STRATEGIC POLICY MODEL FOR MANAGEMENT OF PLYWOOD INDUSTRY USING SYSTEM DYNAMIC METHODS

Heru Kreshna Reza\textsuperscript{A}, Kazan Gunawan\textsuperscript{B}, Sukmo Hadi Nugroho\textsuperscript{C}

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### ABSTRACT

**Purpose:** This study aims to obtain a strategic model for the arrangement of the Indonesian plywood industry after the monetary crisis with high uncertainty.

**Theoretical framework:** This study discusses several theoretical frameworks which include Strategic Policy, Plywood Industry, and System Dynamic Modeling.

**Design/methodology/approach:** This study was conducted covering the stages of collecting data and information, as well as the stages of Dynamic System Modeling.

**Findings:** The result of the study is the preparation of dynamic systems through formulation into dynamic sub-models, namely: plywood industrial production, sawn timber industry, chip mill industrial production, log raw material production for the wood industry, log economic contribution to the center and the region, illegal export logs, domestic and exports of the wood industry as well as financial feasibility of the plywood industry.

**Research, Practical & Social implications:** The results of the study are useful for decision makers in Plywood Industry Management on work culture of Indonesia fabricaton because they show that the proposed practices have an important impact on organizational company excellence.

**Originality/value:** The policies carried out in the plywood industry structuring strategy include a national plywood production limitation policy, a national sawn wood production limitation policy, and a cutting restriction policy in the form of the Annual Allowable Cutting in various combinations which are outlined in eight main policies scenarios and translated into 28 scenarios.

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MODELO DE POLÍTICA ESTRATÉGICA DE GESTÃO DA INDÚSTRIA DE COMPENSADOS UTILIZANDO MÉTODOS DE SISTEMA DINÂMICO

**RESUMO**

**Objetivo:** Este estudo visa obter um modelo estratégico para o arranjo da indústria de compensados da Indonésia após a crise monetária com alta incerteza.

**Referencial teórico:** Este estudo discute vários referenciais teóricos que incluem Política Estratégica, Indústria de Compensados e Modelagem Dinâmica de Sistemas.

**Desenho/metodologia/abordagem:** Este estudo foi realizado abrangendo as etapas de coleta de dados e informações, bem como as etapas de Modelagem Dinâmica de Sistemas.

**Resultados:** O resultado do estudo é a preparação de sistemas dinâmicos por meio da formulação em submodelos dinâmicos, a saber: produção industrial de compensados, indústria de madeira serrada, produção industrial de

\textsuperscript{A} Doctor. Esa Unggul University, Jakarta, Indonesia. E-mail: heru.kreshna@esaunggul.ac.id

Orcid: https://orcid.org/0000-0002-7797-5442

\textsuperscript{B} Professor. Esa Unggul University, Jakarta, Indonesia. E-mail: kazan.gunawan@esaunggul.ac.id

Orcid: https://orcid.org/0000-0002-4124-9334

\textsuperscript{C} Doctor. Esa Unggul University, Jakarta, Indonesia. E-mail: sukmo.hadi@esaunggul.ac.id

Orcid: https://orcid.org/0000-0003-4055-0173
lascas, produção de toras de matéria-prima para a indústria madeireira, contribuição econômica de toras para o centro e região, exportação ilegal de toras, nacionais e exportações da indústria madeireira, bem como viabilidade financeira da indústria de compensados.

Implicações de pesquisa, práticas e sociais: Os resultados do estudo são úteis para os tomadores de decisão na gestão da indústria de compensados na cultura de trabalho da fabricação da Indonésia porque mostram que as práticas propostas têm um impacto importante na excelência organizacional da empresa.

Originalidade/valor: As políticas implementadas na estratégia de estruturação da indústria de compensados incluem uma política nacional de limitação da produção de compensados, uma política nacional de limitação da produção de madeira serrada e uma política de restrição de corte na forma de Corte Anual Permitido em diversas combinações que estão descritas nos oito cenários de políticas principais e traduzidos em 28 cenários.


