Dynamic Model for Analyzing Trade off between Furniture and Crude Palm Oil Industry to Build a Sustainable Supply Chain

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Furniture industry uses forest products as raw material, such as many kind of woods, rattans, and the others. Normally, after cutting down the trees, people have to re-planting balance number with how many trees they cut. But most of people just take everything from forest without responsible with sustainability of the forest. In other hand, crude palm oil (CPO) industry creates large palm plantation. In some cases, enlargement those palm plantation areas has taken forest area, which should not use for those purposes. Both CPO industry and furniture industry need to be supported so that they can compete in global market and can contribute for Indonesian economics. The developing of both industries should be balance and should consider trade off among them so both of them can stand longer.

In this research, we propose a dynamic model and simulate the model for showing interaction between Indonesian furniture industry and CPO industry in exploiting forest resources so we can predict how are the forest condition in the future and both industries will be. The results can be used as the suggestion to create a sustainable supply chain of furniture and CPO industry and to save Indonesia forest from the extinction.

Keywords: Dynamic models, forest sustainability, supply chain.
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ABSTRACT

Furniture industry uses forest products as raw material, such as many kind of woods, rattans, and the others. Normally, after cutting down the trees, people have to replanting balance number with how many trees they cut. But most of people just take everything from forest without responsible with sustainability of the forest. In other hand, crude palm oil (CPO) industry creates large palm plantation. In some cases, enlargement those palm plantation areas has taken forest area, which should not use for those purposes. Both CPO industry and furniture industry need to be supported in order they can compete in global market and can contribute for Indonesian economics. The developing of both industries should be balance and should consider trade off among them so both of them can stand longer.

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1. INTRODUCTION

Manufacture industries have very big contribution for the economics of Indonesia. Two of those industries are crude palm oil (CPO) and furniture industry. The CPO industry of Indonesia is the biggest one in the world nowadays, and the furniture industry of Indonesia is the 12\textsuperscript{th} in world [1]. Their growth is supported by our wealth in natural resources that provide the production factor for them, forest provides woods and the other raw materials for furniture product, and palm plantation provides all of CPO industries need.

According to Directorate General of Estate Crops, Ministry of Agriculture Republic of Indonesia 2008 [2], CPO industry is the industry that provides strategic commodity like substance of food (cooking oil) and other export commodities as Indonesian pre-eminent product. CPO is also used as an alternative biofuel (biodiesel). The data shown that amount of CPO production in Indonesia increase from 1990’s until 2000’s. From the CPO production, 75\% is for export and 25\% is for domestic consumption. In the other hand, domestic need is very high and stock less have been occurred so that government has to make regulation like to increase export tax.

Palm oil is the most traded vegetable oil in the world, capturing 40\% of global trade [2]. Palm oil, majority (more than 84\%), is produced in Southeast Asia. Indonesia provide almost 30\% world production. Indonesia export most of CPO production, 60\% of the annual CPO production.

Indonesia also become the 12\textsuperscript{th} biggest one of country which exports furniture product in the world. The exports furniture products of Indonesia are dominated by furniture products from forest woods. Although Indonesia also produces furniture from various raw materials like cane, iron, and plastic but the portion of production and export wood furniture are 75\% and the portion of cane furniture are 20\%. Furniture industries give currency contribution up to 1.64\% [4].

Furniture industries and generally called woods industry are one of pre-eminent industry in Indonesia but its developing were decrease in the view years. The data from BPS shows that in the last three years Indonesian woods product had
negative growth. In 2004, this industry growth -2.1 %, in 2005 growth -1.3 % and -5.8 % at first four month in 2006. Export furniture product of Indonesia up to 1.79 milliard dollar US or growth rate up to 0.088 milliard dollar US per year in the last eight years. In the same period, export furniture product of china growth rate up to 1.1 milliard dollar US. China, which was prohibit cutting down the wood, could export furniture product up to 14 milliard dollar US in 2005.

The decreasing number of furniture production, especially, is affected by the decreasing of wood availability as the raw material because of the destruction of Indonesian forest and the world economic condition. The destruction of forest due to various activities, one of them which becoming attention of the world is opening palm plantation. Production of CPO in Indonesia is increase in the view years and its balance with increasing width of palm plantation. The negative impact to the environment becoming serious because in the practice of developing palm plantation isn’t just at conversion forest area but also at production forest area, protected forest and even at conversion area which has unique ecosystem and high involve variety.

