SPATIAL MODELING FOR HUMAN DEVELOPMENT INDEX IN CENTRAL JAVA

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ABSTRACT

Human Development Index (HDI) is one of measuring tools of development performance especially human development done in a region at specific times. This study examines the HDI and the components of the compilers of HDI, the data used is the data value of HDI components for 35 districts / cities in Central Java. The variable used in this study is the value of HDI (Y) as dependent variable, LE (X1), EPS (X2), ASD (X3) and CRC (X4) as independent variable. The study examines the effects of spatial dependencies by using area approaches. Furthermore, SEM application is given to identify how big the effect of components of HDI can affect the level of HDI in Central Java. The results showed that there is a pattern of regional groupinginthe distribution of HDI in Central Java. The modeling results using SEM shows lambda and all variables are significant. The SEM model results AIC of -4.216 which is better than the regression of the OLS method with AIC of -1.162.

Keywords: Spatial Effect, SEM, HDI

INTRODUCTION

Human Development Index (HDI) is one measure of quality that can be used to determine how far the quality of human development has been achieved. The United Nations Development Program (UNDP) said that HDI is a summary and not a comprehensive measure of human development. HDI basically a value that shows the level of public welfare measured from 3 (three) main components, i.e.: health is measured by long age and healthy life or measured by life expectancy (LE), education is measured by the expected of length of school (EPS) and the educational participation rate that has beenfinished or the average of school duration (ASD), and economics is measured by Decent Living Standards with the Gross Domestic Product per capita approach at per capita real consumption level or public purchasing power (CRC).

The results of HDI measurement in various provinces especially Central Java are usually shown in tabular form. Operational methods that exist todaymostly have not used spatial approaches as object analysis tools, so they have not been able to provide an overview of the pattern of HDI distribution. To overcome these problems, a spatial approach method is used which allows the measurement of HDI to be displayed in the form of visualization to provide information more easily understood andanalyzed. Visualization in the form of maps is expected to provide a better figure of spatial tendencies for spatial analysis in view of the spatial patterns of HDI. Spatial method is a method to get observation information that influenced by the effect of space or location. Spatial effects often occur between one region and another. In spatial data, observations at a site often depend on observations in other neighboring locations. Furthermore, in this stdy used spatial dependency effect approach or area approach that is using Spatial Error Model (SEM) model.

This study takes 3 parameters as the component of HDI in Central Java that is LE, EPS, ASD and CRC. By considering the location factor, the researcher wanted to study more about SEM model to know the pattern of distribution and modeling the HDI in Central Java.

In this study, the problem was limited by data for Central Java in 2017 and used the weighting of Queen Contiguity.

RESEARCH METHODS

Data Sources and Research Variables

The data used in this study is secondary data obtained from the Central Bureau of Statistics (BPS). This data covers the value of HDI and the components of HDI in Central Java in 2017,that is covers 35 districts / cities, i.e.:

Table 1 Districts / Cities Code in Central Java

No	District/City	No	District/City
1	Cilacap District	19	Kudus District
2	Banyumas District	20	Jepara District
3	Purbalingga District	21	Demak District

4	Banjarnegara District	22	Semarang District
5	Kebumen District	23	Temanggung District
6	Purworejo District	24	Kendal District
7	Wonosobo District	25	Batang District
8	Magelang District	26	Pekalongan District
9	Boyolali District	27	Pemalang District
10	Klaten District	28	Tegal District
11	Sukoharjo District	29	Brebes District
12	Wonogiri District	30	Magelang City
13	Karanganyar District	31	Surakarta City
14	Sragen District	32	Salatiga City
15	Grobogan District	33	Semarang City
16	Blora District	34	Pekalongan City
17	Rembang District	35	Tegal City
18	Pati District		

Variables used in this study are 4 variables consisting of 1 dependent variable and 3 independent variables is as follows:
1. Dependent variable (Y) is the HDI value of each district / city in Central Java. Results of HDI ranged from 0 to 100.
2. Independent variable (X) i.e. components of the compilers HDI in Central Java in table 2.

The data structure of the components of the HDI as independent variables on the HDI level in Central Java as the dependent variable is described as in table 2.

