

Infrastructure and social tie: Spatial model approach on understanding poverty in Malang regency, Indonesia

I R D Ari¹, A W Hasyim, B A Pratama, M Helmy, and M N Sheilla

Department of Regional and Urban Planning, Faculty of Engineering, Universitas Brawijaya, Malang 65147, Indonesia

Is2_mu@yahoo.com

Abstract. Poverty is a problem that requires attention from the government especially in developing countries such as Indonesia. This Research takes Place at Kasembon District because it has 53,19% family below poverty line in the region. The purpose of this research is to measure poverty based on 3 poverty indicators published by World Bank and 1 multidimensional poverty index. Furthermore, this research investigates the relationship between poverty with social and infrastructure in Kasembon District. This study using social network analysis, hot spots analysis, and regression analysis with ordinary least squares. From the poverty indicators known that Pondokagung Village has the highest poverty rate compared to another region. Results from regression model indicate that social and infrastructure affecting poverty in Kasembon District. Social parameter that affecting poverty is density. Infrastructure parameter that affecting poverty is length of paved road. Coefficient value of density is the largest in the model. Therefore it can be concluded that social factors can give more opportunity to reduce poverty rates in Kasembon District. In the local model of paved road coefficient, it is known that the coefficient for each village has not much different value from the global model.

1. Introduction

Poverty is a problem that needs to get attention because of its strategic issue for developing countries. In addition, according to United Nation's Universal Declaration of Human Rights, it is stated also in the universal declaration on human rights, that every individual has the right to a decent standard of living. To create a decent life, it is very necessary to know the level of poverty and what the main causes of poverty in the community [1].

In general, it has been known that the availability of the infrastructure was the main catalyst for decreasing or increasing poverty. The role of infrastructure is to provide ease of access, access to education; access to health care; trade access; and others. Infrastructure gives advantage to the poor especially in isolated areas [1]

Although, some of the opinions stated, there is a link between social capitals in the form of social bonds with economic development. Social bonds can overcome poverty through: sharing of resources; building support between communities; and initiate community to do collective action [2].

As the district located on the border of Malang and Kediri, Kasembon is passed by the arterial road network with good quality. Nevertheless, with the ease of access, there are 53.19% of households which are below poverty line [3]. Moreover, Kasembon district consist of six villages, namely Pondokagung, Bayem, Pait, Wonoagung, Kasembon, and Sukosari. In this research, there are two research questions



we search to answer. First, how the poverty level of the villages of Kasembon District? Second, how do infrastructure and social condition affecting poverty level in Kasembon District?

2. Literature Review

The main causes of poverty can be separated into three level characteristics, regional, community, and households. At the regional characteristic, the major cause of poverty are natural disasters, remoteness of the region, and quality of the local government. As for the cause in the community level are the infrastructure (roads, water, electricity), public services (health, education), and proximity to markets [1]. Causes of poverty was examined in this study are the cause of poverty at the community level.

In addition to the physical factors of poverty can also be caused by social conditions that exist in an area. In terms of social condition, we want to focusing on the social tie of the communities in each village of Kasembon District. Social bonds can be a form of social capital in the form of norms and networks that get people to act collectively [4], [5]. It can be said that a society which has a good connection and social network will have advantages in the mobilization towards the development of poor area.

3. Methods

3.1. Data collection and sampling

The method used in collecting data is questionnaire survey to households in each village and also complementary data from local government institution. Institutions' target are BAPPEDA Kabupaten Malang (Regional Planning and Development Agency of Malang Regency), Government of Kasembon District, Health Service of Malang Regency, and Public Works Agency of Malang Regency.

In this research, we use proportionate stratified random sampling. First, we split the sample into two different groups, poor households and non-poor households. Next, we proportionate sample in the two groups to each village. The reason why we stratified the samples is because, we want a clearer portrait of poverty in Kasembon. So, the poor and non-poor household must have the same opportunities to be sampled. To determine the sample size, we use Slovin method. The overall number of samples are 383 households, wherein head of households are the representative respondent for the face-to-face questionnaire survey.

