Modelling the Kampungkota: A quantitative approach in defining Indonesian informal settlements

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Abstract. Bandung City is home to 2.5 million inhabitants, some of which are living in slums and squatter. However, the terms conveying this type of housing is not adequate to describe that of Indonesian called as kampungkota. Several studies suggest various variables in constituting kampungkota qualitatively. This study delves to define kampungkota in a quantitative manner, using the characteristics of slums and squatter. The samples for this study are 151 villages (kelurahan) in Bandung City. Ordinary Least Squares, Geographically Weighted Regression, and Spatial Cluster and Outlier Analysis are employed. It is suggested that kampungkota may have distinguished variables regarding to its location. As kampungkota may be smaller than administrative area of kelurahan, it can develop beyond the jurisdiction of kelurahan, as indicated by the clustering pattern of kampungkota. Keywords: kampungkota, informal urbanism, housing system, Indonesia.

1. Introduction to kampungkota in Indonesia

Slums and squatter has been issues of housing in Indonesia. Cities are not merely consisted of slum area but also planned residential area, trading and services centers, offices, and other tertiary sectors. However, the particular social values and the dynamics of local neighborhoods have contributed in generating kampungkota. This term refers to a specific neighborhood which at some extent has unique social values amidst the heterogeneity of urban dwellers. The definition is not settled though, as there is not suitable word in English; several kampungkota are built upon legal property and some are not considered slums (Obermayr, 2017). This condition is exacerbated as legal framework in Indonesia only recognized the management of slums (permukiman kumuh).

The continuing struggles in constituting the definition of kampungkota motivates further studies to gather evidentiary supports thoroughly in order to better grasp what the term actually is. Hence, this study aims to investigate the characteristics of kampungkota as the common issue in Indonesian cities. Quantitative methods are employed in this study, in which analyses are done using GIS. Taking case in Bandung as both the third most inhabited cities with population around 2.5 million citizens and the second highest population living in slum (Tarigan et al, 2015), this study should suggest more suitable definition of kampungkota. In bigger picture, this study should encourage the studies in informal urbanism, which is sometimes having less quantitative data. Also, this study should identify basic model of how kampungkota will manifest in urban perspective of Indonesia.
2. Previous studies pertained to kampungkota

The emergence of slums and squatter has been widely witnessed in mostly developing countries, including in Bangladesh (Paul, 2006), Albania (Pojani, 2013), The Philippines, and Vietnam (Minery et al., 2013). However, the terms of ‘slums’ and ‘squatter’ is too vague to discern, leading to the use of more comprehensive term which is called “marginalized settlements” (Obermayr, 2017). Several evidences found by Obermayr (2017) suggest that the dwellers of squatter could be lower and middle class and most of them have legal ownership of their properties, while a large part of them don’t have clear ownership over their property (Özdemirli, 2014). Another findings by Pugh (2000) suggests that squatters typically do not only have low access to water, but also possess high risk of mortality, particularly the children.

The vulnerability of slums’ dwellers and squatters’ inhabitants encourages various global initiatives to upgrade the livability in slums and squatters throughout the world. Kool et al. (1989) conclude that vast implementation of slums upgrading—particularly done in low to moderate standards—diminishes the needs of displacement. Milone (1993) investigated the implementation of Kampung Improvement Program in small and medium-sized cities in Java, Indonesia and found that improving the accessibility of water supply and sanitary facilities correlates with higher livability. However, Minery et al (2013) suggest that security of tenure, government and regulation setting, public participation, up-scaling and extension program, and the connections between slum upgrading and sustainable livelihoods in implementing effectual slum upgrading programs and integrating them into urban planning.

A comprehensive study by Obermayr (2017) identifies two polarized types of Indonesian squatter; the first is located in inner-city which could be either kampungkota with improved infrastructure or kampungkota with insufficient infrastructures while the second is located in the periurban area. Kampungkota in peri-urban area may be constructed illegally which characteristics are more rural (Obermayr, 2017). These lead to the recognition that some characteristics of both slums and squatters can be used in indicating which neighborhood is actually kampungkota. These characteristics may include the land use surrounding kampungkota, the number of poor people living there, and number of slum housing.

