ISSN No:-2456-2165

Business Climate Policy Analysis of Flat Steel Industry in Indonesia

Rizky Aditya Wijaya
Industrial Engineering Department
Faculty of Engineering, University of Indonesia
Depok, Indonesia

Abstract:- The steel industry in Indonesia has undergone substantial growth, driven by the expansion of the national infrastructure and construction sector. However, this sector faces multifaceted challenges, including escalating raw material prices, elevated energy and transportation expenses, and intense competition from imported steel. The emergence of the COVID-19 pandemic further disrupted the steel supply chain and reshaped demand patterns. The ease of access to international steel products in the domestic market significantly influences the utilization of domestically produced steel. To foster sustainable and competitive growth, the Indonesian Government has instituted various policies and regulations for industry improvement. Although there is potential for sustainable growth in the national steel industry, it is imperative to acknowledge and effectively address the prevailing dynamics and challenges. This research endeavors to provide a comprehensive analysis of the steel industry, specifically focusing on the sheet steel segment in Indonesia. Employing system dynamics simulations, this study seeks to estimate the trajectory of developments, challenges, opportunities, and shifts in the supply and demand for domestic sheet steel products. Four dynamic hypotheses within the system are proposed and rigorously examined. The current model structure suggests that augmenting steel mill capacity and introducing regulations on steel product imports lead to an upsurge in domestic flat steel production. Furthermore, providing tax incentives and tariff adjustments presents a promising avenue for mitigating price differentials between flat steel and its raw materials within the country. The findings of this research hold the potential to provide valuable insights for policy recommendations aimed at propelling the progress of the flat steel industry in Indonesia.

Keywords:- *Flat Steel Industry, Steel Production Supply and Demand, Dynamic System Simulation, Tax Incentives, Industrial Competitiveness.*

I. INTRODUCTION

The steel and mineral industry is the backbone of a country's economy, playing an essential role in economic development and growth (Xu & Guo, 2022; Ministry of Industry, 2014). The steel industry is a leading indicator of industrial progress, providing vital raw materials for construction, machinery, automotive, shipping, and mining (Ahmad et al., 2021; Hadisancoko, 2018; Cahyani, 2014).

Indonesia, as a steel producer, continues to strive to improve the competitiveness of its domestic steel industry. The long history of the steel industry began in the Dutch colonial period, developing into a priority industry after independence with the establishment of PT. Krakatau Steel. Despite the challenges, Indonesia's steel industry continues to grow and adapt, although foreign investors own some companies. The main challenges in the national steel industry include the provision of raw materials, energy and transportation costs, import dependence, low investment, inadequate national consumption growth, and low competitiveness and suboptimal regulations (Prasetyo, 2021; Priyana, 2016; Cahyani, 2014; Hasni et al., 2011). The impact of steel imports is also significant because Indonesia has yet to be able to meet domestic needs and has to import most of it (IISIA, 2022). The Indonesian Government has implemented various policies and regulations to overcome these challenges, including steel trade governance, import duty tariff policies, subsidies, ease of investment, policies related to steel imports and exports, import substitution, Indonesian local product content (P3DN), Indonesian Standards (SNI), as well as environmental policies such as carbon taxes and emission regulations (Yudika et al., 2021; RIPIN, 2015). The purpose of this policy is to influence the price and supply of steel in the domestic market, create healthy competition, and maintain the sustainability of the steel industry.

The dynamics of the global steel economy are influenced by factors such as fluctuations in raw material prices, changes in market demand, as well as trade policies and protectionism of steel-producing countries such as China, the United States, Japan, India, and Europe have affected the dynamics of the steel economy in Indonesia. In addition, ongoing challenges in the dynamics of the steel industry in Indonesia are influenced by market demand factors, government policies, global competition, technology and innovation, and environmental challenges. Technological innovation and environmental sustainability are essential aspects of maintaining the competitiveness of the steel industry in Indonesia.

Research on the steel industry has been carried out by many international researchers and national researchers with quite diverse research topics. In this study, researchers will conduct research on the climate policy of the steel industry related to the dynamics of supply and demand for steel products in Indonesia. The study of this topic still needs to be improved, so it is interesting to investigate further. Some previous studies that are relevant and related to the research topics conducted by researchers include being conducted by Xiang Yin & Wenying Chen (2013), Elshkaki, et. al. (2018), Skirrow et al. (2013), Mehmanpazir et.al. (2019), Julian Pinto (2019), and Mahmodi, et. al. (2010). Meanwhile, several previous studies in Indonesia that are related and relevant to the topic studied by the author were conducted by Sari et al. (2020), Cahyani (2014), and Priyana (2016). Sari et al. (2020). Sari et al. (2020). Given the limited scope of research in this area, this presents exciting opportunities for further exploration.

In this study, researchers used system dynamics analysis to understand and test the supply and demand dynamics of steel products in Indonesia. This methodology was chosen for its ability to address complex and dynamic issues with policy implications, such as the supply and demand dynamics of steel products in Indonesia. Through system dynamics analysis, various factors and variables that affect the performance of the Indonesian steel industry, including production, supply, demand, pricing, government policies, environmental factors, and others, can be identified. By modeling and simulating the supply and demand dynamics of domestic steel products, various policy scenarios are formulated to assist policymakers and industry stakeholders in gaining a better understanding of the dynamics of the steel industry in Indonesia. From this understanding, more effective and efficient strategies can be planned to address future challenges and opportunities. The modeling process with this methodology starts from a simple model and can be developed more quickly. Causal relationships between variables in the model are more accessible to communicate to the non-technical community.

- *Objectives*

In this study, researchers will conduct research on the climate policy of the steel industry related to the dynamics of supply and demand for steel products in Indonesia. The purpose of this study is to analyze the aspects that affect the supply and demand conditions of flat steel in Indonesia, as well as formulate appropriate policies to improve the competitiveness of the national flat steel industry.