3.2. The poverty indicators

There are four poverty indicators to determine poverty level of each village. The results from poverty indicators used as input in regression analysis. In this research, we use Foster, Greer Thorbecke index (FGT) (1984) and Human Poverty Index (HPI) (UNDP, 1997) as poverty level indicators. The FGT index will measure headcount index (HCI), poverty gap index (PGI), and poverty severity index (PSI). Headcount index (HCI) measures the proportion of the population that is categorized as poor. Formula for headcount index as follows:

$$P_0 = \frac{N_p}{n} \quad (1)$$

Here, N_p is the number of poor and N is the total population (or sample). The households are classified as poor when their expenses are below the poverty line. The advantage from using HCI are it is simple to construct and easy to understand. These are important reason why we use this indicator to get information about poverty level. Poverty Gap Index (PGI) is a moderately popular measure of poverty. The PGI add up the extent to which individuals on average fall below the poverty line by following formula (2).

$$P_1 = \frac{1}{n} \sum_{i=1}^n \frac{G_i}{z} \quad (2)$$

In the PGI, G_i is the gap between expenditure and poverty line, while z is the poverty line. This measure is the mean proportionate poverty gap in the population (where the non-poor household have zero

poverty gap). Some people use it to think of this measure as the minimum cost of eliminating poverty (relative to the poverty line)

To measuring inequality among the poor, we use the poverty severity index (PSI). This is a weighted sum of poverty gaps. In PSI, the poorer households are fall well below the poverty line, puts more weight on observations. Formally,

$$P_2 = \frac{1}{n} \sum_{i=1}^n \left[\frac{G_i}{z} \right]^2 \quad (3)$$

As seen on (3), the PGI and PSI formula almost same. In PSI, we square the poverty gap. So, the increases in measured poverty because of a fall in one's standard of living will be deemed greater the poorer one.

3.3. Hot Spots Analysis

In this research, we also scrutinize expenditure distribution of households using hot spots analysis. So, we can get information where are households with less or more expense. Hot spots analysis will be using Getis-Ord G_i^* statistics, as follows:

$$G_i^* = \sum_{j=1}^n w_{i,j} x_j - \bar{X} \sum_{j=1}^n w_{i,j} \left(S \left(\frac{\left[n \sum_{j=1}^n w_{i,j}^2 - \left(\sum_{j=1}^n w_{i,j} \right)^2 \right]^{1/2}}{n-1} \right)^{-1} \right) \quad (4)$$

In hot spots analysis, G_i value is normalized. The data used in this calculation is based on expenditure of each households and coordinates of the respondents. Where $w_{i,j}$ is the spatial weight between i and j respondents. Distance between the respondents is calculated by using euclidean distance. The output from hot spots analysis are cold spots and hot spots. Cold spots is location of households with less expenses, while hot spots is location of the households with more expenses.

3.4. Social Networks Analysis

In this study, we use rate of participation and density approach to analyze the community social tie. To measure rate of participation and density we use affiliation data of the respondents. The affiliation data obtained by looking community groups that followed by the respondents. Formula for rate of participation of the respondents as follows [6].

$$\bar{a}_{i+} = \frac{\sum_{i=1}^g x_{ij}^N}{g} \quad (5)$$

Where X_{ij}^N is the affiliation matrix of the respondent i and respondent j . Its data are assumed as binary relation whereby attendance in a certain community group is equal to 1, otherwise equals as zero. The density is used to see how the average number of activities that occur by any pair of actors (Wasserman & Faust, 1994). In density, the value ranged from 0 to 1. To calculate density, we use the same affiliation data used in the rate of participation calculation. The formula for density seen on (6)

$$\Delta(N) = \frac{\sum_{i=1}^g \sum_{j=1}^h x_{ij}^N}{g(-1)} \quad (6)$$

Here, $g-1$ is the respondents who have not affiliation with other respondents, while g is the respondents that have affiliation with other respondents.

3.5. Regression Analysis

Regression analysis is a statistical analysis of the process that aims to find out the relationship between dependent variable and one or more independent variables (or predictor) [7]. The regression model will explain how the phenomenon of poverty occurred in Kasembon District.

Regression techniques were used to find the model of poverty is the ordinary least squares (OLS). General equation of the OLS model is as follows [8].

