A Supply Chain Mapping Model of the Textile Industry Upstream Sector: The Proof from Indonesia

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Abstract

This study fills the gap in the supply chain mapping model of the textile industry upstream sector in Indonesia, that it could identify comprehensively, a flow of products, finance, and information from upstream to downstream. This research used a supply chain mapping approach by illustrating the network structure of the supply chains horizontally and vertically from upstream to downstream. The total samples were 43 Fiber Making companies and 249 Spinning companies. The result showed both industries had a strong integration as a continuous production process unit. The output was to give additional values for the exports and to contribute a large foreign exchange. Furthermore, the result of this study revealed that both industries had a high import dependency on the raw materials produced by the petrochemical and cotton industries. The research findings provided a better understanding for the scholars and the company managers to integrate a supplier and a consumer to create a better supply chain mapping model of the upstream sector of the textile industry in Indonesia.

Keywords: Mapping, Supply Chain, Upstream, Fiber Making, Spinning.

1. INTRODUCTION

Textile industries in Indonesia comprise three parts. These are the upstream industry sector, which produces fiber and yarn (unblended and blended) yarn, the midstream industry sector which produces fabric, and the downstream industry sector which produces ready-made garments. The textile industry upstream sector is the main priority to be developed because it contributes significantly to the Indonesian economy. The textile industry upstream sector consists of two industrial sectors: Fiber Making and Spinning. This industry has several characteristics: fully automatic, intense capital, large scale, the number of laborers is relatively small, and the value added is huge compared to the midstream sector and downstream sector. Therefore, the textile industry upstream sector is more strategic in supporting the Indonesian economy compared to the midstream and downstream sectors (Kementerian Perindustrian, 2021).

According to the report issued by the Ministry of Industry in 2021, the growth value of the textile industry upstream sector in 2019 reached 18,98 percent and the investment reached USD174,51 thousand, or an increase of 17,98 percent compared to the same period in the previous year, which was USD147,92 thousand. However, the impact of the COVID-19 pandemic in 2020 caused the textile industry upstream sector a huge contraction of -8,88 percent, and it continued in the I quarterly of 2021 for -13,2 percent. Furthermore, it faced a decreased absorption in the domestic market because of the higher price compared to the imported products. An attempt to recover the performance of the textile industry upstream sector must be done,

mainly on the logistical costs efficiency from its supplier and the distribution flow within the supply chain.

The supply chain mapping model provides a benefit for identifying the bottleneck in the flow of goods, information, and cash in the supply chain, which then could control the risk of a weak integration from the supplier to the end customer. Consequently, it would contribute to cutting the total costs along the company's supply chains (Nishat M. et al., 2006). To gain the best supply chain performance in the textile industry upstream sector, it is deemed important to create the supply chain mapping model to show a detailed connectivity both as a whole and each partner within the supply chain, that an integration improvement with the supply chain partners could be recommended (Jayaratne P. et al., 2012).

However, according to the result of the writer's analysis, there has never been found research that discussed the textile industry upstream sector in Indonesia. Therefore, it is very reasonable to create a mapping model of the supply chain in the textile industry upstream sector in Indonesia with several motives carried out in this study, such as improving the strategic planning process, assisting the design and configuration of the supply chain using supply chain mapping illustration, and analyzing the supply chain for raw material sources and distribution (Gardner, J. T. & Cooper. M.C., 2003).

To fill the research gap in the supply chain mapping model on the textile industry upstream sector in Indonesia, this research has become paramount of importance, as the aim of this study is to create a map of the supply chain in the textile industry upstream sector in Indonesia and to analyze it. Later, the study would obtain complete information regarding factual conditions in the textile industry upstream sector in Indonesia. The benefits of the supply chain mapping model in the textile industry upstream sector in Indonesia requires government strategic level decision that effectively connects the company's strategy with the supply chain partners in achieving competitive advantages in the form of logistics cost efficiency, and timely delivery to customers (Cetinkaya B. et al., 2011).

