Abstract

Suramadu Bridge construction which connecting Suramadu and Bangkalan, expected to reduce development gap between two regions as well as to encourage the growth of economic activity in Bangkalan, Madura. Six years after Suramadu Bridge inaugurated, the various dynamics of the population, economic, and environment, has been going around the bridge. Nevertheless, it is still not known which region get the most benefit from this construction. This paper aims to determine the impact of Suramadu Bridge in Surabaya and Bangkalan. The approach used is system dynamic to see the impact of development along with the dynamics that occur around the bridge. The simulation results that the bridge is shifting the concentration of the growth of Surabaya to Bangkalan, characterized by an increased in-migration, increased investment, as well as changes in land use, although in value, Surabaya is far greater than Bangkalan. The dynamics change that occurred in the two areas must be followed by spatial planning, so that the big population and economic growth to suburban areas (Bangkalan) does not lead to the formation of the structure of urban sprawl on a regional scale.

Keywords: economic growth; equity; system dynamics; Suramadu Bridge.

1. Introduction

Indonesia is a new center of regional and global economies in Eastern Asia. Studies conducted by Oberman et al (2012) showed that Indonesian economy will grow rapidly from rank 16th of the world in 2012 to 7th of the world in...
2030 and it estimated that economic growth exceeds the ASEAN countries and capable of being major exporters in the agriculture, trade, and services sector. Legget (2014), Santikajaya (2014), dan Rastogi et al (2013) adds that Indonesian economic development is caused by the growth of the middle class and consumption levels are higher, so if Indonesia is able to utilize the potential, Indonesia could become the new magnet of growth in Eastern Asia. Therefore, Indonesia should immediately improve its competitiveness, especially in terms of infrastructure and technology that is not optimal yet, referring to the results of a study conducted by Schwab and Sala-i-Martin (2014), which indicates that the infrastructure to be one of the biggest challenges in improving the competitiveness of Indonesia at the global level.

The challenges facing Indonesia are not only related to economic growth, but also related to equitable development. This is a major challenge for developing countries that are often economic growth is not accompanied by equitable development, as is the case in China (Chen and Zheng 2008; Keidel 2007; Fujita dan Hu 2001) and India (Chowdhury, n.d.; Noorbakhsh, 2003). The issue of equitable development itself has become a major issue for Indonesia, especially since the Gini ratio increased from 0.32 to 0.41 in just 13 years (1999 to 2012) (The World Bank, 2014). To overcome this problem the Government of Indonesia has set a wide range of policies, including infrastructure development. This policy is also based on various experiences in various countries as described by Fan and Chan-Kang (2005); Calderón and Servén (2004); Fox and Porca (2001); Nijkamp (1986); and Looney and Frederiksen (1981), which indicates that the development of strategic infrastructure in the region is able to encourage the equity, increase employment, decrease poverty reduction, and reduce disparities between regions.

Suramadu Bridge construction that began in 2003 connects the Surabaya City, Java and Bangkalan Districts, Madura. It is expected to reduce the development gap between East Java and Madura Island which has been focused on the Surabaya City. This can be seen from the high role of investment coming in Surabaya, so that GDP per capita in the city is very high, namely 31.77 million rupiah in 2013, outpacing the surrounding region, such as Bangkalan. In addition the level of poverty in the region is also relatively low, at 6.23% in 2013. This condition is inversely proportional to Bangkalan poverty levels by 24.62%. The unemployment rate in the Surabaya is higher than Bangkalan, namely 5.82%, but employment in the Surabaya has a more adequate education, so that their chances of getting a job is also higher. It is then pushed importance Suramadu bridge construction.

The Suramadu Bridge linking Surabaya to Madura Island by road is expected to reduce the development gaps that exist. Flow of land transportation quickly and effectively is expected to increase the competitiveness of Madura Island with other areas, so that the economy and social welfare can be improved. Besides that, focus of development is also no longer in the mainland Java Island, but it also spread to other areas such as Madura. The existence of Surabaya as one of the growth centers in the province of East Java is expected to provide a trickling down effect on the Madura Island, especially Bangkalan as long as the multiplier effect is running slow because it is separated by the sea.

Now, six years after the Suramadu Bridge inaugurated in 2009, a dynamic range of economic, social, and environment have occurred in the Surabaya City and Bangkalan Districts as the Suramadu Bridge construction impacts. But until now it still not known if the purpose of equalization between Surabaya and Madura (Bangkalan) via the Suramadu Bridge construction actually happening or even the development is still focused on the Surabaya City which is the growth center in East Java. Therefore this study will explore how much impact of the Suramadu Bridge construction in Surabaya and Bangkalan of the economic, social, and land and which region benefited greatly from the construction of this bridge.

