly for sustainable development in industrialized and developing countries (Berndesa et al, 2003). As a result, there will be massive mobilization of the supply of biomass as an effort to meet the energy needs of each region (Welfe et al, 2014).

Biomass is a term for all organic materials derived from plants (including algae, trees and plants). Biomass is produced by green plants that convert sunlight into plant material through the process of photosynthesis. Biomass

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resources can be considered as organic matter, in which the energy of sunlight is stored in chemical bonds. When the bonds between adjacent carbon, hydrogen and oxygen molecules are broken by digestion, incineration or decomposition, this detached substances stored as chemical energy sources (McKendry, 2002).

Utilization of biomass potential as a source of electrical energy, has begun to be developed in several countries in the world. As in China, from the availability of existing biomass, it is possible to produce electrical energy with a capacity of 30 GW (Xingang et al, 2013). Similarly, in the EU region, even the demand for biomass raw materials exceeds the supply capability that can be provided for power generation needs (Bertrand et al, 2014).

However, the development and utilization of biomass as a source of electricity generation, often faces various obstacles. For example oil palm biomass, also has various problems, mainly seen from the supply chain context, among others: 1) The utilization of oil palm biomass is still limited, generally only to meet the internal energy needs of palm oil mills; 2) The lack of detection of linkage relationships between sections that play a role in the development of oil palm supply chain in supporting the development of Biomass Power Plant; 3) Unknown to the size of added value and performance of each supply chain; 4) Unknown to what risks will occur as well as mitigation strategies needed in the development of supply chain of oil palm biomass especially in generating community electricity.

Efforts to utilize bioenergy potential through agroindustry activities cannot be separated from supply chain management. A Supply-Chain Council has grouped several key supply chain management activities into a model called Supply-Chain Operation References (SCOR). SCOR defines supply chain management as an integration of several important activities consisting of: planning, sourcing, make, deliver and return from suppliers to customers, and altogether synchronized with operational strategies, materials, jobs, and information flows (Bolstorff and Rosenbaum, 2007).

Study on the development of Palm Oil Biomass Supply Chain Model (POBSCM) is an effort to maximize the potential of abundant oil palm biomass in Indonesia, one of which is in Riau Province, especially in supporting the development of Biomass Power Plant (BPP). Through this study it is expected to obtain a strategic step that may be implemented in realizing the development of biomass power plants by utilizing palm oil waste.

The objectives of this study are as follows: 1) To analyze the relationship of oil palm biomass supply chain from plantation, palm oil mill, biomass power plant company to community as end user; 2) Measuring the added value of each level of the chain based on the comparison between the input factors, consisting of raw materials and working time compared to the added value ratio as well as the level of profit generated; 3) Perform performance analysis of each link based on various factors that become elements in SCOR method.

Literature Review:-

The palm oil supply chain has been widely studied in previous studies and in various perspectives. In the perspective of the systems approach, studies related to the palm oil supply chain are: Hadiguna (2012), Utama et al. (2011), Suharjo and Marimin (2012), and Hidayat and Marimin (2014).

Hadiguna (2012) has developed a decision support model for supply chain management and assessment of palm oil quality risk. Researchers also recommend minimizing transport times, evaluating trip counts and provision of transport modes in order to properly manage the risks and supply chain of oil palm. Associated with the supply chain of palm oil as bioenergy feedstock, Utama et al. (2011) has developed an intelligent decision support systems to find the optimum path in palm oil based bioenergy supply chain with ant colony algorithm. Researchers use supply chain performance criteria with SCOR, finance, waste, machinery, human resources, product quality, transportation cost and added value so as to obtain optimal route in supply chain of bioenergy based on palm oil.

Assessment of supply chain performance needs to be done at all levels and elements of the supply chain. This is necessary because supply chains are a coordinated and mutually influential system for each other to achieve common goals. Measurement of supply chain performance can help agroindustry in achieving objectives that have been formulated previously based on the strategy of achieving goals (Agami et al, 2011). Furthermore, supply chain strategy can be formulated based on the calculation of supply chain performance, to minimize obstacles in achieving supply chain objectives (SCC and Supply Chain Council 2012; Uysal 2012). In summary, the performance

measurement step to the preparation of performance improvement strategies adopted from SCOR, presented in Figure 1.

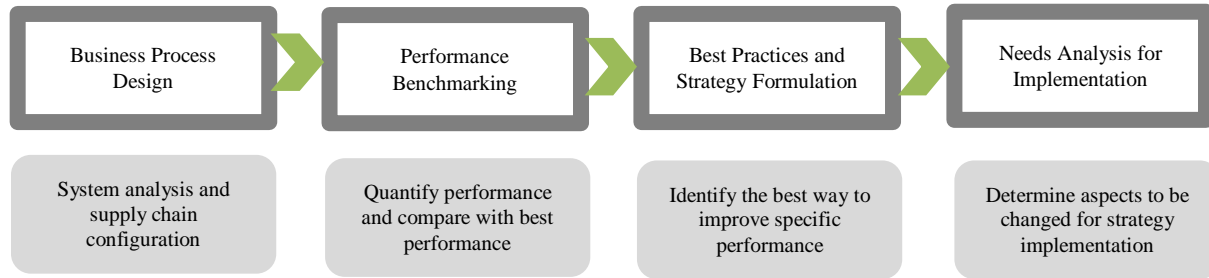


Fig. 1:- Supply chain performance assessment framework

Measurement of supply chain performance is conducted to evaluate and supervise the policy of supply chain management of an agroindustry. Evaluation and monitoring of agroindustry performance is determined through effectiveness and efficiency of agroindustry supply chain (Uysal 2012). Effectiveness is broadly defined as how to meet consumer demand while efficiency can be defined as the use of resources economically and able to meet customer satisfaction.