2. LITERATURE REVIEW

2.1. Benefits of Supply Chain Mapping

The term supply chain first emerged in the 1980s when many companies began to recognize the benefits of its integration and the collaboration in building a good relationship with the supplier, distribution flow, and customers (Díaz, 2006). A supply chain includes manufacturers, suppliers, carriers, warehouses, retailers, and even the customers themselves, who are involved, directly and indirectly, performing a new function of product development, marketing, operations, distributions, finances, and services to meet the customer demands (Chopra S., 2019).

The supply chain is attractive to companies because it can improve the overall performance of company partners with lower material prices, efficiency in production and distribution, and inventory. By mapping the supply chain as a whole,

it proves to be important for a company to take the right and quick decisions (Lummus & Vokurka, 1999).

In reality, the supply chain is very complex because a company must simultaneously be affiliated and integrated using various parties, namely suppliers, manufacturers, distributors, and retailers to end customers (Bowersox, Closs, & Cooper, 2007). The cooperative relationship both upstream and downstream from the supply chain has created a linear graph in the form of a complex network that is interwoven with many partners within the supply chains (Cavinato, Flynn, & Kauffman, 2006; Mentzer, et al., 2001) and the complex supply chain network develops into non-rational supply chain network (Styger, 2009).

The supply chain management is expected to provide their best to the customers by delivering the products and the service on time, with good quality, cost, quantity, and the proper place as promised to customers. As a result, it is very important to properly manage the supply chain management, so that the company could improve its performance through a network visualization approach such as the supply chain mapping process. The supply chain map is a representation of the interrelationship between entities from upstream to downstream within the supply chain (Gardner & Cooper, 2003).

Mapping procedures can be found for industrial clusters (Porter, 1980) and in various scientific fields, such as economic geography, agglomeration economics, supply chain management, and others (Boschma & Frenken, 2003). Plenty of research had been conducted on the application and the potential benefits of the supply chains mapping model. Those studies could be found in the following academic works: Favaro, C. & Lima, 2002; Naim et al. 2002; Childerhouse & Towill 2003; Harper 2007, and in the study related to the projects of supply chain mapping held by industry practitioners (Drickhamer, 2006).

Given the complex supply chain context, it is not easy to spot the problems by examining only a small part of the supply chain. The use of mapping in aiding to visualize the entire activities involved in the supply chain might prove to be useful for identifying and analyzing areas that are problematic. By obtaining a good supply chain map, a company could easily rationalize a better supply chain management procedure (Azevedo, 2011).

Another benefit of the supply chain apart from simplifying the description of the spatial relation between the supply chain partner organizations from upstream to downstream is to inform the nature of a company's business environment within the supply chain (Rouleau, 1993). In addition, the supply chain maps could be useful as a medium to evaluate a company's strategic planning process and facilitate the distribution of key information to supply chain partners. The other functions are that it could provide a basis for supply chain analysis that proves to be complex, improve communication between supply chain partners, and link the company's strategy with supply chain partner's strategies (Gardner & Cooper, 2003). In the end, the supply chain mapping shows a focus on the flow of goods, information, and cash from upstream to downstream through all the supply chain partners (Schroeder, 2000), and emphasizes the perspective of volume, cost, and transaction time

between companies, making it possible to hold an evaluation for the improvement of the company performance (Lambert et al., 1998).

2.2. Approach to Supply Chain Mapping Model

The supply chain map is made by photographing the relationship between the supply chain partners related to the flow of information, product, and money (Gardner & Cooper, 2003). There are six alternative approaches for mapping the supply chain, which could be seen as follows:

1) This method designs the mapping by using the improved value stream mapping (VSM) according to the result of an investigation of the flow of goods and the information from the supply chain partners. Then, the development of this method is called extended value stream mapping (EVSM), which includes as many supplies chain partners as possible by mapping the flow of raw materials from suppliers to distributing products to the end consumers (Jones & Womack, 2002).

2) This approach uses Value Stream Analysis Tool (VALSAT) to determine the best priority for eliminating the dissipation through a contingency approach. Various studies had applied VALSAT to map the flow of information and goods, and to align strategic initiatives to improve the overall supply chain performance (Hines & Rich, 1997).

