Population density and spread of COVID-19 in Bandung City, Indonesia

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ABSTRACT

Population density is an important factor for a sustainable city. However, it turns out that population density is also a problem in cases of the spread of COVID-19 in several countries, although there are other factors that also play a role. This paper aims to prove how population density affects the spread of COVID-19 in Bandung City with the sub-district data unit. To obtain a complete overview, the analysis was carried out by comparing conditions at the weekend as usual with the conditions during the long weekend. Simple regression analysis was used to determine how population density affects COVID-19 cases. A comparative analysis was then carried out to compare the effect of population density on the number of COVID-19 cases in the two different weekend conditions. The analysis found that population density did affect the number of COVID-19 cases, but this did not apply to all sub-districts. Population density has a greater effect on COVID-19 cases during the usual weekend than during the long weekend. In addition, the best model during the normal weekend only applies to 21 sub-districts, while the best model during the long weekend applies to 26 sub-districts. With these findings, urban planners need an in-depth study of the appropriate concept of population density for a compact and sustainable city.

Keywords: Population, Covid-19, Density.

ABSTRAK

Kepadatan penduduk merupakan faktor penting bagi kota yang berkelanjutan. Namun, ternyata kepadatan penduduk juga menjadi masalah dalam kasus penyebaran COVID-19 di beberapa negara, meski ada faktor lain yang juga berperan. Tulisan ini bertujuan untuk membuktikan bagaimana kepadatan penduduk mempengaruhi penyebaran COVID-19 di Kota Bandung dengan unit data kecamatan. Untuk mendapatkan gambaran yang lengkap, analisis dilakukan dengan membandingkan kondisi akhir pekan seperti biasa dengan kondisi akhir pekan panjang. Analisis regresi sederhana digunakan untuk menentukan bagaimana kepadatan penduduk memengaruhi kasus COVID-19. Analisis komparatif kemudian dilakukan untuk membandingkan pengaruh kepadatan penduduk terhadap jumlah kasus COVID-19 di dua kondisi akhir pekan yang berbeda. Analisis menemukan bahwa kepadatan penduduk memang memengaruhi jumlah kasus COVID-19, tetapi ini tidak berlaku untuk semua kecamatan. Kepadatan penduduk memiliki pengaruh yang lebih besar terhadap kasus COVID-19 pada akhir pekan biasa dibandingkan pada akhir pekan panjang. Selain itu, model terbaik pada akhir pekan normal hanya berlaku untuk 21 kecamatan, sedangkan model terbaik pada akhir pekan panjang berlaku untuk 26 kecamatan. Dengan temuan tersebut, para perencana kota membutuhkan kajian mendalam tentang konsep kepadatan penduduk yang tepat untuk kota yang kompak dan berkelanjutan.

Kata kunci: Penduduk, Covid-19, Kepadatan.

1.   **PENDAHULUAN**

For most of 2020, Bandung City, like other regions in Indonesia and other countries, has experienced the COVID-19 pandemic. In other countries, it has even started since the end of 2019, which initially happened in Wuhan, China. As of December 29, 2020, of the total number of confirmed positive COVID-19 cases in West Java Province, Bandung City was in fourth place after Bekasi City, Depok City, and Bekasi Regency (Pusat Informasi & Koordinasi COVID-19 Provinsi Jawa Barat 2020). The cities/regencies with the highest cases are areas with high population density. In Algeria, it was found that population density is one of the causes of the high spread of COVID-19 (Kadi, N., dan Khelfaoui, M. 2020), as well as in Turkey (Coşkun, H dkk, 2021), apart from the influence of wind direction (Baser, O. 2020). In Japan, temperature, together with population density, affects the spread of COVID-19 (Rashed, E dkk, 2020). Meanwhile, research in the US revealed that although population density has an effect on the spread of COVID-19, the effect is not as large as population mobility (Hamidi, S dkk, 2020). Although there are differences in the results of previous studies due to different locations, variables and methods, population density does have an effect on the spread of COVID-19 (Kadi, N 2020; Baser, O. 2020; Rashed, E 2020 dan Hamidi, S 2020). With the COVID-19 outbreak, the concept of population density has received attention from various perspectives because it is considered difficult to implement social distancing (Gill, K. dkk, 2020), while social distancing is an effort to prevent the spread of COVID-19 (Tammes, P. 2020 dan Hughes, R. P 2020).

