Eucalyptus plantation and its integrated supply chain in pulp and paper mill

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Abstract. Nowadays, demand of the pulp and paper production increases quickly. That increasing demand has led to demanding of eucalyptus plantation. That is why eucalyptus plantation has rapidly expanded and became the most planted tree species across the world over the last century. Not only because its unique characteristics, increasing of eucalyptus plantation also happened because its growing gives a socio-economic benefits, industrial benefits, and environmental impacts. However, increasing demand of eucalyptus certainly make availability of eucalyptus being determined, known as limited supply chain. Due to the increasing demand and limited supply chain, the eucalyptus wood supply should managed, by integrated the supply chain well. In this research study, the supply chain of eucalyptus wood for pulp and paper industry was diagnosed and divided into three degree, there are direct supply chain, extended supply chain, and ultimate supply chain. Four main stakeholders in this chain identified consisted of the eucalyptus seedling developers and sellers, the suppliers, the distribution centers, and the pulp and paper production plants.

1. Introduction
Pulp and paper mill is a great producer of paper and the other products, where all products are based on cellulose fiber [1]. Nowadays, it has used diversified types of raw materials, like agricultural leftovers, recycled paper and even there are the mill used non-wood raw materials in their production, such as bamboo, bagasse and oil palm bunches. However, the most essential raw material to produce many kinds of paper is generally wood [2].

As time goes by, demands of wood for industrial uses are increasing, not only in developed countries but also in the developing countries. It happened due to increasing populations. To take on that condition, people usually choose useful, fast-growing and adaptable to any soil conditions tree species to be planted [3]. That is why the increasing demand of the pulp production has led to demanding of eucalyptus woods.

Eucalyptus plantations are mainly destined for production a lot of products, especially for paper mill [4]. The main reason is that eucalyptus is a hardwood and fast-growing tree as a raw material [2]. Ferraz Filho et al. (2018) and Bayle (2019) revealed that compared to another tree species, eucalyptus is more adaptive and it might spring up well even planted on poor soil. Eucalyptus plantation grows faster (around 5-7 years), means that it classified to young plantation.

Increasing population and demand for fire wood, wood for constructions , and wood for pulp and paper production, the demand for eucalyptus had increased both within and surrounding communities.
Increasing importance of eucalyptus is manifested through its increasing price trend during the last 7 years. The price of Eucalyptus log has increased by 1500% and 400% during the last four years [5].

Regardless of its increasing price, it turns out that eucalyptus planting provides superior and useful benefits compared to other trees. It has been proven by Daba (2016), who says “Growing eucalyptus trees is becoming a great concern due to its socio-economic benefits and environmental impacts”[6]. Zerga and Woldetsadik (2016) also suggest “contribution of eucalyptus planting is very considerable. Compared to other income generations, it is time saving, less labor and capital intensive, more secure in terms of climatic change and more profitable than the other food crops” [7].

In summary, this research study is aimed to find out eucalyptus plantation, the availability and supply chain of eucalyptus in a pulp and paper mill and how its effects on socio-economic, industrial and environmental aspects.

2. Materials and Methods
The materials used for this research study are 2 books and 5 articles from diverse publisher and year. Some articles are from Ethiopia and Brazil. These materials are found by searching on Google Scholar with the keyword eucalyptus plantation, pulp and paper industry, eucalyptus supply chain, the benefits and impacts of eucalyptus plantation.

The method used for this research is analyzing some articles from previous research on eucalyptus plantation, pulp and paper industry, and overall about supply chain. The articles used for this research is analyzed thoroughly for the relevance of this research objectives.

The method for this research divided into five stages as follows:

2.1. Identification of Subjects
The first stage is to determine and identify what theme would be discussed. This research study will discuss plantation of eucalyptus and its supply chain for pulp and paper industry. The theme was chosen not only to see availability of eucalyptus plantation for pulp and paper industry but also to know how its socio-economic benefits, industrial benefits, and environmental impacts.

2.2. Collection of Research Articles
The second stage is to collect papers from diverse publisher. Collected papers are based on previously identified theme and taken from different year.

2.3. Filtering Articles by Subjects
The third stage is to select papers out of the collected papers. After reading the article abstract clearly, 2 books, and 5 articles are selected out of the 20 collected papers based on the relevance of the paper’s title and its abstract with this research objectives.

2.4. Analysis of The Selected Articles
One by one, the selected papers are then analyzed on the fourth stage based on the introduction, methods, results, discussions and conclusions.

2.5. Evaluation and Discussion
All papers from the fourth stage are evaluated based on the conclusions of each research and discussed as a reference in answering these research objectives.

3. Results and Discussion
Eucalyptus comes from two words, “Eu” and “Kalypta”. Eu means “Well” and Kalypta means “Cover”, if the two words are combined, the basic meaning of eucalyptus is “well cover”. Eucalyptus is a native plant from Australia and Tasmania, but eucalyptus has been widely spread in several countries, even in small countries such as New Guinea and Philippines since 1955 [3].
Eucalyptus plantation started by Lutheran Federation through its food for work program, followed by Farm Africa, which promoted Eucalyptus plantation in the Anget Mewgia PA. Currently, eucalyptus planting has reached more than 20 million hectares with the largest distribution of about 50% are located in India, Brazil and China. In 2010, the fact reveals that from 100% eucalyptus wood harvested, 45% used for cellulose and paper industry, and another 55% went to industrial firewood, charcoal, and solid wood products.