3) This mapping approach emphasizes different levels of dependence on the processes and the flow of products by focusing on the supply chain organizational map, the technology map used in the supply chain, and the capability map of the business organization of the supply chain. This method aims to prevent possible conflicts and classify opportunities for improving supply chain performance (Fine, 1998).

4) This mapping approach uses Quick Scan Methodology (QSM) with the aim of developing a smooth supply chain by seeking the root causes of problems in the process of raw material delivery from the suppliers and the delivery of the finished goods from the company to consumers, thereby providing the added value for the company (Towill, Childerhouse & Disney, 2000).

5) The mapping approach uses Supply Chain Operations Reference Model (SCOR) that is carried out by using supply chain configuration when identifying the company's five core processes (plan, source, make, deliver, and dan return. The SCOR model is used in various contexts of designing, measuring processes, reconfiguring various types of business into commercial business activity, and supporting effective communication between the supply chain partners (Supply Chain Council, 2020).

6) The mapping approach uses a diagram that illustrates the supply chain network structure. This model describes the process of vocal company business with suppliers, distributors, and customers based on the number of levels (horizontal) and the number of supply chain partners in each level (vertical). The use of this

method could classify properly each supply chain partner's relations and describe the integration that occurs in each process connection within the supply chain (Lambert et al, 2000).

3. METHODS

The supply chain mapping approach in the upstream sector of the textile industry in this study refers to a model using diagrams that describe the network structure from upstream to downstream of the supply chain (Lambert et al, 2000). The map describes the supply chain network structure horizontally (number of tiers) and vertically (number of companies in each tier), and shows the business process relations between the company and the suppliers, and also the customers. The upstream sector of textile industries in Indonesia consists of two industrial groups, namely Fiber Making, which produces natural fiber or synthetic in the form of filament or staple, and Spinning, which uses the output of the fiber-making industry as an input to produce yarn.

The total population of Fiber Making companies in Indonesia is 43 companies, while the total population of Spinning companies is 249 companies, mainly concentrated in West Java and Central Java (Kementerian Perindustrian, 2021).

The questionnaire data collection was conducted from October – November 2021. The respondents were the Production Manager of every company that was chosen. The total samples in the Fibermaking and Spinning companies were calculated using Slovin's sample formula (Stephanie, E. 2003) with a margin of error of 5%. Thus, the number of samples obtained from the Fiber Making companies was 43, while the Spinning companies were 154 companies. Therefore, it could be stated that the number of samples used by the researcher is sufficient.

The questionnaire apart from being filled with a short company profile also contains questions for mapping, mainly on the raw materials. The raw material questions consist of: (1) what types of raw materials are used? (2) are the raw materials obtained locally or are these imported? (3) how many raw materials are needed per year (Unit/Kg/Ton/Liter/Meter)? (4) how much is the raw material per unit (US $/Rp.)? Then, the questions about the product consist of: (1) what is the name of the product? (2) how many are those being marketed locally and exported? (3) how much is the production capacity per year (Unit/Kg/Ton/Liter/Meter)? (4) how much is the price for each product unit (US $/Rp.)?

This research used qualitative description analysis which was based on the accurate interpretation of data and information to determine the facts in the field (Neergaard et al., 2009). This analysis was unique because the aim of its analysis was not a detailed description, theoretical generation, or interpretative meanings from certain events. Instead, the analysis was used to describe the supply chain mapping of the textile industry upstream sector in Indonesia.

4. RESULTS AND DISCUSSION

4.1. The Supply Chain Mapping Model of the textile industry upstream sector in Indonesia

Based on the results of the questionnaire, the researcher then drew a map describing the supply chain network structure horizontally and vertically. Figure 1 showed the supply chain mapping for the textile industry upstream sector in Indonesia which consisted of Fiber Making Industry and Spinning Industry.

The supply chain mapping of Fiber Making Industry began by describing the supply of main raw materials from suppliers and highlighting the business process relationship between Fiber Making with its suppliers and customers (Spinning Industry). The main raw materials of Fiber Making Industry consisted of Purified Terephthalic Acid (PTA), Paraxylene (PX), Chips, Caprolactam, Adipic Acid, Etilena Diamin, Acrylic, and Pulp. The raw materials were obtained from domestic and imported industrial suppliers. The Fiber Making company produced natural fiber or synthetic in the form of filament or staple. Polyester Fiber products were manufactured using PTA, PX, and Chips as raw materials. Polyamide Fiber product which was produced by a Fiber Making company used Caprolactam, Adipic Acid, and Etilena Diamin raw materials. Acrylic Fiber product was produced by using Acrylic raw material. Meanwhile, Rayon Fiber product was produced by using Pulp as raw materials.

