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Analysis of the Impact of Soybean Price Increases on the Availability of Soybean Stocks in the Somber Small Industrial Center Area of Balikpapan City

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Abstract

Soybeans have a major role in the Indonesian economy, as they are the main source of raw materials in various industries. The objectives of this study are to identify factors affecting the increase in soybean prices, develop a dynamic system modelling related to the increase in soybean prices, calculate the availability of soybeans against the effect of soybean prices, and develop alternative policy recommendations to meet the needs of soybeans in the productivity of tempeh and tofu in Balikpapan, East Kalimantan. Applying system dynamics with Powersim uses a causal loop diagram to translate the variables that affect the availability of soybeans to meet the demand for soybeans. The results of this study show that the value of E1 for the sub-model of the rate of import activities is 1.0%, the availability of soybeans is 1.0%, and the need for soybeans is 0.99%, so E1 is declared Valid The value of E2 for the sub-model of the rate of import activities is 0%, the availability of soybeans is 0.622%, the need for soybeans is 0.325% so the value of E2 is declared valid. The forecasting variable of the rate of import activities in this study affects the availability and demand for soybeans. The availability variable influences the fulfilment of soybean demand. Balikpapan City can achieve soybean self-sufficiency for the following years if the needs have been met.

Introduction

Soybean food crops have significant similarities to rice and corn. This type of functional food contains various nutrients, such as isoflavones, saponins, lecithin, and filosterols, which can potentially reduce the risk of cardiovascular disease (Mufidah et al., 2021; Bratha & Irwan, 2023). Soybean is a source of food commodity that has long been cultivated in Indonesia (Andajani & Sidhi, 2019). Soybeans have a major role in the Indonesian economy because they are the main source of raw materials for processed tofu, tempeh, sauce, soy sauce, animal feed, and other processed products (Hanum et al., 2019). Soybeans are the main raw material in processed food. They have high nutritional value and can be a source of protein for side dishes to accompany rice in daily cooking. The increase in demand for soybeans can be attributed to the increasing public consumption of tofu and tempeh, as well as to meet the needs of the soy sauce industry (Andajani & Sidhi, 2019). As the main raw material in manufacturing processed tempeh and tofu, soybeans are key in producing these processed foods (Sahrawi et al., 2023; Villares et al, 2011; Wilson, 1995; Fukushima & Hashimoto, 2019; Ananta et al., 2023).

But along with this increase, there are also problems, such as problems in the supply of raw materials to meet existing demand (Ganjar et al., 2020). The high demand for soybeans must often match increased domestic soybean production (Djuliansah et al., 2020). In Indonesia, production has decreased due to an estimated decrease in harvest area of 55.56 thousand

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hectares or 8.93 percent. The decline in soybean harvest areas is partly due to the competition between domestic and imported prices, so farmers profit less from planting soybeans (Kata et al., 2020; Richards et al., 2012). The average soybean productivity of Indonesian farmers is still low, as seen in 2017 when it only reached 13.76 kilograms per hectare or 1.32 tons per hectare (BPS 2017) (Artini & Mahardika, 2017). This has also resulted in a decrease in harvested area of around 5% per year, which is higher than the projected increase in soybean productivity of 2% per year.

According to Primer Koperasi Produsen Tempe Tahu Indonesia (PRIMKOPTI) in Balikpapan City, East Kalimantan, there are at least 100 production houses of tempeh and tofu industry in the Somber Small Industry Center (SIKS), which is the central environment of the tofu and tempeh industry in Balikpapan City, East Kalimantan. Soybean is not a major commodity produced or has its production, like corn and sweet potato, so the city has never had soybean production. Balikpapan East Kalimantan can have soybean supplies for the production of tempeh and tofu by importing. Imported soybeans are imported from America through importing agents in Surabaya or Jakarta. The stock provided in the cooperative is 13.8 tons/day and 414 tons/month, reaching about 4,968 tons/year. Based on data from PRIMKOPTI in the SIKS Area of Balikpapan City, East Kalimantan, the current soybean price depends on the daily CBOT (Chicago Board of Trade) price or the dollar exchange rate as well as the availability of stock in America. At the same time, the limited stock is known to be due to the weather, the harvest period, and the shipping schedule, which has recently been disrupted due to the conflict between Ukraine and Russia.