2. Methods

The approach used in this study is a quantitative approach that reality is seen as something concrete, observable by the senses, can be categorized according to the type, shape, color, and behavior, has not changed and diversification and see the relationship between variables as causal relationship (Sugiyono, 2010). Furthermore, Sawitri & Andini (2009) states that the direction of the study of quantitative is to describe the state of the past, the state of the present, and the relationship between variables and the development of a model for future viewing and decision making associated with the physical aspects, economy, population, and means infrastructure. In the context of this study, this approach was chosen to look at the dynamic development of the region occurred in two
The method used in this research is a dynamic system. This technique was first introduced by Jay W. Forrester (1968) at MIT in the decade of the fifties - a method of modeling whose use is closely related to the questions about tendencies dynamic complex systems, namely pattern – behaviour pattern generated by the system with increasing time. The main assumption in the paradigm of system dynamics is that the dynamic tendencies are persistent in any complex system derived from the causal structure that make up the system. The existence of that structure is a consequence of the interaction between the constraints of the physical and social goals, rewards and pressures that caused humans behave and generate cumulative tendencies dominant dynamic of the total system (as a whole). Therefore models system dynamics in the form of a mathematical expression based on the argument causal relationships contained in the phenomenon under study.

Modeling of dynamic systems is very important in dealing with the complexity of the problems in regional development and policy formulation (Sterman, 2000) because this model considering the variables that are related, either directly or indirectly with the decision-making process that is fast, scalable, and complex. This complexity should be oriented to anticipate the problems are complex, so it must be cyclic and incorporate feedback at various stages in which the input and output are validated through feedback. Models of the dynamics of this region is a clone of the general structure of the territory then it simulated to gain insight into the dynamic behavior of the region, so as to understand the behavior of the region and the problems that may arise and are expected to perform anticipatory early as possible.

In conceptualizing the development impact Suramadu Bridge to Surabaya and Bangkalan, it used three main variables, namely population, economic activity, and land which refers to the final report of urban dynamics models published by the Directorate General of Public Works with a level of detail which is more macro. At causal loop below, it is known patterns of relationships between variables. The first loop illustrates the positive relationship between population and economic activity. There is an increasing number of people will have an impact on increasing new jobs as the effects of labor specialization, so it will increase economic activity. Meanwhile the increase in the region's economy will improve the welfare of the community, thus increasing the natural population growth and in-migration also increased. The second loop illustrates the negative correlation between the population and the land. The increasing population will reduce available land area, but on the other hand the existence of land that is still likely will have an impact on the increasing population in the region. The third loop, illustrates the negative relationship between economic activity and the land. Increasing number of non productive land become an opportunity to be used as productive land to build a new economic activities, such as industry, trade in services, etc. But the increasing economic activity will lead to a decrease in the availability of land. In the fourth loop, connecting between population, economic activity, and land dynamics. The dynamics of this population will increase economic activity, but it is limited by the availability of land. If the economic development of the population and the carrying capacity exceeds the limit, then the carrying capacity of the environment will decrease and this will have an impact on the economic downturn as well as increasing mortality and migration out of the region. Based on the basic conceptualization, it will be lowered into the conceptualization of models built in the analysis Suramadu Bridge.

The detail concept is built based on three sub-models discussed earlier, namely population, economic activity, and land. In the sub-concept of population, population growth is affected by births, deaths, in-migration and out-migration. The increasing population will improve the economy and this will be followed by an increase in labor

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**Fig. 1. Causal Loop on Regional Development Dynamic Model**

The detail concept is built based on three sub-models discussed earlier, namely population, economic activity, and land. In the sub-concept of population, population growth is affected by births, deaths, in-migration and out-migration. The increasing population will improve the economy and this will be followed by an increase in labor.
requirements and increased employment. Employment itself is influenced by the quality of human resources, so the better the quality of the human being then employment will be better. Increasing labor absorption will have an impact on increasing the labor supply-demand ratio, so this will encourage migration into the region. Conversely, if the ratio of labor supply demand is low, then it will only encourage migration out the region to find work.

In the sub-economic model, an increase in the number of population will increase public saving and it will increase local investment. The increase in local investments helped increase total investment and will result in an increase in GDP region. Increasing GDP regions will impact on increasing labor income and leads to a higher quality of life. Increasing the quality of this population will increase employment in the region.