Furthermore, Figure 1 explained that the output (product) from the Fiber Making industry was used as the materials by the Spinning industry to produce yarn. The output from the Fiber Making Industry consisted of Polyester Fiber, Polyamide Fiber, Acrylic Fiber, and Rayon Fiber, which most of them were used for Spinning Domestic Industry demand, and the rest was exported. While cotton, wool, and other natural and synthetic fibers were imported from various countries, and also used as the raw materials in the Spinning industry. The Output (product) from the Spinning industry consisted of Polyester Yarn, Nylon Yarn, Acrylic Yarn, Rayon Yarn, Cotton Yarn, T/R Yarn, dan T/C Yarn. Most of the Spinning Industry output was used to meet the domestic demand in the textile midstream industrial sector, and a small portion is exported to various countries.

Figure 1: Supply Chain Model Mapping on The Textile Industry Upstream Sector in Indonesia

4.2. Supply chain Mapping in the Fiber-Making Industry

Figure 2 showed the supply chain mapping in the Fiber Making Industry, accompanied by the calculation results of the average demand (material flow) and the cost (financial flow) for imported and raw materials, as well as the average number of production and product sales values for both export and domestic in 20201

Figure 2: Supply chain Mapping in Fiber Making Industry in 2021

The result of the data processing from the respondents of Fiber Making Industry could be categorized into 4 groups when viewed from the raw materials used and the output (products), those are:

1. The company that produced Polyester Fiber. Focusing on the largest amount of raw materials used, then PX used the average at 33.333 tons/year, of which 60% was imported and 40% was from domestic. While the raw materials used for chips were 37.777 tons/year, of which 55% were from the domestics, and 45% were imported. The output (Polyester Fiber) averaged 93.200 tons/year and was dominantly consumed by the domestic industry for 77% and 23% was from export.
2. The companies that produced Polyamide Fiber. Focusing on the largest amount of raw materials used, then Caprolactam was the most dominant with an average consumption of 8.000 tons/year, where 55% from domestic and 45% was imported. While Adipic Acid, the average consumption was 112 tons/year, which was 100% imported. The average Output (Polyamide Fiber) was 8.015 tons/year and it was dominantly consumed by the domestic industry by 75% and exports by 25%.
3. The companies that produced Acrylic Fiber. Using Acrylic materials with an average consumption of 47.777 tons/year, of which 55% was from domestic and 45% were imported. Output (Acrylic Fiber) averaged 5.100 tons/year and was dominantly consumed by domestic industry by 79% and 21% was the exports.
4. The companies that produced Rayon Fiber. Using Pulp as raw materials with an average consumption of 22.222 tons/year, of which 80% was from domestic and 20% was imported. The Output (Rayon Fiber) averaged 21.100 tons/year and was dominantly consumed by the domestic industry by 95% and exports by 5%.

Fiber Making Industry was a capital-intensive industry that used high technology (mechanization) and it was a large-scale company. The Fiber Making Industry produced added value by processing raw materials into semi-finished materials for the Spinning Industry. The main raw materials for Fiber Making Industry were the products of the Petrokimia Industry, where the production of the domestic Petrokimia Industry was not sufficient to meet the needs of raw materials for the Fiber Making Industry. Therefore, Fiber Making Industry had a high dependency on imported raw materials with a cost structure of 55%, which were all the cost of raw materials and 25% from the cost of energy. Indonesia has a great opportunity to develop Petrokimia Industry because the raw materials were in the form of oil and gas, not to mention that plenty of coal could be found in Indonesia. In addition, the pulp raw materials (to make Rayon) could also be found in Indonesia. Therefore, it was necessary to develop Pulp Industry in Indonesia where the products could be used for domestic needs and exports.

