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Gauging the possibility of using property tax to respond to the rapid expansion of built-up area in Depok Municipality

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Abstract. Over the last three decades, Depok Municipality has experienced rapid expansion of built-up area, due to the city's strategic location as a satellite city of Jakarta that functions primarily as a dormitory town. Agricultural, plantation and vacant lands have been largely converted into different forms of built-up area. Some efforts should therefore be made to control this extensive land-use conversion. In particular, a fiscal instrument such as a property tax can be used not only as a source of city revenue, but also as a means for urban environmental control. In this study, we aim to gauge the potentiality of property tax in addressing large-scale expansion of built-up area. In doing so, we employed Pearson Correlation and Moran's Index analyses by comparing built-up area development and property tax performance in 2014 and 2019. The results indicate that property tax has not functioned very effectively as an instrument to steer built-up area expansion in Depok.

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1. Introduction

The phenomenon of peri-urbanization is one of the emerging issues in many metropolitan areas – mostly those located in developing countries (Woltjer, 2014). Due to rapid urban population growth and as cities continue to sprawl, urban peripheries increase in numbers (Al Jarah et al., 2019; Bloch, 2015; Cobbinah & Amoako, 2012; Glaeser & Kahn, 2004; Owusu-Ansah & O'Connor, 2010; UN, 2018). In the context of East Asia, for instance, it is estimated that 40% to 70% of all urban population inhabits peri-urban areas (Webster, 2002; 2014; Woltjer, 2014). Given its chaotic and disorder nature, the urbanization process in peri-urban areas has resulted in a set of adverse physical, environmental, social and economic consequences (Das & Das, 2019; Izakovičová et al., 2017; Morollón & Yserte, 2020). Peri-urban areas are therefore viewed as a major arena where spatial planning and governance are facing great challenges.

Like other metropolises in the developing world, the Jakarta Metropolitan Area (JMA), Indonesia's most prominent urban region, has experienced urban sprawl and rapid peri-urbanization. The JMA, also known in the Indonesian context as "Jabodetabek," consists of Jakarta as its traditional urban center and other adjacent administrative regions of Bogor, Depok, Tangerang and Bekasi, which are commonly categorized as peri-urban areas. The peri-urban transformation in the JMA has mushroomed since the early 1990s, particularly after the gradual economic liberalization policy promulgated by the national government in the 1980s (Indraprahasta & Derudder, 2019). As a result, a large area of vacant, plantation and agricultural land has been converted into built-up areas (Arifin et al., 2018; Pravitasari et al., 2018; 2015; Rustiadi et al., 2020; Utami & Hendarto, 2020).

This paper zooms in on Depok Municipality, which is located to the south of Jakarta. The embryo of Depok's current development can be traced back to the 1970s, when the national government designed a master plan for the development of Jabotabek (Jakarta, Bogor, Tangerang and Bekasi) (Rustiadi et al., 2015). Depok was one of the peri-urban areas that were specifically projected to accommodate the population spillover from Jakarta (Rustiadi et al., 2015). Along with the rapid peri-urban transformation process in the JMA over the past three decades, Depok has quickly emerged as a significant dormitory town. In 1990, Depok was inhabited by around 271,000 people, while in 2000 the city had about 1.1 million inhabitants. In 2019, Depok already had about 2.4 million inhabitants with a population density of 12,017 people/km^2. Currently, the residential area in Depok covers about 65% of the city's total area (BPS, 2020). Depok's rapid urban development and its entailing uncontrolled conversion of land use has, however, raised environmental concerns. In the past, this city used to play a significant role as one of the water catchment areas for Jakarta (Firman & Dharmapatni, 1994).

The environmental and social drawbacks of urbanization and built-up area expansion have often been discussed (e.g. Glaeser & Kahn, 2004; Handayani et al., 2020; Hlaváček et al., 2019; Hudalah & Firman, 2012; Pravitasari et al., 2018; Rustiadi et al., 2020; Senetra et al., 2018; Surya, 2016; Szczepańska, 2016; Winarso et al., 2015). Several studies also examine different fiscal instruments (property tax, land tax, and public transport subsidies) for controlling built-up area expansion (Cozmei & Onofrei, 2012; England et al., 2013; Mendonca et al., 2020). However, little is known about this subject within the context of developing countries. In Indonesia, spatial use control, as stipulated by Law 26/2007 on Spatial Planning, can be carried out through a set of disincentive schemes, including the imposition of property taxes (*Pajak Bumi dan Bangunan Perdesaan dan Perkotaan* or PBB-P2). While this mechanism has been formally encouraged, no studies have been conducted to encapsulate the effectiveness of property tax in helping control urban land development.

