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THE CORRELATION OF SOCIOECONOMIC AND MOBILITY FACTORS ON COVID-19 MORBIDITY IN SEMARANG CITY

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ABSTRACT

Semarang City as the capital of Central Java Province contributes a fairly high number of cases of the COVID-19 virus. This study used a sample of the number of COVID-19 case data in 16 sub-districts in Semarang City. The sampling technique used is purposive sampling with a period of 3 months, namely from October until December 2020. The research aims to find out the impact of social economy and community mobility on the growth of COVID-19 in Semarang City. There is a linkage of spatial factors between sub-districts in the growth of COVID-19 numbers. Spatial influence can show the relationship of influence between sub-districts with each other. In addition, appropriate quantitative approaches are used to obtain a complete view of the expected results through mapping with Geoda software through regression testing analyzed through spatial econometric methods. The process of data collection is carried out by a literature review. This study showed that the model correlated with a high R^2 value of 0.7780. All variables show significant numbers in the model. Through policies at the Semarang City level through coordination between sub-districts to achieve prevention goals in the growth rate of COVID-19 numbers of each sub-district. The findings from this study will inform that the effort to a policy of handling COVID-19 must also be carried out continuously and the regulation of large-scale social restrictions (PSBB) in Semarang city is needed.

Kata kunci:
pertumbuhan COVID-19, ekonometrika spasial, spasial regresi

ABSTRAK

Kota Semarang sebagai Ibu kota Provinsi Jawa Tengah berkontribusi terhadap pertumbuhan jumlah kasus Virus OVID-19. Penelitian ini menggunakan sampel jumlah data kasus Covid-19 di 16 kecamatan di Kota Semarang. Teknik sampling yang digunakan adalah purposing sampling dengan periode waktu 3 (tiga) bulan yaitu Oktober, November dan Desember 2020. Penelitian ini bertujuan untuk mengetahui dampak sosial dan mobilitas masyarakat terhadap pertumbuhan COVID-19 di Kota Semarang. Adanya keterkaitan faktor spasial antar kecamatan dalam pertumbuhan angka COVID-19. Pengaruh spasial dapat menunjukkan hubungan pengaruh antara kecamatan satu sama lain. Selain itu, pendekatan kuantitatif yang tepat digunakan untuk mendapatkan pandangan lengkap tentang hasil yang diharapkan melalui pemetaan dengan perangkat lunak Geoda melalui pengujian regresi yang dianalisis melalui metode ekonometrik spasial. Proses pengumpulan data dilakukan dengan metode studi literatur. Studi ini menunjukkan bahwa model korelasi dengan nilai R^2 yang tinggi, yaitu 0.7780. Semua variabel menunjukkan angka yang signifikan dalam model. Variabel mobilitas menjadi faktor yang paling mempengaruhi tingkat pertumbuhan Covid-19. Pencegahan laju pertumbuhan angka COVID-19 di Kota Semarang dapat dilakukan melalui koordinasi antar sektor terkait dan penerapan kebijakan pembatasan pergerakan tingkat kecamatan di Kota Semarang. Temuan dari penelitian ini menginformasikan pentingnya upaya kebijakan pembatasan sosial berskala besar (PSBB) di Kota Semarang dalam penanganan COVID-19.

INTRODUCTION

This virus shows a very significant rapid spread and there have been many deaths caused by this virus both in China and in other countries, so on January 30, 2020, WHO designated this coronavirus as a Public Health Emergency of International Concern. The spread and increase in the number of cases of COVID-19 occurred at a very fast time and

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has spread between countries including Indonesia. As of August 2020, there was a total of 17,660,523 confirmed cases with 680,894 deaths where cases were reported in 216 countries (1). in Indonesia there were confirmed cases of as many as 165,887 with 7,169 deaths in 34 provinces (2). A result of the COVID-19 pandemic, it will have an impact on the global economy.