It is known that the price of soybeans at the end of the year was Rp 7,700 X 50kg = Rp 385,000/sack and now has reached 13,400 X 50kg 670,000/sack, according to him, the price increase has increased by almost 100%. However, the demand for soybeans in SIKS is known to have decreased since the emergence of COVID-19 due to government programs related to lockdown and PPKM that limit the production of tempeh and tofu and then began to recover in early 2022. The provision of soybeans for tempeh and tofu artisans in the industrial area is also adjusted to the needs of the artisans, or there are no restrictions for artisans to buy soybeans in the cooperative.

The impact of the increase in soybean prices is experienced by some crafters who experience difficulties in producing tempeh and tofu due to the increase, such as many additional production costs, a decrease in employee salaries, and a reduction in production because the costs incurred for production are not comparable to the profits earned by the crafters. An increase in production costs not matched by revenue will result in losses (Jannah, 2018). Suppose this condition continues on an ongoing basis. In that case, it can lead to a lack of productivity of industry players in producing tempeh and tofu, especially for small-scale industry players, because of their inability to continue their business due to the income earned not covering losses / not being proportional to the increase in production costs that have been incurred. The company's supply of raw materials must be managed properly to avoid causing losses (Karima et al., 2022; Juardi et al., 2022).

This research uses a dynamic system approach. System dynamics is a framework that focuses on system thinking through feedback loops, taking some additional steps in a structured manner, and testing the concept through computer simulations (Forrester, 1994; Richmond, 1994; Azar, 2012). Comparing outputs and inputs in a system, better known as system feedback, is a common concept often referred to as a form of greeting by some people (Bahauddin et al., 2020). Changes to the system's dynamic behaviour over time, system dynamics, and feedback provide the latest information about the system's state, which will

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further affect decision-making; with these characteristics, this study uses a dynamic system approach.

The objectives of this study are to identify the factors influencing the increase in soybean prices, to develop a dynamic system modelling related to the increase in soybean prices, to calculate the availability of soybeans against the influence of soybean prices, and to develop alternative policy recommendations to meet the needs of soybeans in the productivity of tempeh and tofu in Balikpapan. The benefit of this study is that it provides alternative policies for soybean providers and decision-makers related to soybean prices, especially in the context of tempeh and tofu productivity in Balikpapan.

Methods

Location and Time of Study

This research was conducted at the Somber Small and Medium Industrial Center (SIKS) of Balikpapan City, East Kalimantan. The selection of this location is based on the consideration that the small and medium industrial centre area is the centre of the small and medium industry of tofu and tempeh production in Balikpapan city. The address of SIKS is on Jalan Ruhui Rahayu I Number 7 Balikpapan City, East Kalimantan. The research was conducted for 4 months, from September 2023 to December 2023.

Data Collection

The data used in this study consists of 2 types of data: primary and secondary. Primary data is obtained directly through interviews with SIKS Stakeholders and Tempe and Tofu Businesses in the SIKS area of Balikpapan City. In addition, questionnaires were distributed and filled in by the business actors. The sample determination used a purposive sampling technique with respondents' criteria relevant to the research topic. Meanwhile, secondary data is obtained through a literature review and relevant data from the Department of Industry, Trade, Cooperatives, Business and Medium Enterprises of Balikpapan City.