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon \quad (7)$$

As Y is the dependent variable and X is the predictors (explanatory variables). The ε is the error vector of regression line. And β is the coefficient of the predictors. After the diagnostic results obtained from the OLS method, then the model will need to undergo test of regression assumption. We use multicollinearity test, heteroscedasticity test, significance test and residual normality test.

4. Results

4.1. Expenditure distribution and poverty level

Expenditure distribution per capita analyzed uses hot spots analysis. Besides expenditure, coordinates of respondent also inputted in hot spot analysis. Then, we will have information where is the community with the high levels of expenditure clustered. Figure 1 portrays levels of expenditure across the district. Red, beige, and blue color represents hot spot-neutral-cold spot. Higher level of expenditure is showed by increasing red color. Beige color means the levels of spending are on average. The bluer, then the level of expenditure lower below the average.

According to the results of hot spot (Figure 1), majority of community expenditure levels are below the average. Cold spot clustering occurs in the region of Pondokagung Village and Pait Village. Hot spots area looks very significant in Bayem Village. In addition, there is also a hot spot in the Sukosari Village toward Malang and Kediri Regency border.

Figure 1 explains that the expenditure is not affected by the existence of the arterial road, the location of border region, as well as center of district location. Even though, there is a hot spot region in Sukosari Village bordering Kediri. However, Kasembon Village as the district center of service and passed by arterial road, thus it has expenditure level below the average. Pait Village, passed by arterial road and located on the border also have expenditure level below the average.

There are 4,986 poor households in Kasembon District. Based on survey results, average households expenditure is Rp 1,151,724 per month. With average family member of 3 persons, therefore average expenditure per capita is Rp 333,199. For reference, Malang Regency poverty line is Rp 254,380 (BPS, 2015). The results of poverty indicators calculation shows Pondokagung Village is the highest poverty level in Kasembon District. HCI value of Pondokagung Village is 42.11%, PGI value is 9.16%, PSI value is 1.22% and HPI value is 26.541%.

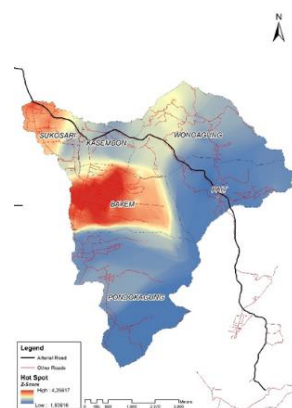


Figure 1. Spot and Cold Spot for Expenditure per Capita.

Table 1. Poverty Indicator per Village.

Village	HCI (%)	PGI (%)	PSI (%)	HPI (%)
Pondokagung	42,11	9,16	3,41	26,451
Bayem	18,92	3,07	0,87	0,022
Pait	39,66	8,43	3,2	0,009
Wonoagung	35,09	5,48	2	0,405
Kasembon	27,59	5,96	2,07	0,007
Sukosari	28	4,16	1,22	11,957

There are three villages that needs to be noticed, namely Wonoagung, Kasembon, and Sukosari. Table 1 illustrates that Wonoagung and Sukosari villages have figures higher than Kasembon Village on HCI. However, PGI and PSI figure out that Sukosari and Wonoagung Villages are lower. Meaning that people of Sukosari and Wonoagung Village are at risk for falls to more severe poverty.

Table 2. Human Poverty Index Value.