Methodology:-

Research Framework:-

Viewed from its supply chain, palm oil biomass can be available from upstream in this case oil palm plantations, to downstream at the palm oil mill. From an oil palm plantation, several sources of biomass that can be utilized such as midrib or stem of oil palm are no longer considered productive. While at the downstream level some biomass sources include empty fruit bunches (efb), shell, fiber and palm oil mill effluent (POME).

In order to develop a pattern of palm oil supply chain, a performance analysis of each supply chain level from upstream to downstream is required. Sustainable use of oil palm biomass to support the development of biomass power plants requires a balance of performance and added value at every level.

SCOR is a method that can be used to assess the level of balance of performance every level. Through the analysis of the importance level with the AHP fuzzy approach, it will be able to know the performance measures of each level ranging from farmers, oil palm agroindustry to biomass power generation companies. This study aims to analyze two key factors to assess the feasibility of developing a palm oil biomass power plant. Through performance analysis with SCOR Method, the measurement of added value with Hayami Method (Hayami et al, 1987), is expected to give an idea of the level of balance between parameters in each chain. The framework of this study can be illustrated by the following diagram (see Figure 2).

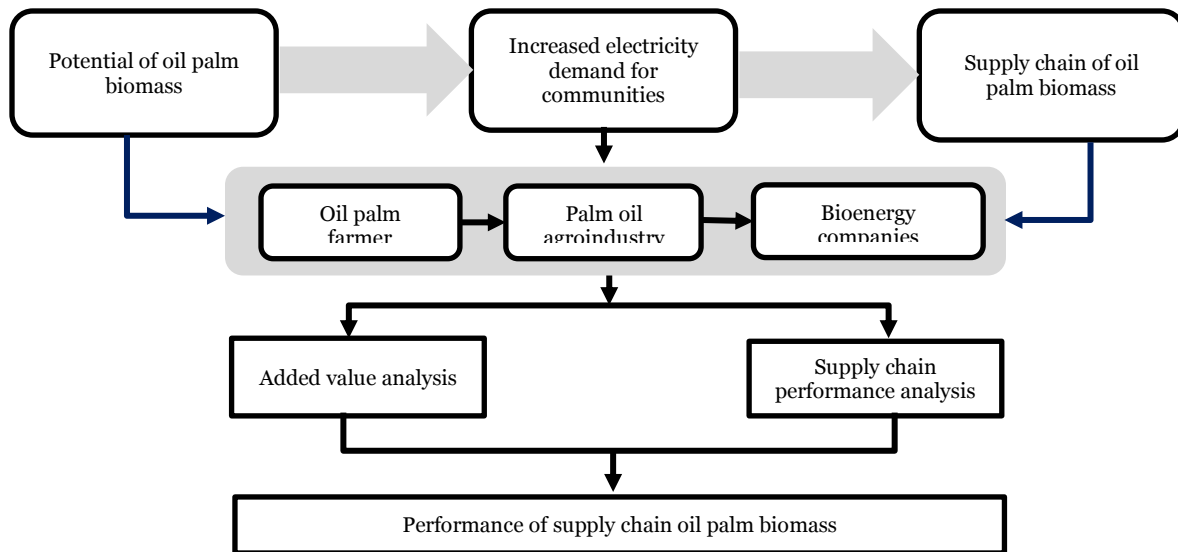


Fig. 2:-Framework diagram

Research Design:-

This research is conducted with several stages as follows: 1) Review of literature to various sources related literature such as scientific articles, reference books and the results of previous research. Through the literature review will be formulated a goal to be done in this study; 2) Analysis of the system consisting of analysis on various aspects such as, actors related to the study of supply chain of oil palm biomass, requirement analysis of each actor, relation between each need and its effect on supply chain performance, which is described in the form of causal loop and system diagram; 3) System modeling consists of performance measurement model, and value-added analysis. Measurement of added value is done by using Hayami Method (Hayami et al, 1987), performance measurement is done by using SCOR and fuzzy AHP Method; 4) Verification model developed in computer program is done by testing using actual data which aims to know whether the model is feasible to use and meet the criteria that have been set; 5) Model validation is carried out to determine whether the verification result is correct or not, ie by manually calculating to ensure its correctness and as a comparison.

Data collection is done by using survey method and expert interview. The selection of experts or experts, according to Marimin and Magfiroh (2010) must have the ability to collect complex data and information and have the ability to interpret data as a planned activity. The research stages can be seen in Figure 3.