II. LITERATURE REVIEW

The metal steel industry is a strategic sector crucial as a raw material supplier for various industries. The utilization of steel is highly demanded in infrastructure development, capital goods production, the transportation sector, and even the defense industry. In Indonesia, the most significant contributor to steel consumption is the construction sector, accounting for 80%, followed by pipe network construction at 8%, the manufacturing sector at 3%, the machinery industry at 2%, and the automotive industry at 1%. The remaining industries constitute 6% (Kemenperin, 2014).

Steel consumption is projected to continue to grow in the foreseeable future. The iron and steel industry is strongly influenced by the development of the construction sector and the processing and manufacturing industry, as these two sectors are the main driving forces that absorb most of the demand for steel as a raw material for direct use. Various methods to estimate steel consumption in the future have been carried out by various researchers, including Xiang Yin & Wenying Chen (2013), Elshkaki et al. (2018), Skirrow et al. (2013), Mehmanpazir et al. (2019), Julian Pinto (2019), and Mahmodi, et al. (2010).

Xiang Yin Wenying Chen (2013) used a stock-based model to estimate the magnitude of steel demand with a case study in China's downstream steel industry. Considering assumptions regarding population and GDP, different product stocks in different industries are estimated, and future demand for steel in each industry is modeled, considering the distribution of product life and steel intensity. Elshkaki et al. (2018) used regression methods with past data mining to identify indications of future decreases in iron supply caused by higher increases in demand compared to supply. Skirrow et al. (2013) analyzed the combination of demand and supply interests, as well as the supply risk of steel materials, using a two-dimensional matrix model. In comparison, Mehmanpazir et al. (2019) used a multi-regression method to develop a model with many variables to observe the influence of steel supply and demand in the Iranian steel industry.

Meanwhile, research conducted by Julian Pinto (2019) focuses on examining the interaction between the European steel industry and its environment to support sustainable policies and causality. In this study, Julian Pinto (2019) also discusses sustainable resource management in the European steel supply chain by looking at variables that affect competitiveness, such as technology, labor wage, and capital costs. This case study research integrates the *Life Cycle Assessment* (LCA) method into *system dynamics* (SD) in circular economy and industrial ecology. Research Mahmodi et al. (2010) use a dynamical system method to examine the supply chain of steel bar products in Iran in order to explain the fluctuation of the bar steel market over the past five years.

Previous research in Indonesia that is related and relevant to the topic studied by the author was conducted by Sari et al. (2020), Cahyani (2014), and Priyana (2016). Sari et al. (2020). Sari et al. (2020) researched the basic pattern of comparative advantage of the Indonesian steel industry using regression-based RCA analysis with an instrument variable method using export data from 25 countries to 35 destination countries. The results showed that Indonesia has the most vital comparative advantage in the steel industry among ASEAN countries. Cahyani (2014) conducted research on the competitiveness analysis of the steel industry in order to deal with ACFTA by using CMS analysis to determine the factors that affect competitiveness and how these factors influence it. Priyanka (2016) researched the role of the upstream steel industry's contribution to meeting national steel demand using the dynamic system method.

In this study, the researcher employs system dynamics analysis to comprehend and examine the dynamics of steel product supply and demand in Indonesia. System dynamics is a computer-based simulation modeling method that was developed initially for managers/leaders to be able to understand and overcome complex problems of a system. Jay Forrester first developed this dynamic system in the 1950s, and until now, this method has developed rapidly and is used by academics from various disciplines and industry practitioners (Sterman, 2000; Sushil, 1993). This method has been widely applied to solve various problems ranging from the global level to the managerial level. The problems that can be solved using this method must meet several specific criteria, including the problem has policy implications, the structure is unclear (ambiguous), can have long-term effects, requires qualitative and quantitative analysis, and others. However, using dynamical systems is more effective in some cases than other approaches. The effectiveness of using this application depends on how much the characteristics of the problem match with the characteristics or features of this methodology.

III. METHODS

This research uses a system dynamics methodology, with the modeling process covering the stages outlined by Sterman (2000): problem articulation, dynamic hypothesis formulation, model creation, model testing and validation, and policy design and evaluation. The system dynamics was chosen in this study because it has successfully addressed complex problems, such as those encountered in the steel industry (Pinto, 2019; Mahmodi et al., 2010). In addition, its foundation in simple concepts facilitates faster model development, and its emphasis on causal relationships makes it more accessible for communication with non-technical communities, including policymakers (Sterman, 2000).

The initial step involves identifying an apparent problem. A literature review of the national steel industry sector is conducted to articulate the research problem effectively. Various preliminary information and related data are crucial at this stage. Next, the key variables, dynamic reference behavior patterns, and time horizons of these key variables are identified. In this study, key variables include Production, Demand, Export, Import, and Capacity of national flat steel mills. Figure 1 presents data on these critical variables from 2015 to 2023.