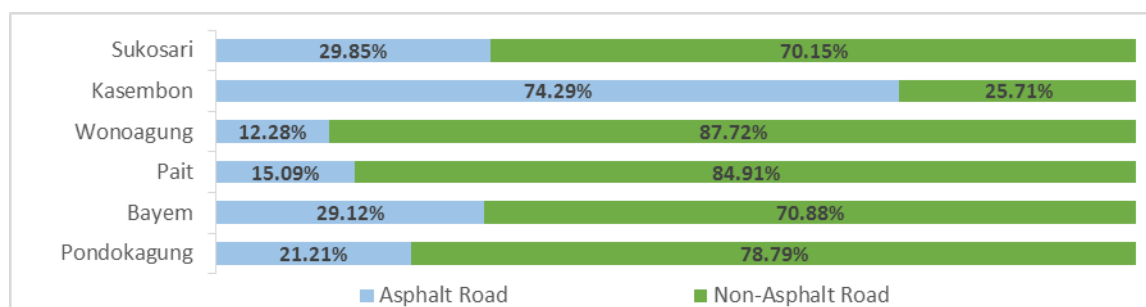
Village	Percentage of Death before age 40	Percentage of Illiteracy	Percentage of malnutrition
Pondokagung	0,03%	28,77%	0,42%
Bayem	0,05%	2,70%	0,45%
Pait	0,02%	2,00%	0,25%
Wonoagung	0,07%	7,14%	0,23%
Kasembon	0,14%	1,85%	0,17%
Sukosari	0,02%	22,08%	0,38%

Visible differences are quite striking on parameter value percentage of illiterate population in Pondokagung and Sukosari Village (Table 2). Difference between smallest and largest illiteracy is 26.82%. Conclusion from these findings are the illiterate population give largest contribution to high value of Pondokagung HPI value.

4.2. Road quality and accessibility

Road quality data is observed by looking at length of asphalt road and non-asphalt road. The data used in this research is sourced from Malang Regency Public Works Service of year 2015. The non-asphalt road pavement consists of cobblestone road and dirt road.

In this research, accessibility observed from distance to Malang Regency center; distance to Kasembon District center; Distance to district market; Distance to education facility such as elementary school, junior high school, and senior high school; also, the distance to health facility.

**Figure 2.** Road Quality Comparison per Village Area.

Length of asphalt road is 24.11km, or 17% of the total length of roads in Kasembon District. Wonoagung and Bayem Villages are the village with the lowest percentage of asphalt road length in Kasembon District. While the village with highest percentage of asphalt road length are Kasembon Village.

In this research, accessibility observed from distance to Malang Regency center; distance to Kasembon District center: Distance to district market; Distance to education facility such as elementary school, junior high school, and senior high school; also, distance to health facility. The distance is the average distance from the neighborhoods towards the facilities Kasembon Village

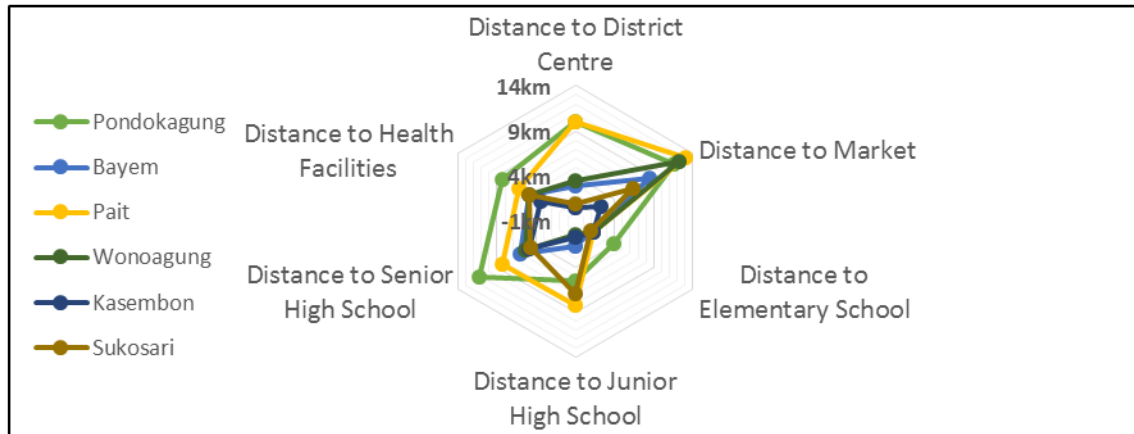


Figure 3. Distance to Facilities from Nearest Settlement for Each Village.

The lowest accessibility to the center of Kasembon District are Pait Village (10 km) and Pondokagung Village (10 km). Pondokagung village is also the farthest distance towards the health facilities (8,3 km), senior high school (11,34 km), and toward elementary school (2,83 km). Pait Village is the farthest distance to junior high school (8,2 km) and district market (6,26 km). Pondokagung village can't meet the elementary school minimal standard of service, because the average distance to elementary school more than 3 km. Pait Village also cannot meet junior high school standard. Junior high school must be ≤ 6 km from nearest settlements.