Data Processing and Analysis

Data processing and analysis of this research used a dynamic systems approach. Sterman (2000) revealed that dynamical systems can study the complexity of a system, understand the sources of policy retention, and design more effective policies. Thus, dynamic systems are used to catalyse sustainable change. Dynamic systems can be used at almost all decision levels, starting from the operational, tactical, and strategic (Suryani et al., 2020). System dynamics is a tool used to understand the behaviour of a complex system to be easier to understand where the elements in a system are interrelated and have a cause-and-effect relationship between system components (Dewi et al., 2015; Purnomo & Izza, 2020). Thus, a dynamic system can help determine the most influential factors in the system, simulate future policy predictions, understand dynamic complexity, understand sources of policy resistance, and design more effective policies to keep the business environment conducive and good for business development (Kurniawan, 2008).

The processing and analysis tool used to support the application of dynamic systems in this study is Powesim Studio software. Powersim Studio is used to develop Causal Loop Diagrams (CLD) and Stock and Flow Diagrams (SFD). SFD to show the relationship between variables in CLD. SFD is the main component of a dynamic system. A stock represents storing information or entity (such as money or population) in the system (Pramulya, 2021). Flows define the rate of change to stocks and add or subtract types of information or entities to or from stocks as they move through the system. Other inputs to the system that are not part of

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the system model itself, including converters and sources, can be integrated. The stages of data processing and analysis are described as follows:

Causal Loop Diagram (CLD)

In dynamic systems, the first step of this stage is to define a conceptual model to understand the behavioural patterns and relationships between variables in the simulation to assess the model's suitability to real-life behaviour. This can be achieved using a Causal Loop Diagram (CLD) created to show the cause-and-effect relationships of the variables to be modelled in the system. Stocks and converters, depicted with arrows, are represented from their source to the point that gives the effect (Atmaja et al., 2019). The arrows are labelled to understand whether the change in impact value is in the same direction as the cause value (positive increase or decrease) or whether the values change in the opposite direction. Both types of relationships, positive and negative feedback, are depicted.

Stock and Flow Diagram (SFD)

The SFD diagram illustrates the system's structure by showing the variable relationships in the Causal Loop Diagram that are clarified based on the quantitative data obtained. SFD is a more detailed description of the Causal Loop Diagram.

Model Formulation

The model formulation is formulating problems into mathematical forms that can represent real systems. This system formulation connects the variables identified in the conceptual model using symbolic language (Fabiani et al., 2019). In this stage, a flow diagram model of the system will be produced, which will then be simulated to observe the system's behaviour.

Validation

Validation is the process of determining whether a simulation conceptual model is an accurate representation of the real system being modelled (Pasha & Suryani, 2017). Simulation results will be validated to ensure the model accurately describes the real system conditions (Prabowo et al., 2020). There are two validation testing events, namely with the Statistical model mean comparison test and model validation with the amplitude variation comparison test (% error variance) (Barlas, 1989).

Design and Evaluate Improvement Scenario Policy

The next step that will be taken after the base model has been validated and verified is to create a simulation scenario (Aldillah, 2019). There are 2 types of scenarios in dynamic system simulations divided into two, namely structure scenarios and parameter scenarios. Structure scenarios are used to change the model structure by adding or reducing variables, while parameter scenarios are used to change the parameter values of a variable that affects the model..

Results and Discussion

Model Development

The developed system dynamics model is limited to the aspects related to the price increase and soybean demand on the productivity of tempeh and tofu in Balikpapan City. To analyse the soybean price increase, a simulation model is made using the problem model in the field as a guide in policy decision-making.

Causal loop Diagram

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The causal loop is used as a translator of variables that affect the availability of soybeans to meet soybean needs; in this causal loop, variables are described as having a relationship or mutual influence on these variables and have feedback as feedback to the existing system.