Before COVID-19 became an epidemic, there was a debate about overcrowding in the neighbourhood. Some studies argue that high population density negatively impacts satisfaction with the living environment (Bramley, G., and Power, S. 2009), the sense of attachment, and the quality of public utilities (Dempsey, N. dkk, 2012). Studies conducted in Bandung City also prove that population density negatively affects life quality (Arifwidodo, S. D. 2012 In other studies, different things were found. Population density is expressed as the core dimensions of the compact urban form (Mouratidis, K. 2019 dan Kotharkar, R. 2020). Although there may be mistakes in implementing the compact city concept (Metre, K. dkk, 2021), a compact city will also become a sustainable city (Bibri, S.

E., Krogstie, J., dan Kärrholm, M. 2020). Therefore, with the COVID-19 outbreak, the compact city concept, especially regarding population density, has become a new normal planning issue (Lennon, M. 2020).

This study aims to find evidence of whether the population density in Bandung City causes the high number of COVID-19 cases or not, based on its distribution at the sub-district scale. To obtain better results, the analysis was carried out using the latest data (December 2020), when there were many holidays, and carried out in September 2020. During the year-end holidays, Bandung was visited more frequently than in September 2020. Significantly, the COVID-19 outbreak has indeed caused reduced mobility in cities (Fatmi, M. R. 2020) as well as reduced demand for public transport (Liu, L. dkk, 2020). With reduced mobility between cities, internal COVID-19 migration tends to be more influential as the number of cases increases. This argument is the basis for analyzing the effect of population density on the spread of COVID-19 under two different conditions: when the movement of people from outside Bandung is not too much and when Bandung is the destination for the movement of many people from outside. Furthermore, the discussion section will also discuss how the concept of "population density" is appropriate to positively impact Bandung City residents based on experiences from other places and similar studies. Simple regression analysis was used to find a model for the effect of population density on COVID-19 cases, and a comparative analysis was conducted to find similarities/differences between two different conditions of the weekend.

2. METODOLOGI

This study used secondary data with sub-district data units. The variables used were total positive cases for each district as the dependent variable and population density (population per acre area of the sub-district) as the independent variable. Data on positive cases of COVID-19 were obtained from the Bandung City COVID-19 Information Center (Pusicov Bandung) (Pusat Informasi COVID-19 Kota Bandung 2020 https://covid19.bandung.go.id/data [downloaded on 29 December 2020, 11:00 WIB]) which is online data. The downloading data was carried out on December 15, 2020, and was checked again on December 29, 2020, to update the data. Meanwhile, population density data were obtained from Bandung Municipality in Figures 2020 (Statistics of Bandung Municipality. 2020).

The analysis method uses a simple regression analysis with IBM SPSS Statistics 20 and Excel. Classical assumptions for regression analysis follow the general theory, namely normality, linearity, and heteroscedasticity (Fox, J. 2015).

This study was a descriptive quantitative study, including comparative analysis, comparing models using data in September 2020 and December 2020. The data used are positive case data in each sub-district. The selection of the case on December 26, 2020, was because it was a long weekend, so that on that date, there were many movements out of and into Bandung City. As a comparison, case data were used on September 26, 2020, where there were not as many cases of external movements to and from Bandung City as during a long holiday. Both dates are Saturdays. For a long time, Bandung City has been a vacation destination, especially for people from Jakarta.

There are two hypotheses that will be proven in this study. Hypothesis I is:

H0: there is a positive effect of population density on the number of COVID-19 cases, and

H1: there is no positive effect of population density on the number of COVID-19 cases.

