



Value chain analysis for green productivity improvement in the natural rubber supply chain: a case study



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ABSTRACT

The main objective of this research was to map and to analyze green productivity of a natural rubber supply chain and formulate scenarios for increasing its green productivity level. The case studies were conducted in private enterprises engaged in natural rubber plantation and processing. Material flow analysis was performed using the green material flow map to analyze the seven sources of green wastes. The best strategy for green productivity improvement was determined by using the Analytic Hierarchy Process (AHP). The performance of green productivity improvement strategies was then assessed as future GPI (Green Productivity Index) and compared with current GPI. Results of this research have shown that the natural rubber cultivation combined with latex production improvement and waste minimization was the best green productivity improvement strategy. The best selected strategy for the production process was reusing the processing water.

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1. Introduction

Indonesia is the second largest natural rubber (NR) producer in the world with a production about 28% of the total production in 2010. However, rubber plantation productivity in Indonesia is lower compared to other major natural rubber producing countries such as Thailand and Malaysia.

Indonesia's natural rubber industries have three possible sources of raw material, namely smallholders, Government Owned Enterprises, and large scale private plantations (estates). They are characterized by their low productivity on both the upstream and downstream¹ sides. Indonesia natural rubber upstream productivity was 935 kg/hectare/year (Ministry of Agriculture, The Republic of Indonesia (2012)). This figure was lower than those of other natural rubber producing countries such as Thailand, Malaysia and India. In 2008, Thailand's natural rubber upstream productivity was 1698 kg/hectare/year, while Malaysia was 1430 kg/hectare/year and India was 1930 kg/hectare/year

(Damardjati and Jacob, 2009). Besides the low productivity of natural rubber upstream industry, the raw material supply for manufacturing industry was scarce due to the export of most of the NR.

Existing studies on natural rubber have focused on upstream practices rather than the natural rubber supply chain as a whole. Several studies on plantation practices have been conducted such as on the germination and seedling (Basyaruddin, 2009; Permadi and Ginting, 2009; Hickling et al., 2009; Sundiandi et al., 2009; Boerhendhy et al., 2009; Muluk, 2009), and land preparation (Nugroho and Istianto, 2009). Although several studies have been done on natural rubber production and rubber-related supply chains, such as rubber wood (Zachariah and Patrick, 2011), and environmental impact (Tekasakul and Tekasakul, 2006; Singh et al., 2011; Mohammadi et al., 2011), only few of them examined the integration of productivity and effects on the environment. Arifin (2005) identified the need for integration between productivity and environmental concerns by increasing production with the introduction of new varieties of rubber trees, combined with land use that meets the requirements of sustainable resource management and environmental quality. The Arifin study, however, did not address increasing productivity throughout the supply chain nor did it integrate productivity and environmental issues in a systemic and systematic fashion. Rao (2000) suggested that an approach towards an environmental initiative required a long-term vision of a sustainable world encompassing a three-stage strategic solution

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¹ The liquid latex tapped from trees is not a stable material and processing is required to change it to a form suitable for storage or shipment. The use of the term 'downstream' here refers to the processes used to convert the latex to a solid form as crumb rubber, ribbed sheet, or crepe rubber.

for the environment, namely (1) pollution prevention before pollution control, (2) product stewardship and (3) clean technology. A systemic approach is required in order to see the problem from both an economic and environmental viewpoint.

The concept used in this research was Green Productivity (GP), focused on the issues at hand. The Asian Productivity Organization (APO) in 2006 stated that GP focuses on the environment through a reduction in the rate of use of environmental resources while at the same time reducing the negative impact on the environment. GP also focuses on the economical reduction of material and energy costs used to create goods and services, thereby reducing the direct costs that ultimately have an impact on profitability.

This research has two purposes; (1) mapping and analyzing green productivity of the natural rubber supply chain, and (2) formulating scenarios to increase the productivity of the NR business based on a Green Productivity approach through case studies of large-scale plantations (estates).

2. Literature study

2.1. Indonesian natural rubber supply chain

Businesses in the natural rubber industry supply chain are very closely interlinked; therefore, a supply chain analysis has the potential to indicate methods of reducing the cost of NR as a commodity. Large estates are able to integrate all activities in the chain resulting in the ability to implement effective and efficient production, while small and medium estates need further improvement in order to integrate their upstream and downstream supply chain. Indonesia's NR industry produces commodities in the form of crumb rubber (Standard Indonesian Rubber), sheet (Ribbed Smoked² Sheet), concentrated latex³, and crepe. The need for integration between the downstream and upstream natural rubber businesses is important.

