SCENARIOS DEVELOPMENT TO INCREASE PRICE STABILITY AND INVENTORIES OF SUGAR INDUSTRY USING SYSTEM DYNAMICS APPROACH

Agung Brastama Putra, Erma Suryani

Student Magister Program Major In Information System, Department Of Informatics Engineering, Faculty Of Information Technology, InstitutTeknologiSepuluhNopember, Surabaya, Indonesia
Email : agung11@mhs.if.its.ac.id
Lecturer Magister Program Major In Information System, Department Of Informatics Engineering, Faculty Of Information Technology, InstitutTeknologiSepuluhNopember, Surabaya, Indonesia

Abstract

Sugar is one of the strategic commodities owned by Indonesia as a tropical country, sugar has been produced in 110 countries, such as Brazil, India, Australia, Thailand, China, and Cuba. The sugar production in PT.Perkebunan Nusantara (PN) IX reached 58.000 quintals until this month and expected to increase to 878.000 quintals at the end of the year. PTPN production continues to decrease.This is due to machine condition that getting old. furthermore, sugarcane land area decline, which resulted in the supply of raw materials decline and sugar prices getting out of control. Currently, the price of sugar handed over to market mechanisms, market mechanism occurs when the sugar supply is higher than demand then the prices tend to decline, but when the sugar demand is higher than supply then price tend to an increase. With the above issues, the system of national sugar industry has a dynamic variable and flexible.

System behavior changes with time, the dynamics system which large and complex, availability feedback to the system and the feedback latest information about the state of system so that produce a decision. With the behavior of the system changing and dynamic, this paper use System Dynamic approach to solve complex problems by determining the scenarios sugar policy.

This paper presents a conceptual framework for scenarios development to increase stability price and inventories of sugar industry using system dynamics modeling approach, and adding bufferstock management into system dynamics model.

Keywords: Buffer Stock Management, Stability Price And Inventories, Scenarios Policy In Sugar Industry, System Dynamics Approach.

1. Introduction

Performance of the sugar industry depends on national and international factors, influencing factors are national sugar prices which referring to international sugar prices, consumption public, consumption private sector andgovernment policy. reference to the law number 7 of 1996about strategic food commoditiesand KEPRES (presidential decree) number 57 of 2004, Indonesian government set to sugar as goods in surveillance.

Since in 2000 the indonesia government appoint to PTPN IX, PTPN X dan PTPN XIin east java as the registered importer, ptpn have an authority to keep stability domestic sugar price, so not depends on the import of sugar [24]. result sugar production in PTPN IX is 458000 and have expected to increase until 878.000 kw at this year.

By Djarot irawan, Chief of Public Affairs PTPN IX, the PTPN production continues to decline because mill machine condition was old. Meanwhile,sugarcane land area has declined. and supply of raw material also decline[4].

Which influence factors in sugar demand are the government policy, price, availability and consumer preference, technological advances, per capita consumption, population growth[12]. therefore, availability of sugar should estimate the long term in order to meet consumer demands, according to BPS (Badan Pusat Statistik/central agency of statistic) availability of the national sugar progressively decreased while the population growth rate progressively increased. The last data (Fig.1) of cane land area is a 197.762 ha.

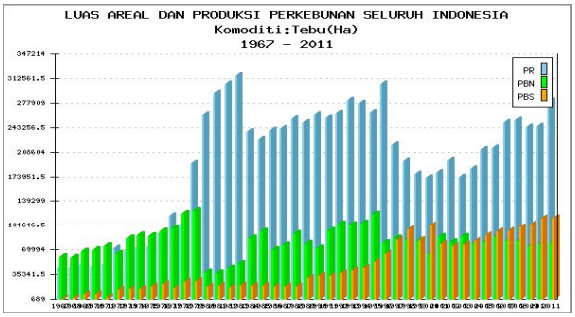

Figure 1.Rate of National Land Area[17]

With PR are afarmer land, PBN aregovernment land and PBS are a private sector land. cane land area can be increased or decreased, an increase cane fields could be improve the production cane into sugar crystals (Table 1). Increased and decreasedcan be due to by the environment, weeds, pests, diseases and rainfall (climate / weather)[8].