Hypothesis II that will be proven is the comparative hypothesis of the effect of population density on the number of COVID-19 cases in Bandung City at different times. The hypothesis is:

H0: the positive effect of population density on the number of COVID-19 cases is greater at the general weekend, and

H1: The positive effect of population density on the number of COVID-19 cases is the same during the long-weekend and general weekend.

Bandung City consists of 30 sub-districts with various population densities. For analysis purposes, population density and the number of COVID-19 cases are grouped into 5 (five) classifications, namely very low (VL), low (L), medium (M), high (H), and very high (VH). Considering the amount of data is only 30 sets, a shortcut was taken to facilitate analysis. The shortcut taken was to determine each sub-district classification based on the criteria for population density and the number of COVID-19 cases. The results of this grouping are shown in Tables 1 and 2.

Table1. The sub-district classification is based on population density and the number of COVID-19 cases on September 26, 2020.

		Number of COVID-19 Cases				
		VL	L	M	H	VH
Population Density	VL	Bandung Wetan, Cinambo, Gedebage, Panyileukan	Bandung Kidul, Cidadap, Sumur Bandung	Cibiru	Arcamanik	
	L	Bojongloa Kidul	Ujungberung, Mandalajati, Sukasari, Regol	Rancasari, Cibeunying Kaler	Buah Batu	Coblong, Lengkong, Cicendo
	M		Batununggal, Babakan Ciparay	Kiaracondong, Bandung Kulon, Sukajadi, Antapani	Andir	
	H		Astanaanyar, Cibeunying Kidul			
	VH		Bojongloa Kaler			

Table 1 shows that in several sub-districts, there is no positive correlation between population density and the number of COVID-19 cases. Coblong, Lengkong, and Cicendo have population densities of L, but the number of positive cases is VH. On the other hand, Bojongloa Kaler has a population density of VH but the number of cases of COVID-19 L. To test the hypothesis using simple linear regression, it was done two times. The first is to test all sub-districts, the second excludes sub-districts that have extreme differences between the classification of population density and the classification of the number of COVID-19 cases.

Table 2. The sub-district classification is based on population density and the number of COVID-19 cases on December 26, 2020.

		Number of COVID-19 Cases				
		VL	L	M	H	VH
Population Density	VL	Bandung Wetan, Cinambo, Cidadap, Gedebage	Sumur Bandung, Bandung Kidul, Panyileukan, Cibiru			Arcamanik
	L		Mandalajati, Sukasari, Cibeunying Kaler	Ujungberung, Lengkong, Bojongloa Kidul, Regol,		Coblong

		Number of COVID-19 Cases				
		VL	L	M	H	VH
				Rancasari, Buah Batu, Cicendo		
	M		Batununggal	Babakan Ciparay	Kiaracondong, Andir, Sukajadi, Antapani	Bandung Kulon
	H			Astanaanyar, Cibeunying Kidul		
	VH		Bojongloa Kaler			

Several sub-districts experienced a change in the classification of the number of COVID-19 cases on December 26, 2020 (Table 2) when compared to the cases on September 26, 2020 (Table 1). The same analysis was carried out for data on December 26, 2020, and then the results obtained were compared with the results for modeling on September 26, 2020.

## 3.	HASIL DAN PEMBAHASAN

Figure 1 shows a comparison of the scatter plot, trendline, and regression model. There is a striking difference between Figures 1a and 1b. R2 in Figure 1a is very small and using SPSS, the assumptions for the regression test are not fulfilled, so it is natural that the resulting model is not significant. By removing outlier data (Figure 1b), which is data from 9 sub-districts as can be seen in Table 1 (Cibiru, Arcamanik, Buah Batu, Coblong, Lengkong, Cicendo, Astanaanyar, Cibeunying Kidul, and Bojongloa Kaler), the results are significant R2 is good enough, increased from 0.011 to 0.46.