Table 2 Data Structure

Dependen Variable	Independen Variable			
HDI	LE X_1	ASD X_2	EPS X_3	CRC X_4
y_1	x_{1_1}	x_{2_1}	x_{3_1}	x_4
y_2	x_{1_2}	x_{2_2}	x_{3_2}	x_{4_2}
⋮	⋮	⋮	⋮	⋮
⋮	⋮	⋮	⋮	⋮
y_{35}	$x_{1_{35}}$	$x_{2_{35}}$	$x_{3_{35}}$	$x_{4_{35}}$

Analysis Method

In this study, the software used is using ArcView, Geoda and Minitab. As for the steps of analysis conducted in this research are:

1. Exploring thematic map data to find out the pattern of deployment and dependencies of each variable to know the relationship pattern of variables X and Y.
2. Conducting regression modeling using Ordinary Least Square (OLS) method.
3. Identification of the existence of spatial effects in SEM by using residual freedom test.
4. Doing SEM modeling with the following stages.
   a. After the W matrix is formed with its elements (W_{ij}) of 1 and 0, a weighted coding is used to obtain the matrix W.
   b. Conduct parameter estimation, parameter significance test and regression assumption test of SEM that is formed.
   c. Interpret and conclude the results obtained.

RESULTS AND DISCUSTION

Pattern of Distribution of HDI and Components of HDI

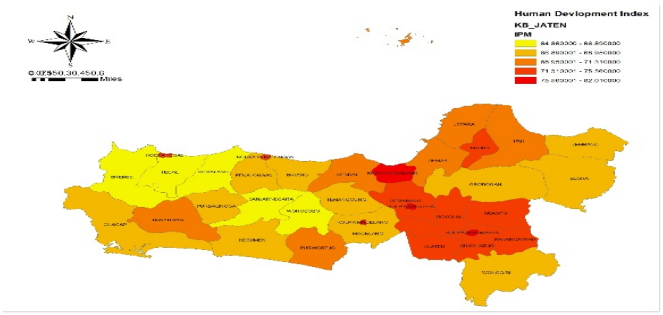

Figure 1 The distribution of HDI by district / city in Central Java at 2017

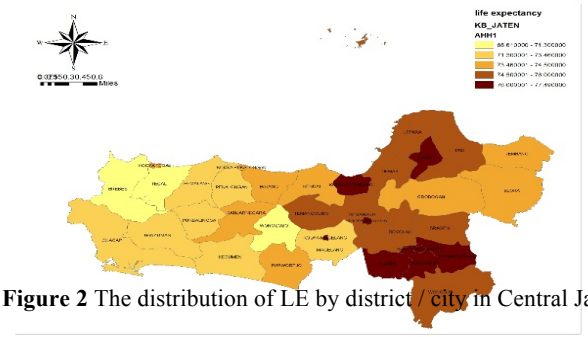

Figure 2 The distribution of LE by district / city in Central Java at 2017

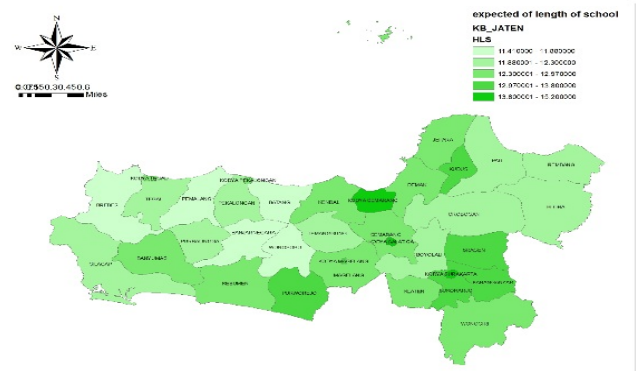

Figure 3 The distribution of EPS by district / city in Central Java at 2017

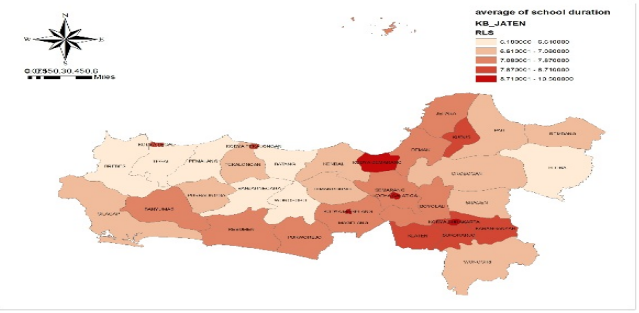

Figure 4 The distribution of HPS by district / city in Central Java at 2017

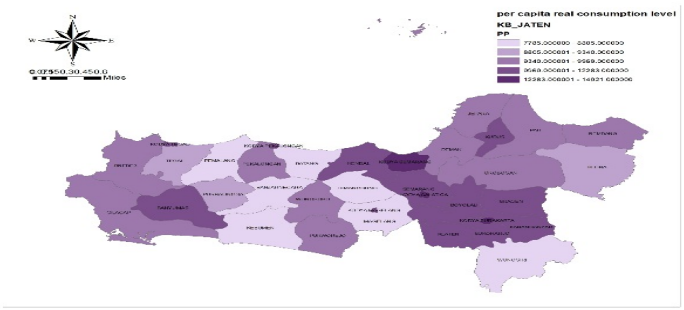

Figure 5 The distribution of CRC by district / city in Central Java at 2017

Regression Model

In regression modeling, parameter estimation is done by using Ordinary Least Square (OLS) method. By OLS modeling, will get the significant parameters or not, which affects the value of HDI. Then it proceed by SEM modeling.

Table 3 OLS Regression Parameter Testing

Parameter	Coefficient	t-Statistics	P-Value
Constants	7.128	3.919	0.000
LE	0.450	16.331	0.000
EPS	0.758	7.331	0.000
ASD	1.508	18.631	0.000
CRC	0.001	22.171	0.000
R^2			99.78%

Based on Table 5 it is known that the parameters LE, EPS, ASD and CRC have a value of 0.000 less than α = 5%, it means that it has significant influence on the value of HDI at α = 5%. The values of LE, AMH and CRC are assumed to be not equal to zero.