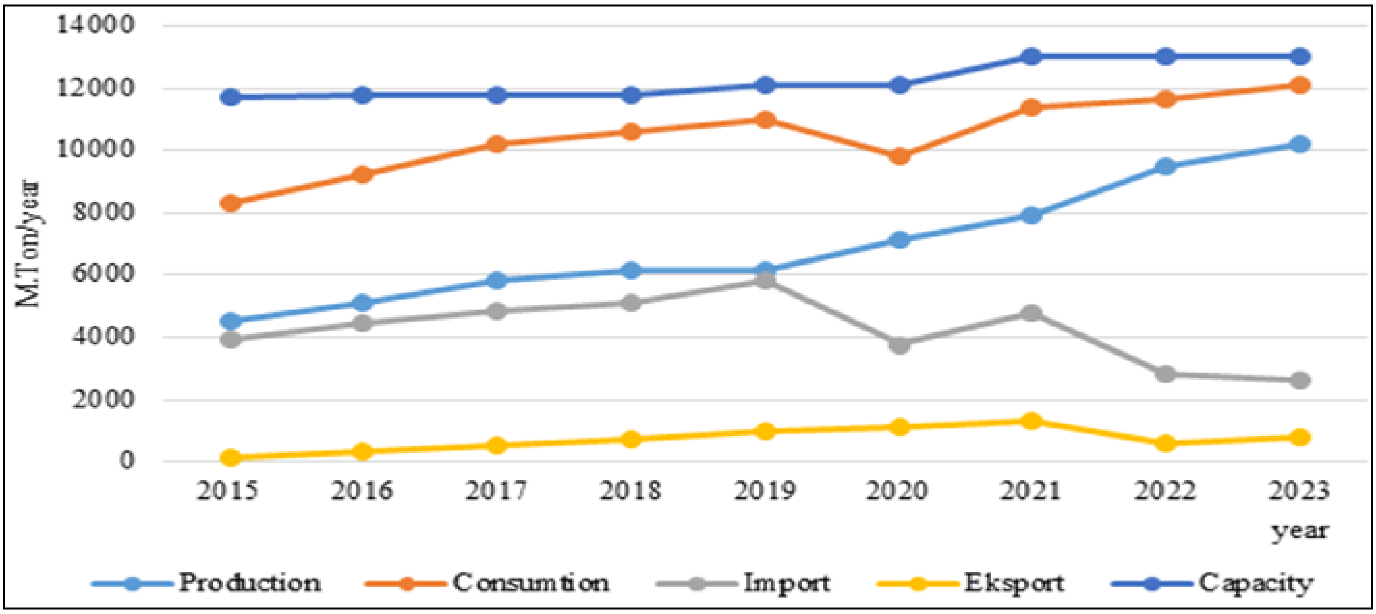

Fig 1 Reference Behavior Graph of Critical Variables of Flat Steel for the Period 2015-2023
Source: IISIA and Kemenperin (2022)

The next stage involves formulating dynamic hypotheses and conceptualizing models. In system dynamics, the goal is to explain phenomena based on endogenous variables rather than exogenous variables. These dynamic hypotheses can be expressed verbally using a causal map structure. In this study, the following dynamic hypotheses were proposed: 1) the high price of domestic flat steel products causes a reduction in the production and supply of domestic industrial flat steel, resulting in lower quantities; 2) the limited production capacity of the domestic flat steel industry leads to a constrained ability of domestic flat steel production to meet the demand or consumption of industrial flat steel in the country, 3) an increase in the import of flat steel may lead to reduced domestic flat steel production, dan 4) the expansion of the capacity of domestic flat steel mills will enhance the production capability of the domestic flat steel industry. The conceptual model of this research system is illustrated in Figure 2.

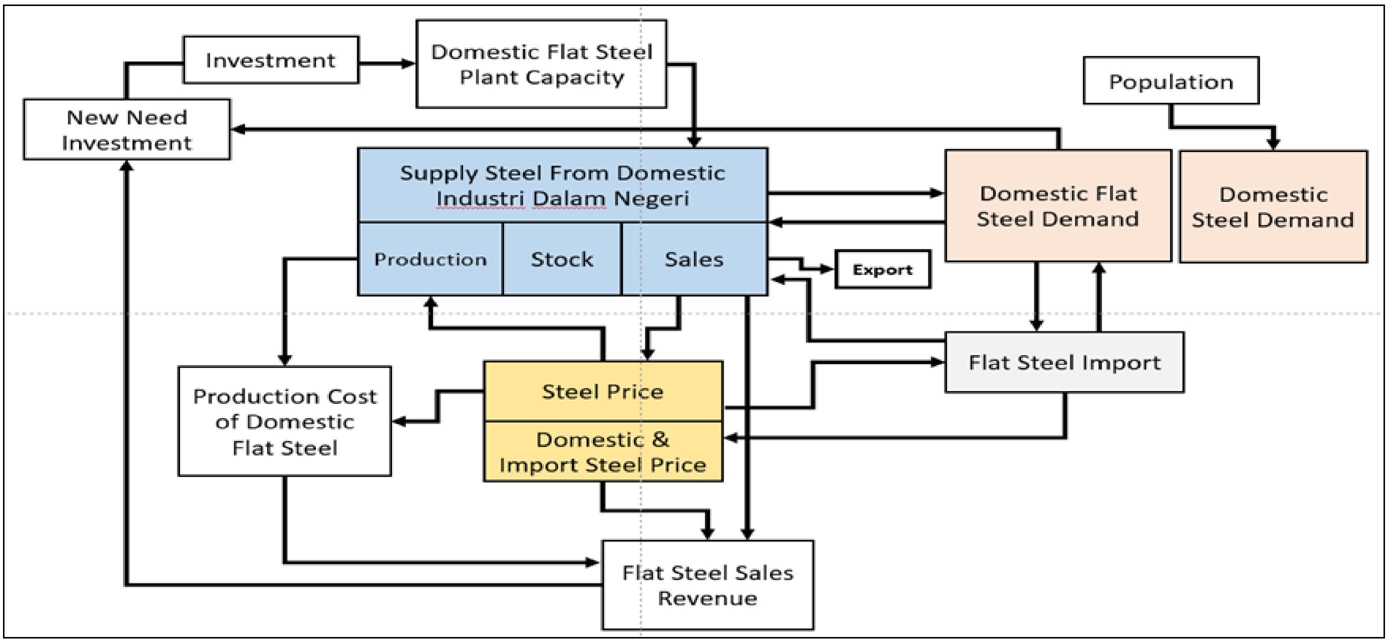

Fig 2 Map of the Supply and Demand System of the Domestic Flat Steel Industry

The third stage is the creation of dynamic models. At this stage, the modeling process involves creating a formal model complete with various mathematical formulations that explain the cause-and-effect relationships of all variables, estimating the values of numerical parameters and initial stock values that represent the system, and testing the consistency of the model internally against dynamic hypotheses. This process also involves the use of computer software packages. In this study, Powersim Studio 10 was used. Figure 3 shows the stock and flow diagram of the sub-model of the production and sales system in this study.