While the sub-models of land, increasing population will result in an increased need for residential land, so the availability of land for housing decreased. Increasing the availability of residential land will encourage higher-migration because of residential land available more widely. On the other hand, land development is also affected by economic developments that will increase the need for land to support development activities. This affects not limited productive land that can be utilized, so that the lower the environmental carrying capacity. The low capacity of the environment will affect the increased mortality and migration out of the area to look for a more decent environment.

Causal loop models are used as a basis for modeling the dynamics that occur in the city of Surabaya and Bangkalan without development Suramadu Bridge. As for modeling the dynamics of regional development in two districts/cities are using the Suramadu Bridge will be used intervention scenarios by changing and adding variables that can describe the impact of the construction of the Suramadu Bridge of the dynamics of the city of Surabaya and Bangkalan. In the scenario development Suramadu Bridge, the Suramadu Bridge was put into operation in 2009, so the simulation scenario focuses on the scenario changes that occur after the bridge. Here is the scenario used in this study.

![Causal Loop of Regional Development Model in Suramadu Bridge](image)

### Table 1 Scenario Development Suramadu Bridge

<table>
<thead>
<tr>
<th>No</th>
<th>Sub Model Condition</th>
<th>Indicator</th>
<th>Condition 1 (Pessimist)</th>
<th>Condition 2 (Moderate)</th>
<th>Condition 3 (Optimistic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The operation of the Suramadu bridge in 2009 affect on increased in-migration to Bangkalan and increase out-migration to the city of Surabaya as well as the impact on the increase in labor absorption</td>
<td>Increased migration from the Surabaya to Bangkalan ranges from 0-30%</td>
<td>10% people who migrated out of Surabaya to Bangkalan</td>
<td>20% of the people who migrated out of Surabaya to Bangkalan</td>
<td>30% of the people who migrated out of Surabaya to Bangkalan</td>
</tr>
<tr>
<td>No</td>
<td>Sub Model Condition in Bangkalan</td>
<td>Indicator</td>
<td>Condition 1 (Pessimist)</td>
<td>Condition 2 (Moderate)</td>
<td>Condition 3 (Optimistic)</td>
</tr>
<tr>
<td>----</td>
<td>---------------------------------</td>
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</tr>
<tr>
<td>2</td>
<td>Suramadu Bridge will improve the economy of the region in Bangkalan and Surabaya</td>
<td>Improved economic growth in the district / city up to 30% of the baseline scenario</td>
<td>Increased economic growth of 10% from the baseline scenario in Bangkalan and 0% in Surabaya</td>
<td>Improved economic growth 20% from the baseline scenario in Bangkalan and 10% in Surabaya</td>
<td>Improved economic growth of 30% from the baseline scenario in Bangkalan and 20% in Surabaya</td>
</tr>
<tr>
<td>3</td>
<td>After the longest bridge is operated in 2009, the rate of conversion of land into residential land, industry, commerce, and services become faster</td>
<td>An increase land conversion by 10-30% in Bangkalan</td>
<td>Increased conversion of residential land, industry, commerce, and services amounted to 10% of the basic scenario</td>
<td>Increased conversion of residential land, industry, commerce, and services amounted to 20% of the basic scenario</td>
<td>Increased conversion of residential land, industry, commerce, and services amounted to 30% of the basic scenario</td>
</tr>
</tbody>
</table>

3. Result and Discussions

3.1 Regional Development Dynamics Without Suramadu Bridge Construction

Based on simulation results that has been done, it can be seen that both in Surabaya and Bangkalan experienced a population increase significantly. In 2035, the total population in the Surabaya is 3,365,301 and Bangkalan is 967256 people. But if it is seen from the increase of population each year, the trend of development in the Surabaya showed a decline due to the limited residential land available, so this limits the migration into this city. In contrast to the increase in population Bangkalan constantly increasing because the land is still available for development, not only housing, but also industry, the hotel and restaurant trade is still very high. This then becomes a driving factor towards increasing population Bangkalan.

Population growth in the Surabaya and Bangkalan dominated by the addition of the migration. In the Surabaya in-migration has higher level than other factors because of the high urge residents to migrate into the Surabaya with hope for a better life. It is also in line with the increase in GDP is quite large in this city. But it is different from Bangkalan. Without the Suramadu Bridge construction, a higher rate of out-migration because the district is still not able to provide enough jobs for its people.