Eucalyptus plantations are mainly destined as a raw materials for pulping because the genus eucalyptuses of many species are fast growing even on very low nutrient sites, high yielding per unit area and year, short rotation, desiccation-tolerant, drought-tolerant, unpalatability of its leaves, and its adaptability to a wide range of site condition, coppicing, produce large quantities of wood in a given area, versatile uses and high economic benefits [5].

Generally, supply chain of eucalyptus for pulp and paper production starts in the forest, known as harvest area. The yields of harvest area is logs and they will be collected in log terminals. The logs then brought to pulp mill where the pulping process is carried out. Pulping is a systematic method for removing bonds of the lignin component so that the fiber is separated from the lignin. Result of the pulping is pulp, to be processed be a paper rolls there. Paper rolls then converted to paper rolls and sheets and will be saved in warehouse. The production then linked to merchants or retailers as distributor of paper rolls and sheets in the market for pulp and paper products [1].

Due to the limited supply chain of pulp and paper industry, the eucalyptus wood supply should be well managed to meet the demand and gain more efficiency. So, what ought the mill to do to overcome that problem? Yes, the best handling is by integrated the supply chain well. Based on the explanation above, these are three degrees of integrated supply chain [2]:

3.1. Direct Supply Chain
According to the name, direct supply chain involves company, supplier, and customer directly in every flows of products, services, finances, and information.

3.2. Extended Supply Chain
Different with direct supply chain, an extended supply chain only involves immediate supplier and immediate customer in each flows.

3.3. Ultimate Supply Chain
In this degree, all the partiers (both organizations and individuals) are directly involved in all the flows without exception.

According to this research study, the supply chain of eucalyptus wood for pulp and paper industry had four main stakeholders. There are as follows:

1. Eucalyptus Seedling Developer and Seller
   The main function of this part is researching and selecting suitable species of eucalyptus in each area and seedling for sale for the supplier.

2. Supplier
   The main duties consisted of preparing the area before plantation, planting the eucalyptus trees, maintains and fertilizing the eucalyptus tree, and harvesting the eucalyptus.

3. Distribution Center
   In this stage, their responsibility was bought and quality checked eucalyptus woods from the supplier before delivery to the pulp and paper production plant.

4. Pulp and Paper Production Plants
   Production plant uses eucalyptus woods as raw material that they chopped the wood into the specific pieces and uses it to produce the chemical pulp to serve paper production.
From studied deeply in process in four main stakeholders of this supply chain, 7 risks were identified as high risks in this supply chain. Those included: eucalyptus trees are cut too early, farmers’ lack of understanding about how to grow eucalyptus properly, stem size is too small, eucalyptus wood price is highly fluctuated in the market, stock quantity is too low, contaminated soil, and lack of knowledge about quality control.

Eucalyptus planting has numerous required socio-economic benefits including employment, security and financial benefit [6]. Eucalyptus plantation has played an important role in improving the community livelihoods, and reducing poverty. In native place of eucalyptus, about 72% of the community's cash income comes from eucalyptus and widely used to purchase food, and other household needs.

The other benefits of Eucalyptus plantation can be seen from industrial aspect. There are four benefits in industrial aspect, as follows:

1. Eucalyptus plantations create employment and wealth.
2. Eucalyptus is profitable and sustainable, therefore eucalyptus plantation for industrial application increases quickly.
3. Eucalyptus is a renewable natural resource which is most appropriate for pulping.
4. Eucalyptus is also used for several industrial needs, such as essential oil and eucalyptus oil manufacture.

Environmental impacts of eucalyptus plantation, divided into two effects, there are:

1. Positive effect
   Eucalyptus planting is the best choices in providing biomass needs because it is fast-growing tree species and classified to young plantation (5-7 years) based on its short-term period.
2. Negative effect
   Eucalyptus cultivation requires a large area of land along with pulp and paper production, which can lead to land scarcity.

4. Conclusion
Eucalyptus has rapidly expanded and became the most planted tree species over the last century. Currently, eucalyptus plantations are developed worldwide because its unique characteristics. Those unique characteristics are fast growing even on very low nutrient sites, high yielding per unit area and year, short rotation, desiccation-tolerant, drought-tolerant, unpalatability of its leaves, and its adaptability to a wide range of site condition, coppicing, produce large quantities of wood in a given area and eucalyptus plantation also gives a socio-economic benefits, industrial benefits, and environmental impacts.

In this research study, three degrees of integrated supply chain have been identified, videlicet direct supply chain, extended supply chain, and ultimate supply chain. The three degrees using eucalyptus wood as the main raw material and had four main stakeholders. Those have consisted of the eucalyptus seedling developer and seller, the supplier, the distribution center, pulp and paper production plants.

Therefore, in order to avoid or minimize “Eucalyptus Limited Supply Chain”, the pulp and paper mill must understand and apply the integrated supply chain in each production. Hopefully, this method can keep the availability of eucalyptus well, and some risks of supply chain, like eucalyptus trees are cut too early, farmers’ lack of understanding about how to grow eucalyptus properly, stem size is too small, eucalyptus wood price is highly fluctuated in the market, stock quantity is too low, contaminated soil, and lack of knowledge about quality control can be solved too.

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