4.3. Rate of participation and density

Social tie of Kasembon District community is measured with social network analysis approach using rate of participation and density indices. Rate of participation in the villages are calculated by number of groups that is followed by individual in the villages. The higher the level of participation, the higher awareness of the communities will be. The rate of participation will be classified into three levels – low, medium, and high based on the village value of rate of participation. The rate of participation is calculated through affiliation data between the respondents.

Table 3. Rate of Participation for Each Village.

Village	Rate of Participation	Number of Groups	Classification
Pondokagung	1,5789	24	High
Bayem	1,4189	8	Low
Pait	1,4800	13	Low
Wonoagung	1,3889	12	Low
Kasembon	1,2609	15	Medium
Sukosari	1,5195	10	Low

As seen on Table 3, the highest level of participation is Pondokagung Village (1,5789). This value means the average of Kasembon peoples are joint participation on 2 community groups. Mostly villagers are joint in a kind of religious group, namely Tahlilan. According to the respondents, besides tahlilan people also hold regular social gathering for women known as Arisan. The arisan mostly held by close neighbors. Calculation of density aims to know about density of connections between the respondents in one village. The density value is also a mean for measure kinship value in the village.

Table 4. Density Value and Level of Kasembon District.

Village	Density Value	Classification
Pondokagung	0.404	Low
Bayem	0.722	High
Pait	0.595	Medium
Wonoagung	0.632	Medium
Kasembon	0.493	Medium
Sukosari	0.793	High

Amongst all, the lowest density is Pondokagung Village. It shows also that the Pondokagung villagers tend not to have similarities in the organization participation. Otherwise, it can be said that one organization member don't know with the other member of the organization. In contrast, for Bayem and Sukosari Village, the density is in high level.

4.4. Regression analysis

The regression model analyzed uses ordinary least squares (OLS) technique. In selecting appropriate model we use exploratory regression from ArcGIS. With exploratory regression, we might find the right model combination with the desired parameters. The parameters inputted are, maximum number of explanatory variables is 12 and minimum is 2; minimum adjusted R² is 0,5 (50%); minimum p-value is $\leq 0,1$; minimum VIF (multicollinearity test) is $\leq 7,5$; and residual autocorrelation is $\geq 0,1$.

Table 5. Variables of Poverty Indices.

Dependent Variable	X1	X2
Head Count Index	(-)Density	(-)Asphalt Road Length
Poverty Gap Index	(-)Density	(-)Asphalt Road Length
Poverty Severity Index	(-)Density	(-)Asphalt Road Length

The three models have the same explanatory variables, i.e. density and the length of asphalt road. Those two variables even have the same inverse relationship with three poverty indices. Since HCI, PGI, and PSI representing poverty, it can be concluded that greater density and asphalt road length, the lower the poverty in Kasembon District.

Regression OLS diagnostics (Table 6) is useful to illustrate the results of calculation that will be used to testing hypothesis, multicollinearity test, and residual normality test. Standard error column represents difference of observation value and the regression line. The coefficient column is the independent variable influence to poverty indices. Intercept is the intersection value between regression lines with y axis

Table 6. OLS Regression Diagnostic.

Dependent Variable	Independent Variable	Coefficient	Std. Error	Probability	VIF	Koenker BP Statistic	Jarque Bera Statistic
HCI	Intercept	72,377740	8,613644	0,0000	-	0,7333	0,6196
	Density	-	11,551253	0,0472	1,000083		
	Asphalt Road Length	-0,003059	0,000813	0,0208	1,000083		
	Intercept	17,425756	2,461122	0,0000	-		
PGI	Density	-	3,300467	0,0133	1,000083	0,3148	0,7116
	Asphalt Road Length	-0,000573	0,000232	0,0893	1,000083		
	Intercept	13,138299	2,461122	0,0000	-		

