

## **The Influence of Road Infrastructure, Electricity Consumption and Agriculture Land on Gross Regional Domestic Product: An Empirical Study in a Special Region of Yogyakarta Indonesia**

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**Abstract:** This study aims to analyse the influence of road infrastructure, electricity consumption and agriculture land on the Gross Regional Domestic Product (GRDP) of the special region of Yogyakarta (DIY) using the concept of sustainable development. Increased development in Yogyakarta Province often has an impact on the reduction of agricultural land. The model used is multiple regression and a partial adjustment model with time series data for the period 1999-2014. Partially, the results showed that only the electricity consumption is significantly positive for GRDP in the special region of Yogyakarta while the road infrastructure and agriculture land have no significant effects. However when combined, the condition of road infrastructure, electricity consumption and agriculture land have significant impact on the GRDP of the special region of Yogyakarta. The result of this research is expected to contribute in the policy making where the government should continue to consider the concept of sustainable development for the benefit of the fulfilment of the needs of the next generation and environmental sustainability.

**Key words:** Sustainable development, road length, electricity consumption, agriculture land, GRDP, sustainability

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### **INTRODUCTION**

The regional-scale economic development can be measured using the increase in Gross Regional Domestic Product (GRDP). The economic development of a region is influenced by many factors involving both economic variable factors and non-economic supporting factors. To increase the economic development, government can implement both monetary policy and fiscal policy, despite the economic development result not being directly observed.

The development conducted by the government and society currently should not sacrifice the needs of future generations, therefore development must be well-planned for the benefit of present and future generations. There is a concept within development known as sustainable development. Sustainable development is development that meets the needs of the present without compromising the ability to meet the needs of future generations. Sustainable development should pay attention to the use of the environment and the preservation of the environment to maintain the quality of the environment. Neglecting environmental sustainability will cause a reduced or even an entirely lost supporting capacity of the environment, thereby disrupting the continuity of further development.

The economic growth development of DIY generally tended to increase between 2000 and 2014 even though it was accompanied with fluctuations in several years. Figure 1 shows that after the earthquake period in 2006, DIY indicated the economic growth development, however, in 2009 due to the global crisis, the economic growth of DIY experienced a decline from 5.03- 4.43%. The global crisis impact on DIY did not last long which was shown by the improvement of DIY economic conditions starting with the economic growth in 2010 amounting 4.88%, following by 5.17% in 2011, 5.32% in 2012, 5.40% in 2013 and 5.18% in 2014.

The economic development of DIY cannot be separated from the electricity consumption, road infrastructure development and farmland provision. The success/failure of DIY economic development is not merely the success/failure of the economic aspect in development but it is also, correlated with the success/failure of those several aspects above mentioned. The road infrastructure is a capital reserve of a state which means that when the road infrastructure development grows rapidly, it shows that the country has adequate reserved capital.

Construction of road infrastructure is important to be carried in order to provide public services efficiently, quickly and without a hitch. In Indonesia, based on the

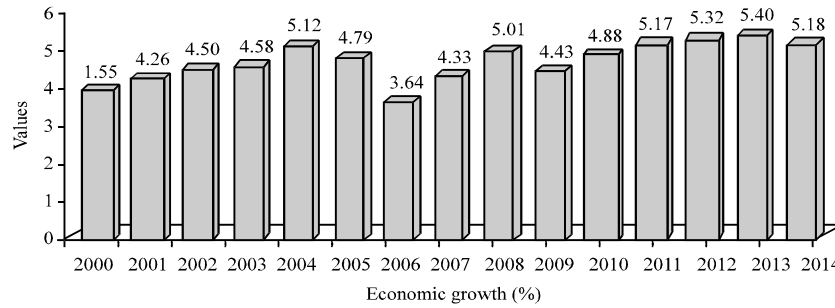


Fig. 1: DIY economic growth (%) year from 2000-2014: BPS, DIY in the figures, processed

research conducted by the OBE (2013) it is discovered that the need for road infrastructure has increased significantly, since, 2004 after the crisis hit Indonesia in 1998. Post-2004 the economic growth in Indonesia is always in the top 5% and at one time even reached more than 6% such conditions need to be matched with adequate road infrastructure improvement. Increasing advanced economy requires the support of the highway infrastructure in good condition and adequate long with a good spread. But according to the OBE (2013) with a high economic growth Indonesia was in fact still encountering obstacles such as lack of a long road and the low quality of the roads, even though adequate road infrastructure is believed to be capable of sustaining economic growth in the future. Meanwhile, Kumari and Chatteraj (2012) in their study in India found that the potential growth of the road infrastructure sector in India is still very large, especially, if supported by high economic growth and the increasing need for world-class road infrastructure.

