Dynamic Simulation Model to Analyze Some Factors that Influence the Growths of Agricultural SMEs and the Impact on GDP in East Java

Erma Suryani[1], Umi Salama[2]

Information Systems Department, Faculty of Information Technology, Institut Teknologi Sepuluh Nopember (ITS) Surabaya, 60111, Indonesia

Abstract. Agricultural sector is the third largest contributor to GDP in East Java. According to data from the Central Statistics Agency (BPS) in East Java by August 2010, from the entire workforce in East Java, the largest contributor is in the field of agriculture, amounting to 42.46%. Nationally, the largest proportion of business units for Small and Medium Enterprises (SMEs) comes from agriculture, animal husbandry, horticulture and fisheries. Based on these facts, farm sector is showing a lot of potential for economic development in East Java. This research aims to develop a system dynamics simulation model to conduct a comprehensive analysis of the factors affecting the growth of SMEs in the agriculture industry in East Java and its impact on GDP of East Java province. The dynamic *simulation results show that* the growth of SMEs in the agricultural sector in East Java is strongly influenced by the agricultural area and the amount of credit to SMEs. In addition, the growths of SMEs have a significant impact on the growth of GDP in East Java.

Keywords: small medium enterprise, system dynamics, simulation, agriculture

1. Introduction

Small and medium enterprises have a very important role in Indonesian economy because of the significant amount of this industry which came out to 52,764,603 units in 2009 or 99.99% of all industrial units. SMEs are the most contributing industry in Indonesian economy in terms of employment, compared to big industries (Susilo, 2007). Many developing countries view the growth and development of SMEs as an integral part to economic development and prosperity (Atherton, 2005). Meanwhile, SMEs are often ignored by the government (Ritchie & Richardson, 2004).

In East Java province, agricultural sector is the third biggest contributor of its GDP. According to data from East Java Bureau of Statistics in August 2010, 42.46% of all workforces in East Java work in this sector. Agricultural sector is also has the highest proportion of national SMEs industry. Considering these facts, agricultural SMEs is considered to have potentials for the economic growth of East Java. This research is expected to be able to give analytical description about the condition of agricultural SMEs growth in East Java, so that government will be able to initiate steps to empower this industry.

There aren't a lot of researches about SMEs simulation using system dynamics. Previous research was provided by (Kameyama, Kobayashi, & Suetake, 2001). Its objective is to build a standard of SMEs model both in micro and macro environment, and to see the effect of government policies to the SMEs. Meanwhile other researchers (Mansur & Sulistio, 2010) have developed a model of SMEs in micro environment and analyse the effect of government policies to the SMEs growth in such environment. From those researches, there isn't yet any discussion about SMEs growth in agricultural sector in macro environment, and its effect to economic growth in a region. It is therefore, in this research, the model is built generally and not specific to any sector of SMEs.

This research is more focused on the growth of SMEs in agricultural sector in East Java, and to see its effect on economic growth of East Java. The growth of SMEs is not only seen from its number or its production but also from its contribution to East Java GDP.

[1] *E-mail address*: erma.suryani@gmail.com
[2] *E-mail address*: oem.liverpudlian@gmail.com

2. Methodology

According to Sterman (2000) there are several steps to develop system dynamics model, as described in figure 1:

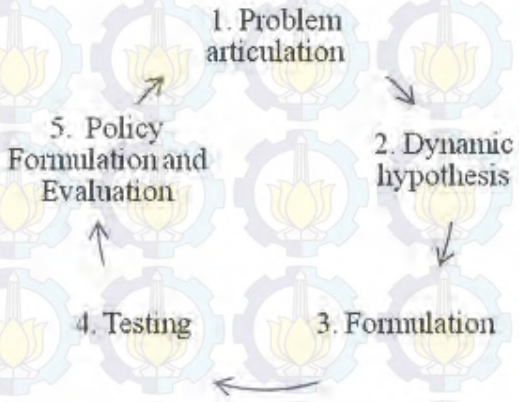

Fig. 1 System dynamics modeling process

- Problem articulation: a modeler has to find the problem, determine the key variables and the simulation timing, and also need to identify the problem dynamically to give understanding in designing policy to solve the problem.
- Dynamic hypothesis: a modeler should develop a theory about how the problem arose. The modeler has to make a causal loop diagram explaining the causal relationship among variables, and convert the causal loop diagram into a flow diagram.
- Formulation: a modeler has to translate the system into level, auxiliary, and rate equation. In this step, modeler also has to estimate the parameters, initial condition and relationship among variables.
- Testing: in this step, we need to compare the data from simulation result with historical data from the real behavior of the system.
- Policy formulation and evaluation: once, we have developed a confidence in the structure and the behavior of the model, we can utilize it to design and evaluate policies for improvement by changing the parameter values or re-designing new structure.