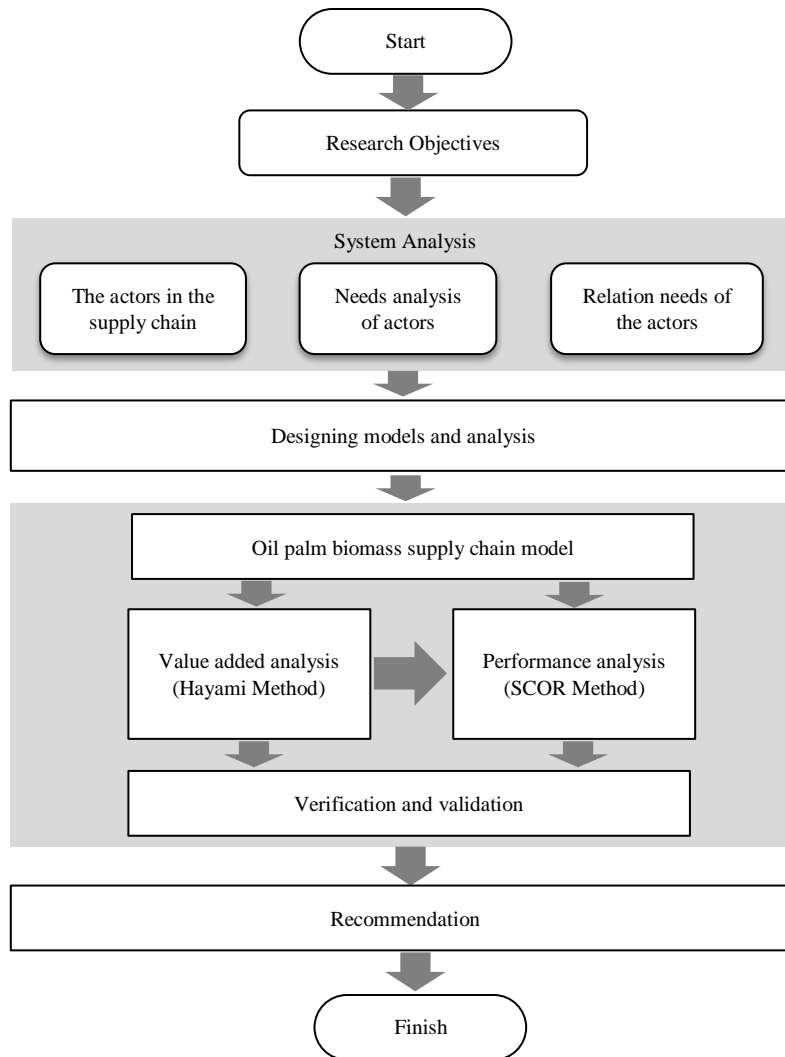


Fig 3:- Research stages diagram

The types of data used in this study are primary and secondary data consisting of qualitative and quantitative data. Primary data includes the results of interviews with experts and practitioners who are directly involved in the development of agroindustry and expert judgment on the questionnaire. Secondary data was obtained from document review at various related institutions such as Plantation Office, Industry Service and Central Bureau of Statistics in Riau Province, Indonesia.

Analysis Method:-

SCOR (Supply Chain Operation Reference) Method:-

SCOR is a systematic method that combines elements such as business, benchmarking, and best practices that can be applied within the supply chain. The combination of these elements is embodied in a comprehensive framework as a reference to improve the performance of a company's supply chain management. The scheme and scope of chain performance measurements adopted from SCOR and Chopra and Meindl (2013) in oil palm agro-industry can be described as in Figure 4.