Road network is land transportation infrastructure which has a vital role in transportation sector especially for the goods and service distribution sustainability. The effective method in designing and planning is badly needed to obtain the best and economical result which also, fulfil the safety element of road use and is ecosystem friendly. The progress of length and condition of DIY roads can be in Fig. 2.

The length of roads in the special region of Yogyakarta Province reached 4735.46 km in 2010 with the road quality involving 1944.76 km in good condition, 1709.44 km in middle condition and 1081.26 km as damaged road. In 2011, it reached 4592.06 km involving 1961.35 km in good condition, 1648.67 categorized as middle condition and 982.04 in damaged condition. In the next year, 2012, the road length of 4190.37 km comprised 2041.42 km of good condition roads, 1350.11 km of middle condition roads and 798.84 km of damaged condition roads. In 2013 the road length covered 3688.82 km with

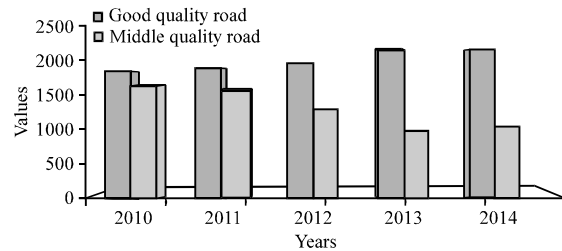


Fig. 2: The good and middle quality of road (km) year 2010-2014: BPS, DIY in the figures, processed

2244.93 km in good condition, 1044.11 km in middle condition and 399.78 km considered as damaged roads. And in 2014 the road length covered 3901.70 km with 2273.81 km in good condition 1084.06 km in middle condition and 543.83 km considered as damaged roads. Generally, the road quality development in DIY increases from year to year.

The strategic position of DIY makes this region a connecting area which has a significant role in supporting the goods and service distribution activities and workforce mobilization of the surrounding regions.

Meanwhile, as one form of energy which is readily used by the consumers, electricity power also plays determining role to reach the development target; therefore, it needs to be managed harmoniously, correlatively and simultaneously throughout the DIY development stages. Figure 2 shows the difference between the amount of electricity produced by electricity consumption in DIY from 2010-2014. The trend of electric power production equal July 28, 2018 to consumption trends.

DIY Province is known as a rich province and has large farms and consists of Gunungkidul Regency, Kulonprogo Regency, Sleman Regency, Bantul Regency and Yogyakarta City. The more extensive and productive agricultural land will certainly be a greater contribution to regional income or GRDP. Increased development in

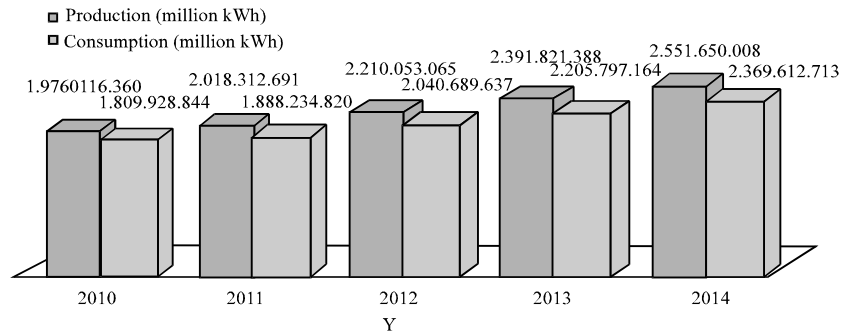


Fig. 3: Amount of electricity production and consumption (Million kWh) year 2010-2014: BPS, DIY in the figures, processed

Yogyakarta Province often has an impact on the reduction of agricultural land for physical development purposes such as housing, markets, schools and colleges, hotels, terminals and other public proposition development (Fig. 3).

In such, this research will address three problems. First, it will examine whether the road infrastructure (good and middle quality) has contribution to GRDP of DIY province. Second, it will analyze if the electricity consumption always supports each stage of the DIY development, particularly in enhancing the societal prosperity and promoting economic improvement. Third, it will also elaborate whether the reduction of agricultural land will reduce GRDP of DIY Province.