These results show that population density in 21 sub-districts affected the spread of COVID-19 by 46%, while 54% was influenced by other factors that were not tested in this research. The complete regression analysis results that exclude outliers are shown in Table 3.
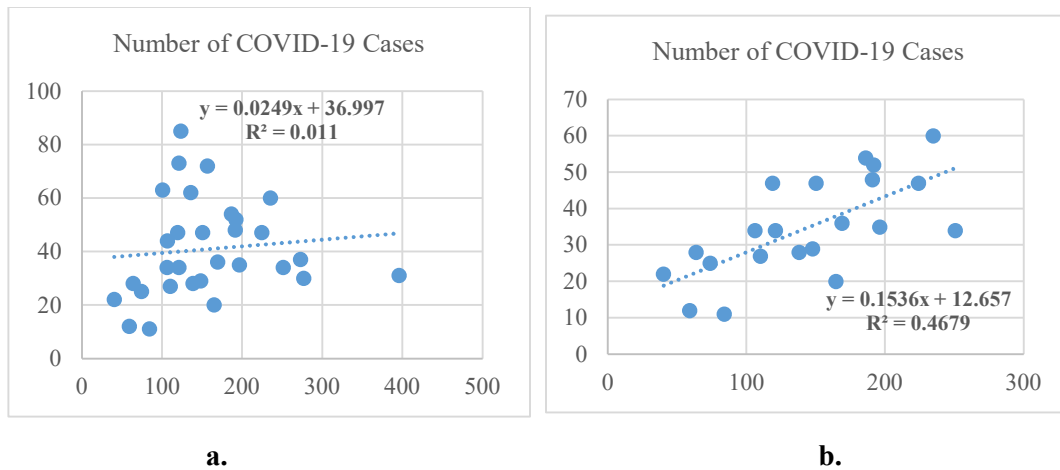
a.   b.

Figure 1. *Scatter plot and population density trendline with the number of COVID-19 cases*
September 26, 2020 (a. all districts and b. outlier data released)

In Table 3, it can be seen that apart from R2, which is quite large (0.467), the significance value of F is 0.000627528, which is <0.05 (because the confidence level used is 95%), it can be seen that the regression model obtained is significant. It means that for 21 sub-districts, the effect of population density is 47% on the number of COVID-19 cases for September 26, 2020.

Table 3. *Statistical results of data regression analysis on September 26, 2020*

a. Regression statistics

Regression Statistics	
Multiple R	0.684025155
R Square	0.467890412
Adjusted R Square	0.439884645
Standard Error	10.14612576
Observations	21

b. Anova

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	1719,876034	1719,876034	16,70693038	0,000627528
Residual	19	1955,93349	102,9438679		
Total	20	3675,809524			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	12,65728088	5,843654602	2,165987167	0,043238724
Population Density per Acre	0,153554365	0,037567633	4,087411208	0,000627528

The scatter plot and trendline of population density and COVID-19 cases on December 26, 2020, is shown in Figure 2. Like the data for September 26, 2020, the effect of population density on the number of COVID-19 cases in Bandung City on