Based on data from the Central Java Provincial Health Office, the distribution of COVID-19 cases in Central Java until Thursday, January 14, 2021, at noon, amounted to 11,995 positive confirmed cases (active cases), confirmed recovery amounted to 89,438 cases, and 6,745 died. In the data of the National Covid-19 Handling Task Force, of five provinces with the highest addition of new cases, Central Java ranks third (3). This shows that the spread of the COVID-19 virus in Central Java makes a very dangerous threat to the survival of people. In addition, the Semarang city as the capital of Central Java Province also contributes a fairly high number in Central Java Province. Based on data obtained from the website page of the city government of Semarang and data as of January 14, 2021, the city of Semarang ranks 4th out of all districts/cities in Central Java (4). The total confirmed cases of COVID-19 amounted to 24,016 cases with details of suspect cases of 313 cases, probable cases of 68 cases, confirmed cases treated by 712 cases, patients who have recovered as many as 16,151 people and confirmed death by 1,325 cases. The downturn caused by the COVID-19 pandemic has a mild impact on all sectors and it also helps design a healthy city (5)(6).

The spatial econometric model in this study was applied to analyze the growth of COVID-19 in Semarang City (7). In the analysis of the population growth of a region, the indicator that shows the population growth of a region is population density (8). Semarang City has a distribution of residents in each sub-district that has not been evenly distributed (9). This is seen from the number of residents who live in certain sub-districts, which tend to approach the city center. The existence of COVID-19 brings global problems that bring about a new social order; this requires people to adjust to new habits (8). On the other hand, this condition is aggravated by COVID-19 which is quite difficult for the economy. With the corona outbreak, economic growth will be drastically cut which means that credit growth will also be very low (10). The drastically declining economic conditions are strongly felt by lower-middle-income people who are less able to meet their needs. In addition to socioeconomic factors, this study considers spatial interactions in modeling the growth of COVID-19 cases in Semarang City so that spatial econometric approaches are used. Among economic players surviving in the midst of the COVID-19 pandemic, the use of marketing platforms and social media has proven to be superior in maintaining a position in the market, being able to suppress the decline in production and absorption of products in the market (5).

Modeling the growth of COVID-19 cases in Semarang City employs a spatial econometric model that uses sub-district cross-section data in Semarang City. However, the cross-state variation of the relationship between socioeconomic and mobility change and virus spread is less explored, which is the focus of our study.

The study aims to find out the relationship of spatial factors between sub-districts through spatial methods of econometrics and how they affect the growth of COVID-19 in Semarang city. Spatial influence can show the relationship of influence between sub-districts with each other, so it is expected that the model can show how high the interaction between sub-districts occurs.

METHODS

This study uses data from the Central Bureau of Statistics (BPS) of Semarang City and other relevant publications. The scope of the research area is all sub-districts and cities in Semarang city. The data published in 2021 are the latest publication. This study used a sample of the number of COVID-19 case data in 16 sub-districts in Semarang City from the website https://siagacorona.semarangkota.go.id/. The sampling technique used is purposive sampling with a time period of three months, namely October, November and December 2020.

Spatial Regression Analysis

The development of the classical linear regression method produces spatial regression.

The development is based on the influence or spatial on the analyzed data (11)(12).

$$Y_{it} = \rho \sum_{j=1}^{n} Wij\, Yit \ + \ \beta xit \ + \ \mu i \ + \ \varepsilon it \ldots\ldots 1)$$

The spatial lag (SAR) model shows the influence of the independent variable on space j on dependent variable space I (13). Where it is an autoregressive spatial coefficient (spatial lag parameter), and W is a spatial weighting matrix with diagonal elements equal to zero.

The spatial error (SEM) model determines the correlation between spaces in the error value. This model describes the spatial interrelationships that occur in its random errors, where a variable independent is expressed by the following equations:

$$Y_{it} = \ \beta xit \ + \ \mu i \ + \ \varepsilon it \ldots\ldots 2)$$

$$\varphi_{it} = \lambda \sum_{j=1}^{n} Wij\, \varphi it \ + \ \varepsilon it \ldots\ldots 3)$$

One statistical test to determine the existence of spatial dependency is to perform initial regression selection using the Lagrange Multiplier (LM) test to detect the presence of spatial dependencies more specifically, namely between the model LM (lag), LM (error), or both commonly called Spatial Autoregressive Moving Average (SARMA). This test determines the best model choice between spatial lag or spatial error based on the criteria of good comparison spatial model (14). Geoda was selected to analyze spatial regression in this study (15). The spatial correlation test for the COVID-19 morbidity rate was also performed in Geoda. The study uses quantitative approaches with explanatory and descriptive methods.