Table 1. Statistic Land Area in East Java [3]

Year	Land Area in East Java
2004	145172
2005	169448
2006	173829
2007	198343
2008	206263
2009	186026
2010	193396
2011	197762

Table 2. Population in East Java[4]

Year	Total
2008	37.094.836
2009	37.284.631
2010	37.492.905
2011	37.700.727

Table 3. Sugar production in East Java[5]

Year	Total
2008	1.065.523
2009	1.020.481
2010	1.014.272
2011	1.051.642

Figure 2. Local sugar price monthly[13]

On direct analysis has been obtained information about the productivity trends[7] due to the climate change / weather or climate variability ([19]&[14]). CCS Productivity (*Commercial Cane Sugar*) could decline if it contains a lot of water content[15]. Another variable is arainfall in the 30 days before harvest, it can influence CCS result.the high rainfall can be influence the rate of accumulation sucrose in the stalk and tend to increase the rate of hydration [18].

On research javalagi[12], advanced technology is an important component for the sugar industry, especially in handling the stock and distribution. Many companies are successful in handling distribution and stock with supported by technology and good management[11]. Information availability very important in sugar industry[12] and availability information can be improve the knowledge into the cane production system and helpfulness decision making in industry[15].

System behavior changes with time, the dynamics system which large and complex, availability feedback to the system and the feedback latest information about the state of system so that produce a decision[22]. Because the system behavior is a dynamic,this paper use system dynamic approach with a scenarios development to increase price stability and inventories of sugar industry

2. Literature Review

A.Model

Suryani in the book "modeling and simulation" ([22], 2006:1) model is a representation of the system in real life at the center of concern and the main issues.Modeling is process of establishing the model on system using a specific language. AnderssondanKarlsson ([1], 2001:17) model is a abstraction of the real object or system. Modeling was to describe the relationship of each component and behavior system to achieve goals.

Three types of modeling methods [1] is a analythical models, continuous models and discrete models.

a. Analythical Model
   Analythical Model which provides average data for process behavior and commonly used in software community.
b. Continous Model
   Types of continuous simulation technique, based on system dynamics and often used for modeling the project environment. This technique is useful when controlling the system, with dynamic variables, which change over time. Examples productivity variable and detect the error rate.
c. Discrete Model
   In the discrete model, the time increase because discrete events. This means that variable is constantly changing.

1. **Positive Feedback**
   Kind of this feedback to create the growth of process, where's an event be able to influence that will increase the incidence of continuously, This feedback can be lead to instability, inbalance, as well as continous growth. Example : population growth system.

2. **Negative Feedback**
   This type of feedback is try to create a balance by providing correction for the purpose can be accomplished. Example : air-conditioning system

Dynamic system is a professional field related to the complex system.System dynamics is a necessary foundation as a basis for effective thinking about the system[9].