3. Result and Analysis

3.1. Base Model Development

The main factor influencing agricultural SMEs growth is technical support from the government or private party. The technical support is focused on financial support which means the availability of credit. Credit availability for SMEs affect positively to the number of industrial units, which means the more credits are available, and the more unit of SMEs will grow. Meanwhile, the number of industrial unit of SMEs will affect the agricultural area used, which will affect the total production of agricultural SMEs.

The agricultural area used to agricultural activity will affect positively to the total production of agriculture (Wiranatha & Smith, 2000). This means, the more industrial units of SMEs growth, the less agricultural area used to agricultural activity, so the total production of agriculture become smaller. The agricultural area is also affected by population growth that will lead to housing area.

Variable GDP is accumulation of four variables such as (1) consumption, (2) investment, (3) government purchases, and (4) net export.

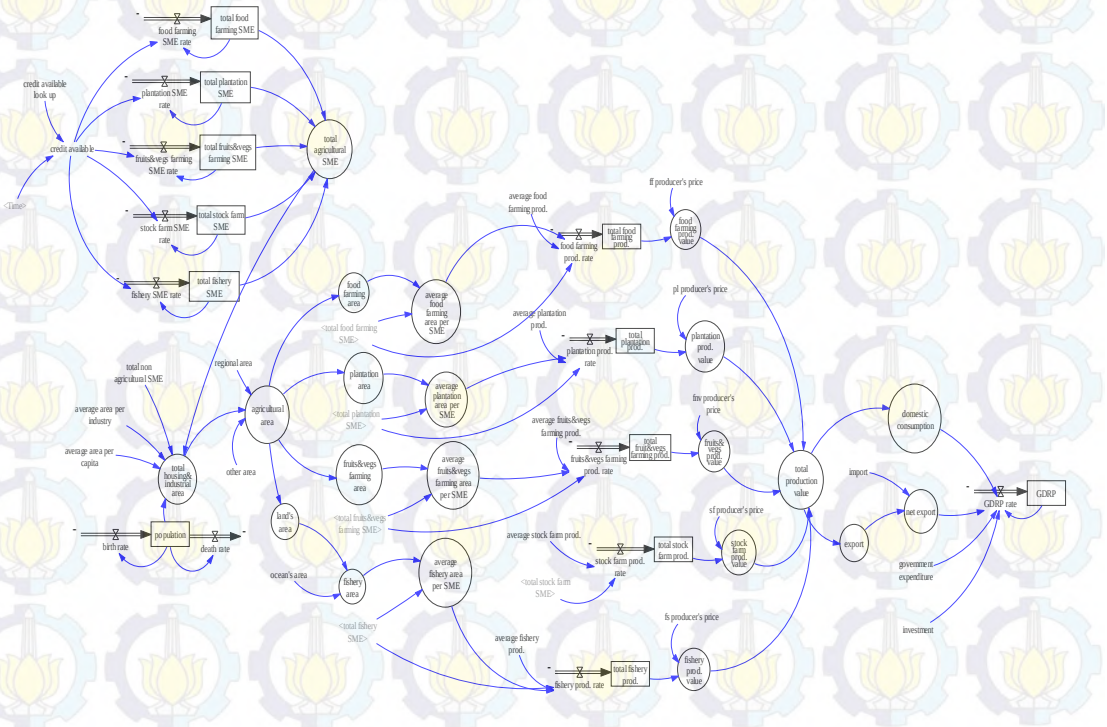

Fig. 2 Flow Diagram of the Base Model

3.2. Model Validation

Model validation is required to checked whether the conceptual model of simulation is an accurate representation from the real system (Law & Kelton, 1991). Historical data during the time horizon of simulation of the base model is required. The method used in this research is behavioural validation test. There are two ways of behavioural validation test:

- Error Rate (mean comparison)

$$E1 = \frac{[\bar{S} - \bar{A}]}{\bar{A}} \quad (1)$$

Where:

$\bar{S} = the\ average\ of\ simulation$

$\bar{A} = the\ average\ of\ data$

Model is considered valid if E1 ≤ 5%

- Amplitude Variations Comparison

$$E2 = \frac{[S_s - S_a]}{S_a} \quad (2)$$

Where:
S_s = *standard deviation of model*
S_a = *standard deviation of data*

Model is considered valid if E2 ≤ 30% (Barlas, 1989).

The error rates (mean comparisons) of GDP, total agricultural SMEs and domestic consumption are described as follows:

$$Error\ Rate\ GDP = \frac{[443.684.691.926.295 - 426.109.789.317.273]}{426.109.789.317.273} = \mathbf{0.04}$$

$$Error\ Rate\ Total\ agricultural\ SME = \frac{[2.363.928 - 2.454.376]}{2.454.376} = \mathbf{0.04}$$

$$Error\ Rate\ Domesic\ consumption = \frac{[316.872.912.082.758 - 300.598.597.641.854]}{300.598.597.641.854} = \mathbf{0.05}$$