One of the tests to determine whether or not the interconnection between location or region is Moran's I test. The test hypothesis of Moran`s I as follow:

H_0: ρ = 0 (There is no autocorrelation between locations)

H_1: ρ ≠ 0 (There is autocorrelation between locations)

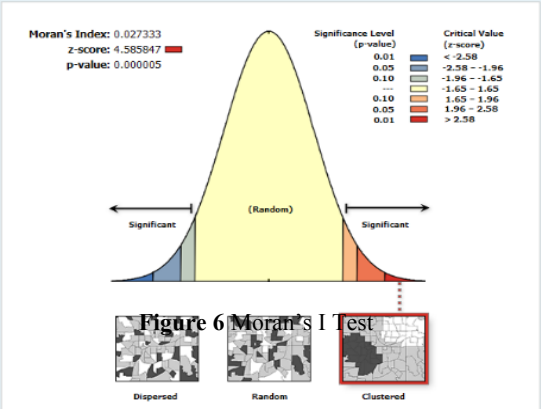

Figure 6 Moran's I Test

The P-value in this Moran`s I test is 0.00005 which is smaller than 0.05. This shows that at the 5% significance level H0 is rejected. In other words, there is interconnection (autocorrelation) between locations. Thus, the model is necessaryto be done by using spatial regression model.

Weighted Matrix

In a regression model, the properties of the error none other than the properties possessed by the dependent variable. Based on Figure 1, HDI in Central Java appears to be patterned clustered between adjacent areas. So the appropriate spatial weighting matrix in this study is the weighted Queen Contiguity matrix. This weighted matrix requires the grouping of regions that have a cross-sectional connection between the sides and corners of the area, where Wij = 1 for the common side or vertex to meet the area of concern, Wij = 0 for the other region.

Spatial Error Model (SEM)

The next step is modeling using SEM. The following is the output of SEM modeling with each parameter value at the 5% significance level.

Table 4. SEM Parameter Testing

Parameter	Coefficient	t-Statistics	P-Value
Constants	6.253	5.145	0.000
LE	0.457	24.066	0.000
EPS	0.800	8.875	0.000
ASD	1.483	22.576	0.000
CRC	0.001	28.146	0.000
Lambda	-0.483	-2.071	0.0383
R^2			99.81%

Based on the Geoda output in Table 6, the results of the SEM shows the existence of spatial dependencies on the error. This is evident from LE, EPS, ASD and CRC have possitive and significant signs at the 5% level. The lambda coefficient is significant at 5%, it means thatt there is a lingage of HDI in an area with other adjacent areas. So it can be concluded that lambda plays an important role in SEM modeling. In addition, teh LE, EPS, ASD, and CRC variables play an important role in SEM with a significance level of 5%. That is, HDI in a region is affected by the value of LE, EPS, and CRC of the region as well as spatial residuals from other adjacent areas and have similar characterictics.