Study Area

The research was conducted in the administrative region of Semarang City consisting of downtown and rural suburbs then divided into 16 sub-districts. The sub-district consists of two of the largest and smallest sub-districts; the district with the largest area is located in the southern part which is a hilly area where most of the area still has agricultural and plantation potential, namely Mijen District with an area of 57.55 km² and Gunungpati District with an area of 54.11 km².

Research Design

A cross-sectional study on the spreading of COVID-19 levels related to socioeconomic factors and community mobility (7)(13). The variables were studied with the following details (Table 1):

Table 1. List of Variables

Code	Variable	Explanation
Y(dependent)	COVID-19	Rate of COVID-19 morbidity (percentage)
X1(Independent)	recipient	Recipient of compensation (percentage)
X2(Independent)	Poverty	Poverty (percentage)
X3(Independent)	density	Population density (percentage)
X4(Independent)	Mobility	Mobility

Classic regression

The technique requires getting the association between the dependent and independent variables that will be used as a determinant of the advanced spatial model is through Ordinary Least Squares. The variable terms that can be utilized are R^2 0.5 < x < 0.1 and = 10%. Classical regression has a mathematical formula.

$$\mathrm{COVID}-19_{i} = \ \beta_0 + \beta_1 i.recipient + \beta_2 i.poverty + \beta_3 i.density + \beta_4 i.mobility \ldots\ldots 4)$$

Figure 1 shows the main study design analysis for the relationship of each of the influencing aspects and morbidity levels of COVID-19 was conducted by correlation analysis (16). The type of data used is secondary data in the form of COVID-19 data per sub-district, namely the merger of cross-section data of 16 sub-districts in Semarang City and time series data with a period of three months, namely in October, November, and December 2020. The data were obtained from the Semarang City Health Office, Semarang City in Number 2020 of the Central Statistics

Agency (BPS) Semarang City; the step in this study was to use panel data that were then averaged and combined data with maps in the form of SHP to regression processing using Geoda software. The secondary data used consist of dependent variables and independent variables consisting of the growth rate of COVID-19 cases in 2020. More details are presented in the following diagram.

RESULTS

The data used in calculating the growth of COVID-19 are daily case data in the city based on calculations obtained on the average value per sub-district in the city of Semarang. The analysis of COVID-19 growth modeling in Semarang City used a spatial econometric approach between October and December 2020. In this study, morbidity rate factors of COVID-19 were defined as the ratio of confirmed cases to the average population in every sub-district. A total of confirmed cases of COVID-19 was collected on the website of COVID-19 in Semarang City government. Factors that affect the growth of COVID-19 cases are explained as dependent variables, namely the growth rate of COVID-19 in Semarang City but by paying attention to spatial aspects or location factors as dependent variables while independent variables are the percentage of poor people, percentage of aid recipients per sub-district during the COVID-19 pandemic, the density of sub-district areas and data on the number of arrivals of people from outside to sub-districts at the research site. After conducting some testing in this study, it was shown that sub-districts in Semarang City occurred spatial autocorrelation found using the calculation of values from the Moran index where there is a grouping of individuals in the city of Semarang with information (High-Low), which means explaining that each region that has a high case growth rate will be surrounded by areas that have a low COVID-19 growth rate, and, conversely, if a region has a low case growth rate it will be surrounded by areas that have areas with high COVID growth rates (Low-High). In this case, the effect of spatial dependencies in influencing the growth of COVID-19 cases in Semarang city can be seen in Figure 2.