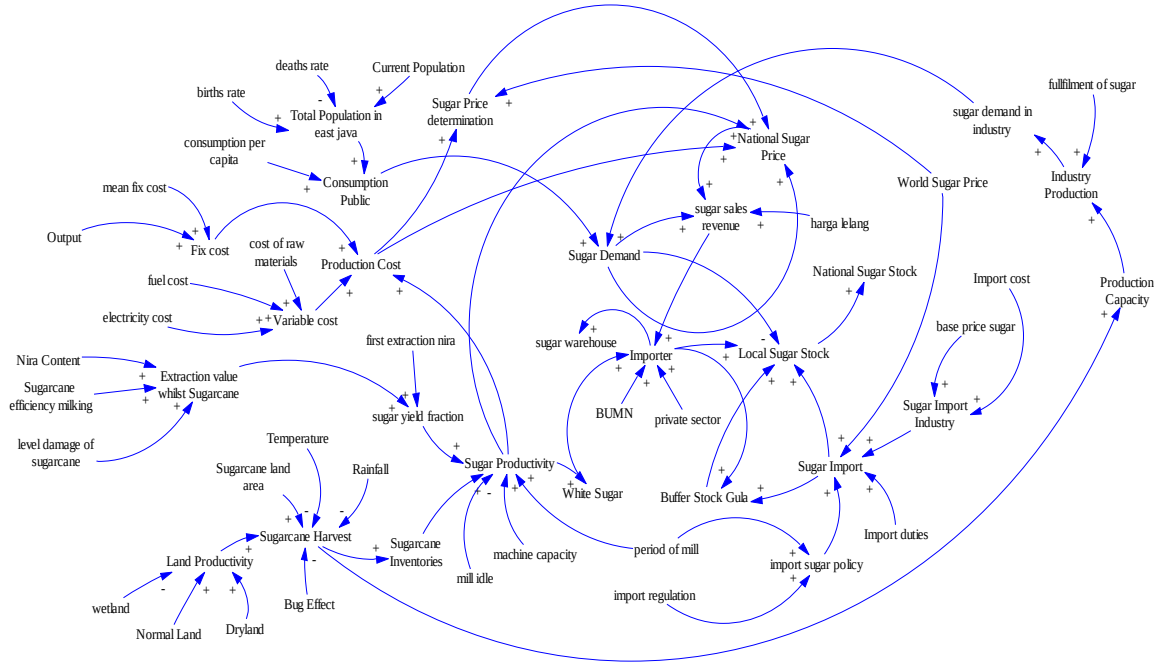

Figure. 3 Proposed Metodology Causal Loop Diagram of SD to Sugar Industry

B. System Dynamics Model

Complex dynamical systems approach need a formal models and simulation methods to test, improve and design new policies[21].

Simulation of dynamic systems is a continuous simulation that was developed by Jay Forrester (MIT) in the 1960s [2], focuses on the structure and behavior of systems composed between variables and loops feedback (feedback)([22], 2006:63).Relationship and interaction among variables declared in the causatic diagram, the feedback process can be categorized into two parts:

Five stages in developing a dynamic system models[21]:

Step 1: ***Problem articulation:***
In this stage, we need found the main problem, identifykey variableandconcept, determine the time horizonandcharacterize the dynamic problem to understandinganddesigning policy to goals.
Step 2: ***Dynamic hypothesis:***
Model makers must develop a theory of how to the problem occur. In this step, need to develop causal loop diagrams that explain the causal relationship between the variables and convert the causal loop diagram into a flow diagram.

Step 3: ***Formulation***:
To determine the dynamic system models, after change the causal loop diagram into a flow diagram, further the system must translate into "levels", "rates" and create *auxiliary equations*. To estimate the number of parameters, behavior relationship, and the initial condition.

Step 4: ***Testing:***
The purpose of testing is to compare the behavior of simulation models against actual behavior of the system.

Step 5: ***Policy Formulation and evaluation***:
Modelers could take advantage of the model is valid for designing and evaluating policies for improvement.

C. Bufferstock Management

According to Cognizant[2] difference between buffer stock and safety stock is a buffer stock to prevent manufacturers from the possibility can not meet customer demand while safety stock helps manufacturers to meet variations in the supply of raw materials.

According to Jensen et al.[10] in Puijman [16], the main purpose of the buffer stock is to protect against failures in the supply chain steps in the production process at the factory to meet customer demand from the upstream and downstream. Bufferstock has been implemented in stabilizing prices as for example in research Swaray [23] showed that the presence of a bufferstock could stabilize prices and incomes from cocoa producers

3. Methodology

A. Causal Loop Diagramming

A Dynamic system can be used for a methodology in studying problems in the sugar industry because it operates on the basis of feedback. dynamical systems are used to assist in identifying the variables associated with the sugar industry, and showing the relationship of each variable, behavior of system changing and dynamic nature. The system dynamics facilities [12]:

- Generates and explain past behavior of the industry.
- Identify variable which related with the sugar industry.
- To project the future behavior of industry and also toanswer IF-THEN type of questions.
- Test the various policies, which can be designed to increase the performance of sugar industry.
- Recommend the suitable policies, which help in price stabilization, increase inventories, cane price determination suitable for long-term growth.

Dynamic system can be used to analyze the sugar industry in Indonesia (fig. 3) because the problem are very complex, instability sugar prices while demand increases and the decline of sugar production, fig.3 identifies all variables related to the sugar industry and government policies.

B. Causal Loop Scenarios development to increase price stability and inventories

In this chapter describes the scenario to increase inventories and stability the price of sugar (fig. 4).