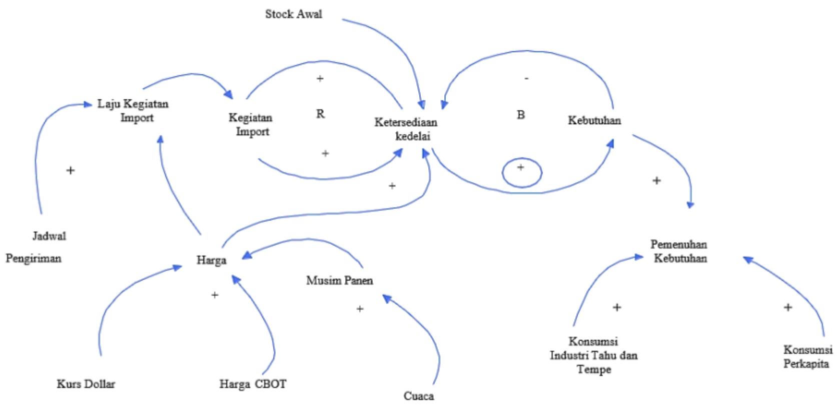

Figure 1. Causal loop Diagram of Soybean Availability of Balikpapan City

The availability of soybeans is influenced by import activities carried out by cooperatives to meet soybean needs; the more often cooperatives carry out import activities, the more soybean stock availability they have. However, if the availability of soybeans decreases, then import activities will also be more frequently carried out by cooperatives. The availability of soybeans is used to meet the needs of the community and the needs of the tempeh and tofu industry. If the needs are met, then the availability of stock can be said to be sufficient or exceeded and can be the government's hope in creating soybean self-sufficiency (Pasha & Suryani, 2017; Supadi, 2009).

The sub-model is a model used as a basis for validation, whether the model is close to real or current conditions.

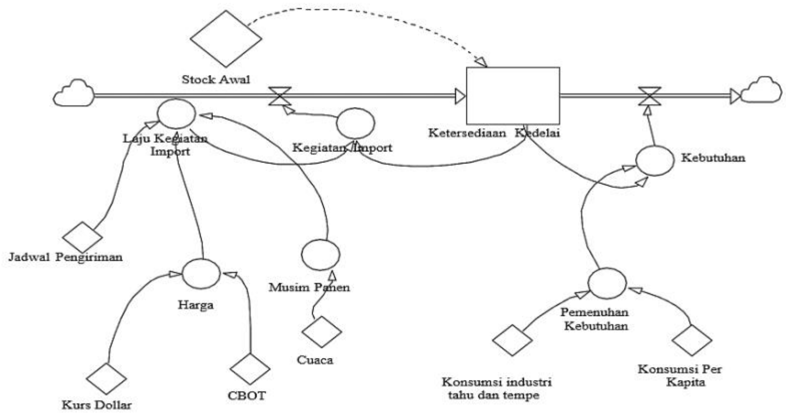

Figure 2. Stock and Flow Diagram

The figure above shows that the availability of soybeans is affected by the import activities carried out, with the average availability of soybeans amounting to 93.231 per import activity/kg; the average import activity is 53 times, so this factor affects the variable availability of soybeans in Balikpapan city. The amount of soybean availability in Balikpapan City continues to increase because soybean demand for tofu and tempeh industry and per capita consumption also increases.

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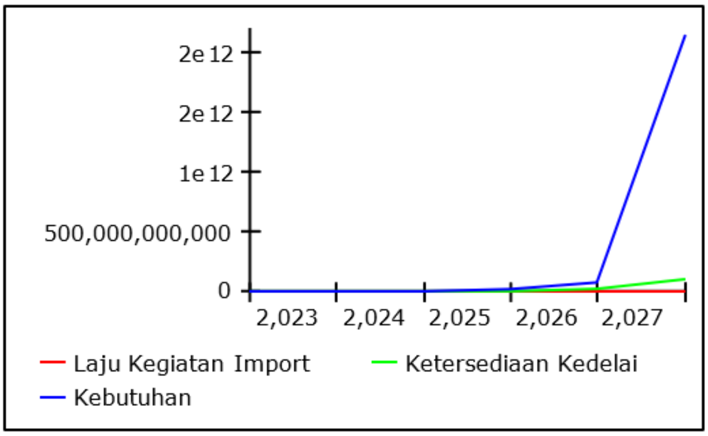

Figure 3. Graph of the Rate of Import Activities, Needs, and Availability of Soybeans

Figure 3 shows that soybean demand continues to increase every year, but an increase in the rate of import activities and soybean availability does not accompany the increase in demand.