**Literature review:** The road infrastructure in various studies shows improvement of socioeconomic conditions in a country. According to Mushir and Hailemariam (2015) road and transport infrastructure in Ethiopia has been able to support the improvement of the economy significantly. The importance of road construction in order to encourage the economic growth of a country turned out to have another negative side. As the construction of roads that damage the environment, reduce green land, reducing mammal species and protected species and can increase accidental causes of death.

The development of public work infrastructure including road infrastructure is a crucial activity in increasing the economic development of a region. The existence of those public works will result in the productivity increase in production factors. On the contrary, if the condition where the infrastructure is neglected, the productivity will decline. In several countries, the road infrastructure establishment is under the authority of a particular institution. For example, Singapore has the Land Transport Authority (LTA) as an officially authorized agent for road establishment, according to Ling and Ng (2011).

Development is aimed at improving society welfare. The government role as development mobilizer is very strategic to support the society welfare improvement and national economic development. Economic growth is one of the indicators to observe the results of the development implemented and it is also, useful to determine the future development direction. A positive economic growth shows an existence of economic increase whereas a negative economic growth indicates a decrease. Prasetyo and Firdaus (2009) found that infrastructure including electricity, road and clean water positively influences Indonesian economy. Electricity has the most important role in production process. Consequently, the infrastructure development policy to promote Indonesian economy in facing global crisis is precise and needs all element's support.

However, it is also, possible that infrastructure development has no significant influence on economic growth as described by Maqin (2014) that electricity just solely serves a significant influence on economic growth but not road infrastructure and education which apparently have positive direction yet no significant contribution. The insignificant road infrastructure may occur due to the inadequate road condition as Worku (2011) argued that roads with inadequate quality will not significantly influence the economic growth. Basically, economic growth also has causality relation not only with infrastructure development as found by Nazlioglu *et al.* (2014) who stated that there was a causality relation between economic growth of Turkey and the electricity consumption.

Al-Mulali (2014) and Al-Mulali and Mohammed (2015) have investigated the relationship between energy consumption including electricity and Gross Domestic Product (GDP) in emerging countries. The result revealed that GDP and energy consumption are co-integrated, the renewable and non-renewable energy consumption also, discovered having a long running positive relationship with the economic sectors.

Because of that, several studies later talked extensively about sustainable agriculture such as agriculture to preserve the environment while also providing a significant economic impact for the region. Tey *et al.* (2012) explains that sustainable agriculture has a definition that is a process that can integrate agricultural system with the realization in practice which includes aspects such as environmental sustainability, optimization of natural resources, economical, environmentally friendly and socially as well as viable functional of time to time. In order to realize sustainable agricultural systems, farmers are always faced with the trade-offs between economic, environmental and social dimensions.

One important aspect that can help to achieve the success of sustainable agriculture in urban areas is the agricultural information system. Through the application of appropriate technology, China has managed to build a good system of agricultural information. The agricultural information system is the Beijing agricultural information. Shi *et al.* (2013) have done a research about it and found that agricultural information system can support the change from traditional agriculture to the modern agriculture and also, be able to help the promotion of economic growth in urban areas based on agriculture in the countryside.

According to the mentioned literatures, we develop a simple model of GRDP of special region of Yogyakarta (DIY) which is symbolized by Y as follow: The variables used in regressive macro analysis were as follows:

$$Y = f(X_1; X_2; X_3; X_4) \tag{1}$$

Where:

- Y = Constant GRDP value (IDR million)
- X1 = Good quality road length (km)
- X2 = Middle quality road length (km)
- X3 = Electricity consumption (kWh)
- X4 = Agriculture land (ha)

Based on this literature review, there is one important research gap that has not been discussed in the previous studies. The studies mentioned in this study were focused on certain variables, partially and they also have different variables and combinations compare to this research.

For example, Ali and Meaza only discussed about road construction, Bangun and Firdaus discussed only about electricity, road and clean water while Maqin discussed about electricity, road infrastructure and education. In other words there were no research combining road infrastructure (with two different qualities which is good and middle quality road), electricity and agriculture land. Therefore, this research will focus on these four variables as a combination in response to the afore-mentioned gap.

## MATERIALS AND METHODS

This study analyses the influence of independent variables which include good quality road length, middle quality road length, electricity consumption and agriculture land to the GRDP of special region of Yogyakarta during 1999-2014. Data was collected through library research from the Central Bureau of Statistics (BPS), of special region of Yogyakarta (DIY). Specifications model built in this research is the GRDP function equation = f (good quality road length, middle quality road length, electricity consumption, agriculture land). Based on the model of GDP in Eq. 1 in this study used two regression models that multiple regression and Partial Adjustment Model (PAM).