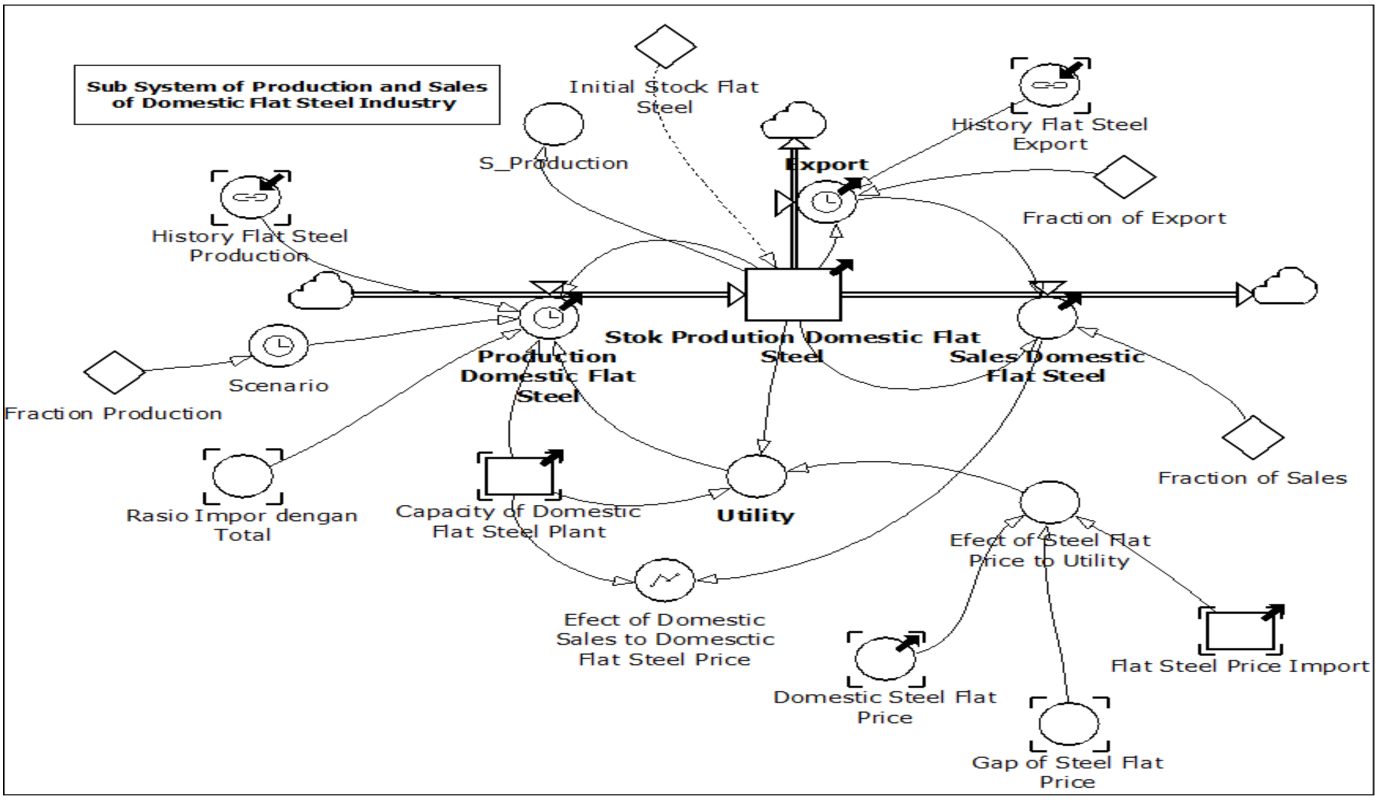

Fig 3 Stock and Flow Sub System of Production and Sales of Domestic Flat Steel Industry

The fourth stage is the test and validation of the model. At this stage, testing is carried out to see whether the model built is enough to represent real problems by referring to the objectives of this study by looking at two aspects, namely, structural and behavioral models produced. Structural validation involves testing the linkages between variables, including unit validation of model equations. In contrast, behavioral testing involves testing the model's behavior patterns compared to its historical data. Figure 4 shows the test results and model validation for the national flat steel demand variable.