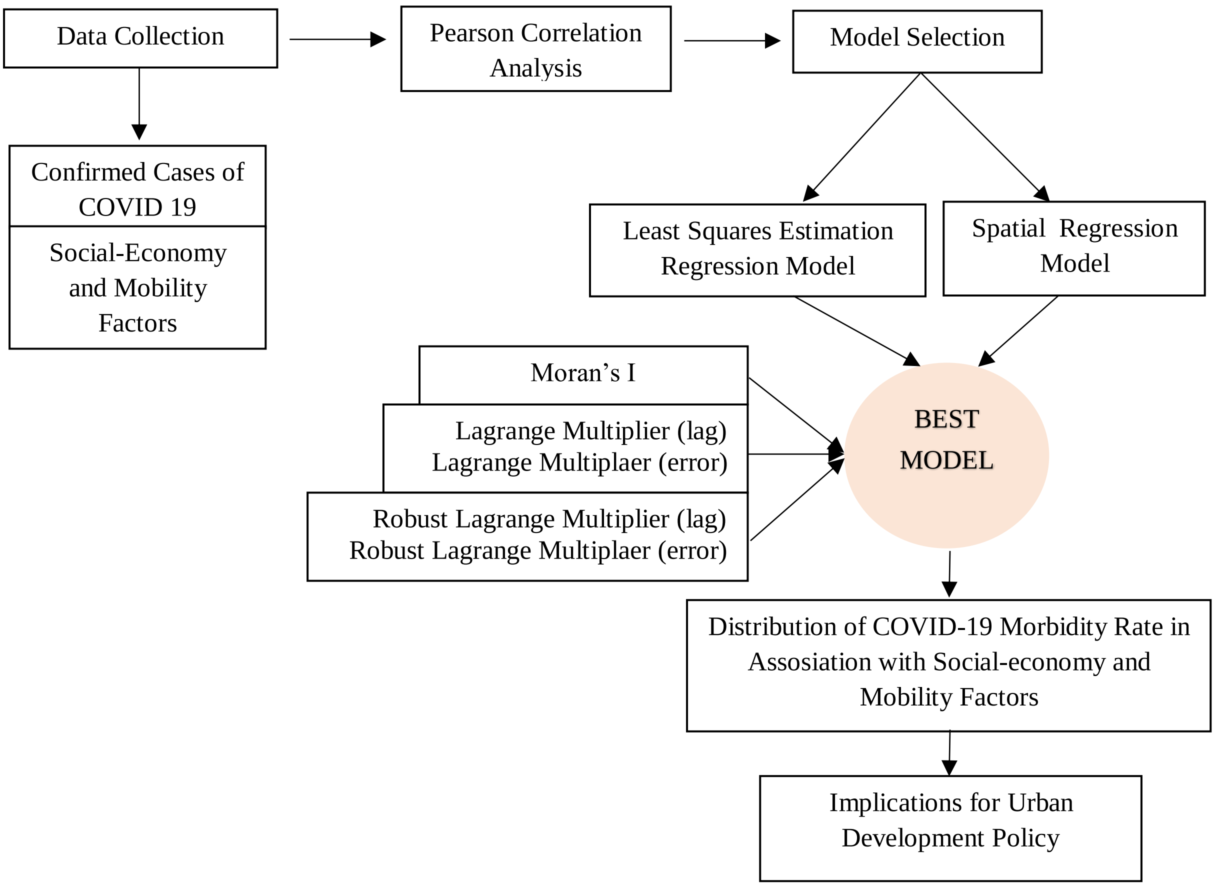

Figure 1. Research Design Diagram

Mapping Cases of COVID-19 with Geoda

Mapping the number of cases of COVID-19 growth can be done with several categories of interval classes (17). The type of map chosen is based on a clear goal because each choice of map type will present a different visualization and each map provides different conclusions to the location of high or low case numbers. High values are generally depicted with more dark colors.