**Multiple regressions:** Multiple regressions is a simple model to estimate the response of several independent variables on the dependent variable in a static linear relationship. Based on the theoretical model expressed in Eq. 1, the econometric model developed as follows:

$$y_t = \alpha_0 + \alpha_1 X_{1t} + \alpha_2 X_{2t} + \alpha_3 X_{3t} + \alpha_4 X_{4t} + e_t \tag{2}$$

Multiple regressions have constant ( $\alpha_0$ ) and four coefficients  $\alpha_1$ - $\alpha_4$  while  $e_t$  is the residual.

**Partial Adjustment Model (PAM):** Partial adjustment models is a dynamic model that can explain the effect of several independent variables of the GRDP as the dependent variable. Using the findings Feige as quoted in Feriyanto (2014), a Partial Adjustment Models (PAM) is a model capable of describing the relationship between one or more independent variables with the dependent variable in the regression form dynamically in disequilibrium condition. The GRDP which symbolized by  $Y_t$  will be different from the planned yearly:

$$Y_t = \lambda Y_t^* + (1-\lambda) Y_{t-1} \tag{3}$$

where  $0 < \lambda < 1$ . Equation 3 reflects the short-term relationship between long run desired GRDP and lag of GRDP as independent variables with actual GRDP as a dependent variable. According to eq. 1, the GRDP or  $Y_t$  depends on good quality road length ( $X_1$ ), middle quality road length ( $X_2$ ), electricity consumption ( $X_3$ ) and agriculture land ( $X_4$ ). The long run model can be written as follows:

$$Y_t^* = \alpha_0 + \alpha_1 X_{1t} + \alpha_2 X_{2t} + \alpha_3 X_{3t} + \alpha_4 X_{4t} + e_t \tag{4}$$

Substituting Eq. 4 into Eq. 3 gives:

$$Y_t = \varepsilon_0 + \varepsilon_1 X_{1t} + \varepsilon_2 X_{2t} + \varepsilon_3 X_{3t} + \varepsilon_4 X_{4t} + \varepsilon_5 Y_{t-1} + v_t \quad (5)$$

Where,

$$\lambda = b_1 / (b_1 + b_2)$$

$$\varepsilon_4 = (1 - \lambda)$$

$$\alpha_0 = \varepsilon_0 / \lambda$$

$$\alpha_1 = \varepsilon_1 / \lambda$$

$$\alpha_2 = \varepsilon_2 / \lambda$$

$$\alpha_3 = \varepsilon_3 / \lambda$$

$$\alpha_4 = \varepsilon_4 / \lambda$$

$$v_t = \text{error term}$$

Equation 5 is estimable model using Ordinary Least Square (OLS). Therefore, this research provides empirical model based on this equation. The data used in this regressive analysis were the time series data from 1999-2014.

## RESULTS AND DISCUSSION

**Multiple regression:** The model used did not show multicollinearity, heteroscedasticity and autocorrelation. The multicollinearity test showed that there was no auxiliary regression determinant coefficient which was larger than the original regression determinant coefficient, consequently there was not multicollinearity. The result of heteroscedasticity and white tests concluded that there was no heteroscedasticity problem, since, prob Chi-square was more than  $\alpha = 5\%$ .

The model also did not contain autocorrelation as shown by the Lagrange Multiplier (LM) test result in which  $x^2$  calculation value (chi square) was smaller than  $x^2$  table value (chi square). The calculation value of  $x^2$  (chi square) was 4.737175 and the table value of  $x^2$  (chi square) was 9.488 on df 4 and  $\alpha = 5\%$ .

**Partial Adjustment Model (PAM):** The model used did not contain multicollinearity there are no heteroscedasticity and no autocorrelation. It was evident from the test results that showed no multicollinearity determination coefficient auxiliary regression greater than the original regression coefficient of determination that there is no multicollinearity. The results of the test white heteroscedasticity test concluded that the regression model there is no problem heteroscedasticity. The model does not contain autocorrelation shown test results Lagrange Multiplier (LM), the value probability  $x^2$  (chi square) count is greater than the value of  $\alpha = 5\%$ .