The management of both strategic industries carried out by partial system where each sector competing to use natural resource that is on the diminishing. The development of CPO industry seem so fast supported by increasing of palm plantation but furniture industry seem decreasing because of decreasing of forest affected by increasing of palm plantation.

![Figure 1. Width development of each kind of palm plantation](attachment:image1.png)

The goal of this research is to know about the tradeoff between furniture industry and CPO industry in usage of the forest area as the resource of their raw material. Relation of both industries can be analyzed with system analysis and simulate the dynamic system. To determine the right strategy to developing furniture industry and CPO industry we use SWOT analysis consider to behavior of system (the result of simulation system).

2. Supply Chain Model of CPO and Furniture Industry


1. Supplier of palm consist of 2,565,000 ha people palm plantation, at least 38.7% of national palm plantation, 687,000 ha government plantation, at least 10.3% of national palm plantation, and 3,358,000 ha private palm plantation, at least 50.7% of national palm plantation.

![Figure 2. Width development of each kind of palm plantation and total national palm plantation width](attachment:image2.png)

CPO producer is companies those are produce CPO from palm plantation. CPO producer consist of government, People Company, and private company. The number of Indonesian CPO production until 2008 is 15.120.644 tones. Government company produced 13.6%, private company produced 47.5%, and people company produced 38.8% of total national product.

2. Consumers of CPO are industries which are process CPO become the next product. Consumers are divided as two.

   a. Domestic industries which consume CPO as raw material for their products like cooking oil industry, bioenergy industry, food and beverage industry, cosmetic industry. According to the data from Directorate General of Estate Crops, Ministry of Agriculture Republic of Indonesia shown produce of CPO in 2008 up to 15.120.644 tones & allocated for domestic consume in 2008 just 40 % or 6048257.6 tones [2]. Produce of CPO in Indonesia shown by figure 3.

   b. Foreign industry

The export of CPO progressively mounts either volume or value of export. In 1980, volume of export just 350000 ton or US$240 million & increase up to 9.6 million ton or US$ 3.9 billion in 2004. Five countries to be market country for Indonesian CPO are India, China, Nederland and Singapore. Now days, export of CPO Indonesia up to 60 % from the produce or 9072386.4 tons in 2008.

1. Furniture industries need forest woods to fulfill raw material to produce furniture product. Consume of forest wood in furniture industries up to 7 – 7.5 million m3 per years. But, in the couple of years, the woods for fulfill the raw material of furniture industry were import from another country and the import was increase year by year. The type of the forest woods that used as raw material in furniture industry is log that got from natural forest, conversion forest, industrial forest plantation, etc.

2. The forest woods then used to produce furniture product at center of furniture industry and craft industry in Java Island, Sumatra Island, Kalimantan Island and Sulawesi Island. The forest wood isn’t not just used as raw material in furniture industry but also used by ply wood industry, pulp industry, and other industry, so that the competitive was happen indirectly to get the woods. Now days, in Indonesia, there are 950 units of furniture industry with consume 3.41 million m3 woods per year.

3. Most of the Indonesian furniture products are exported and the others are sold in domestic markets. For the domestic consumption, beside from domestic products, consumer also can get imported furniture. The average of the export of furniture products in the last 3 years is 1,465,980 m3, and for domestic markets, including imported furniture, the consumption amount is 31,939 m3 annually.

Besides those elements identified above, both industry have close interaction with environment. Environmental aspect especially Indonesian forest is a subsystem in supply chain of furniture industry but indirectly with CPO industry related about palm plantation.

Government as a regulator and policy maker is one of subsystem which has important role to keep stability of domestic supply and export. The government role is also important in managing the natural resources exploitation and the development of industries.

The relation between CPO and furniture supply chain is in using land resources. Forest and palm plantation, which are resources for both industries, need width land area. Forest width today is about 133.57 million ha, 59.1 million of which are in critical condition. Palm plantation width in 2008 is 6.61 million ha. That is bigger enough then palm plantation width in 1967, which are 105,808 ha only. CPO need of palm from plantation increase while the demand for keeping forest sustainability become louder.

We have to remember that land area is limited resources, and is used to fulfill many needs, settlement, agriculture, forest, plantation, and so on. However, it is impossible to overcome all the need of land. There must be some tradeoff among them.

Widodo et al (2009) [7] explained that developing industry, especially agroindustry and forestry industry, do not just concern about concern about how to get the biggest profit. The developing industry should concern about social and environment aspect too. Ortiz et al (2008) [8] sustainable development as the increasing of life quality in order human being could live in the healthy environment and improve the social, economics, and environment circumstances for now and next generation. Those points of view are important in order aid to develop sustainable industry. Without sustainability, industry will not get bigger potential profit and development.