Dependent Variable	Independent Variable	Coefficient	Std. Error	Probability	VIF	Koenker BP Statistic	Jarque Bera Statistic
PSI	<i>Intercept</i>	7,127937	0,90227	0,0000	-	0,2714	0,6804
	Density	-5,639812	1,20992	0,0014	1,000083		
	Asphalt	-0,000265	0,00008	0,0503	1,000083		
	Road Length						

The regression equation describes how the relationships between poverty and infrastructure with social condition and its influence. Findings from Table 6 shows that on the three models, the coefficients of density is greater than the asphalt road length coefficient. Then, density known have bigger influence to poverty than asphalt road length. For example, asphalt road length of Kasembon Village is 17 km longer than Sukosari Village. However due to higher level density of Sukosari Village, so the poverty in the Sukosari Village is lower.

In the probability column, it could be illustrated whether the independent variables have influence or not with the poverty indices. P-value significant test in this research using $\leq 0,1$ value. It is different than the commonly used in other research. So, it brings more model options to us.

Density and asphalt road length have meet significance test ($p\text{-value} \leq 0,1$) However, density had lower p-value in PGI and PSI model (lower than 0,05). While the p-value of asphalt road length on PGI and PSI model are above 0,05. In this case, density showing to have stronger connection with poverty. Although asphalt road length has significant p-value, its relation to poverty is not as big as the density. Heteroscedacity test uses to see if the Constanta of variables are stationary or not. Heteroscedacity happens when the Koenker BP value $> 0,05$. Koenker BP value of the three models (Table 7) are above 0,05. It means, heteroscedacity does not occur in the three models.

Multicollinearity is condition where two or more variables are highly correlated. That is not allowed to occur in a regression, because it is violates the assumption of regression model. In this research, multicollinearity detected by using VIF calculation. If the VIF value is greater than 7.5, then the model have multicollinearity problem. For the three poverty models, the VIF values are below 7.5. So it can be concluded multicollinearity does not occur in the model

Residual normality is the one of linear regression assumptions. In this study, the residual normality is seen through the Jarque-Bera. Residual is normally distributed when the Jarque-Bera value greater than 0,05. For the three poverty model, the residual values have normaly distributed. As seen in last column of Table 7, Jarque-Bera value for the three poverty model above 0,05.

5. Conclusion

The level of Kasembon District community expenditure is not affected by the availability of arterial road, the border location, and the center of activity in Kasembon Village.

According to the 4 indicators of poverty that is used in this study, Pondokagung Village is the worst village in poverty. The largest contribution to the high HPI value is from percentage of illiterate person. Other findings from the poverty level analysis is the Wonoagung Village and Sukosari Village have more risk towards more severe poverty. That is because Wonoagung Village and Sukosari Village HCI are higher than Kasembon Village, but those have lower PGI and PSI level.

Regression analysis results through OLS indicates that social conditions (density) and infrastructure (asphalt road length) have an inverse relationship with poverty. It might assume that density has more influence to poverty compared to asphalt road length. In other words, in order to deal with poverty alleviation in Kasembon District, development of physical infrastructure does not the merely solution, but it is also a must to deal with the development of capacity buidling of the villagers. Existence of social tie between villagers may open more possibility for them to enhance their possibility towards local and extra local resources mobility, especially information resources.

References

- [1] B. N. Bhattacharyay, "Asian Development Bank Institute," Tokyo, 138, 2009.

- [2] A. Afridi, "Social networks : their role in addressing poverty," York, 2011.
- [3] Centre Bureau of Statistics, "Malang in figures 2016," Malang, 2016.
- [4] M. Woolcock and D. Narayan, "Social capital: Implications for development theory, research, and policy," *World Bank Res. Obs.*, vol. 15, no. 2, pp. 225–250, 2010.
- [5] R. D. Putnam, "Bowling Alone by," *J. Democr.*, pp. 65–78, 1995.
- [6] S. Wasserman and K. Faust, *Social network analysis: Methods and applications*. New York: Cambridge University Press, 1994.
- [7] R. E. Walpole, *Introduction to statistics*, Third Edit. London: Collier Macmillan Publishers, 1982.
- [8] A. Mitchell, *The ESRI guide to GIS analysis*, Volume 2. Ohio: ESRI Press, 2005.