Against this background, this research aims to gauge the potential for property tax (PBB-P2) to control built-up area expansion in Depok. In doing so, we evaluate the existing connection pattern between built-up area development and property tax performance in this city by carrying out two analyses: (i) Pearson correlation between built-up area development and property tax performance and (ii) Global and Local Moran's Indexes to compare spatial distribution patterns of the two variables. Pearson correlation is conducted to measure the effectiveness of property tax imposition in responding to built-up area expansion. It is expected that there is a strong positive correlation between built-up area development and property tax performance: the greater the built-up area development, the higher the property tax performance. While Global and Local Moran's Indexes have the same purpose as the previous analysis, these methods can provide a more detailed spatial perspective on the issue.

2. Materials and methods

2.1. Study location

Depok Municipality is part of the JMA, a primate urban region within the Indonesian urban system. This city has a total area of 200.29 km^2 that is divided into 63 villages (*kelurahan*) (Fig. 1). Prior to its establishment as an autonomous region (*daerah otonom*) in 1999, Depok was part of Bogor Regency. As an autonomous region, the city government of Depok has the authority to govern the development of this city in various sectors, including spatial planning, infrastructure, certain types of tax (including property tax), and others. Since its inception as an autonomous region, Depok has experienced rapid land-use conversion from vacant land to built-up areas. In 2000, the proportion of built-up area to total area was 16.27%; it then increased rapidly to 55.39% by 2015 (Arifin et al., 2018). The physical development of Depok is concentrated in the areas close to Depok's Central Business District (CBD) and Jakarta. However, the recorded speed of land-use change between 2013 and 2017 was faster in the southern part of the city (Utami & Hendarto, 2020).

2.2. Data collection and analysis

The two main variables used in our analysis are (1) built-up area (hectare) and (2) PBB-P2 revenue (million rupiah). The data on these variables were obtained from the Central Bureau of Statistics (BPS) of Depok Municipality with village-level units for the years 2014 and 2019. The built-up area was used as a proxy for the city's rapid urbanization. The built-up areas consist of residential areas, offices, trade and commercial centers, and other building structures. Meanwhile, PBB-P2 revenue was used as a proxy for property tax performance. The formulation of PBB-P2 revenue is based on property price (sales value of taxable object or *nilai jual objek pajak* NJOP) multiplied by property tax rate. There are only two categories of property tax rate in Depok, i.e. 0.125% for NJOP below Rp 1 billion and 0.25% for NJOP above Rp 1 billion. NJOP and property tax rate are set by the city government of Depok. The scope of PBB-P2 includes different forms of building and land, excluding agricultural land.