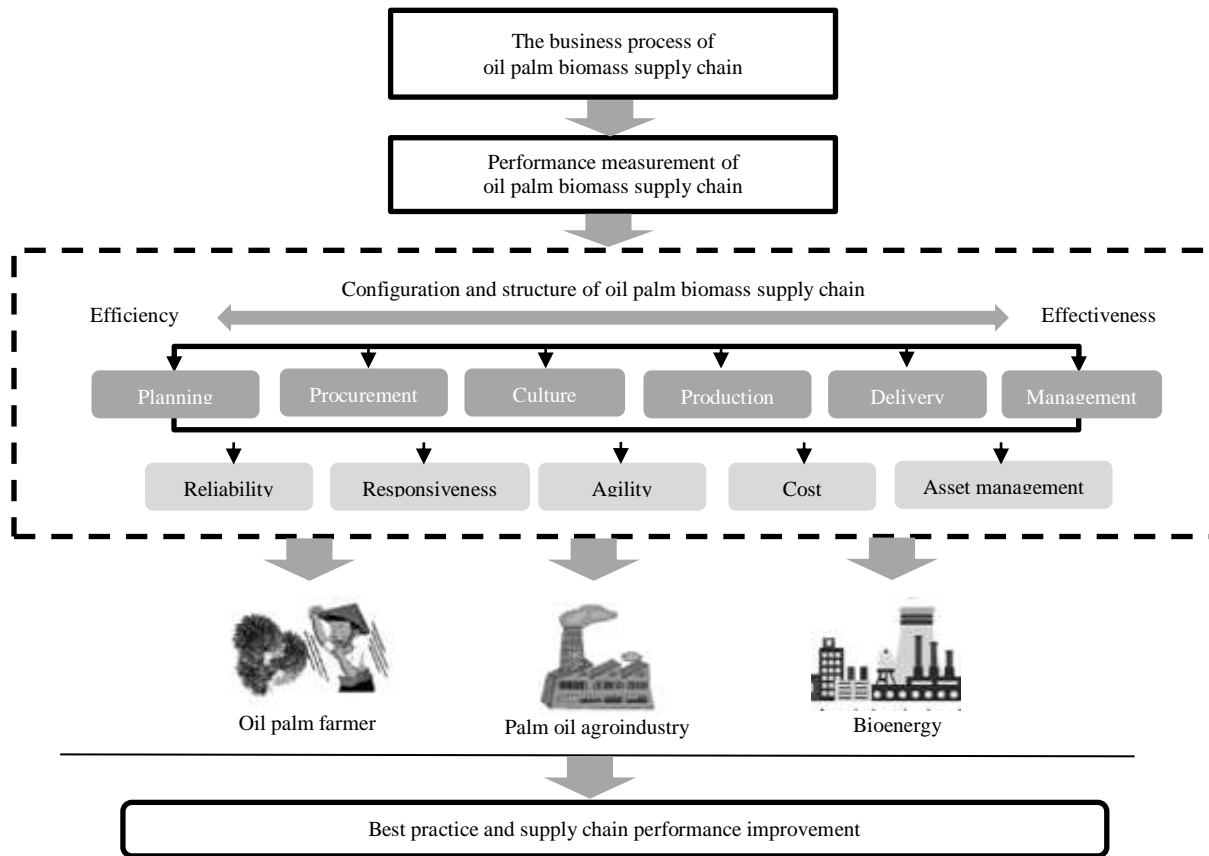


Fig. 4:-Measurement framework of oil palm supply chain

The SCOR Method is a process reference model developed by the Supply Chain Council that is used as a tool to diagnose supply chain management. This method can be used to measure the performance of the enterprise supply chain, improve performance and communicate to the parties involved. SCOR scope scheme can be in Figure 5.



Fig. 5:-Schematic of SCOR Scope

Hayami Method:-

Added value analysis is performed to assess the ratio of output generated from an input measure used at each level of the chain, from farmers to power generators. Input consists of raw materials and direct labor in units of mass (kg) and working hours. While important parameters that need to be considered in analyzing added value is a ratio of value added and profit level expressed in percentage form.

The added value analysis on the palm oil supply chain was done by using modified Hayami Method (Hidayat et al, 2012) by taking into account all inputs and outputs within one year of production with the mathematical model as shown in Table 1.

Table 1:-Method of calculating the added value of modified Hayami Method

No	Variable and units	Values
Supply-Chain Interaction		
1.	Material purchase price (IDR/kg)	(1)
2.	Product sale price (IDR/kg)	(2)
3.	Total value added per kg of output (IDR/kg)	(3) = (2) – (1)
Output, Input, and Price		
4.	a. Output (sales volume) (kg)	(4a)
	b Output (Sale value) (IDR)	(4b)
5.	Basic raw materials (IDR)	(5)
6.	Direct workforce (HOK)	(6)
7.	Conversion factor (%)	(7) = (4b) / (5)
8.	Coefficient of direct workforce (IDR/HOK)	(8) = (5) / (6)
9.	Wage of direct workforce (IDR)	(9)
Incomes and Value Added		
10.	a. Other input prices (Production) (IDR)	(10a)
	b. Other input prices (Non Production) (IDR)	(10b)
11.	a. Value added (IDR)	(11a) = (4b) - (5+10a+10b)
	b. Value added ratio (%)	(11b) = (11a) / (4b)*100
12.	a. Profit (IDR)	(12a) = (11a) – (9)
	b. Profit rate (%)	(12b) = (12a)/(4b)*100
Owner Rewards Factor Production		
13.	Margin (IDR)	(13) = (4b) – (5+10a)
	a. Contribution of other input costs (%)	(13a) = (10a+10b)/(13)*100
	b. Corporate profits (%)	(13b) = (12a)/(13)*100

Fuzzy Analytical Hierarchy Process (F-AHP):-

F-AHP is a combination of AHP method with fuzzy concept approach. The basic concept of fuzzy logic was first introduced by Professor Lotfi A. Zadeh who was a professor at the University of California in 1965. Fuzzy logic has the value of vagueness or disguise that is between right and wrong. While AHP is a method developed by Saaty (1990) which aims at determining decision alternatives and chooses one of the best for multi-criteria cases combining qualitative and quantitative factors in the overall evaluation of alternatives. F-AHP is used to examine the problems that begin by defining the problem thoroughly and then compiling it into a decision hierarchy.

In this study, the function of fuzzy membership used is triangular fuzzy number (TFN). TFN membership function is formulated as presented in Table 2.

Table 2:-TFN membership function

Fuzzy Number	Explanation of importance between variables	TFN Membership Function	TFN reciprocal
~1	A equally important with B	1,1,3	(1/3, 1, 1)
~3	A is slightly more important than B	1,3,5	(1/5,1/3, 1)
~5	A is clearly more important than B	3,5,7	(1/7, 1/5, 1/3)
~7	A very obviously more important than B	5,7,9	(1/9, 1/7, 1/5)
~9	A is absolutely more important than B	7,9,9	(1/9, 1/9, 1/7)

Results:-

Supply Chain Model of Palm Oil Biomass:-

This study was conducted within the scope of Riau Province. Based on the situational analysis that has been done, Riau Province is currently divided into 12 districts. The distribution of electricity generated from the biomass power

plant is carried out through the electricity network owned by State Electricity Company, both in the form of low voltage and medium voltage networks.