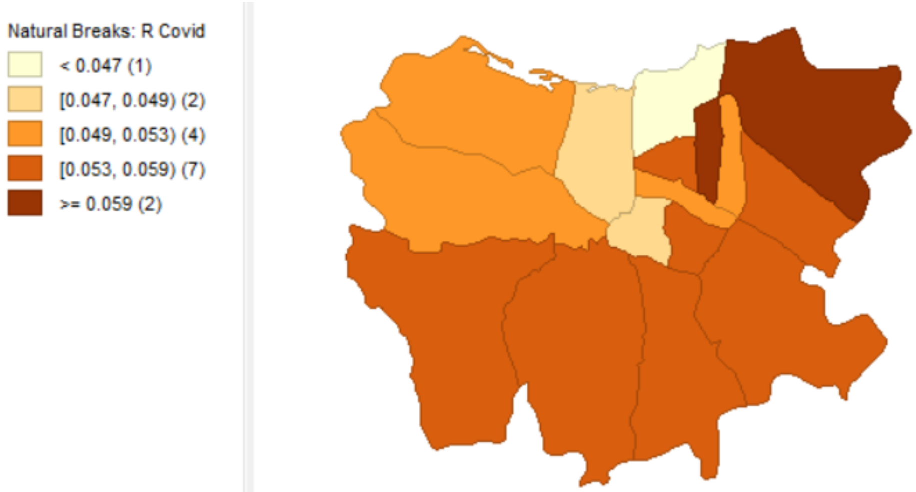

Figure 2. COVID-19 Growth Distribution Map in Semarang City

The effect of spatial dependency on the growth of COVID-19 is shown in sub-districts that have a high COVID-19 growth rate; the districts having a growth in the number of COVID-19 by > 5.9% are Genuk District and east Semarang District, while the district with the lowest COVID-19 growth is in North Semarang District with a percentage of growth of 4.3%. More is shown in the following picture.

Spatial Autocorrelation

These studies evaluated the robustness of the classic regression specification known in the criminological literature when spatial effects were explicitly considered (18). Spatial autocorrelation analysis seeks to understand the similarity between objects or activities at one point on the surface of the earth and near it (19). Autocorrelation is the correlation between the variable and itself, while spatial autocorrelation is the correlation between the variable and itself at various spatial positions (11). Cross-section data are characterized by the emergence of diversity and spatial autocorrelation between sites (20).

The next stage of analysis is the identification of spatial autocorrelation. This will help determine which risk model is more appropriate to use on the data it has. Global auto-correlation states auto-correlation for the overall location while local for each location. Regression results indicate a strong autocorrelation between the dependent variable, namely growth of the COVID-19, and independent variables which are mobility, density, poverty and recipient.

The result of parameter estimated results with classic regression shows that the correlation with R^2 = 0.749656 and the probability values for all variables are less than 0.1 for data significance. This indicates a strong influence on each variable. The results of classic regression testing are given in Table 2.

This research model equation is as the following equation:

$$\mathrm{COVID}-19_{\mathrm{i}} = 0.0552 + 0.003.\beta_1 i - 0.003.\beta_2 i - 4.995.\beta_3 i + 0.00011.\beta_4 i \quad \ldots\ldots 5)$$

Where:

COVID-19i: Rate of COVID-19 morbidity (%)
$\beta_1 i$: Recipient of compensation (%)
$\beta_2 i$: Poverty (%)
$\beta_3 i$: Population density (%)
$\beta_4 i$: Mobility (number of people arriving in Semarang city)

The mobility variable is highly correlated discovered from the results of the regression above. it occurs when the government gives leave during Christmas and New Year activities (21), and the arrival of people to the city of Semarang in the regression test table shows a significance number of 0.005 < α = 0.05. The recipient variable also shows that it is positively correlated with growth of COVID-19 in Semarang City. On the other hand, the variables of the poor population and population density negatively affect the addition of COVID-19 cases, as is seen from the p-value which shows the number 0.046 and 0.043.

Spatial modeling is modeling that is related to the point-and-area approach. Stages to perform spatial modeling are regression of multiple linear, multicollinearity test, residual assumption test, spatial error model (SEM), spatial autoregressive model (SAR), spatial modeling, and Lagrange Multiplier Test (LM) (19). The significance level of the model is at α = 0.05 or α = 0. The results of LM testing using Geoda *software* can be seen in Table 3.