4.3. Supply chain Mapping in the Spinning Industry

Figure 3 showed that the supply chain mapping in the Spinning Industry, accompanied by the results calculation of the average demand (material flow) and the cost (financial flow) for imported and domestic raw materials, and the average number of production and sales value of the product for both export and domestic

in 2021. The raw materials used by the Spinning Industry were the output of the Fiber Making Industry for both domestic and imported. However, in the case of Acrylic Fiber dan Rayon Fiber, the entire supply was from domestic sources. On the contrary, for the Cotton raw materials, the entire supplies were imported because domestic cotton had a low quality, expensive, and only supplies 3% of Indonesia's total needs. The most used cotton was at 300.000 tons/year (US$ 300M), but even though the demand for Polyester Fiber was lower (88.798 tons/year), the most expensive price was at US $ 133.197.000 per year. The output (product) from the Spinning Industry, an average of 75% was used to meet the domestic demand for the intermediate sector of TTPI, namely Weaving Industry, Knitting, and Non-woven. However, in the case of Cotton Yarn production, it was entirely used for domestic demand because of its high demand. The Spinning Industry was included as a capital-intensive industry, with full use of mechanization in the production process and its production was at a large scale. The Spinning Industry also provided high added value by producing yarn as the main raw material for producing textiles (Weaving Industry, Knitting, and Non-Woven). The Spinning Industry had a strong integration with the Fiber Making Industry as a production process unit. The Spinning Industry had advantages in terms of exports compared to the Fiber Industry with the second largest contributor after the garment product.

Figure 3: Supply chain Mapping in Spinning Industry in 2021

The main raw materials of the Spinning Industry were cotton (60%), of which 100% came from imported, while the cost structure of the Spinning Industry comprised 58,1% of the cotton raw materials and 18,5% of the energy. A potential substitution for cotton was rayon, of which the raw materials were widely available in Indonesia. However, the only obstacle was that rayon finishing technology was not available in Indonesia to make the quality of rayon equal to that of cotton. Actually, the finishing technology of this rayon was already available in various countries, and it could help Indonesia to adopt the aforementioned technology to produce a high-quality rayon, which was equal to cotton.

5. CONCLUSION AND FUTURE WORK

This research has succeeded in Mapping the Supply Chain of the Textile Industry Upstream Sector in Indonesia, from the Fiber Making Industry to the Spinning Industry. Mapping the Supply Chain of the Textile Industry has given a clear picture that these two industries have a strong integration as a unified and sustainable production process. The outputs of Fiber Making Industry were Polyester Fiber, Polyamide Fiber, Acrylic Fiber, and Rayon Fiber, which were used as the raw materials for the Spinning Industry to generate the output Spinning Industry. The outputs of the Spinning Industry were Polyester Yarn, Nylon Yarn, Acrylic Yarn, Rayon Yarn, Cotton Yarn, Teteron Rayon (T/R) Yarns, and Teteron Cotton (T/C) Yarns.

The number and the average costs of the domestic and imported raw materials used per year for the second year of the industry had been identified in the supply chain map. The findings indicated that Fiber Making Industry had a high dependency on the imported raw materials produced by the Petrokimia Industry. In addition, crude

oil and natural gas, which were the raw materials for the Petrokimia Industry, were all widely available in Indonesia. Therefore, the government should be able to develop Petrokimia Industry in Indonesia.

The results of the mapping further indicated that Spinning Industry provided a high added value because it produced yarn for textile production. This yarn could then be partly exported, and then it would generate the second highest foreign exchange after the garment products. The mapping results identified that the main raw materials for the Spinning Industry mostly were cotton (60%) of which 100% were imported. Cotton could be substituted by rayon, where the pulp as its raw material was widely available in Indonesia. However, it required a finishing technology for rayon, which was currently not available in Indonesia, to produce a rayon that has the equivalent quality to cotton.

This research could be further developed by Measuring the Supply Chain Performance in the Textile Industry Upstream Sector in Indonesia. The measurement indicator could be developed by adding green aspects of the supply chain, which has become an issue in Indonesia. The result of the study could be then used as a strategy to improve the competitiveness in the Textile Industry Upstream Sector in Indonesia.

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