3. DISCUSSION

This research uses data from many legal sources to help us in construct the model. The model of supply chain in CPO and furniture industries developed can be a base to construct the model. The model that construct in this research explain about related between forest, industrial forest and palm plantation to see the opportunity and tread in industry, social, and environment.

Issues about forest become important see at condition of nature that is progressively destruct. Besides delivering many disasters, the loss of various natural resources degrades the natural ability to support society economic activity. Discussion about palm plantation and its influence to forest existence has also progressively been done, as the response to the actual condition, which indicates the role of plantation in damaging of Indonesia forest.

Forest is important component in our life. It is not only as resource and employment opportunities provider, but also as the guard of the condition of environment. Forest Indonesia is known as the third widest forest in the world and the one the forest having most various biodiversity. Since Indonesia forest condition progressively decreases, attention of which also becomes greater.

Deforestation becomes the main threat for Indonesian forest. The deforestation number of Indonesian forest is bigger than the efforts to recovery the lost forest by reforestation, regreening, and the other similar activities. As actual circumstances today, it can be predicted that the Indonesian forest width in the future will decrease continuously and even will be extinct if there is no effort to prevent that.

There are many factors those are contributing in deforestation. In the negative meaning of deforestation, illegal logging is the most significant factor, it is exactly understood. The others are related with industrial activities. They are extension of palm plantation and industrial forest.
Figure 4. Simulation model of CPO and Furniture Industry
plantation. They always take the forest area as extension of their land with illegal way. The model that we construct can be used to prediction the impact of extension of industrial forest plantation and palm plantation to Indonesian forest.

3.1 Simulation Results

In the simulation, we map interaction among supply chain elements of both industries. Actually, both of industries do not have relation directly, because they produce different product from different raw material. But, indirectly, they have relation (or specifically tradeoff) in using land, furniture industry need land as the forest that support its raw material, CPO industry need land for developing palm plantation.

![Figure 5. The simulation result of natural forest width development](image)

The existence and the condition of Indonesian forest will be having an effect on many pre-eminent industries. Indonesian forest is being prop for many vital industries such as furniture industry. The supply of log from the forest is important raw material for furniture industry. Those raw materials are come from production forest from the company which has legal permission from government to cut down the trees. Beside from natural production forest, the supply of log also comes from industrial forest plantation up to 32% of produce of industrial forest plantation allocated for furniture industry and 68% allocated for pulp industry. However, amount of log that produce by industrial forest plantation are still small compared to produce by natural production forest.

The degradation of natural production forest having an effect on less supply of wood for many industries which consume log as their raw material because until now, natural production forest still being especial source for furniture industry and other industry so that if it degradation so the supply of wood can be decrease. Figure 5 shown that the supply of wood for industries are decrease in the years and can be 0 in the next 20 years. From the simulation result known that supply availability of wood for furniture industry is decrease with assumption the requirement of wood for furniture industry and other industries that consume the wood are constant.

There is the thing that has to consider, it is the fact about almost of two last decades the width of natural forest concessionaires was decrease from 60.48 million ha in 1991 to 28.27 in 2007. In the other hand, industrial production forest is increase and shown by exponential pattern and if now the width of industrial production forest is 9.88 million ha so in the next 20 years it will be 57.22 million ha.

Figure 6 shows that how the growth of natural forest concessionaires and industrial production forest in the next 20 years. Figure 6 shows that width of natural forest concessionaires will be disappear in the next 15 years but industrial production forest will be progressively mount. According to that analysis, the furniture will support by industrial production forest and not by natural forest concessionaires anymore.

The existence of industrial production forest initially is to keep the forest well but in the fact the manage of industrial production forest is bad than natural forest. Even, majority of industrial production forest is mastered by small group of investor, as a affects, the manage of industrial production forest just for little interest of people without looking back to the function of industrial production forest for help the sustainable of the industries.

Industrial forest plantation managing is very bad. From the all capacity of land area, there are only 23.6% planted with productive plant, the others are unplanted and become critical land areas, which is potential in creating natural disasters. The owners of industrial forest plantation more prefer to cut down the trees that have been growth in the area than must plant from the beginning. Even though, if industrial forest plantation was managed properly, the purpose of creating industrial forest plantation could be obtained as the supplier of industrial raw material need and forest existence protection.