The result from the Table Diagnostics For Spatial Dependence for Weight Matrix shows that Moran's I statistic gives significant and positive results, which is 0.041 or LM (lag) value < α = 0.05. The p-value in this test is less than the real level of 5%, so it can be decided the H_0 is rejected and concluded that there is a spatial *lag* influence in this model. Based on the results of the LM error test > α = 0.05. P-value in this test exceeds 5%, so it can be decided H_0 is accepted and it can be concluded that there is no influence of spatial error in the model. As Lagrange Multiplier (Error) is more robust than Lagrange Multiplier (Lag)/SEM, we now test the variables to COVID-19 in Semarang City, Central Java (Table 4).

Table 2. Parameter Estimated Results with Classic Regression

Variable	Coefficient	Std.Error	t-Statistic	P-value
Constant	0.0522441	0.00264107	19.7814	0.00000
Recipient	0.00308413	0.00149321	2.06543	0.06327*
Poverty	-0.00316761	0.00141384	-2.24043	0.04667**
Density	-4.9954007	2.1908007	-2.28017	0.04352**
Mobility	0.000112252	3.28163005	3.42062	0.00572***
R^2	0.749656			

The estimated coefficient of significance at * p≤0.1; ** p≤0.05; *** p≤0.01
Source: Author analysis results, 2020

Table 3. Output Table for Spatial Econometric of Socioeconomic Factors and Mobility of the Community with The Distribution of Morbidity of COVID-19

Test	MI/DF	Value	Prob
Moran’s I (error)	0.0638	1.2089	0.22672
Lagrange Multiplier (lag)	1	1.5652	0.21091
Robust LM (lag)	1	4.1363	0.04197**
Lagrange Multiplier (error)	1	0.1414	0.70688
Robust LM (error)	1	2.7125	0.09957*
Lagrange Multiplier (SARMA)	2	4.2777	0.11779

The estimated coefficient of significance at *p≤0.1; **p≤0.05;***p≤0.01
Source: Author analysis results, 2020

In the model, it can be known that the increasing number of arrivals/mobility (X_4) in one sub-district, has a significant influence on the growth of COVID-19 cases in a sub-district with an elasticity of 0.4044 (22). If the original income of the district increases by 1%, it will obtain an additional Gross Regional Domestic Product (GRDP) of 0,00010% (23).

Increasing the number of poor people (X2) in one sub-district has a significant influence on the decrease in the number of COVID-19 sub-districts with the elasticity of -0.0031. That is, if poor people in a district of Semarang City increase by 1%, it means there are no cases of COVID-19 in the sub-district by -0.0031%.

The increasing number of aid recipients (X1) in one district of Semarang City has a significant influence on the growth of COVID-19 numbers in the sub-district with an elasticity of 0.003. That is, if the recipient of assistance during the COVID-19 pandemic in the district has increased by 1%, there will be a growth in the COVID-19 rate of 0.003%.

Table 4. Lagrange Multiplier (Error) Output Table

Variable	Coefficient	Std. Error	p value
CONSTANT	0.0527276	0.00226383	0.0000*
Recipient	0.00302499	0.00124579	0.0152**
Poverty	-0.003172	0.0011745	0.0069**
Density	-5.12364	1.8301e-007	0.0051**
Mobility	0.00010	2.63711e-005	0.0005**
LAMBDA	0.000107056	0.0337874	0.58031
R^2	0.754718		

The estimated coefficient of significance at * $p \leq 0.1$; ** $p \leq 0.05$
Source: Author analysis results, 2020

The model has a high R^2 value, which is 0.7780. All variables that showed significant numbers in the model were the number of poor people (X2), regional density (X3), and the mobility of people (X_4). Through testing of spatial interactions and spatial effects on the model it obtained that there were spatial interactions and spatial effects in each studied sub-district in Semarang City. While fixed effects and random effects models have variables that are not significant and negative values. This is due to the availability and limited time-series data of COVID-19 growth that only uses three months, namely October, November, and December 2020 as research data.