MODELO DE POLÍTICA ESTRATÉGICA PARA LA GESTIÓN DE LA INDUSTRIA DE PLYWARDS UTILIZANDO MÉTODOS DE SISTEMAS DINÁMICOS

RESUMEN

Propósito: Este estudio tiene como objetivo obtener un modelo estratégico para el arreglo de la industria de madera contrachapada de Indonesia después de la crisis monetaria con alta incertidumbre. Marco teórico: este estudio analiza varios marcos teóricos que incluyen la política estratégica, la industria de la madera contrachapada y el modelado de sistemas dinámicos. Diseño/metodología/aproximación: Este estudio se realizó abarcando las etapas de recolección de datos e información, así como las etapas de Modelado Dinámico de Sistemas. Resultados: El resultado del estudio es la elaboración de sistemas dinámicos a través de la formulación en submodelos dinámicos, a saber: producción industrial de madera contrachapada, industria de la madera aserrada, producción industrial de astillas, producción de troncos como materia prima para la industria maderera, aporte económico de los troncos al centro y región, exportación ilegal de troncos, exportaciones de la industria maderera y nacional, así como viabilidad financiera de la industria del contrachapado. Implicaciones sociales, prácticas y de investigación: Los resultados del estudio son útiles para los responsables de la toma de decisiones en la gestión de la industria de la madera contrachapada en la cultura laboral de fabricación de Indonesia porque muestran que las prácticas propuestas tienen un impacto importante en la excelencia organizativa de la empresa. Originalidad/Valor: Las políticas implementadas en la estrategia de estructuración de la industria de la madera contrachapada incluyen una política nacional que limita la producción de madera contrachapada, una política nacional que limita la producción de madera aserrada y una política de restricción de corte en forma de Corte Anual Permitido en varias combinaciones que se describen en las ocho políticas principales. escenarios y traducido a 28 escenarios.

Palabras clave: Política Estratégica, Industria de Madera Contrachapada, Modelo de Sistemas Dinámicos.

INTRODUCTION

The role of agro-industry is very vital for the Indonesian people, because it contributed US$ 47.757 million from non-oil and gas foreign exchange in 2000 (BPS 2001), while the forestry sector agro-industry in 2000 contributed US$ 1.814 (Ministry of Forestry 1999/2000). The above conditions illustrate that agro-industry can function as a means to realize prosperity because it can provide added value through technology transfer. The definition of agroindustry according to Austin (1992), is a company that manages materials derived from plants or animals, while the processing includes transformation and preservation through physical or chemical changes, storage, packaging, and distribution. Agro-industrial projects are unique
because they have three characteristics in their raw materials, namely seasonality, perishability, and variability. Meanwhile, according to Astika et al (2020), agroindustry is a business that processes raw materials for agricultural products into various products that consumers need.

The agro-industry development strategy which is part of plantation and forestry economic development is directed not only at economic growth, both at the national and regional levels, but must also move towards (1) increasing the capacity of communities and community institutions involved in forestry development and plantations, (2) empowerment of each component involved in the development process of the forestry and plantation sectors, (3) improvement of the efficiency of resource use, (4) distribution of productive assets and sustainable yields that are resistant to external influences. The development of forestry and plantation-based agro-industry is also related to the role of the government as a bureaucratic apparatus, facilitator, and regulator (Astegiano et al, 2019). This function cannot be privatized like physical development work, so there needs to be a renewal in the way of working, ethics, and work spirit of government officials. On the other hand, the government's reference in determining the direction of operational policies by emphasizing the improvement of the non-oil and gas sector through competitive advantages, especially those based on natural resources (including forest resources) is expected to further spur an increase in natural forest destruction (Sukhawatthanakun et al, 2023).

There are three main sources of agro-industry products that have the potential to be developed, namely (1) plantation, (2) forestry, and (3) fishery products. Specifically regarding the forestry sector, according to BPS data (2001), the sustainable potential is 26 million m3 per year or about US$ 5 billion (calculated from the log price of $150 per m3). If you include illegal logging, then the foreign exchange value of the forest reaches around $12 billion. If the wood is processed into other products in the form of plywood and pulp, the potential for foreign exchange earnings can increase to 16 billion per year (Bandono et al, 2019).