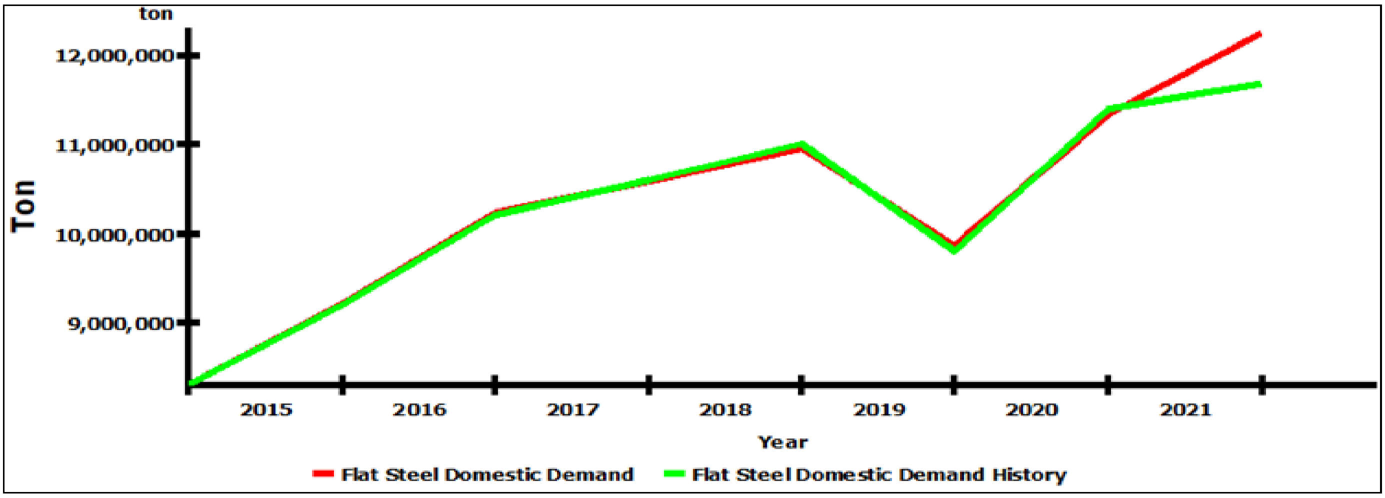

Fig 4 Graph of Domestic Flat Steel Demand Behavior Test Results

The final stage is policy design and evaluation. Policy design and model evaluation is carried out when the model is tested, and its properties are understandable. This stage is done to test new policy options to see how likely it is that the model can improve the dynamics of the model. Policy is rule-making, a common way of making decisions. Thus, policymaking will be expressed by a set of equations that describe how the resulting decisions are made within the organization. At this final stage, policy options are designed to be tested by running simulations. Furthermore, dynamic system models can be used to study the dynamics of new policy implementation. The key to success is the involvement of the owner of the system implementation in all stages of the development and analysis of the model so that it is easier to ensure the validity and usability of the system.

IV. DATA COLLECTION

This research begins with conducting preliminary studies, including documentation and literature studies. The aim is to collect secondary data that includes an overview of steel research, regulations, and policies in Indonesia, as well as data on production, supply, demand, imports, and exports of steel products in Indonesia from 2015 to 2022. In addition to secondary data, primary data was also obtained through interviews with key respondents from various related agencies, such as the Directorate of Metal Industry, Directorate General of ILMATE, Ministry of Industry, Republic Indonesia, Indonesian steel industry associations, and industry players. The selection of critical respondents is carried out purposively based on their expertise and understanding of the research problem.

V. RESULTS AND DISCUSSION

The purpose of this study is to examine policies that might affect the climate of the national flat steel industry related to supply and demand dynamics during the period 2015 to 2035. In this study, four simulation scenarios were built to explore the policy. The first is the basic scenario, which is a scenario that follows the developments and trends that occur at the moment. Second, the second scenario is scenario of increasing the capacity of domestic flat steel plants at this time to meet national flat steel demand. The third scenario is in the form of increasing the utility of domestic flat steel production with domestic steel trade regulation policies in the form of regulating the import and export of steel products, and the fourth and the fourth scenario is in the form of a scenario of providing convenience to obtain cheaper raw materials and sufficient quantities in the form of raw material tax incentives, tariffs, quotas, which can later reduce production costs so that the flat steel products produced can be competitive.

Table 1 Results of Simulation of Steel Supply and Demand Model of Flat Products at Basic Scenario

Year	Capacity (ton)	Production (ton/year)	Production Stock (ton)	Domestic Sales (ton/year)	Export (ton/year)	Import (ton/year)	Demand (ton)
2015	11.700.000,0	140.382,0	4.488.800,0	4.348.418,0	140.382,0	3.953.000,0	8.300.000,0
2016	11.700.000,0	332.442,0	5.184.564,0	4.852.122,0	332.442,0	4.360.878,0	9.213.000,0
2017	11.800.000,0	510.840,0	5.899.509,0	5.388.669,0	510.840,0	4.837.761,0	10.226.430,0
2018	11.800.000,0	691.020,0	6.231.280,0	5.540.260,0	691.020,0	5.044.095,1	10.584.355,1
2019	11.800.000,0	983.070,0	6.599.395,0	5.616.325,0	983.070,0	5.338.482,5	10.954.807,5
2020	12.100.000,0	1.083.060,0	7.122.885,0	6.039.825,0	1.083.060,0	4.010.476,8	9.859.326,7
2021	12.100.000,0	1.275.120,0	8.230.530,0	6.955.410,0	1.275.120,0	4.601.956,5	11.338.225,7
2022	13.000.000,0	862.290,0	9.144.135,0	8.281.845,0	862.290,0	3.495.753,0	12.245.283,8
2023	13.000.000,0	1.283.449,9	10.695.415,5	9.411.965,6	1.283.449,9	3.363.013,8	13.224.906,5
2024	13.000.000,0	1.256.199,7	10.468.331,2	9.212.131,5	1.256.199,7	4.472.417,0	14.282.899,0
2025	13.000.000,0	1.248.761,8	10.406.348,2	9.157.586,4	1.248.761,8	5.528.327,1	15.425.530,9
2026	13.000.000,0	1.242.956,8	10.357.973,5	9.115.016,7	1.242.956,8	6.654.299,0	16.659.573,4

ISSN No:-2456-2165

Year	Capacity (ton)	Production (ton/year)	Production Stock (ton)	Domestic Sales (ton/year)	Export (ton/year)	Import (ton/year)	Demand (ton)
2027	13.000.000,0	1.237.628,6	10.313.571,8	9.075.943,2	1.237.628,6	7.864.261,4	17.992.339,3
2028	13.000.000,0	1.232.684,3	10.272.369,4	9.039.685,1	1.232.684,3	9.165.780,5	19.431.726,4
2029	13.000.000,0	1.228.094,8	10.234.123,5	9.006.028,6	1.228.094,8	10.566.568,1	20.986.264,6
2030	13.000.000,0	1.223.835,7	10.198.631,2	8.974.795,5	1.223.835,7	12.074.906,6	22.665.165,7
2031	13.000.000,0	1.219.884,4	10.165.703,1	8.945.818,7	1.219.884,4	13.699.718,2	24.478.379,0
2032	13.000.000,0	1.216.219,3	10.135.160,8	8.918.941,5	1.216.219,3	15.450.618,3	26.436.649,3
2033	13.000.000,0	1.212.820,5	10.106.837,3	8.894.016,8	1.212.820,5	17.337.971,8	28.551.581,2
2034	13.000.000,0	1.209.669,1	10.080.576,0	8.870.906,9	1.209.669,1	19.372.954,3	30.835.707,7
2035	13.000.000,0	1.206.747,7	10.056.230,6	8.849.482,9	1.206.747,7	21.567.617,8	33.302.564,3