DISCUSSION

Possible Impacts of Social, Economic and Mobility Factor on COVID-19 Cases

Social restriction (social distancing) means to make a distance from oneself to others to prevent the transmission of certain diseases. It is assumed that the psychological impact of a significant increase in positive confirmation cases of COVID-19 has more effect on the behavior of residents in avoiding travel and crowds. This dramatic decline of growth rates could potentially reflect the fundamental association between the dynamics of the intense social restriction and virus transmission in the initial stage of the pandemic, also observed by (8).

This pandemic caused several local governments to implement Large-Scale Social Restrictions (PSBB) policies that have implications for restrictions on community activities, including economic activities, educational activities, and other social activities (24). This takes a look at analyzing the growth of the COVID-19 instances in affiliation with social, economic, and mobility factors in Semarang City. Local and National authority's efforts to defend the maximum-prone companies of the network throughout the instantaneous reaction levels are crucial, as are recuperation measures that lessen city inequalities, toughen human rights and bolster the resilience of prone companies to destiny shocks. Against this background, precedence moves that policy makers ought to make in session with applicable stakeholders are: first, COVID-19 is effectively in the early stages of the first wave of the pandemic, where a substantial decline in human mobility as a consequence of the increasing level of social restrictions is followed by a sharp decrease in growth rates and a sharp increase in the doubling time of the spread of COVID-19. This dramatic decline in growth rate may reflect the fundamental link between the dynamics of powerful lockout instructions and virus transmission in the early stages of a pandemic. It was also observed by the government and some scientists (6).

There are extra combined styles of mobility-unfold correlation after the preliminary degree of in-depth lockdowns. The distribution of COVID-19 growth has a likely clarification that social restriction rules can also additionally have an effect on the virus unfolding is now no longer simply due to their direct impact on mobility levels; however, additionally via their effect on different kinds of character behaviors, such as character social distancing, hygiene, and masks wearing (8). The local government of Semarang City can determine the right strategy in locations that must get more attention to anticipate and minimize the occurrence of COVID-19 growth in the future.

The importance of this research is to support the literature on the impact of people's mobility factors and travel behaviors on the COVID-19 pandemic. Furthermore, our research also has importance to control and guide COVID-19 policies aimed at limiting mobility. We know that, during the two weeks of the implementation of PPKM Jawa Bali in the Semarang City area, the development of Covid-19 cases in Semarang City until the third week of January 2021 is claimed to have been suppressed or decreased (25). Our results reveal that people's mobility levels quickly recovered after April despite the severe COVID-19 situation and mobility restriction policies across areas in Semarang City. Our result is that restricting people's movements to fight a pandemic is not effective only in a short period, after which movement restrictions are effective in limiting people's travel opportunities and reducing the spread of the virus. It suggests that may disappear. This implies that a policy announcement, regardless of whether it is of monetary or fiscal nature, about limitation of movement would be more impactful in stimulating activity in the city to decrease the virus spread (22) (26).

CONCLUSION AND SUGGESTIONS

Conclusion

In the end, through modeling and mapping the relative risk of this disease, the author can see a clearer picture of locations that have a high risk of COVID-19 growth and what factors are dominant in influencing the growth of COVID-19 in Semarang City with the right analysis. Regression results indicate a strong autocorrelation between the dependent variable, namely growth of the COVID-19, and the independent variables of mobility, density, poverty and recipient. The districts having a growth in the number of COVID-19 by > 5.9% are Genuk District and east Semarang District and the dependent variable is strongly affected by the mobility variable. The result of the R-square value with classic regression and spatial error is 74.96% and 75.47%, respectively. It is shown that the spatial error model is more accepted than classic regression. Through testing of spatial interactions and spatial effects on the model obtained, as a result, there were spatial interactions and spatial effects in each sub-district in Semarang City.

Suggestion

The growth of COVID-19 in the district of Semarang City in addition to being related to inputs from each sub-district itself is also highly related to inputs from the surrounding districts. There is a need to develop a collaborative framework and policy to improve coordination between sub-districts to achieve prevention goals. In addition, large-scale social restriction policies (PSBB) in Semarang City are needed, such as a limitation of movement from outside into the sub-districts in Semarang city.

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