1. Scenario increases sugar production in sugar mills.

- Opening new land of sugarcane and building

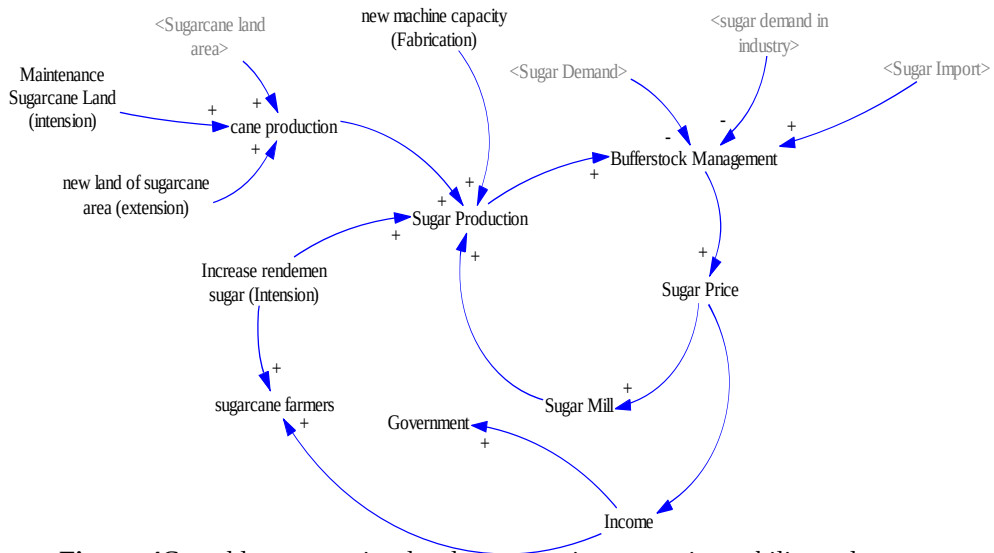

Figure. 4 Causal loop scenarios development to increase price stability and inventories of sugar industry

- mills sugar in the new land

  When the amount of land area enlarged cane sugar production it is expected to increase.
- Revitalisation of sugar factory

  Renewing the mill sugar machines obsolete and increase the machine capacity
- Sugarcane Land Revitalization

  Expansion, renovation and rehabilitation of land after harvest and before the sugar cane harvest.
- Increase rendemen sugar

  Rendemen/yield is a the sucrose content of sugar cane crop or sample, if the rendemen can be improved then it will be influence the production of sugar.

2. Scenarios maintain the bufferstock of sugar

During this time in Indonesia, implement price determination of sugar given to market mechanism, which means that when demand is high and production increased, the price can decrease/stable, while if demand is high and the production decrease and then the sugar prices to rise and uncontrolled, all information production and sugar import will be through bufferstock so the bufferstock will protect against failures in the supply chain stages in the production process at the factory to meet customer demand and prices stabilize from upstream to downstream[16].

4. Conclusion

The paper gives an overview of application of system dynamic modeling for scenarios development to increase stability price and inventories of sugar industry. It gives an overall scenarios of sugar industry in east java, indonesia. It also highlights the major problems faced by Indonesia sugar with case studies in east java, Indonesia. and how SD modeling can be used for the analysis of sugar industry. Proposed methodology for application of SD to sugar industry in east java, indonesia and described in the causal loop diagram. Scenarios generated by using SD will help in analysis of indonesian sugar industry. the results and scenarios of SD analysis can be implemented to all sugar industries in Indonesia.