To convert oil palm biomass into electrical energy, currently in Riau Province has grown as many as 12 companies in the field of bioenergy. As a supplier of biomass to be converted into electricity, Riau Province has also established 244 palm oil factories spread in every region in Riau Province. Waste in the form of empty bunches, shells or fibers will be distributed to power companies. While liquid waste in the form of POME can be processed independently by each palm oil factory as a source of electrical energy through biogas technology or methane capture.

While basic raw materials in the form of fresh fruit bunches of palm oil supplied from oil palm plantations spread in eleven districts / cities in Riau Province. Fresh fruit bunches (ffb) that have been processed into crude palm oil (CPO) will leave waste in the form of biomass which will become the main source of power plants. The model diagram of the oil palm supply chain from upstream to downstream can be described as Figure 6.

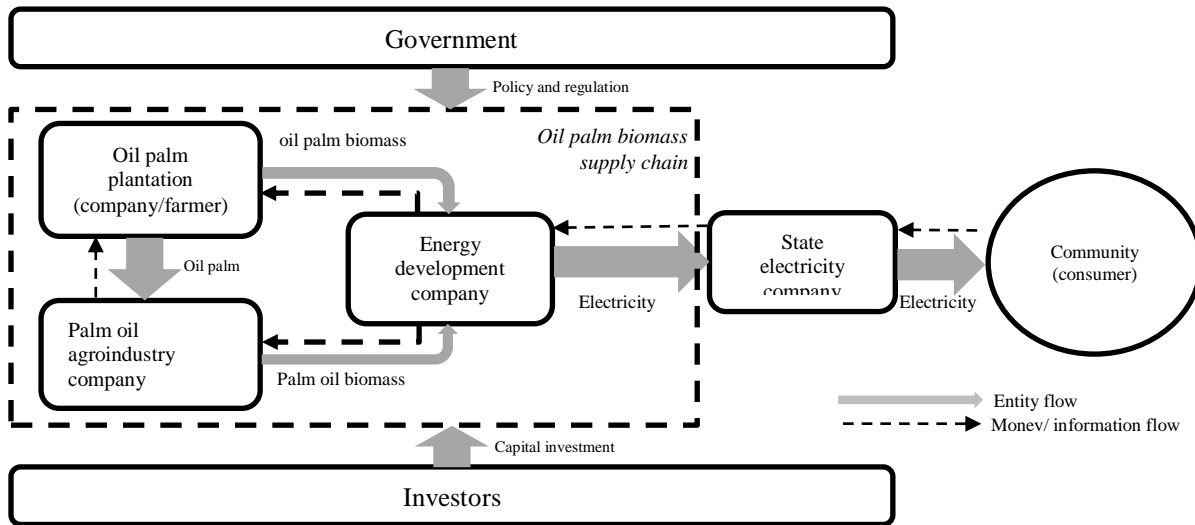


Fig. 6:-Oil palm biomass supply chain model

Needs Analysis:-

Needs analysis is the first step in a system approach. This analysis will be expressed in the needs that exist, and then carried out the development stage of the needs that are described (Eriyatno 1998). Needs analysis invariably involves the interaction between the responses arising from a decision maker over the course of the system. This analysis may include the results of a survey, expert’s judgment, discussion, field observation and so on.

In the agro-industry system, there are several stakeholders who are directly or indirectly involved in it and have interests that are generally different from each other. Analysis of the needs of each stakeholder is a first step in a study with a system approach. The needs and desires of interested parties who are actors or actors of the oil palm agro-industry development planning system are described in Table 3.

Table 3:-List of needs of each actor (1)

Actors	Description	Needs
Farmers of Oil Palm	Providing raw materials (biomass) through the process of agriculture and plantation, plantation products utilized oil palm agroindustry as raw materials	<ul style="list-style-type: none"> - Availability of quality seeds, fertilizers and pesticides in sufficient quantities. - Price stability of seeds, fertilizers and pesticides - Stability of the ffb selling price throughout the year
Palm oil mill (palm oil agro-industry)	Processing ffb into CPO, producing plantation waste in the form of empty bunches, shell,	<ul style="list-style-type: none"> - Guaranteed quality and supply of ffb - Stability of ffb prices - Increased productivity

	fiber, and POME as Biomass potential for Bioenergy Industry	<ul style="list-style-type: none"> - Increasing competitiveness - Increase in selling price of CPO and biomass
Energy development company	Utilizing palm oil biomass as raw material becomes electricity for society, through energy conversion process	<ul style="list-style-type: none"> - Guaranteed quality and supply of biomass - Stability of biomass prices - Availability and capacity of conversion technology - Certainty of price regulation, cooperation and management of environmental impacts
Energy development company	Utilizing palm oil biomass as raw material becomes electricity for society, through energy conversion process	<ul style="list-style-type: none"> - Guaranteed quality and supply of biomass - Stability of biomass prices - Availability and capacity of conversion technology - Certainty of price regulation, cooperation and management of environmental impacts
State electricity company	Distribution and commercialization of electricity to the public	<ul style="list-style-type: none"> - Guaranteed stability of power supply - Availability of infrastructure and power grid - Balance between Feed in tariff of electricity with investment
Government	Provide policies and regulations on the management and utilization of oil palm biomass in various aspects of economic, social and environmental	<ul style="list-style-type: none"> - Increasing the electrification ratio of each region - Increase in foreign exchange and regional income
Investors	Provide investment capital for development of oil palm companies and energy development companies	<ul style="list-style-type: none"> - Guaranteed payback - The appropriate profit margin - Business and marketing sustainability
Community (consumer)	The end user (consumer) and the beneficiary, provide a fee in the form of purchase of electricity in accordance with the price offered	<ul style="list-style-type: none"> - Power supply available every time - Stability of electrical voltage - The price of electricity is affordable