3. Methodology

This study employs three quantitative methods, which are Ordinary Least Squares (OLS) linear regression, Geographically Weighted Regression (GWR), and Clusters and Outliers Analysis (COA). Clusters and Outliers Analysis (COA) is a method which identifies the clusters of objects having similarities not only in value but also in geographical proximity (ESRI, 2012). Also, this analysis recognizes the outliers that having no similarity with surrounding or similar objects. Both clustering objects and outliers can be defined by looking the z-score, p-value, and Moran’s Index (Moran’s I).

OLS linear regression generates predictions or models a dependent variable in terms of its relationships to a set of explanatory variables. However, if any misspecification resulted by trying to model nonstationary variables using OLS, then GWR may be used to improve predictions and to better understand the nonstationarity (regional variation) inherent in explanatory variables (ESRI, 2012). GWR models spatially varying relationships, whose coefficients are functions of spatial location (Fotheringham et al, 2002; Chi et al, 2013) give a general form of a basic GWR model as:

\[ y_i = \beta_k x_k + \epsilon_k \]  

where \( y_i \) is the dependent variable at location \( i \); \( x_k \) is the \( k \)-th independent variable at location \( i \); \( \beta_k \) is the local regression coefficient for the \( k \)-th independent variable at location \( i \); and \( \epsilon_i \) is the random error at location \( i \).

Firstly, ratio of slum area in kelurahan in Bandung City are analyzed using COA. This will reveal the likeliness of kelurahan having high ratio of slum area to cluster with another kelurahan which has
relatively similar condition. Secondly, GWR is employed to explore what factors influencing the kampungkota. Several variables used in GWR will be described in Table 1.

3.1. Variables
The objects to analyze in this study are the possible clusters of kelurahan (This term is equivalent to “village”. There is also kecamatan which is equal to “subdistricts”. Kelurahan is hierarchically lower than kecamatan) which have significant relationship in term of ratio of slum area in each kelurahan and the relationship between the area of slum in each kelurahan and its predictor variables. The predictors are selected after the reiterations of GWR using various variables inputted to reach the highest possible value of R-square and the lowest value of Akaike Information of Criterion (AIC). R-square indicates how accurate the model is while AIC looks for the model having a good fit to the actual condition but minimum parameters.

The data used in this study are gained from Potensi Desa 2014. There is also the calculation of land use ratio compared to the area of kelurahan whose data are attained from the land use map of Bandung in 2015, with scale 1:5000. The area of slum in each kelurahan in Bandung City is collected by the Mayor Decree 648/2015 about The Location of Slums Area in Bandung City.

Table 1. Variables used in GWR

| Variable | Definition |
|----------|------------|
| AS       | The area of slum in kelurahan (m²) |
| RHDRA    | Ratio of high density residential area in kelurahan (m²) |
| RMDRA    | Ratio of medium density residential area in kelurahan (m²) |
| RCA      | Ratio of commercial area in kelurahan (m²) |
| PD       | Population density in kelurahan (persons/km²) |
| NSH      | Number of slum housing in kelurahan (unit) |
| SKTM     | Number of Identification Letter of Being Poor (Surat Keterangan Tidak Mampu) issued in kelurahan (household) |

3.2. Model
Based on the basic GWR model, the relationship between the area of slum and the variables aforementioned is mathematically expressed as:

\[ AS_i = \beta_0 + \beta_1RHDRA_i + \beta_2RMDRA_i + \beta_3RCA_i + \beta_4PD_i + \beta_5NSH_i + \beta_6SKTM_i + \epsilon_i \] (2)

4. Results
Regarding to the ratio of slums area in each kelurahan, the analysis shows that several kelurahan do cluster into two groups, along with two outliers (see Table 2 and Figure 1). From this analysis, there are three kelurahan which have the highest z-score and having COType of HH (High-High), indicating the similarity of each kelurahan in terms of ratio of slums area. It is indicated that the characteristics in these kelurahan is relatively similar.

From the OLS and GWR results (see Table 3), it is found that GWR outperforms OLS by the higher R-square and Adjusted R-square of GWR than that of OLS, though AIC values of both models imply that two models are good fit with minimum parameters. However, it is also found that the significant variables in OLS are only the intercept and the ratio of high density residential area.