The SEM model that is formed is as follows:

$$y_i = 6{,}253 + 0{,}457X_{1_i} + 0{,}800X_{2_i} + 1.483X_{3_i} + 0{,}001X_{4_i} + u_i$$

$$u_i = -0.483 \sum_{j=1,i\neq j}^{n} w_{ij}u_j + \varepsilon_i$$

Explanation:

yi : HDI in i-district / cities
X_{1_i} : LE in i-district / cities
X_{2_i} : EPSin i-district / cities
X_{3_i} : ASDin i-district / cities
X_{4_i} : CRCin i-district / cities
W_{ij} : spatial matix
u_i : the spatial residual of the i-districts / cities
ε_i : the residual of the i-districts / cities

The SEM model can be interpreted that the effect of LE on HDI is the same for each district / city with its elastiseness of 0,457. This means that if other factors are considered constant, if the value of LE in a district / city rose by1 unit then the value of HDI will increase by 0,457 units. The influence of EPS on HDI is also teh same for every district / city with its elasticity of 0,800. This means that if other factors are considered constant, if the value of EPS in a district / city rose by 1 unit then the value of HDI will increase by 0,800 units.

The influence of ASD on HDI is also the same for every regency / city with its elasticity equal to 1,483. This means that if other factors are considered constant, if the value of ASD in a district / city increases by 1 unit then the value of HDI will increase by 1,483 units.

The effect of CRC on HDI is the same for each district / city with its elatisity of 0,001. This means that if other factors are considered constant, if the value of CRC in a district / city increase by i unit then the value of HDI will increase by 0,001 units.

Comparison of OLS Regression Model and SEM Model

The goodness criteria of the model uses is to compare the AIC values of the two models.

Table 5 AIC value of SEM Model

Model	AIC
OLS	-1.162
SEM	-4.216

Based on Table 5 shows that the model with minimum AIC value is SEM model. So SEM model is better used to analyze the data of HDI in Central Java Province compared with regression model by using OLS method.

Based on the relationship between HDI with LE, EPS, ASD and CRC, it can be interpreted that the similarity and characteristic differences in each of the adjacent districts / cities can lead to an increase or decrease in HDI in Central Java.

Testing of the SEM Model Assumption

Normality test for human development index used Probability test of normality (jarque-bera) test, with hypothesis proposed as follows.

H_0: residual spread normally
H_1: residual does not spread normally

The value of P-value is 0.330 greater than 0.05, then reject H0. Thus, at the significance level α = 5% it can be concluded that the residual is normally distributed.

Heteroscedasticity test aimed to find out is there a variety or heteroscedasticitybetween locations used statistical test Probability on test breusch-pagan test, with the hypothesis proposed as follows.

H_0: $\sigma_1^2 = \sigma_2^2 = \cdots = \sigma_n^2 = \sigma^2$ (There is no intermediate heteroscedasticity)
H_1: at least one $\sigma_i^2 \neq \sigma^2$ (Hteroskesddatatisity between locations)

The P-value value of this Durbin-Watson test is 0.047 which is smaller than 0.05. This shows that at the 5% significance level H0 is rejected, inter-location heteroscedasticityoccurs on the SEM model.

CONCLUSION

The pattern of distribution of HDI in Central Java seems to the pattern between groups of adjacent areas. Based on the relationship between HDI with LE, EPS, ASD and CRC, it can be interpreted that the similarity and characteristic differences in each of the adjacent districts / cities can lead to an increase or decrease in HDI in Central Java.
The SEM regression model is better than the OLS regression model and the determination of the HDI distribution components to the HDI value in Central Java because there are spatial dependencies on the dependent variable. The SEM model formed to model HDI in Central Java by 2017 is:

$$y_i = 6{,}253 + 0{,}457X_{1_i} + 0{,}800X_{2_i} + 1.483X_{3_i} + 0{,}001X_{4_i} + u_i$$

$$u_i = -0.483 \sum_{j=1, i \neq j}^{n} w_{ij} u_j + \varepsilon_i$$

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