Analysis of Crude Palm Oil Supply Chain using Food Supply Chain Network (FSCN): A Case Study

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Abstract. Palm oil industry is one of the leading industrial sectors in Indonesia. In order to fulfill CPO demand as well as increasing of CPO sales, a research to analyse the supply chain flow of CPO was conducted. This research was conducted in ABC company, which is a privately owned business entity engaged in oil palm plantations located in South Tapanuli Regency, Indonesia. Analysis of supply chain had been done by using Food Supply Chain Network (FSCN) to define the integration of key business processes provided by original suppliers that provide products, services, and information from end users to customers and other stakeholders. Result of this research clearly defined the supply chain process with a clear flow of material, information and finance. The key process of CPO supply chain is the distribution of raw materials of CPO, namely fresh fruit bunches (FFB) which were collected from privately owned oil palm plantations and nearby community gardens, then processed in mills, deliver to storage tank, and export to customers. Analysis of this case study provided a clear description of CPO supply chain and may let further researchers to easily examine the potential risks at each stages and actors of CPO supply chain.

1. Introduction
Palm oil industry is one of the leading industrial sectors in Indonesia. Palm oil plant is known by the Latin name *Elaeis Guineensis Jacq*. This plant originates from the African Continent around the country of Angola to Senegal. The geographical similarity of African Continent and Indonesia is the main reason for development of oil palm plantations, then followed by the palm oil industry with its downstream industries which provide significant value added to Crude Palm Oil (CPO) [1].

The major product of palm oil industry which called crude palm oil (CPO) can be derived into various products including food industries such as cooking oil, margarine and also non-food industries like shampoo, soap, cosmetics and glycerin [2]. Despite the fact that on the other hand, another widely used derivative products of CPO is biodiesel [3] which also become a significant opportunity in developing the CPO supply chain, especially in Sumatera [4]. Increasing demand of a product will be followed by uncertainty in the supply chain that requires further study to analyze the flow and actors involved in the supply chain [5].
An initial survey at ABC Company showed that all installed capacity by the company could not be fully utilized optimally. This was concluded by the average volume of FFB processed by ABC Company in previous year was still below its maximum production capacity. The fluctuating and poor processing volume will cause risk increasing demand and increasing CPO production volume in North Sumatra Province.

In order to fulfill CPO demand as well as increasing of CPO sales, a research to analyse the supply chain flow of Crude Palm Oil is needed to be conducted. Previous research concluded that are several factors could influence the supply chain of CPO, including capacity, efficiency, critical point, etc. These factors can be discovered in the process of processing palm oil until the process of delivering and selling to customers [6]. In other hand, supply chain analysis also used to determine several sources of uncertainty in upstream, midstream, and downstream along the supply chain [7]. Another research described that Food Supply Chain Networking (FSCN) used to design the fulfillment of a company's raw material supply based on their installed capacity at the processing plant [8].

Based on these phenomena above, a research to analyze the supply chain flow of Crude Palm Oil was conducted. As a case study, this research using ABC Company as a benchmark to analyze the integration of Supply Chain and the key business processes provided by original suppliers that provide products, services, and information from end users to customers and other stakeholders.

2. Method
This study was conducted from August 2019 to February 2020, while the annual production data used was 2018. This research belongs to descriptive research, to describe systematically, factually and accurately about the facts and properties of a particular object [6]. While the object of this research was the CPO Supply Chain.

Primary data [9] used in this study were data from interviews with factory employees, factory managers, smallholder farmers, collectors and Forum Group Discussions (FGD). In other hand, the secondary data used in was previous research, journals and data from Indonesia Central Statistics Agency (BPS).

Descriptive analysis of Food Supply Chain Networking (FSCN) was carried out to describe the CPO Supply Chain. Analysis of CPO supply chain including several aspects consist of chain management, network structure, chain resource, chain business process [10].

![Figure 1. Framework for chain/network development](image)

3. Results and Discussion
ABC Company is a privately owned business entity engaged in oil palm plantations located in South Tapanuli Regency, North Sumatera Province, Indonesia. ABC Company has a total area of 7,909.30 and 157.50 hectares of plasma that have been planted and actively producing Fresh Fruit Bunches (FFB). The company also has a palm oil mill with FFB processing capacity of 60 tons/hour, while the
FFB sources including both their own plantations and third parties from nearby community. The following Figure 2 shows the company’s production data in 2018.