As one of the largest urban areas in Indonesia, Surabaya has a good human quality which is measured through a high HDI and estimated its value will continue to increase in 2035 to reach 90.36. While Bangkalan, HDI people still low and below the national average, so this effect on labor absorption is relatively slow. Correlation between quality of life and employment can be seen in the graph unemployment rate. Although the aggregate and the percentage, the unemployment rate in the Surabaya is higher than Bangkalan, but the reduction in unemployment was higher than Bangkalan. Bangkalan which has a poverty rate of 7.2% in 2005, a decrease in unemployment rate is slow due to lack of quality people to be able to get into the business field in Bangkalan.

In terms of GRDP, GRDP in Surabaya is much higher than Bangkalan. At the end of the simulation, GRDP Surabaya 28 times greater than Bangkalan. While investment growth was dominated by foreign investment. The development of foreign investment in these two areas tend to decrease as a result of environmental degradation and the limited productive land that can not be utilized, so this limits the entry of foreign investment into these two areas.

A decrease in the carrying capacity of the environment and the limited land for development can be seen on the dynamics of land in the city of Surabaya and Bangkalan. Forest area which serves to protect the area tend to decrease due to high changes in land use for tourism activities. The decline also occurred in the open areas and agriculture areas as a result of the expansion of urban areas and an increase in the number of residents in two districts/city. At Bangkalan, decrease in agricultural land is very high at 19 820 hectares or 20.63% at the end of the simulation. The same thing happened in the Surabaya, which has decreased to 69.24% of agricultural land from the existing agricultural land area. Urban expansion is done to support the population and industrial deconcentration widespread, so that urban areas are becoming increasingly widespread.
Fig. 3. Simulation of Population and Increasing Population in Surabaya and Bangkalan

Fig. 4. Simulation of Increasing Population in Surabaya and Bangkalan

Fig. 5. Simulation of HDI and Unemployment Rate in Surabaya and Bangkalan

Fig. 6. Simulation of GRDP and Investation in Surabaya and Bangkalan
3.2 Regional Development Dynamics With Suramadu Bridge Construction

The table below illustrates the results of model simulations using Suramadu Bridge. In terms of population, the Suramadu Bridge even further decrease the number of residents in the city of Surabaya as a result of the limited land and the ease of access to the surrounding region, namely Bangkalan, so predictable Surabaya City people will move to Bangkalan. This has an impact on the number of people in Bangkalan estimated his immigration levels become very high, so the optimistic scenario, the population were higher by 129.77% from the baseline scenario. But the low human quality led to employment absorption in Bangkalan is low, so an increase in this population correlates to the increase in unemployment is expected to reach 9.63% in 2035 (optimistic scenario). This condition is different from Surabaya city in which the presence Suramadu Bridge can reduce unemployment rate.

From the regional economic side region, the Suramadu Bridge construction have a major impact on the GRDP Bangkalan which increased by 256.06% from the scenario without the Suramadu Bridge, so it can be said that this bridge capable of encouraging the growth of a new economy in this district and improve the welfare of society. Besides the Suramadu Bridge is also able to increase the level of public consumption, government spending, export, import in Bangkalan by more than 100%. In the Surabaya, although growth is not too big, but in terms of value, much larger than Bangkalan. Even using an optimistic scenario, GRDP Surabaya is 9 times greater than Bangkalan.

In terms of land, the Suramadu Bridge will further increase the rate of land conversion in two districts / cities. In the city of Surabaya, the Suramadu Bridge is improving agricultural land use changes amounted to 25.21% as well as an open area of 17.12% from the initial condition without Suramadu bridge. A large increase in land use in the city of Surabaya is a residential land use be 12,471.77 ha in 2035 (optimistic scenario). While in Bangkalan, the Suramadu Bridge increases the conversion to agricultural land and open land into smaller plots. The highest increase in area is on recreational land (160.03%), commercial (125.72%), and industrial (102.38%). The existence of this Suramadu Bridge facilitates deconcentration of population and industry which has been concentrated in the city of Surabaya, so that the ease of access is expected to be more evenly distributed development.