System Identification:-

System identification is a relationship between a statements of needs with a specific statement of the problem to be solved to satisfy those needs (Marimin 2004). In this regard, the identification of the oil palm agroindustry development planning system is illustrated in the form of causal loop diagrams, as shown in Figure 7.

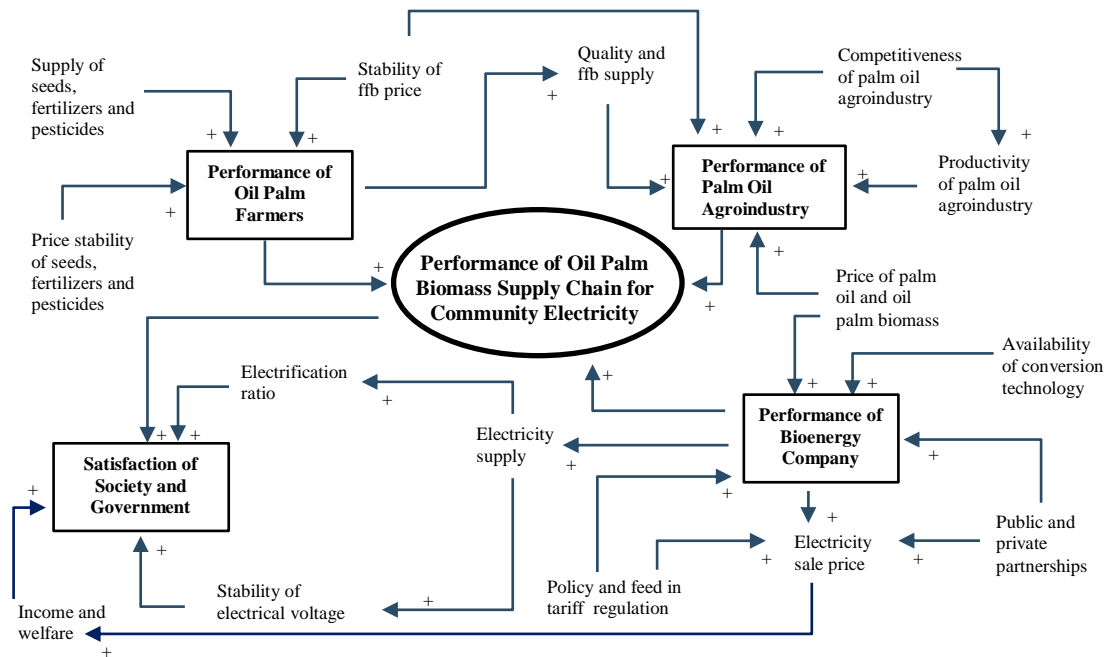


Fig. 7:-Causal loop diagram of oil palm biomass supply chain

Added Value Analysis (Farmers, Agroindustry and Bioenergy Company):-

To analysis added value at the farm level is based on the productivity of oil palm plantations. The amount of oil palm production is highly dependent on various factors, including soil type, seed type, climate and applied technology. Under optimal circumstances, palm oil productivity can reach 20-25 tons of ffb / ha / year or about 4-5 tons of palm oil. The average production of ffb for the productive age of oil palm 3 - 25 years is 17.4 tons. While the price range of ffb by age is estimated at IDR 1,200 / kg, and the price of each stem of palm oil seedlings of IDR 30.000 / trunk (Info Sawit 2014).

To measure the added value at agroindustry level, the raw material used is 17.4 tons which is the average of ffb production per 1 Ha of land area. This value is converted into biomass units. According to Hambali (2010), at 100% ffb, biomass can be produced consisting of: 21% empty bunches, 6.4% shells, 14.4% and 58.3% POME. This portion is the basis for determining the mass of each biomass based on the ffb base of 17.4 tons.

Utama et al (2011) in his study stated that, from 100% of each oil palm biomass, not entirely can be utilized as an energy source. In addition to empty bunches and POME, for oil palm shells, only 50% of the mass can be utilized, for fiber only 25%. The total biomass that can be produced from 17.4 ton of ffb production per Ha is 14.98 ton. This biomass output value of 14.98 kg is the basis for calculating value added at the level of oil palm agroindustry. Detailly can be presented in Table 4.

Table 4:-Percentage of each oil palm biomass from 17.4 tons of ffb

Palm oil biomass	Percentage*	Mass (kg)	Assumption **	Output (kg)
Fresh fruit bunch (ffb)	100%	17,400	-	-
Empty fruit bunch (efb)	21%	3,654	100%	3,654
Shell	6.40%	1,114	50%	557
Fiber	14.40%	2,506	25%	626
Palm oil mill effluent (POME)	58.30%	10,144	100%	10,144
Total Biomass of 1 ha palm oil plantation				14,981

*) Hambali (2010); **) Utama et al (2011).