In 1993 the government issued a policy requiring share ownership between HPH holders and the plywood industry to ensure the distribution of logs from HPHs to industry. The above policy was motivated to create vertical integration of HPH and plywood and also had an impact on encouraging the timber industry to thrive and causing industrial capacity to exceed the supply capacity of logs from natural forests m3/year. The need for raw materials to meet the needs of the timber industry is 63.48 million m3, while the availability of raw material supply (log) is 23.36 million m3 (Herdiawan & Ahmadi, 2019), resulting in a gap between supply and demand of 40.12 million m3.
According to the Indonesian Wood Panel Association (Apkindo, 2003) of 128 plywood industries, currently, 69 industries are under the control of IBRA (Herdiawan & Ahmadi, 2019). This can be seen in 2000, the plywood industry has exported 4,630,846 m³ with a foreign exchange contribution of US$ 1,697,072,917. The number of exports in 2000 was the smallest amount in the last five years. The above conditions are indicators of problems and prospects being faced by the plywood industry. The current performance of the Indonesian plywood industry is due to several things, such as 1) the supply of raw materials that the production of official logs from HPHs and other sources has decreased to an irrational limit to say that the industry is financially and legally sound 2) industrial efficiency and 3) financial health, that 59% of the financial health of the plywood industry has been controlled by IBRA.

According to Homer & Oliva (2001), this occurs due to 1) unbalanced supply of raw materials with the need for raw materials for industry, 2) pressure from several parties regarding the need for industrial restructuring, 3) illegal logging, 4) low efficiency in the use of raw materials, 5) security and business uncertainty, 6) volatility of the rupiah exchange rate against the dollar. Apart from the problems above, there are also several other things (Hitt et al, 1998), as follows:

a. Japan as one of the plywood export destinations applies discriminatory regulations against Indonesian products by imposing high tariffs.

b. Indonesia is related to the provisions of the International Tropical Timber Organization which enforces ecolabel provisions for tropical forest products, while in reality there are very few forest entrepreneurs who have obtained certification.

c. The existence of regional economic cooperation, such as APEC and AFTA.

The above conditions illustrate a negative change that impacts the increasingly difficult development of the forestry sector industry, especially the plywood industry, on the other hand, the government is determined to continue forest exploitation because it is a source of economic growth and non-oil and gas exports. The description above is an indicator for reviewing the integrated development strategy of the Indonesian plywood industry in the form of structuring the plywood industry with dynamic system modeling. According to Kiani & Pourfakhraei (2010), the scope of industrial structuring as contained in the priority commitments of the Consultative Government on Indonesia (CGI), namely 1) evaluating the capacity and restructuring of the timber industry, 2) closing the timber industry which has large forests and is under the supervision of the Bank Restructuring Agency National (IBRA). Meanwhile, according to Coyle & Exelby (2000) the scope of industrial structuring termed as restructuring...
policy is 1) shrinking (capacity, production, input of raw materials) forestry industry, 2) restructuring (changing structure) forestry industry, 3) closing debt-laden forestry industries, 4) Linking debt write-off proposals with capacity reductions. Meanwhile, dynamic systems are used because they can simplify complexity without losing the essence or main element of the object of concern. The purpose of this study is to obtain a strategic model for the arrangement of the Indonesian plywood industry after the monetary crisis with high uncertainty.

**MATERIALS AND METHODS**

**Strategic Management**

The company is an organization that is always faced with challenges that come from two sources, namely limited resources and future uncertainty. The strategic issue for the management who is responsible for managing the above organization is to find a way to put the company in the best position and be ready and capable, both to save themselves and to develop the company in question. Strategy can be seen as a guide which is basically in the form of a general plan as a plan, the strategy outlines the direction of goals, programs, and priority patterns of resource allocation. Strategic management is a set of managerial decisions and actions that determine the long-term performance of a company (Coyle, 2000).

**Soft Systems Methodology**

In principle, Soft Systems Methodology (SSM) is developed in the context of irregular problems, which do not have a clear view of the scope of the problem, or it is not clear what actions should be taken to solve the difficult problems encountered (Checkland & Scholes, 1990). The focus of SSM is “what to do?” SSM describes and presents multiple perspectives as part of the decision-making process.