Table 2. Regional Development Modeling Surabaya and Bangkalan the Suramadu Bridge

<table>
<thead>
<tr>
<th>Condition</th>
<th>Without Suramadu Bridge Initial Conditions</th>
<th>Changes from initial conditions due to Suramadu Bridge (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SBY (2035)</td>
<td>BKL (2035)</td>
</tr>
<tr>
<td>Demography</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population (person)</td>
<td>3,365,301</td>
<td>967,256</td>
</tr>
<tr>
<td>Unemployment Rate</td>
<td>6.69</td>
<td>4.21</td>
</tr>
<tr>
<td>HDI</td>
<td>90.36</td>
<td>73.63</td>
</tr>
<tr>
<td>Regional Economic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GRDP (Billion Rp)</td>
<td>202,376.84</td>
<td>7,089.53</td>
</tr>
<tr>
<td>Investment (Billion Rp)</td>
<td>10,962.97</td>
<td>1,155.68</td>
</tr>
<tr>
<td>Consumption (Billion Rp)</td>
<td>167,703.15</td>
<td>5,604.36</td>
</tr>
</tbody>
</table>

Fig.7. Simulation of Land Use in Surabaya and Bangkalan
3.3 Suramadu Bridge Construction: Who Benefited?

Based on the foregoing discussion it can be seen that the Suramadu Bridge providing dynamic change for the two regions. The existence of Suramadu Bridge improve migration into the Bangkalan, so as to decrease the concentration of the population that had been concentrated in the Surabaya. Besides that, the bridge also increases GRDP in Bangkalan and capable of encouraging the growth of new economic activities in the district. GRDP Surabaya is much higher, but the economic growth in Bangkalan after the existence of Suramadu Bridge is very high, so that indicates the start of a shift of economic activities to Bangkalan, such as the activities of industry and trade and services to support the development of rapid population in this district. Nonetheless, the Suramadu Bridge construction gives the work its own because of the low level of education in Bangkalan cause low labor absorption, so that the increase in population and GRDP would increase the unemployment rate regions. It is certainly different from Surabaya city in which the presence of this Suramadu Bridge, capable of lowering the unemployment rate regions.

In terms of land use is estimated for land-use change, especially in Bangkalan to support the expansion of the Metropolitan Gerbangkertosusilo based in Surabaya. The existence Suramadu Bridge facilitates connectivity between two districts that had been separated by the sea, so as to encourage people in the city of Surabaya to migrate out to Bangkalan which residential land availability is still high and a more comfortable environment. It is also encouraging investors to invest in Bangkalan, not only because of the availability of land that is still widespread, but wages are cheaper, so as to reduce production costs.

This land use change is expected to occur around the development of which has been directed Suramadu Bridge in Suramadu Bridge Street Area Development Plan measuring 1200 hectares (600 ha and 600 ha in Surabaya in Bangkalan). In the original plan, each region, both in the city of Surabaya and Bangkalan planned as a modern complex, both trade and services, industry, warehousing, tourism, housing, CBD, to public facilities. Even in Bangkalan specifically be directed asebagai East Java Integrated Industrial Zone to international ports and bonded zone, Integrated Industrial Estate based on local resources (technology and material) to relationships on the island of Madura, which is expected to become an economic powerhouse in Madura.

But six years after the bridge was put into operation, development of the area in Suramadu, particularly in the increasingly alarming Madura side, marked by the increasing number of street vendors as well as the lack of planning that are still unclear, so the impact on the increase in illegal settlements around Suramadu bridge. These conditions would encourage the growth of unplanned corridor at the Metropolitan Gerbangkertosusilo. Results of the analysis of dynamic systems in this study did show that the Suramadu Bridge will alter land use in Bangkalan become more awakened and urbanized, so that the development of this activity is able to stimulate the economy of the region. But predictions of the impact will not be felt if not accompanied by regional planning to the implementation of an adequate plan, so the Suramadu Bridge is capable of developing profitable for both regions, both Surabaya and Bangkalan.
4. Conclusions

Suramadu Bridge Construction affect on population, economic, and land dynamics around the region, both in Surabaya and Bangkalan. The simulation results that the bridge is shifting the concentration of the growth of Surabaya to Bangkalan, characterized by an increased in-migration, increased investment, as well as changes in land use, although in value, Surabaya is far greater than Bangkalan. But the change dynamics that occurred in the two areas must be followed by spatial planning, so that the big population and economic growth to suburban areas (Bangkalan) does not lead to the formation of the structure of urban sprawl on a regional scale (Garcia-López & Muñiz, 2010, p. 3036; Gilli, 2009, p. 1386; Gottdiener, Kephart, & others, 1991; Hudalah et al 2013). Therefore, the construction of the Suramadu Bridge can be seen as an opportunity to promote better regional planning, so that the development of the area in the city of Surabaya and the Bangkalan integrated with other regions, so that the impact can be greater. Besides that, it is necessary to increase the capacity of local governments to formulate, adapt and implement spatial policy, so that Suramadu Bridge construction is not only in accordance with the district spatial plans, but also in accordance with the spatial planning provincial and national levels.

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