Table 1: Result of multiple regression analysis (OLS)

Variable	Coefficient	t-statistic	Prob.
ZC	5600725.	5.070764	0.0004
X <sub>1</sub>	78.12834	0.294765	0.7737
X <sub>2</sub>	-1.237172	-0.479034	0.6413
X <sub>3</sub>	0.008602	38.21954	0.0000*
X <sub>4</sub>	-0.701862	-0.298808	0.7707
R <sup>2</sup> , 0.997976; Adjusted R <sup>2</sup> , 0.997239; F-statistic, 1355.662; Prob. (F-statistic), 0.000000. *Significant at 0% level significance			

Table 2: Result of Partial Adjustment Model (PAM)

Ariable	Coefficient	t-statistic	Prob.
C	664914.7	1.059432	0.3170
X <sub>1</sub>	-28.67881	-0.319136	0.7569
X <sub>2</sub>	-0.928831	-1.065126	0.3146
X <sub>3</sub>	0.001311	1.735027	0.1168*
X <sub>4</sub>	-0.120639	-0.155053	0.8802
Y (-1)	0.903797	9.725169	0.0000*
R <sup>2</sup> , 0.999798; Adjusted R <sup>2</sup> , 0.999686; F-statistic, 8919.341; Prob. (F-statistic), 0.00000*, *Significant at $\alpha = 10\%$ level significance one side			

Using two regression models which are multiple regressions static and dynamic (PAM) showed partially the length of the road for the good quality of the road as well as the medium quality and the agriculture land have not yet as significant effect towards the DIY GRDP. Meanwhile, the variable of electricity consumption partially has a significant effect toward the DIY GRDP. (Table 1 and 2).

The length of the roads in the special region of Yogyakarta (DIY) which consists of a long road good condition and the middle is still insufficient to support economic activities of the region to the fullest because in addition there are many areas that have not been included in the procurement of road length, also, the length of roads in the city centre already inadequate accommodate the vehicles that would otherwise need to be extended again. But the difficulty extending the road in the city centre for all districts and cities in the region of Yogyakarta is the difficulty of freeing the area for the construction of roads, given the already dense population and the needs of the life facilities such as a place to stay (home), markets, schools and other public facilities. In addition, it is possible that the length of the road with excellent quality consisting of a ring road South and North that connects DIY with Central Java Province (Western part of the Purworejo Regency, Northern part of Magelang Regency and Eastern part of the Klaten and Surakarta Regencies) instead of huge benefit to the economic improvement regencies in Central Java Province, considering the position of Yogyakarta Province situated between the Purworejo Regency, Magelang regency and Klaten-Surakarta Regencies. Special region of Yogyakarta serves as a liaison between that regency areas.

This causes a minimal contribution to GRDP DIY path length of this region does not significantly support the rapid movement of economic activity in the province and surrounding areas. These findings also, fortify what is researched by Worku (2011), one of which is that the poor quality of the road has no significant effect on economic growth.

Although, it has not yet had a significant influence on GRDP, the roads of DIY must be improved in terms of quantity and quality, so that, it fulfils the standard of sustainable development. Acceleration of infrastructure development should be implemented in addition to meeting the basic needs of society and improve the welfare of society as well as the expansion and improvement of employment opportunities with the ultimate goal to reduce poverty.

In addition to being able to support the developing economic activity needs in DIY, it can also, attract the investors to invest their money in DIY considering the adequate procurement of road length and good quality of the road which will also, open the previously under developed areas. The adequate road length and good quality road are also, expected to invite more tourists, especially because DIY is the second tourist destination after Bali. Eventually, the conditions are going to be able to increase DIY GRDP from trade, hotel and restaurant sectors through the tourist visit to tourist sites in DIY as well as other economic sectors.

Using the result of static model of multiple regression, the electricity consumption role can be observed partially (*ceteris paribus*) in the increase of DIY constant price GRDP by looking at the coefficient. The coefficient of electricity consumption amounting 0.008602 shows the significant impact of electricity consumption change on DIY constant price GRDP change. DIY constant price GRDP will increase around IDR 0.008602 million if the electricity consumption increases by 1 kWh and conversely, DIY constant price GRDP will decrease around IDR 0.008602 million if the electricity consumption decreases by 1 kWh. The electricity consumption in DIY is closely related to the rapidly developing productive activities in DIY like micro business, small and middle scale (UMKM) business and other productive activities such as factories, hotel and mall/supermarket.