The SSM process can be distinguished into two types of thinking, namely 1) abstract and ideal systems thinking, and 2) context-specific, real-world thinking. SSM consists of seven stages of the investigation process. In practice, SSM cannot be set at the beginning and end, but theoretically, it can be started from the first stage. The actual "problem-solving" activity in SSM can run flexibly between stages as shown in Figure 1 below.
System Definition

The system according to Bandono et al (2019), the system is a unit consisting of parts that are related to each other trying to achieve a goal in a complex environment. This understanding shows that a system is a group of elements that interact with each other regularly to achieve goals or sub-goals. The basic properties of a system, among others, are as follows:

a. Achievement of goals, the orientation of achieving goals will give a dynamic nature to the system, characterizing the continuous change to achieve goals.
b. The business unit reflects a basic nature of the system where the overall result exceeds the sum of its parts or is often called the concept of synergy.
c. Openness to the environment, the environment is a source of opportunities and obstacles to development. Openness to the environment assesses a system relative or called equifinality or achieving the goals of a system does not have to be done in the best way. However, a system can be implemented in various ways according to the environmental challenges faced (Nugroho et al, 2019).
d. Transformation is the process of changing inputs into outputs carried out by the system.
e. The relationship between the parts, the link between the subsystems is what will provide the system analysis a broader understanding base.
f. There are various kinds of systems, including open systems, closed systems, and feedback systems.
g. Control mechanism, this mechanism involves a feedback system which is a part that provides information to the system about the effects of system behavior (Setiadjji et al, 2019).
System Dynamic Methods

System dynamics is a methodology for understanding certain complex problems (Nugroho et al, 2020). System dynamics examines the system or process as a unit consisting of elements where each element interacts with each other which will determine overall performance.

Two reasons about the system dynamic perspective, namely:

a. The system approach with the dynamic system method is a thorough and unified thought process that can simplify complexity without losing the essence or main element of the object of concern.

b. The dynamic system method is suitable for analyzing system mechanisms, patterns, and trends based on an analysis of the structure and behavior of complex systems, change rapidly and contain uncertainty (Reza et al, 2020).

System and Model Simulation

According to Leopold (2016) simulation is the imitation of a symptom or process and aims to understand the symptom or process, make analysis and forecast the behavior of the symptom or process in the future. Or in other words, is an attempt to imitate the operation of a system through (using) a model.

The model is defined as an abstraction of an object or actual situation, which shows direct or indirect relationships and reciprocal links in the cause and effect of every aspect involved in the development of the plywood industry. The modeling stages are as follows (Nikolaou et al, 2015).

a. Concept Selection Stage
b. Model Engineering Stage
c. Computer Implementation Stage
d. Validation Stage
e. Sensitivity Analysis Stage
f. Stability Analysis Stage
g. Model Apps
RESULT AND DISCUSSION

Model Development

Plywood is significantly incapable of survival, while on the other hand, plywood exports as a non-oil and gas export must be maintained and even increased to increase foreign exchange. This condition is caused by several things, including industrial efficiency, imbalance in raw material supply, financial health and illegal logging, land damage, changes in forestry policies, smuggling and tariff and non-tariff barriers from export destination countries (Romagnoli et al, 2014).

The complexity of the dynamics of the problem with high uncertainty affects the development system of the plywood industry. Therefore, this research will focus on the strategy of structuring the plywood industry with a system dynamics model approach, which aims to understand the dynamic behavior of the modeled system and determine strategies that can be used as input for government policies.

The system being modeled is a plywood industry structuring strategy. To facilitate the development of the model, several sub-models were formed, such as the sub-model of the availability of raw materials, the sub-model of national raw materials, the sub-model of the raw material of the plywood industry, the sub-model of the sawn wood raw material, the sub-model of the raw materials of the chip mill industry, the sub-model of the plywood industry, sawn wood industry sub-model, chip mills industry sub-model, plywood industry feasibility sub-model, plywood export and domestic sub-model, sawn wood export and domestic sub-model, chip mill industry export, and domestic sub-model.

In determining the pattern of strategies applied for the arrangement of the plywood industry, the certainty of the supply of raw materials so that the industry can run according to its capacity and achieve the targeted production amount. Several factors influence the arrangement of the plywood industry, including:

a. Availability of raw materials
b. Availability of national raw materials
c. Plywood industry log needs
d. Export and domestic plywood
e. The need for logs for the sawn timber industry
f. Export and domestic sawn timber
g. Export and domestic chip mill industry
h. Plywood industry feasibility
System Dynamic Model of Plywood Industry Management

The development of the dynamic system model for the arrangement of the plywood industry consists of 82 sub-models, namely: 6 log contribution sub-models, 1 illegal log export sub-model, 7 plywood industry sub-models, 7 sawn wood industry sub-models, 1 chip mill industry sub-model, 34 sub-model of the financial feasibility of the plywood industry, 3 sub-models of domestic and export sales and 23 sub-models of the availability of raw materials for the wood industry which are divided into 8 sub-models of Sumatran raw materials, 5 sub-models of Kalimantan raw materials, 6 sub-models of Sulawesi raw materials, 3 sub-models of raw materials for Maluku & NTB and 1 sub-model for raw materials for Papua, which interact with each other between the sub-models so that they become a model system.