December 26, 2020, data when tested for all sub-districts did not produce a significant regression model. After the outliers were removed (Bandung Kulon, Bojongloa Kaler, Arcamanik, and Coblong), the results were significant, and the R2 value was better than before (0.3984).
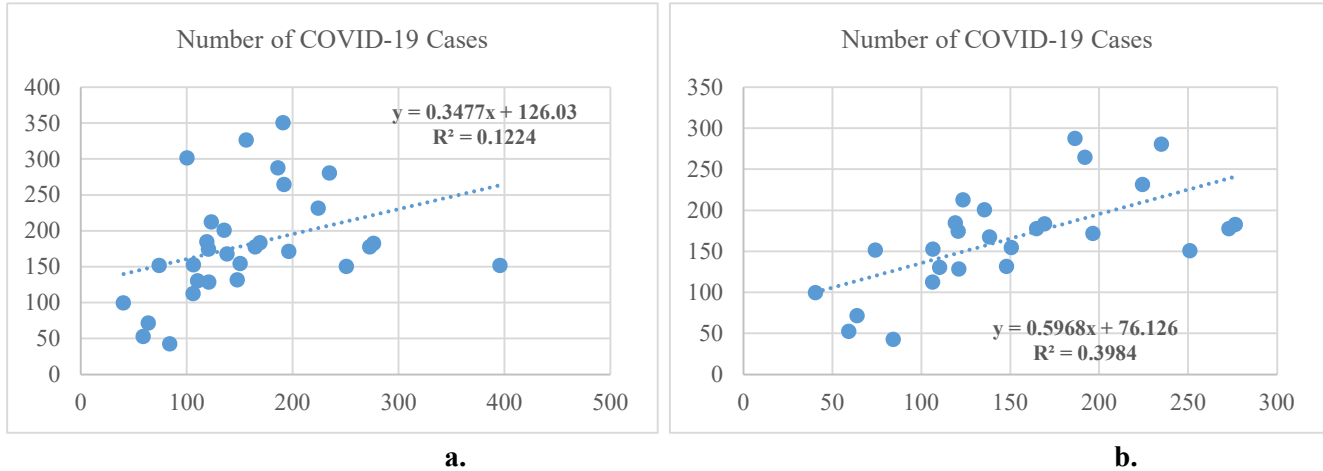

a.   b.

Figure 2. *Scatter plot and population density trendline with the number of COVID-19 cases December 26, 2020 (a. all districts and b. outlier data released)*

The results of statistical regression analysis for data on December 26, 2020, is shown in Table 4. The significance value of the model is 0.000545495, which is much smaller than 0.05. For December 26, 2020, population density on the number of COVID-19 cases is 40%, which applies to 26 sub-districts.

Table 4. *Statistical results of data regression analysis on December 26, 2020*

a. Regression statistics

Regression Statistics	
Multiple R	0,631150995
R Square	0,398351578
Adjusted R Square	0,373282894
Standard Error	48,90623227
Observations	26

b. Anova

	df	SS	MS	F	Significance F
Regression	1	38006,98453	38006,98453	15,8904063	0,000545495
Residual	24	57403,66931	2391,819555		
Total	25	95410,65385			
	Coefficients	Standard Error	t Stat	P-value	
Intercept	76,12576679	24,24401529	3,139981801	0,004439642	
Population Density per Acre	0,596812304	0,149716707	3,986277249	0,000545495	

From the results obtained, the overall H0 was acceptable, both for the cases of September 26, 2020, and December 26, 2020. This means that there is indeed an effect of population density on the number of COVID-19 cases in sub-districts in Bandung City. These results are consistent with previous studies (Kadi, N. 2020; Coskun, H. 2021; Baser, O. 2020; Rahed, E 2020 dan Hamidi, S. 2020). It is just that it does not apply to all districts. The sub-districts that were outliers for the two data sets were Bojongloa Kaler, Arcamanik, and Coblong. If Bojongloa Kaler has a very high density, but with a low number of COVID-19 cases, Arcamanik and Coblong are the opposite. The results obtained with the case of Bandung City provide further evidence that planners must immediately find the right model to use population density to measure a sustainable city in the new normal era (Bibri, S. 2020 dan Lennon, M. 2020).

Then, there are differences in the September 26, 2020, case results and the December 26, 2020, case. The first difference is that the sub-districts that have population density affect the number of COVID-19 cases. The second difference is the magnitude of the influence of population density on the number of COVID-19 cases. The effect of population density on the number of COVID-19 cases for data on September 26, 2020 was greater than December 26, 2020. Other possible influencing factors differ between the two cases.

4. KESIMPULAN DAN SARAN

Population density is proven to have an effect on the number of COVID-19 cases in the sub-districts of Bandung City, although the effect is less than 50%. It is necessary to find other factors that affect the number of COVID-19 cases with various conditions. There is also a possibility that during the long weekend, the effect of mobility is more dominant than on other days. The COVID-19 pandemic opens up research opportunities in the future, including what population density conditions can guarantee a healthy city.

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