At bioenergy company level, the calculation of the amount of electrical energy is determined based on the thermal energy content of each type of biomass. The thermal content of each biomass, for the empty fruit bunch is 18,838 kJ / kg, the shell is 20.108 kJ / kg, the fiber is 19.068 kJ / kg. The potential of electrical energy that can be generated from each biomass above, can be seen in Table 5.

Table 5:-Potential of electricity in each oil palm biomass

Palm oil biomass	Output (Kg)	Thermal content (kJ/Kg)	Thermal energy (kJ)	Electricity (KWh)
Empty fruit bunch (Efb)	3,654	18,838	68,834,052	19,122
Shell	557	20,108	11,196,134	3,110
Fiber	626	19,068	11,944,195	3,318
POME				547
Total Electricity				26,098

Meanwhile, to determine the potential of electricity derived from POME can be done with the calculation as presented in Table 6.

Table 6:-Potential of electricity in POME

Ffb as basis (Kg)	17,400
POME (Kg)	10,144
Methane (m ³)	304,320
Electricity (watt)	608,640
Internal Consumption (10%) (watt)	60,864
Electricity production (kWh)	547.8

Source: Adopted from the calculation of PTPN - V Methane Capture Technology

An example of value-added analysis can be seen for agro-industry level, as presented in Table 7. To measure added value at farmer and bioenergy level, it can be done in the same way.

Table 7:-Result of added value measurement from 14,981 kg of biomass on palm oil agroindustry

No.	Indicators	Values
Output, Input and Price		
1	Output (Kg/ha)	14,981
2	Mass of ffb as raw material (Kg/ha)	17,400
3	Direct workforce time (day/month)	10
4	Conversion Factor	0.86
5	Direct workforce coefficient (HOK/Kg)	11.61
6	Price of output (IDR/Kg)	125,000
7	Wages of workforce (IDR/day)	5,000
Incomes, Value Added and Profits		
8	Raw material prices (IDR/Kg)	1,200
9	Other input prices (IDR/Kg)	300
10	Output value (IDR/Kg)	107,622
11	a. Added value (IDR/Kg)	106,122
	b. Added value ratio (%)	98.61
12	a. Direct workforce income (IDR/Kg)	58,074
	b. Share of direct workforce (%)	54.72
13	a. Profit (IDR/Kg)	48,049
	b. Profit rate (%)	44.65
Rewards owner of production factors		
14	Margin (IDR/Kg)	106,422
	a. Direct workforce income rate (%)	54.6
	b. Other input donations (%)	0.3
	c. Company profit rate (%)	45.1

Based on the analysis of value added at three levels of the supply chain, it can be seen the ratio of value added and profit rate respectively as summarized in Table 8. Meanwhile, the graph of added value added and profit level between the three actors, presented in Figure 8.

Table 8:-Added value and profit rate of farmers, agroindustry and bioenergy company

Actors	Added Value	Profit Rate
Oil palm farmer	80.4%	68.5%
Palm oil agroindustry	98.6%	44.6%
Bioenergy company	93.0%	92.9%

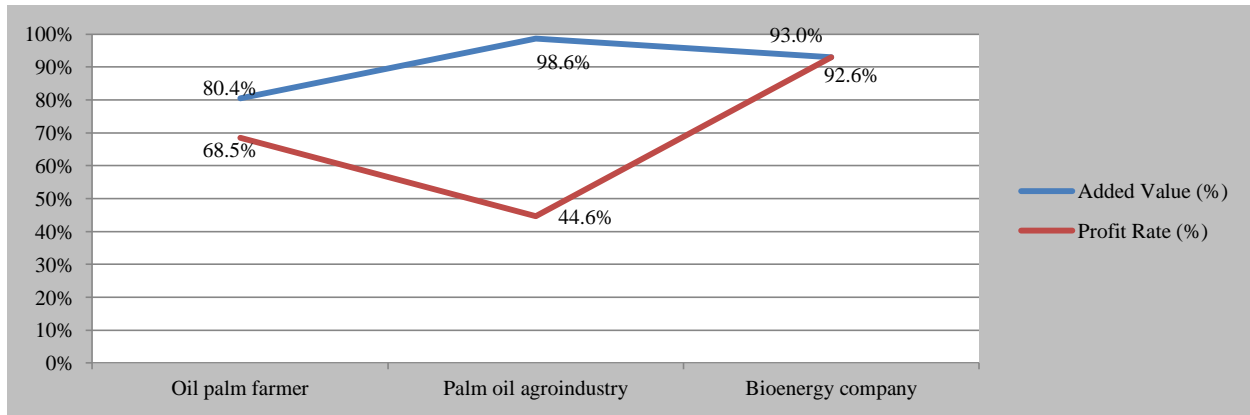


Fig. 8:-Graph of comparison between added value and profit rate in each actors

Supply Chain Performance Analysis:-

Weight Measurement:-

In the assessment of supply chain performance using the SCOR Method, it is necessary to measure the weight values for each of the business process criteria, performance parameters, performance attributes and performance metrics. In this study, in accordance with the SCOR Method, 5 business process criteria that are considered include: 1) planning (Plan); procurement (Proc); processing (Mfg); delivery (Delv) and return (Return). While the measured performance parameters include: 1) added value (AV); 2) quality (Q); and 3) risk (Risk).