The main problem in structuring the plywood industry lies in the availability of round wood raw material supply which is decreasing significantly from year to year. Based on this statement, the development of the sub-model begins with the development of a sub-model of the availability of raw materials that can provide a comprehensive picture of the ability of natural forests to produce logs. The description of this sub-model is grouped into five forms, namely:

a. Sumatera island
b. Kalimantan island
c. Sulawesi island
d. Maluku and Nusa Tenggara Islands
e. Papua Island

From the five forms, it can be seen an overview of the availability of raw materials in national aggregates. The availability of national raw materials serves as a supply for primary/upstream industries which are divided into three industrial groups, namely:

a. Plywood Industry, in this industry is formed into six islands, each of which is described in each province.
b. Saw industry, in this industry is formed into six islands.
c. Chipmill Industry, in this industry, is formed into six islands.

Sub-Model of the Availability of Raw Materials for Each Island

This sub-model can provide an overview of the availability of national aggregate logs which are broken down into provinces. Limitations in this study include:
a. Virgin Forest (VF), Log Over Area (LOA), and non-forested land are production areas of Forest Concession Rights (HPH) that function to produce logs and have forest stands.
b. Deforested land island that has lost its forest cover permanently or temporarily.
c. Deforestation rate is the accelerated rate of deforestation in the form of illegal logging, fires, belDindah cultivation.
d. Enrichment is the growth of open land that has been used for logging activities into productive land that produces wood naturally. The area of natural growth is assumed to be equal to the area of openness due to logging so that the natural growth that occurs is the area of land that is open due to logging.
e. Rehabilitation is the construction of stands in deforested forest areas through the implementation of reforestation.
f. IPK is a Timber Logging Permit and the use of wood in a forest area that has been determined for Industrial Plantation Forests (HTI) and non-forestry purposes (plantations, transmigration, mining).
g. AAC (Annual Allowable Cut) is the Annual Cutting Allowance (JTT) in the form of cutting area each year with the formula: Productive land area/cutting cycle x potential vol per ha x exploitation factor (0.7) x safety factor (0.8).
h. RKT is the Annual Work Plan determined by the Ministry of Forestry to HPH to carry out the annual cutting allotment in the form of combination.
i. The felling cycle, is the interval between planting and felling logs, which is divided into:

\[ Sv = \text{Remaining area of Virgin Forest (Ha)} \]
\[ Sd = \text{Remaining cycle (years), calculated based on a 35-year logging rotation minus the average age of the HPH in a weighted manner} \]
\[ Uh = \text{Average HPH age (years)} \]
j. Log volume is the number of round logs produced from the Annual Work Plan (RKT) and IPK.

Sub-Model of the Availability of National Raw Materials

This sub-model provides an overall picture of the national availability of log raw materials obtained from the combined production of logs which are then absorbed by the three Upstream/Primary Wood Processing industries, namely: Sawmill Industry, Plywood Industry,
and chip mill industry. Dominantly the production of the three wood industries is oriented to export consumption. The limitations of this sub-model are composed of several variables, namely:

a. National logs are the result of national log production which is the sum of log production from five islands (Sumatra, Kalimantan, Sulawesi, Maluku, and NTB, and Papua).

b. Domestic logs are logs destined for the upstream/primary wood processing industry (plywood industry, sawn industry, and other industries).

c. Plywood industrial logs (plywood), are round wood that is absorbed by the plywood industry on a national aggregate basis.

d. Industrial sawn logs (Sawmill), are logs that are absorbed by the sawn timber industry in national aggregates (de Almeida et al, 2022).

e. Other industrial logs (Chipmill and Veneer), are logs that are absorbed by the Chipmill industry on a national aggregate basis.