References

[1] Andersson, Carina & Karlsson, Lena. 2001. A *System Dynamics Simulation Study of a Software Development Process*. CODEN:LUTEDX(TETS-5419)/1-83/(2001)&local 3. Lund Institute of Technology

[2] Barlas, Y., Multiple tests for validation of system dynamics type of simulation models, *European Journal of Operational Research 1989;42:59-87*

[3] BPS. Statistic Land Area in East Java (Online)http://jatim.bps.go.id/tables/2012/pertanian/tabel_6.2.9.pdf, accessed on 02-02-2013

[4] BPS. Population in East Java (Online). http://www.bps.go.id/tab_sub/view.php?kat=1&tabel=1&daftar=1&id_subyek=12&notab=1, accessed on 02-02-2013

[5] BPS. Sugar Production in East Java (Online). http://www.bps.go.id/tab_sub/view.php?kat=1&tabel=1&daftar=1&id_subyek=12&notab=1, accessed on 02-02-2013

[6] Cognizant. 2011. A new framework for safety stock management. Cognizant 20-20 insights

[7] Ellis, R.N., Basford, K.E., Cooper, M., Leslie, J.K., Byth, D.E., 2001. A methodology for analysis of sugarcane productivity trends 1. *Analysis across districts*. Aust. J. Agric. Res. 52, 1001–1009

[8] Ferraro, Diego O. & Rivero, Dario E. & Ghersa, Claudio M. 2009. An analysis of the factors that influence sugarcane yield in Northern Argentina using classification and regression trees. *Field Crops Research 112 (2009) 149–157*

[9] Forrester, J..W., (2010). System Dynamics: the Foundation Under Systems Thinking. *System Dynamic D-402, 2010*

[10] Jensen, A. Paul et all. 1991. Optimal buffer inventories for multistage production systems with failures. *European Journal of Operational Research 51 (1991) 313-326*

[11] Goldsby, J. Thomas &Griffis, Stanley E. &Roath, Anthony S. 2006. Modeling lean, agile, and leagile supply chain strategies. .*Journal of business logistics.Vol. 27. No. 1,2006*

[12] Javalagi.C.M, Bhushi U.M, 2007, An Overview of Application of System Dynamics Modeling For Analysis of Indian Sugar Industry, *proceeding of the 1-4244-1529-2/07 2007 IEEE*

[13] Kemendag. Local sugar price monthly (online).www.kemendag.go.id, accessed on 08-03-2013

[14] Lawes, R.A., Lawn, R.J., Wegener, M.K., Basford, K.E., 2004. The evaluation of the spatial and temporal stability of sugarcane farm performance based on yield and commercial cane sugar. Aust. J. Agric. Res. 55, 335–344.

[15] Lawes R.A & Lawn R.J. 2005. Applications of industry information in sugarcane production systems. *Field Crops Research 92 (2005) 353–363*

[16] Puijman, Roy. 2008. Buffer and inventory management downstream of a cracker: A queuing theory approach. *BSc. Industrial Engineering and Management Science (2008)*

[17] Report of the land area sugarcane in Indonesia for the 1967-2011. Departement of agriculture. http://ditjenbun.deptan.go.id/cigraph/index.php/graph/komoditiutama_bar/9-Tebu, accessed on 02-02-2013.

[18] Robertson, M.J., Muchow, R.C., Wood, A.W., 1999. A physiological basis for response of sugarcane to drying-off before harvest. Proc. S. Afr. Sugar Technol. Ass. 21, 196–202.

[19] Russell, J.S., Wegener, M.K., Valentine, T.R., 1991. Effect of weather variables on C.C.S. at Tully simulated by the AUSCANE model. Proc. Aust. Soc. Sugar Cane Technol. 13, 157–163.

[20]SuaraMerdeka. Sugar Production in PTPN IX (media online)http://www.suaramerdeka.com/v1/index.php/read/news/2012/09/28/131247/Produksi-Gula-PTPN-IX-Capai-458.000-Kuintal, diakses 02-02-2013

[21] Sterman, John D. 2000. *Business Dynamics Systems Thinking and Modeling for a Complex World*. McGraw-Hill Companie, inc.

[22] Suryani, Erma.2005, *Pemodelan dan Simulasi*, Graha Ilmu.

[23] Swaray, Raymond. 2011. Commodity buffer stock redux: The role of International Cocoa Organization in prices and incomes. *Journal of Policy Modeling 33 (2011) 361–369*

[24] Zaini, Achmad. 2008. Pengaruh Harga Gula Impor, Harga Gula Domestik, dan Produksi Gula Domestik terhadap Permintaan Gula Impor di Indonesia. *EPP.Vol.5 No.2. 2008. Program Studi Agribisnis Fakultas Pertanian Universitas Muawarman, Samarinda*