Model Formulation

At the model formulation stage, the process of transforming the system concept or model structure compiled into equations is carried out. This step reflects the change from an informal conceptual view to a formal, conceptual view or quantitative representation of the model. The formulation of the import activity rate is as follows:

Table 1. Formulation of Import Activity Rate, Soybean Availability and Needs

No	Variable in Causal circle	Model Building	Formulation	Unit
1.	Import Activity Rate	Stock	Price+'Schedule Delivery'+'Harvest Season'/3	Dollar/Moon
2	Schedule Delivery	Variable	1	/Moon
3	Price	Variable	(CBOT+'Kurs Dollar')/2	Dollar/item
4	Kurs Dollar	Variable	50	
5	CBOT	Variable	50	
6	Harvest Season	Variable	= weather	/ Moon
7	Cuaca	Variable	6	/ Moon
8	Import Activities	Variable	= Pace of Activities Import	/ Moon
9	Availability Soybean	Stock	('Early Stock'*7.866)	Ton/ Moon
10	Initial Stock	Variable	414	Ton/ Moon
11	Soybean Needs	Flow	('Soybean Availability'*'Fulfillment Need')	Ton/ Moon
12	Fulfillment Necessity	Variable	'Consumption Per	Ton/ Moon

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			Capita'+'Tofu and tempeh industry consumption'	
13	Industrial Consumption Know and Tempe	Variable	13	Ton/ Moon
14	Per Capita Consumption	Variable	10	Person/ Moon

Model Validation

Model validation is carried out through two methods (Barlas, 1989): model validation with mean comparison test and model validation with amplitude variation comparison test (% error variance).

Sub-Model Validation of Import Activity Rate, Soybean Availability, and Soybean Needs. E1 is the simulation data's average value subtracted from the real average. The result is divided by the average value of the real data, and the number should be at most 5%. The E1 value for the import activity rate sub-model is 1.0%, soybean availability is 1.0%, and soybean needs are 0.99% If E1 is declared valid. Meanwhile, for E2, the model standard deviation value subtracted by the real standard deviation value and the result divided by the real data standard deviation value, the E2 value must be less than or equal to 30%. The value of E2 for this sub-model. The rate of import activity is 0%, the availability of soybeans is 0.622%, and the need for soybeans is 0.325% If the E2 value is declared valid. Thus, if the E1 Value ≤ 5% and the E2 Value ≤ 30% for the land area sub-model are met, this model is considered valid.

Scenario Improvements

After the model that has been developed is considered valid enough, the next step is to compile a simulation scenario according to the policy scenario to be decided (Aprillya, 2020). The government can increase the pace of import activities by forecasting demand for soybean availability to meet soybean needs in Balikpapan City.

Conclusion

Based on the findings and analysis of the research above, the conclusions of this study are: The E1 value for the import activity rate sub-model is 1.0%, the availability of soybeans is 1.0%, and the need for soybeans is 0.99% so for E1 it is declared valid The E2 value of the import activity rate sub-model is 0%, the availability of soybeans is 0.622%, the need for soybeans is 0.325% so the E2 value is declared valid. Developing a model using a dynamical systems approach requires a deep understanding and information of the conditions that occur or are current so that the model built can describe them. The forecasting of the rate of import activities in this study is a variable that affects the availability of soybeans and soybean needs. Variable availability has an impact on meeting soybean needs, if the needs have been met, then Balikpapan City can achieve soybean self-sufficiency for the following year. Recommendations for further research include adding variables related to productivity, such as the needs of the tofu and tempeh industry, production, and consumption, then improving scenarios about soybean price stability in import activities or the availability of national soybeans to meet domestic needs.

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