**Sub Model of Plywood Industry Raw Material**

The supply of logs for the plywood industry on a national aggregate basis will then be absorbed by the plywood industry on the islands of Sumatra, Kalimantan, Java, Sulawesi, Maluku, and Nusa Tenggara as well as Papua which then from each island will be absorbed into the combined plywood industry in each province. The limitations of this sub-model are composed of several variables, namely:

a. The raw material for the plywood industry is round wood which is absorbed by the plywood industry on a national aggregate basis.

b. The raw material for the Sumatran plywood industry is round wood which is absorbed by the plywood industry in Sumatra.

c. The raw material for the Javanese plywood industry is round wood which is absorbed by the plywood industry in Java.

d. The raw material for the Kalimantan plywood industry is round wood which is absorbed by the plywood industry in Kalimantan.

e. The raw material for the Sulawesi plywood industry is round wood which is absorbed by the plywood industry in Sulawesi.

f. The raw material for the Maluku and Nusa Tenggara plywood industry is round wood which is absorbed by the plywood industry in Maluku and Nusa Tenggara.
g. The raw material for the Papuan plywood industry is round wood which is absorbed by the plywood industry in Papua.

Sub-Model of Plywood Industry

This sub-model is divided into six islands (Sumatra, Java, Kalimantan, Sulawesi, Maluku and Nusa Tenggara, and Papua) that describe plywood production. The limitations of this sub-model are composed of several variables, namely:

a. Raw materials are raw materials that are absorbed by the plywood industry in provincial aggregates.
b. Plywood production is the output of the plywood industry in the aggregate province.
c. Yield is a comparison between input (round wood) and output (plywood).
d. Plywood export is the province's aggregate amount of plywood exported to destination countries.
e. Domestic plywood is the amount of plywood consumed domestically in the aggregate province.
Sub-Model of the National Sawn Timber Industry

This sub-model describes the raw material needs of the national sawn timber industry which are met from each of the major island provinces (Sumatra, Java, Kalimantan, Sulawesi, NTB, and Maluku, and Papua) which will then be absorbed from each island to the sawn timber industries in each province.

Figure 3. Sub-model of the national sawn timber industry

Sub Model of Chipmill Industry

This sub-model provides an overview of the supply of raw materials and production on six islands (Sumatra, Java, Kalimantan, Sulawesi, Maluku and Nusa Tenggara, and Papua). Then the national aggregate production and percent installed capacity are obtained.
Sub Model of Plywood Domestic and Export

This sub-model provides an overview of the volume of plywood exported and its foreign exchange value, besides that it also describes sales for domestic (domestic). National export and domestic volume is the sum of six islands (Java, Sumatra, Kalimantan, Sulawesi, Maluku, and NTB as well as Papua).
Sub Model of Sawwood Export and Domestic

This sub-model provides an overview of the volume of sawn timber exported and its foreign exchange value, besides that it also describes sales for domestic (domestic). The export and domestic volume of sawn timber nationally is the sum of six islands (Java, Sumatra, Kalimantan, Sulawesi, Maluku, and NTB as well as Papua).
Sub Model of Chipmill Industry Domestic and Export

This sub-model provides an overview of the export volume of the chip mill industry and its foreign exchange value, besides that it also describes domestic (domestic) sales. The export and domestic volume of the chip mill industry nationally is the sum of six islands (Java, Sumatra, Kalimantan, Sulawesi, Maluku, and NTB, and Papua).

Figure 7. Sub Model of Chipmill industry domestic and export

Sub Model of Plywood Industry Financial Feasibility

This sub-model provides an overview of the financial viability of the plywood industry. The description is obtained from a sample of several plywood industries located in six islands (Java, Sumatra, Kalimantan, Sulawesi, Maluku, and Papua) which are then divided into several provincial samples, such as:

a. In Java, the sample of plywood industry located in Banten province is PT. A, and the province of East Java, namely PT. B and PT. C.
b. Sumatra Island, samples of plywood industry located in Riau province, namely PT.D and PT. E.
c. Kalimantan Island, samples of plywood industry located in East Kalimantan province, namely PT. F and PT. G, South Kalimantan province, namely PT. H and PT. I, West Kalimantan province, namely PT. J.
d. Sulawesi Island, samples of plywood industry located in the province of South Sulawesi, namely PT. K.
e. Maluku Island, samples of plywood industry, namely PT. L.
f. Papua Island, samples of plywood industry, namely PT. M.