![Volume of CPO Production in 2018](image)

**Figure 2.** Volume of CPO production ABC company in 2018

ABC Company has a FFB production capacity of 60 tons/hour requires FFB or averagely 1,500 tons per day. The productive area of ABC Company estate is 7,909 Ha and the productivity level of the farm is 3.5 tons/ha. Then obtained FFB per month is as much as 27,681.50 tons or 1,153.40 tons per day. In other words, 346,60 tons of FFB per day are needed from external parties.

The FSCN framework has a supply chain analysis with FSCN approval consisting of 4 key elements that can be used to evaluate, analyze and develop supply chains that are specific to the FSCN model, namely chain management, network structure, chain resource, chain business process.

3.1. Chain Management

Chain management is a combination of the planning, coordination and control processes of all business processes and activities in the supply chain to meet the needs of consumers at minimum cost. Things that need to be discussed in ABC Company chain management are management structure, partner selection, contractual agreements, and transaction systems.

3.1.1. Management Structure. Smallholder farmers and collectors are the actors in the upstream section, where they act as producers in producing FFB to be sold to ABC Company. Then, the company procure the FFB according to the standards set by themselves for smallholder farmers and collectors, along with FFB from their own internal gardens. After that, the palm oil mills carry out the processes of weighing raw materials, sorting, boiling, drying, extracting, refining, quality control and temporary storage. The sales and distribution process are regulated by the marketing office of ABC Company in Medan City.

3.1.2. Partner Selection. The selection of partners of ABC Company is needed to improve their strategical and operational capabilities among supply chain actors. Strategic cooperation seeks to help each other in achieving the desired benefits together and sustainable.

3.1.3. Contractual Agreements. The contractual agreement applied by ABC Company to collectors is an agreement that the supplier must fulfill the FFB demand required by the company in accordance with the company's standardized quantity and quality, FFB delivery schedule and payment system. If the FFB supplied does not meet the required standards previously set by the company, the company will not buy the provided FFB. As for the supply of FFB from the company's internal plantations, it will be fully accepted, but the maturity specifications of the fruit will be recorded.
3.1.4. **Transaction systems.** The system of transactions used by ABC Company is a transaction carried out with a crossed check on behalf of the supplier with the account number determined by the company. Payments made for ABC Company are payments for net products from farmer as suppliers with net products that have been sorted by suppliers and confirmed by Palm Oil Mills. This confirmation sorting is done in order to calculate the weight of the products that have been sorted.

3.2. **Network Structure**

Network structure describes a commodity that is determined by the members or main actors of the supply chain network and the number of supply chain actors and material, information, and financial flow between the actors. Following is the network structure of ABC company supply chain, which can be seen in Figure 3 below.

![ABC company supply chain structure](image)

**Figure 3.** ABC company supply chain structure

Based on the results of a survey of nearby community local farmers’ estates in South Angkola District, it was found that FFB per day was sold directly to Palm Oil Mills of ABC company, namely as many as 16,30 tons per day. There is also data on community farmers’ estates in South Tapanuli Regency including the village of Mosa Pacang, Mosa Jae, Kampung Sedikit obtained from the Forestry Service that there are 739 Ha of land used as oil palm plantations and producing FFB per month reaching 747.8 tons per month or 37.39 tons per day.

Overall, 48 local farmers’ estate location data obtained has an area of about 431 hectares. If an overlay with a map of the forest area, showed that as many as 19 estates with an area of approximately 45.69% (196 hectares) of the total area is in protected forest areas. In addition, 8 estate with an area of approximately 11.19% (48 hectares) of the total area is in production forest area, 11 estate with an area of approximately 35.31% (151.5 hectares) of the total area is in limited production forest area and 10 estates with an area of approximately 8.28 (35.5 Ha) total area is located in another area of use.

3.3. **Chain Resources**

Supply chain resources are needed to support the development and efficiency of CPO supply chain activities. Supply chain resources consist of physical resources, human resources, and technology.