A. Basic Scenario Model Simulation

The simulation of the domestic flat steel supply and demand model in the basic scenario is an attempt to see the tendency of behavior patterns of critical variables studied in the future when problems or system conditions occur as in the current state (current policy) in the sense that no intervention of any policy action is carried out on the model. Table 1 shows the results of simulated models of supply and demand of flat product steel under primary conditions for the critical variables observed. Table 1 is the essential condition of the model simulation results based on the assumption that the magnitude of flat steel demand growth is, on average, 8% per year, the total flat steel plant capacity is 13,000,000 tons, the average flat steel production growth is 10%, the average export growth is 12% per year, and the average flat steel import growth is 15% during the simulation period. From Table 1, it can be seen that the capacity of the flat steel plant in 2015 was 11,700,000 tons, then there was an addition to 13,000,000 tons in 2022. If there is no additional flat steel plant capacity during the simulation period, then with an average steel demand growth of 8%, steel imports in 2035 will be 21,567,617.8 tons from 3,953,000 tons in 2015.

B. Scenario Simulation Model

Figure 5 shows the simulation results of the critical model variables for the four different simulation scenarios. Figure 5a is a graph of simulation results under primary conditions, while Figure 5b, Figure 5c, and Figure 5.d are simulation results for the second, third, and fourth scenarios, respectively. In this second scenario, the flat steel capacity is increased by 30% of the current capacity in the 10th year from the initial period of simulation. In the third scenario, the parameter value of the percentage of flat steel imports is increased or decreased by 10% from the current condition. In the fourth scenario, it is done by changing the parameter value of the fraction of the difference between domestic slab steel prices and imports to 10%, adding the new capacity of steel slab by 30%.

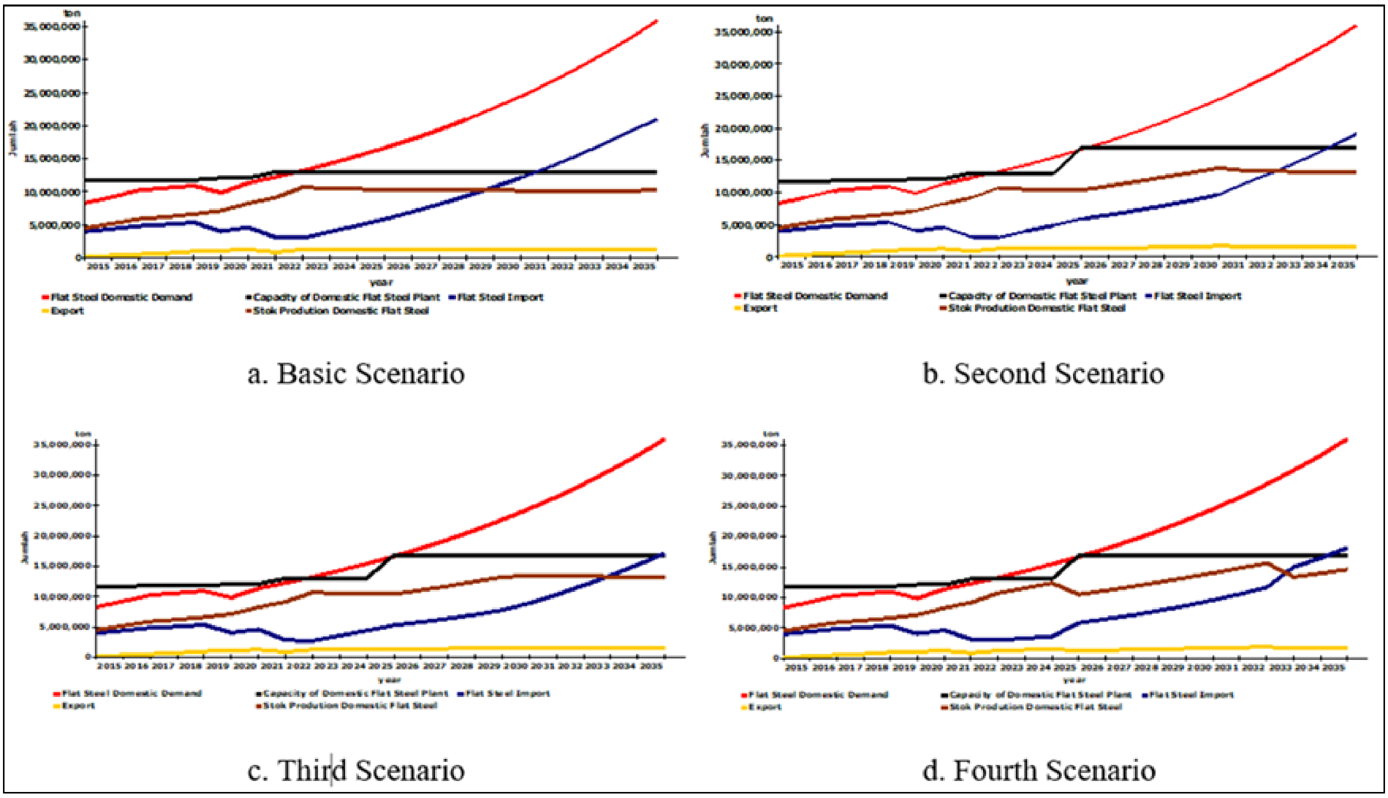

Fig 5 Graph of Behavior Pattern Simulation Results of Flat Product Steel Supply and Demand Model for Four Simulation Scenarios Performed

C. Steel Industry Development Strategy

The four scenarios have been built and simulated from factual information, simulating the behavior of various key variables studied that are the same as actual conditions. Improvements are made to the basic scenarios (primary conditions). Based on these four scenarios, three strategies for developing the steel industry were prepared.