The limitations of this sub-model are composed of several variables, namely:
CONCLUSION

Formulating a strategy for structuring the plywood industry in Indonesia after the monetary crisis using a dynamic system through the formulation into dynamic sub-models (SMD), namely: 7 SMD for plywood industry production, 7 SMD for the sawn wood industry, 1 SMD for chip mill industry production, 23 SMD for material production standard logs for the wood industry, 6 SMD economic contributions of logs to the central and regional levels, 1 SMD for export of illegal logs, 3 SMD for domestic and export wood industries and 34 SMD for the financial feasibility of the plywood industry. The policies carried out in the plywood industry structuring strategy include a national plywood production limitation policy, a national sawn wood production limitation policy, and a cutting restriction policy in the form of the Annual Cutting Allowance (JPT) in various combinations which are outlined in eight main policy scenarios and translated into 28 scenarios. From the 12 criteria, six criteria are recommended, namely: (1) average plywood production per year, (2) average sawn wood production per year, (3) average log production per year, (4) average gap the need for wood per year, (5) the average decrease in the area of Virgin Forest and the area of Log Over Area per year as well as the increase in the area of non-forested land per year, and (6) the financial condition of the sample company with the parameters of BCR and NPV values, then obtained three alternatives The best policies are::

a. Scenario policy which implements a policy of setting a national plywood production limit of 80%, a national sawn timber production limitation of 40%, and a logging restriction under the JPT (Annual Cutting Allowance). This policy scenario has a national average annual plywood production value and a relatively high average annual sawn timber production compared to other scenarios, which are 7,551,727,15 m³/year and 4,403,494,60 m³ respectively. /year. The application of the cutting
restriction policy (JPT) causes the national log production of 5,015,611.67 m³/year to be unable to meet the demand for raw materials for the wood industry in the market and this harms the occurrence of a gap in the need for logs for the wood industry which is relatively high, namely 20,102,933.04 m³/year. On the other hand, the implementation of this logging restriction policy has a positive impact on forest area, in this case, the area of Virgin Forest (VF) and the area of Log Over Area (LOA) because the logging that occurs is smaller than the actual condition so that the average decrease in VF and The LOA that occurred was relatively smaller, namely 64,189.46 Ha/year and 157,636.24 Ha/year, respectively. The average increase in the area of non-forested land is also relatively smaller, which is 200,093.06 Ha/year. The financial conditions of the 34 sample companies are generally in good condition with an average BCR of 1.48 and an average NPV of IDR. 569,621,342,365.91.

b. Scenario policy applies a policy of setting a national plywood production limit of 80%, a national sawn timber production limitation of 40%, and actual logging under the AAC. This policy scenario has an average annual production of plywood and an average annual production of sawn wood which is the same as scenario 8 – policy 5 which is 7,551,727.15 m³/year and 4,403,494.60, respectively. m³/year. The production of wood logs is relatively large, namely 13,295,441.17 m³/year, so that the gap in the need for industrial wood logs is relatively smaller, which is 12,472,657.34 m³/year. Log production is quite high because logging is carried out according to AAC, but this harms forest area in this case Virgin Forest (VF) and Log Over Area (LOA). The decrease in the area of VF and LOA that occurred was relatively larger, namely 313,462.82 Ha/year and 277,251.27 Ha/year, respectively. The average increase in the area of non-forested land is also relatively large, which is 328,600.61 ha/year. The financial conditions of the 34 sample companies are generally in good condition with an average BCR of 1.48 and an average NPV of IDR. 569,621,342,365.91.

c. Scenario policy applies a policy of setting a national plywood production limit of 80% and a logging restriction following the JPT. This policy scenario has a national average annual plywood production of 7,551,727.15 m³/year and an average annual production of sawn wood which is higher than Scenario 4 – policy 5 and Scenario 8 – policy 5 which is 5,601,494.15 m³/year. The production of wood logs is relatively small at 5,015,611.67 m³/year so that the gap in the need for industrial logs is relatively large, which is 22,517,283.14 m³/year. Log production that occurs is quite low due to the
implementation of a cutting restriction policy in the form of JPT. This has a positive impact on forest area, namely the area of Virgin Forest (VF) and the area of Log Over Area (LOA). The decrease in the area of VF and LOA that occurred was relatively smaller than the other scenarios, which were 65,460,19 Ha/year and 166,807,95 Ha/year, respectively. The average increase in the area of non-forested land is also relatively small at 210,891.32 ha/year. The financial conditions of the 34 sample companies are generally in good condition with an average BCR of 1.48 and an average NPV of IDR. 569,621,342,365.91.

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REFERENCES