In this study, there are four performance attributes to be considered, among others: 1) reliability (Rel); 2) responsiveness (Resp); adaptability (Adp) and cost (Cost). In the performance attribute of reliability, there are four measured performance metrics, among others: 1) full sent order (fso); 2) delivery performance (dp); 3) document accuracy (da); and 4) perfect goods condition (pgc). At the responsiveness attribute, there are also three performance metrics, namely: 1) procurement cycle time (pct); 2) manufacturing cycle time (mct); and 3) delivery cycle time (dct). The attribute of adaptability, there are three performance metrics, namely: 1) upper supply chain flexibility (uscf); 2) adjustment of the upper supply chain (usca) and 3) adjustment of the lower supply chain (lsca). While at the cost attribute, consisting of three performance metrics, among others: 1) raw materials (rm); 2) production (prod), and delivery (del).

The weight of each criterion and attribute is obtained by using AHP fuzzy. The result of weighting by using AHP fuzzy method for each criterion, performance parameter, and attribute and performance metrics summarized in hierarchy diagram as in Figure 9.

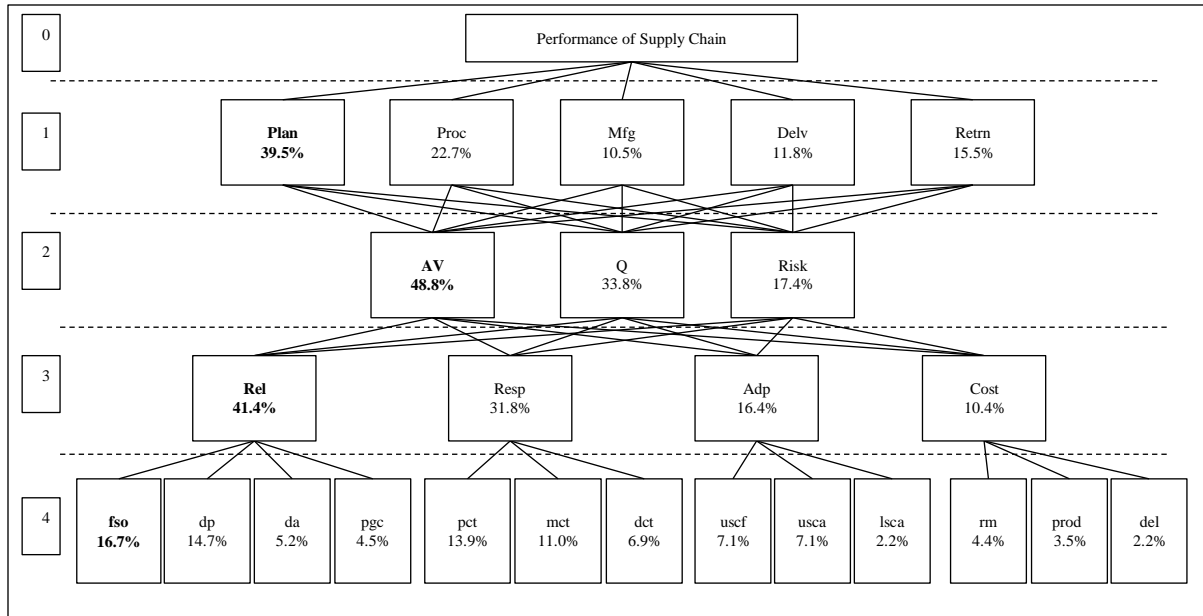


Fig. 9:-Hierarchy and weighting of criteria and attributes

Based on the weight measurement with AHP fuzzy, it can be seen that business process that has the highest importance weight is on planning criteria (Plan) with weight value of 39.5%. At the level of performance parameters, of the three parameters considered, the highest weight is on the added value (AV) aspect with weight of 48.8%. On the performance attribute, of the four attributes, reliability (Rel) is the most important performance attribute with weight of 41.4%, while in the performance metric, the full sent order (fso) is the highest weighted metric of 16.7%.

Performance Measurement:-

The result of weight measurement of each aspect, becomes the determinant factor in performing performance measurement for each level of supply chain of oil palm biomass. To classify the performance of the supply chain, Munczka et al (2011), has divided into 6 classifications, namely: excellent (above 95)%, above average (90-94)%, moderate (80-89)%, below average (70-79)%, poor (60-69)%, and not acceptable (less than 60%). The performance and classification for the three actors, presented in Table 10.

Table 10:-Performance classification of oil palm biomass supply chain in each actors

Actors	Performance (%)	Classification
Oil palm farmer	60.62	Poor
Palm oil agroindustry	70.07	Below average
Bioenergy company	72.80	Below average

Conclusions:-

Based on the results of the analysis that has been done, it can be drawn some important conclusions. The oil palm biomass supply chain model has shown a distribution relationship from farmers, agroindustry and bioenergy companies. Based on value added analysis it can be seen that the highest added value is in palm oil agroindustry with value added ratio of 98.6%. The highest profit level of the three levels of supply chain is found in bioenergy companies, which is 92.9%. While the performance for the three actors is less than the standard, where the best performance is in bioenergy companies, with a performance value of 72.80%.

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