First, the strategy of increasing steel plant capacity by 10% to 30% of the existing factory capacity. Ideally, this capacity addition is at least 30% of the existing capacity and can be done every three years starting in 2025, 2028, 2031, and 2034. This strategy answers the second dynamic hypothesis related to the limited production capacity of domestic flat steel, causing the limited ability of the domestic flat steel industry to meet the demand for national industrial flat steel. Increasing factory capacity is not easy and fast because it requires a significant investment. In this case, it is expected that the Government will be able to attract investors to invest in the steel industry, exceptionally flat steel, by increasing the capacity of existing factories and investing in new factories. The addition of flat steel plant capacity is quite significant in reducing the gap between the amount of flat steel that can be supplied by domestic producers and the demand or need for flat steel from domestic industry players, which will later have an impact on reducing steel imports.

Second, the strategy of regulating the provision of flat steel imports to domestic industries to increase domestic utility and flat steel production. In this second strategy, the Government can reduce the percentage of steel imports up to 40%-50% of current imports. In addition, in this second strategy, the additional steel capacity is assumed to be a maximum of 15%. This strategy answers the third dynamic hypothesis related to high flat steel imports, which can lead to low domestic flat steel production. This arrangement to reduce flat steel imports must be followed by the ease of domestic flat steel producers to obtain cheaper flat steel raw materials so that domestic producers can produce flat steel at prices competitive with imported flat steel prices. With this second strategy, it is expected to be able to encourage investment in the flat steel industry and the steel industry more upstream (flat steel raw materials). However, this second strategy must also be followed by improvements in supporting factors such as the availability of energy supplies and auxiliary materials that are easy and affordable.

Third, the strategy of providing incentives in taxation and tariffs for raw materials in order to reduce the price disparity of domestic flat steel with imported steel. This strategy answers the first dynamic hypothesis related to the high price of flat steel domestic products, causing the amount of production and supply of flat steel in domestic industries to be reduced or low. Strategy is an important policy related to Strategy 1 and Strategy 2. In addition to making efforts to increase the capacity of flat and upstream steel mills, steel trade arrangements (importation arrangements) must be carried out simultaneously. By obtaining cheaper flat steel raw materials, it will be able to increase the utility of the factory so that more production. Figure 6 and Figure 7, respectively, show the simulation results of flat product steel for the combination scenario of capacity strategy increased by 15%, importation limited to only 50% of current conditions, and the difference between domestic and imported steel prices by 10%, and the combination scenario of capacity strategy increased by 35%, importation limited to only 50% of current conditions, and the difference between domestic steel prices and imports by 10%.

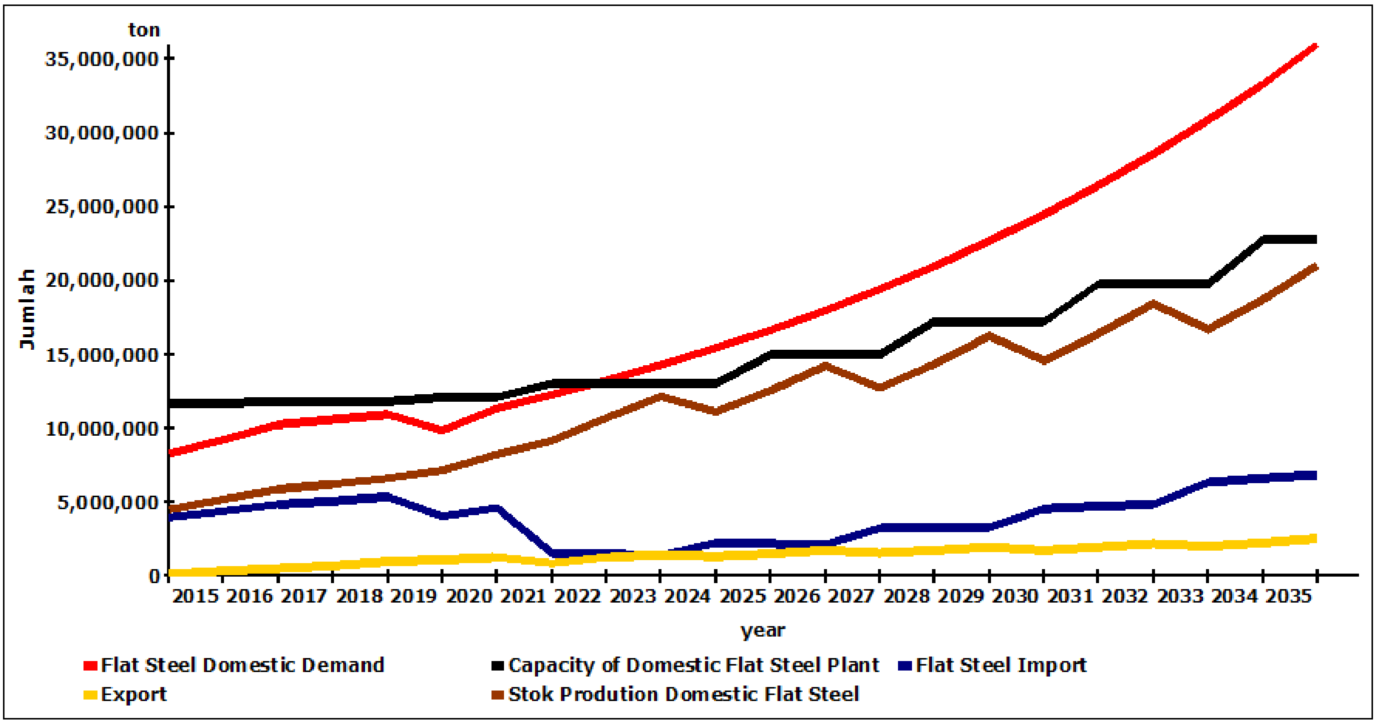

Fig 6 Flat Steel Base Scenario Results Chart Combination of 15% Capacity Increase Strategy, 50% Steel Import Restriction, and 10% Steel Price Difference.