If using the results of the regression PAM, the coefficient electricity consumption by 0.001311. This means that if the electricity consumption increased by 1 kWh then the GRDP of special region of Yogyakarta will increase by IDR 0.001311 million. Electricity consumption

in the province is closely related to the rapidly growing productive activities in the special region of Yogyakarta (DIY). Developments in the DIY travel very rapidly, since, the province is the second tourist destination after Bali. The high growth of hotels and restaurants in DIY aligned with the advent of more and more tourists both local and foreign. Tourists visit the course followed by the flow of funds both for shopping and enjoying the tourist objects and for investment in hotels and restaurants. Trade and banking services also, affected the positive impact that market, shops and malls flourish participate in the special region of Yogyakarta. The development of hotels, restaurants, markets, shops and malls have an impact on the increase in the power consumption requirements.

The agriculture land, partially (*ceteris paribus*) has insignificant influence on GRDP, since, there has been much agriculture land in of special region of Yogyakarta which has altered its function to be non-agriculture land, so that, it does not have quite important influence on the increase of GRDP of special region of Yogyakarta. Moreover, the worsening irrigation condition in many areas of special region of Yogyakarta have made that agriculture land lacking constant water supply which results in less productive even unproductive agriculture and which in turn it does not give any contribution to GRDP of special region of Yogyakarta. Agriculture land development policy must be based on the concept of sustainable agriculture development, so that, future generations can still enjoy the productivity of agriculture land as well as environmental sustainability to improve quality of life and welfare of the community.

The research result also, shows that the infrastructure condition (road length involving good quality and middle quality as well as the amount of electricity consumption) and the agriculture land provision in DIY altogether significantly give positive influence on GRDP of special region of Yogyakarta. It is necessary to give the serious attention both in terms of number and quality to promote the increase in GRDP of special region of Yogyakarta.

## **CONCLUSION**

Infrastructure and electricity consumption in the economic context is used as terminology to cover many activities related to social overhead capital. Furthermore, the social overhead capital is seen as a foundation of living standard improvement, better national land use and sustainable economic growth. Contextually, the

definition indicates that infrastructure and electricity consumption had an important role and is considered as a crucial factor to give a boost to the economic growth.

Infrastructure development is one of the important aspects to accelerate the development process in a region and act as a motor of economic development. This is because the economic progress and development of a region cannot be separated from its infrastructure procurement. Therefore, the infrastructure development in the special region of Yogyakarta must be continued since, it becomes the important foundation for the special region of Yogyakarta and economic development. DIY government must be able to increase the length and quality of the roads, the society electricity consumption and the agriculture land width and quality which altogether constitute a significant role in increasing the GRDP of DIY.

Infrastructure development program, particularly roads, should be conducted while still referring to meeting the needs of today's society by paying attention to sustainability and environmental conditions for the needs of the life of the next generation. It requires government to work intelligently because aside from making policy to accelerate the current development the government also, needs to conduct a strategy of sustainable infrastructure, so that, the benefits of infrastructure development can continue to be received by the next generation.

The decreasing trend in agriculture land must be stopped or minimized in order that the agriculture products can be maintained. With the agriculture and intensification, the agriculture products can be improved, so, the agriculture sector results can significantly increase their contribution in GRDP of the special region of Yogyakarta.

In sustainable agriculture development done by the local governments and communities there is a need of support of an interdisciplinary studies (holistic) to create recommendations for solving them comprehensively toward the ecological variable, social development and economic conditions of a region. Through the comprehensive study will also be obtained the direction of policy and the implementation of long-term agriculture development and productivity.

Based on the concept of sustainable agriculture development, the development strategy must strongly support farmers to ensure the sustainability of their economic activities and improve their welfare. Sustainable agriculture development should also be able to support the development of the market-oriented agro-industries downstream such as the processing of agricultural and horticultural agro-industry as well as agro-industry upstream such as seeds, fertilizer and farm tools industries. The implication of this findings shows that it

is important for the government to continue considering the concept of sustainable development for the benefit of the fulfilment of the needs for the next generation and environmental sustainability.

## RECOMMENDATIONS

Further research can also, be done by focusing on other aspects of agriculture. One of the ideas that can be realized into a more in-depth and elaborated research is to analyze the influence of agriculture land towards the self-sufficiency of food in DIY Province.

## ACKNOWLEDGEMENT

The researcher would like to express gratitude to Bappeda DIY and DPPM UII for supporting the raw data and the funding of this research.

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