![Figure 6. The simulation result of natural forest concessionaires width and industrial forest plantation width development](image)

The competition in getting land area for each purpose happen in furniture and CPO industries development. Furniture industry requires raw material availability by keeping the existence of natural production forest. In other hand, CPO industry increasing production capacity by creating new palm plantation, which mostly also takes forest area. According to the simulation results, while the natural forest width decreases, the palm plantation and industrial forest plantation width increases. The development of CPO industry and market attract CPO industry stakeholders increase their production capacity.
Even though, the development pattern adopted by mostly Indonesian palm plantation is extension, different with in Malaysian palm plantation, which increase production capacity by intensification. By the kind of Indonesian development pattern, bigger production capacity increasing wanted will require wider land area needed to open new palm plantation.

Extension is more preferred in developing production of CPO industry because it is the simplest and most profitable than intensification. By intensification, it needs to invest more for the technology. Extension is also supported by the availability of land area and government policies. It is the main cause of the increasing of palm plantation and deforestation number.

The most significant development of palm plantation happen at people plantation and private plantation, much faster than state plantation. In the fact, private plantation, with the big fund of owner of the company, they can get license for open new plantation and invest for managing those plantation easily. Even though, majority of private palm plantation become focus of attention because they do not have environment wisdom in developing and managing palm plantation.

Simulation result for the next 20 years shows palm plantation width continuously develop, contrary with natural forest development. We guess, there is close relationship between the decreasing number of natural forest width with the increasing number of palm plantation and industrial forest plantation width.

In this research, we have statistics test to simulation result in order to know how far the relation between natural forest, palm plantation, and industrial forest plantation width. The test uses linier regression analysis. In this analysis, natural forest width becomes the dependent variable, which depends on two independent variable, palm plantation and industrial forest plantation width. The test is done to know the influence of both palm plantation and industrial forest plantation width together to natural forest width.

3.2 Trade off Between CPO and Furniture Industries

Relation between forest width, palm plantation width, and industrial forest plantation development shown from simulation result above shows tradeoff exactly occurred among them. The most reasonable way done to increase CPO production is by enlarging the palm plantation width. In other hand, the extension of palm plantation width in order to increase CPO production without considering the forest condition will threaten Indonesian forest sustainability. The next effect because of which is the uncertainty of raw material (woods) availability for forest product industry. The decreasing number of wood supply will disturb the performance stability of furniture industry.

The simulation results, statistically, shows that the natural production forest development is contrary with the progress of either palm plantation width or industrial forest plantation. So, we can guess that if width of palm plantation and industrial forest plantation increases continuously, as shown by the simulation, the natural forest width must will decreases. As the decreasing of natural forest width, the ability of forest to supply wood for many industries decreases. In other hand, as the increasing of palm plantation width, the supply of palm as the CPO raw material will increase too.
The increasing of CPO supply as the development of palm plantation while the decreasing of forest ability in supplying wood for industries as the high rate of deforestation shows the trade off among those strategic industries. Improving only on one side of those two industries maybe will worsen another. Balance development important to assure the sustainable development of both industries.

Actually, government can make changes in forest development and management strategy. Now, furniture industry very depends on natural forest in gaining raw materials. Industrial forest plantation can replaces the role of natural forest in supplying furniture industry, because the development of industrial forest plantation has big potential resources. But, it requires improving the management and development pattern of industrial forest plantation. It should improve effectiveness of land usage and plantation productivity.

Kishor and Belle (2004) [8] explained that income, statistically, significant and negative impact on deforestation, i.e., rising incomes are likely to reduce the rate of deforestation. The governance measures have a statistically significant and quantitatively large impact in increasing incomes—i.e. improving governance may act as a catalyst to increasing incomes. Together, improving governance may have an indirect but strong impact on curbing deforestation. So, the development of both industries in the future depends on government.

4. CONCLUSION

The results of this research show the interaction between Indonesian furniture industry and CPO industry in exploiting forest resources. According to the result of simulation that supply of wood for industries are decrease in the years and can be lose in the next 20 years and natural forest width can be explained 100% by palm plantation and industrial forest plantation width. According to the simulation result for the next 20 years shows palm plantation and industrial forest plantation width continuously develop, linear contrary with natural production forest width development.

The next research can be done for more detail explain about the development of both industry and the destiny of Indonesian forest. The next research can explore the other factor threatening forest sustainability and analyze the potential strategy for developing both industries.

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