In this research, we also test the amplitude variations (variance errors) of GDP, total agricultural SMEs and domestic consumption as follows:

$$Variance\ Error\ \ GDP = \frac{[199.158.065.162.199 - 209.858.721.526.509]}{209.858.721.526.509} = \mathbf{0.05}$$

$$Variance\ Error\ \ Total\ agricultural\ SME = \frac{[161.091 - 232.933]}{232 - 933} = \mathbf{0.3}$$

$$Variance\ Error\ \ Domestic\ Consumption = \frac{[136.297.967.452.604 - 127.282.622.084.404]}{127.282.622.084.404} = \mathbf{0.07}$$

3.3. Optimistic Scenario Development

This scenario is developed to see the growth of GDP if the average growth of *total agricultural SMEs* is 3% (by considering the highest growth of SMEs unit in 10 years), and the growth of agricultural SMEs can contribute to East Java GDP. This contribution is determined by dividing total production of agricultural SMEs (in Rupiah) with the total GDP of East Java. Total agricultural SMEs growth is the difference of the number of SMEs unit in time (t) with the number of SMEs unit in time (t-1), then divide the result with number of SMEs unit in time (t-1).

Table 1. Optimistic Scenario Result

GDP Growth	Production Value Growth	Ratio of GDP and Production Value
16,24 %	14,14 %	32,24 %

3.4. Pessimistic Scenario Development

The next step is to find out the growth of agricultural SMEs production and its contribution to East Java GDP in the future if the growth rate of total agricultural SMEs unit is around 1%. This growth is made by considering the lowest growth rate of total agricultural SMEs in the last 10 years.

Table 2. Pessimistic Scenario Result

GDP Growth	Production Value Growth	Ratio of GDP and Production Value
16,11 %	13,42 %	31,35 %

3.5. Most Likely Scenario Development

After developing both optimistic and pessimistic scenarios, the next step is to analyze the growth of agricultural SMEs and its contribution to East Java GDP based on most likely scenario. In this scenario, the growth rate of total agricultural SMEs is projected to be around 2% by considering the optimistic and pessimistic scenarios.

Table 3. Most Likely Scenario Result

GDP Growth	Production Value Growth	Ratio of GDP and Production Value
16,22 %	14,02 %	32,16 %

3.6. Conclusion

From the scenario results, we can conclude that:

- In estimating the contribution of agricultural SMEs to East Java GDP in the future, it was found that agricultural SMEs growth is very much affected by agricultural area, productivity, and financial support provided by government or private party.
- Agricultural SMEs growth has contributed a large portion to GDP, with average contribution of around 32% of total East Java GDP.
- The contribution of agricultural SMEs to East Java GDP is keep decreasing from year to year. This is likely because of a decrease in agricultural area. The growth of population and industry units will reduce the area for plantation. It was found that the contribution of agricultural SMEs will keep decreasing to the average of 23% in 2015.

4. Acknowledgements

We are very thankful to all of those who supported and helped us in any respect during the completion of this research, such as Central Bureau of Statistics Indonesia, Provincial Government of East Java, Cooperative Agency, Micro, Small and Medium Enterprises. With all their support and the data, this research can be completed.

5. References

[1] Arnold, R. A. (2008). *Economics, 8th edition.* Mason, Ohio: Thomson South-Western.

[2] Atherton, A. (2005). A Future for Small Business? Prospective Scenarios for the Development of the Economy Based on Current Policy Thinking and Counterfactual Reasoning. *Futures 37* , 777-794.

[3] Barlas, Y. (1989). Multiple test for validation of system dynamics type of simulation models. *Europe Journal of Operational Research* , 183-210.

[4] Kameyama, S., Kobayashi, H., & Suetake, T. (2001). Model for SMES Sector Development. *19th International Conference of the System dynamicss Society* (p. 86). Atlanta, Georgia USA: System dynamicss Society.

[5] Law, A. M., & Kelton, D. W. (1991). *Simulation Modeling and analysis (2nd edition).* New York: Mc GrawHill, Inc.

[6] Mansur, A., & Sulistio, J. (2010). Policy Analysis and Design of Small and Medium Enterprises for Development Program. *The 11th Asia Pasific Industrial Engineering and Management Systems Conference.* Melaka.

[7] Ritchie, J., & Richardson, S. (2004). Disclosing Smaller Business Success and Failure. *The British Accounting Review 4* , 233-250.

[8] Suryani, E., Chou, S.-Y., & Chen, C.-H. (2010). Air Passenger Demand Forecasting and Passenger Terminal Capacity Expansion: A System dynamics Framework. *Expert System with Applications* , 2324-2339.

[9] Susilo, Y. S. (2007). Pertumbuhan Usaha Industri Kecil - Menengah (IKM) dan Faktor-Faktor yang Memmpengaruhinya. *Jurnal Eksekutif 4* , 306-313.

[10] Wiranatha, A. S., & Smith, P. N. (2000). A Conceptual Framework for a Dynamic Model for Regional Planning: Towards Sustainable Development for Bali, Indonesia. *1st International Conference on System Thinking in Management*, (pp. 649-654).