3.3.1. **Physical Resources.** Physical resources owned by ABC company include a factory building with a production capacity of 60 tons of FFB per hour. Facilities and infrastructure in the palm oil supply
chain resources, consisting of plantation areas, road conditions, housing for employees, offices, transportation facilities and product storage facilities. In creating CPO products in accordance with quality, good application of technology is needed.

3.3.2. Human Resources. Human resources are the key factors of the company. Therefore, ABC Company human resource policies are designed to empower, optimize performance, utilize and maximize the potential effectively of employees. The company has designed a management trainee program that lasts 9 months to provide comprehensive preparation in terms of leadership through a balanced off the job and on the job learning system in various departments and existing business units.

3.3.3. Technology. Today, the application of technology in the factory has used technology machines and certified and trained HR support. In addition, ABC Company has obtained ISO 14001 (environmental management system), ISPO, RSPO and OHS certification.

3.4. Chain Business Processes
The supply chain business process is a business process that reflects the flow of processes that occur along the CPO supply chain. These business processes are integrated with one another. Figure 4 is a CPO supply chain business process at ABC Company.

**Figure 4.** ABC company business process

3.5. Benefits and Impact of Research for Related Stakeholders
After analyzing the supply chain of CPO at ABC Company that located in North Sumatera Province, some of the benefits and impacts for related parties can be revealed as follows.

3.5.1. Company Itself. It will be better to expand the marketing and sales network along with build a refinery factory that increases the value of palm oil derivative products (downstream). Increasing of value will give positive impact on revenue as well as the popularity of company branding. In addition, ABC Company is expected to be able to participate with Smallholder Oil Palm Oil Plantation (PSR) for farmers so that smallholder oil palm estate may have high competitiveness and also giving chance for local community estate to obtain Indonesian Sustainable Palm Oil System (ISPO) certification.
3.5.2. Core Estate. As said before, it needs higher intensification of core estate especially in assisting the nearby local community to obtain ISPO so that the produced CPO will be suitable for export quality.

3.5.3. Community Estate. Community Estate which located outside the of the prohibited forest area, should be soon prepare their replanting by using superior seeds from the Oil Palm Plantation Fund Management Agency (BPDPKS) to increase plantation productivity and also prevent exploitation of protected forest area.

3.5.4. Local Government. In granting permits to establish Mills, it is necessary for Local Government to pay higher attention to the adequacy of the oil palm land, to prevent the using of protected forest area for palm oil plantation.

4. Conclusion
Based on the results and discussion conducted above, it can be concluded that:

- CPO Supply Chain in this case study can be described as the material flow which starts from the upstream to downstream, from nearby community estate and collectors, and its own core estate. Then supply the raw materials FFB to Palm Oil Mills. After being processed to CPO, the CPO will be export to consumers in Singapore and India while the by-product PKO will be sold to local consumers for other derivative product raw material. In other hand, the financial flow starts reversely from downstream to upstream, while the information flow goes in both directions that creates two-way communication between supply chain actors.
- The FSCN framework of CPO Supply Chain consists of 4 key elements that can be used to evaluate, analyze and develop supply chains that are specific to the FSCN model, namely chain management, network structure, chain resource, chain business process. The key points of FSCN framework of CPO Supply Chain is the integration of key business processes provided by original suppliers that provide products, services, and information from end users to customers and other stakeholders.
- CPO Supply Chain analysis of this case study provided a clear description of CPO supply chain and may let further researchers to easily examine the potential risks at each stages and actors of CPO supply chain.
- This case study further proved FSCN as a supply chain analysis tool may be easily applied in CPO supply chain. By using FSCN analysis, this case study described the flow and actors involved and related with the CPO supply chain. Thus, further researchers may be able to easily examine the potential risks at each stages and actors of CPO supply chain.

5. Acknowledgment
This research was supported by Research Institution of Universitas Sumatera Utara and international non-governmental organization in the field of wilderness preservation and the reduction of human impact on the environment. Furthermore, we would express our gratitude to colleagues from Universitas Sumatera Utara who provided insight and expertise that greatly assisted this research.

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