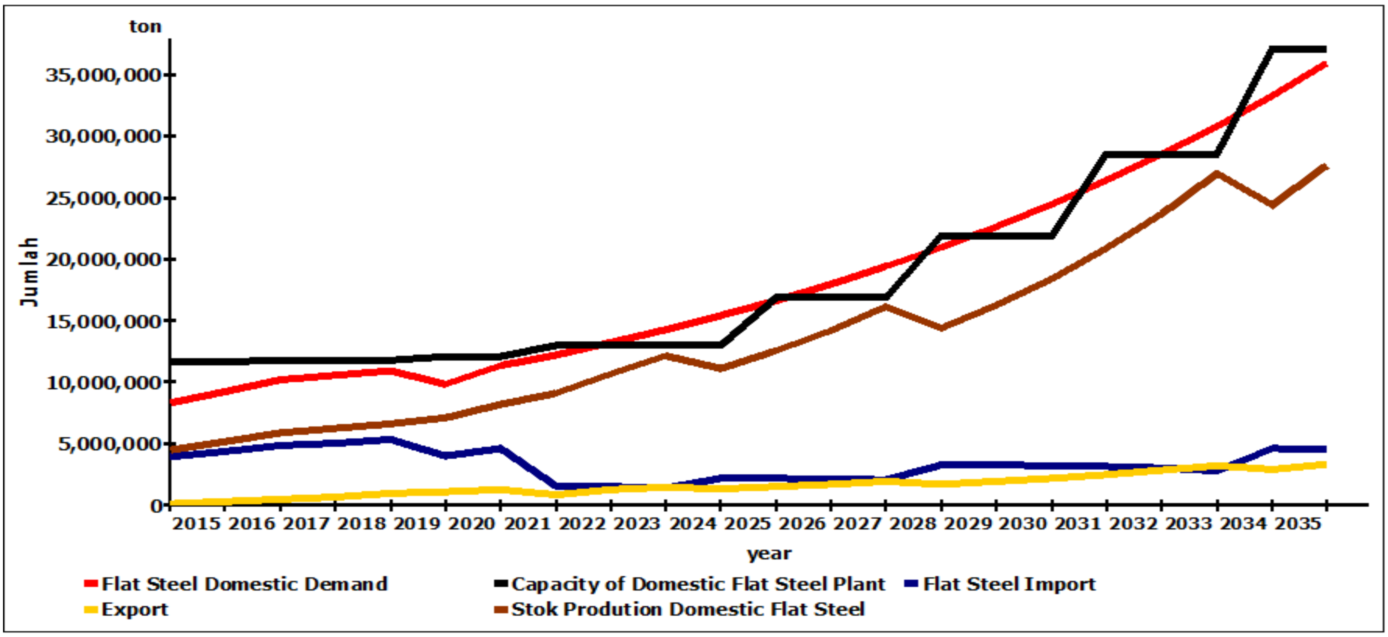

Fig 7 Flat Steel Base Scenario Results Chart Combination of 30% Capacity Increase Strategy, 50% Steel Import Restriction, and 10% Steel Price Difference.

VI. CONCLUSION

This research has produced a system dynamics model that can be utilized to determine appropriate policies for enhancing the competitiveness of the national steel industry, specifically the national flat steel industry, by studying the supply and demand of flat steel in Indonesia. The system dynamic model, constructed based on the findings of the study, incorporates a series of different parameters to assess and predict the future conditions of supply and demand for flat steel in Indonesia.

Through scenario testing on the constructed model to address the proposed dynamic hypotheses, it was found that: 1) The variable of flat steel plant capacity significantly influences the ability to generate production levels that can meet the increased demand for flat steel in the future. The increase in national flat steel plant capacity is ultimately expected to reduce the importation of flat steel. 2) The importation of flat steel must be regulated to enhance the utility and domestic production of flat steel. High levels of flat steel imports are one of the reasons for the low domestic production of flat steel. However, the regulation of flat steel imports must be accompanied by facilitating domestic flat steel producers to obtain cheaper and more readily available raw materials, enabling them to compete with imported products. 3) The variable of domestic flat steel price is one of the factors contributing to the low production and supply of flat steel in the industry. The price disparity between domestic and imported flat steel can be reduced through strategies involving tax incentives and tariffs for flat steel products and raw materials. Of course, this strategy has limitations and must be combined with other approaches. 4) Factors such as flat steel plant capacity, import regulation, and tax incentives and tariff adjustments to minimize the price disparity in steel cannot be implemented in isolation but must be combined or integrated to achieve optimal outcomes.

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BIOGRAPHY

Rizky Aditya Wijaya, an experienced Indonesian government official in the field of chemical and metal industries, holds a Bachelor's Degree in Chemical Engineering from the University of Indonesia and is currently pursuing a master's degree in industrial engineering at the same institution. He has held significant roles within the Ministry of Industry of the Republic of Indonesia, leading divisions and directorates related to the chemical and metal industries. His contributions include participation in national technical committees, where he served as vice-chair and chair in several committees, strengthening the quality of industrial products. As the Secretary of the Board of Commissioners at PT. Krakatau Baja Industri, Rizky Aditya Wijaya continues to be involved in the development of the steel industry in Indonesia, reflecting a solid commitment to the advancement of the national industry and international standards.