Table 2. The result of spatial clusters and outliers analysis

| Kelurahan       | Kecamatan | Local Moran’s I | z-score | p-value | COType |
|-----------------|-----------|-----------------|---------|---------|--------|
| Garuda          | Andir     | 0.006514        | 2.216655| 0.026647| HH     |
| Dungus Cariang  | Andir     | 0.010308        | 3.772482| 0.000162| HH     |
| Maleer          | Batununggal| 0.020147       | 5.087551| 0       | HH     |
Table 3. The result of OLS and GWR

| Explatory Variables | OLS | GWR |
|---------------------|-----|-----|
|                     | β   | Significance (p-value <0.05) | Min. | 1<sup>st</sup> Quartile | Median Value | 3<sup>rd</sup> Quartile | Max. |
| Constant            | 0.071924 | Yes | -0.021176 | 0.042298 | 0.067999 | 0.084537 | 0.141261 |
| RHDRA               | 0.188206 | Yes | -0.182355 | 0.182699 | 0.251664 | 0.584486 | 1.683953 |
| RMDRA               | -0.071623 | No | -2.256099 | -1.88014 | -0.069691 | -0.035128 | 0.043207 |
| RCA                 | -0.019501 | No | -0.301951 | -0.174507 | -0.033771 | 0.136894 | 0.698841 |
| PD                  | 0.000001 | No | -0.000007 | 0.000001 | 0.000002 | 0.000002 | 0.000004 |
| NSH                 | -0.000105 | No | -0.000373 | -0.000183 | -0.000115 | -0.000076 | -0.000019 |
| SKTM                | 0.000002 | No | -0.000048 | -0.000001 | 0.000005 | 0.000027 | 0.000106 |
| Residual sum of squares | 1.631524 | | | | | | |

**Figure 1.** The clusters and outliers of kelurahan in terms of slums area ratio.
| Explanatory Variables | OLS | GWR |
|-----------------------|-----|-----|
|                        | β   | Significance (p-value <0.05) | Min. | 1st Quartile | Median Value | 3rd Quartile | Max. |
| Akaike Information of Criterion | -166.191220 | -173.649031 |     |             |             |             |      |
| R-square               | 0.134172 | 0.462420 |     |             |             |             |      |
| Adjusted R-square      | 0.098096 | 0.268034 |     |             |             |             |      |

From the GWR, the residuals of the models vary regarding to its spatial location. Ratio of slums area in 69 kelurahan can be modeled by the GWR using the same variables as this study does as the residuals are minimum. On the other hand, Figure 2 further suggests that there are more explanatory variables to be included in the GWR (as the area gets red and darker) or even excluded (as the area gets blue and darker).

![Figure 2. The residuals of GWR.](image)

**5. Discussion and Concluding Remarks**

From the results, although a kelurahan may have a high ratio of slums area, it may be statistically unrelated with its surrounding kelurahan in terms of kampungkota. There are high yet significant relationships of kelurahans clustering by high ratio of slums area. The clustering kelurahans indicates that the kampungkota may expand beyond the administrative area of kelurahan. However, the relatively weak accuracy of GWR models in this study to better define kampungkota still needs to be explored. It should also be noted that kampungkota is not only slums and squatters, as there is still unclear definition of variables constituting it.

In city scale, there is a palpable difference of kampungkota in city centers and periphery area, as the models in both areas are distinctive. It can be noticed that the models are relatively similar in
Kelurahan located on the periphery area, while the models of kelurahan located in city centers vary considerably. This slightly corroborates the classification of informal settlements as seen in other cities such as Surakarta (Obermayr, 2017). This may be caused by the lack of exploratory variables that better represent the socio-economic and socio-demographic conditions, land use, historical background, and legal framework. Noting that spatial location does influence the variables, it can be concluded that variables of kampungkota are different from one to another.

The construction of model is somehow limited by the data availability. Kampungkota in this study consists only of the ratio of several land uses—accommodating the location proximity to jobs of slum dwellers by the ratio of commercial area in each kelurahan and the tendency to build intensified buildings in a narrow space as represented by the ratio of high density residential area and population density of each kelurahan. There is also several socio-economic elements such as the numbers of slums housing and the number of Identification Letter of Being Poor issued in kelurahan. There should be more relevant variables in conveying the condition of kampungkota, for example the ratio of legal area in kelurahan to be built as housings and the growth rate of the housings in each kelurahan. These facts suggest the construction of better kampungkota information system to integrate this area into city planning (Minnery et al. 2013).

Acknowledgements

This study is conducted by research grant from Institut Teknologi Bandung entitled “Program Penelitian, Pengabdian Kepada Masyarakat, dan Inovasi“.

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