The price of natural rubber is caused by several factors such as the phenomenon of the business cycle and the effect of Cobweb⁴ theory on rubber commodity, the dynamic changes in fundamental factors and economic shocks/policies that affect the demand and supply of the world's natural rubber, and the emergence of non-physical market as hedging efforts of investors and speculators in the futures market exchange, especially in Singapore Commodity Exchange (SICOM), Shanghai Future Exchange (SHFE), Tokyo Commodity Exchange (TOCOM) and others. World rubber price volatility is often used by speculators to make a profit, but for rubber planters, this is often detrimental to farmers particularly when prices fall and only a momentary benefit in the event of price increases (Permadi, 2010).

The natural rubber supply chain in Indonesia consists of supplier, distributor, processor, and marketer. The suppliers are smallholder farmers, private and government estates, and natural rubber importers. The smallholder supply goes through various intermediaries, usually including village, district and provincial level collectors. The larger private and government estates establish their own internal distribution. Smallholders supply over 90% of the total natural rubber supply, and it is primarily in one of the solid forms. NR processed products consist of crumb rubber of

Indonesian Standard (SIR), Ribbed Smoked Sheet (RSS), Centrifuge Latex, Crepe rubber (Brown Crepe and White Crepe) and others. The natural rubber markets comprise national market and international markets. The national market consists of local brokers and traders that supply national downstream manufacturing. The international market, on the other hand, consists of overseas brokers that supply overseas manufacturers of rubber goods. The overall NR supply chain is exhibited in Fig. 1.

2.2. Green productivity

Green Productivity stems from the concept of "lean and green" concept, which is an integration of both lean and green thinking. Lean thinking was introduced in order to enhance productivity in terms of economy over the last several decades. Recently, environmental consciousness in industrial practices has received considerable attention. It has triggered the emergence of green thinking in the way firms operate in various industries. Lean and green thinking tries to minimize waste in terms of production and terms of the environment. Overlap between the two paradigms has been studied by Dues et al. (2012). The literature study concluded that the relationship between lean and green are very close. Based on the studies that have been done on companies implementing lean production system, it was found that lean could help create green supply chains. On the other hand, the application of green approaches in the production system can help production become lean.

One of several lean and green initiatives is 'Green Productivity' that was designed by The Asian Productivity Organization. It was created following the 1992 Rio Earth Summit as both concept and strategy integrating the lean and green initiative. The definition of Green Productivity as stated by the Asian Productivity Organization (2006) is:

"Green productivity (GP) is a strategy for enhancing productivity and environmental performance simultaneously to achieve overall socio-economic development. Its aim is well-rounded socio-economic development that leads to sustained improvement in the quality of human life. It is the combined application of appropriate productivity and environmental management tools, techniques and technologies that reduce the environmental impact of an organization's activities, products and services while enhancing profitability and competitive advantage".

Although there are very few research articles on Green Productivity, it is a growing topic in the field of lean and green. Several papers explicitly mentioned Green Productivity, namely Gandhi et al. (2006), Tuttle and Heap (2008), and Hur et al. (2004). Fliedner and Majeske (2010), although they did not explicitly mention the term Green Productivity, argued that lean and green concepts intercept and supported each other in order to enhance productivity.

2.3. Green Value Stream

Green Value Stream (GVS) map method was introduced by Wills (2009), which was known as the principle of green intentions with green value stream mapping, as a tool to map the seven waste generators that exist in value added systems. The GVS has its roots to the original value stream map that was first developed by operations management staff at Toyota Motor Corporation, Japan, in the late 1980s. It was originally used to identify ways to smooth the flow of material and information, improve productivity and competitiveness, and help implement the system rather.

² Concentrated latex is an alternate downstream NR form. It is normally processed, by centrifuging the liquid latex and adding an ammonia stabilizer.

³ Part of the process necessary to produce solid forms of NR is drying. Originally drying was aided by heat of the smoke from burning wood. The term 'smoked' comes from that history.

⁴ Cobweb model is based on a time lag between supply and demand decisions. Since there is lag between planting and harvesting in agricultural markets, the Cobweb model is said to be applicable in these market.

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