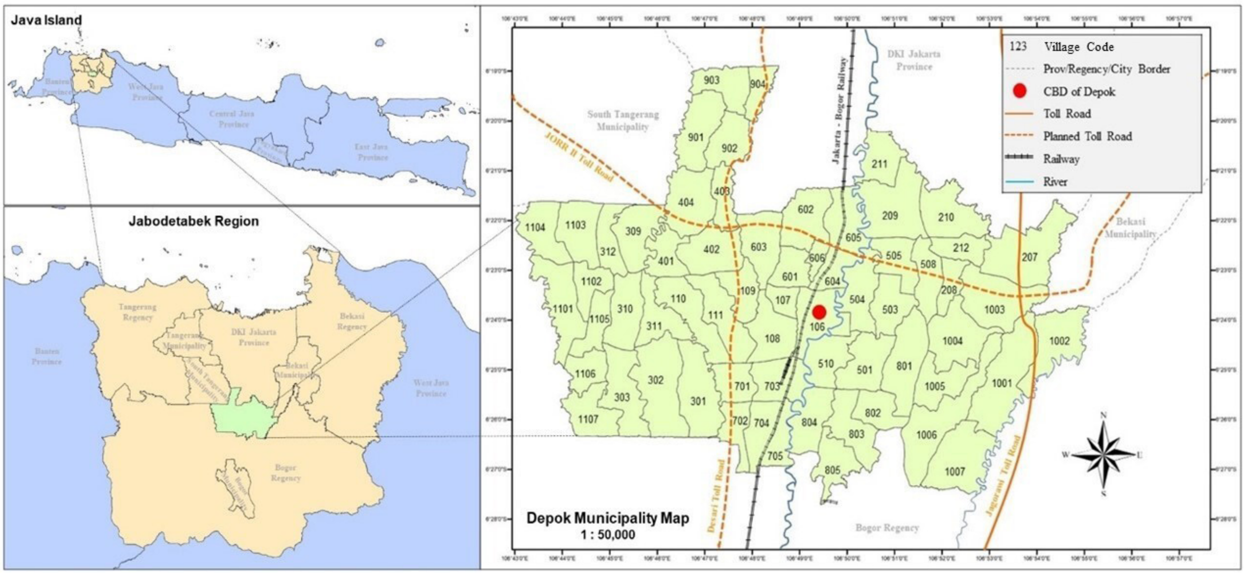

Fig. 1. Study location
Source: Own elaboration from Geospatial Information Agency (BIG)

Our data analysis is divided into two stages. In the first stage, the two variables were analyzed using Pearson Correlation. Then, Global and Local Moran's Indexes were applied in the second stage. The details regarding the methods used in each stage are briefly discussed in the next section.

2.3. Methods

2.3.1. Pearson Correlation

In this study, Pearson Correlation was used to measure the strength of linear associations between built-up area development and property tax performance. Correlation coefficients are within the range of -1 (inversely proportional relationship) and +1 (directly proportional relationship). The coefficient of 0 refers to no relationship between the two variables. Meanwhile, the Pearson Correlation formula is as follows (Guilford, 1956):

$$R_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}$$

where R_{xy} is the correlation coefficient of variable x (built-up area) and variable y (PBB-P2 revenue), x_i is the value of variable x in observation i, y_i is the value of variable y in observation i, $\bar{x}$ is the average value of variable x, $\bar{y}$ is the average value of variable y, and n is the number of observations (63 villages). The correlation coefficient between the two variables is classified into five categories: slight (≤0.2), low (0.2–0.4), moderate (0.4–0.7), high (0.7–0.9) and very high (>0.9) (Guilford, 1956).

2.3.2. Moran's Index (global and local spatial autocorrelation)

We calculated Global Moran's Index to compare spatial distribution patterns between built-up area development and property tax performance. Spatial patterns indicate the dependence on each of the two variables with itself spatially. Global Moran's Index is formulated as follows (Jin et al., 2019):

$$I = \frac{N \sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij} (x_i - \bar{x})(x_j - \bar{x})}{(\sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij}) \sum_{i=1}^{n} (x_i - \bar{x})^2}$$

where I is Global Moran's Index, N is the number of observed locations (63 villages), X_i is the value of variable X (built-up area or PBB-P2 revenue) at location i, X_j is the value of variable X at location j, $\bar{X}$ is the average value of variable X, and W_{ij} is the weighted element in the matrix between locations i and j. We employ the queen contiguity method using first-order as W_{ij}. Our rationale is based on the fact that all villages' spatial interactions (or inter-village interactions) in Depok are well-connected supported by the availability of adequate road networks without any significant physical environmental barriers (see Anselin (1992) for further detail on the spatial weighting). Global Moran's Index is applied to test spatial dependencies or autocorrelation in a region that consists of subregions. If Global Moran's Index approaches +1, it means that there is a positive autocorrelation (clustered). On the other hand, if it approaches -1, it means that there is a negative autocorrelation (dispersed). Meanwhile, if the value is close to 0, it means that there is a random distribution.

On the other hand, Local Moran's Index or Local Indicator of Spatial Autocorrelation (LISA) was applied to identify spatial autocorrelation on each of the two variables locally. If the local value is higher, the closest location will have almost the same value or form a cluster distribution. LISA is formulated as follows (Jin et al., 2019):

$$I_i = x_i \sum_{j=1}^{n} W_{ij} x_j$$

where Ii is the LISA coefficient value in a particular local area (i area), x_i is the value of variable x (built-up area or PBB-P2 revenue) in location i, x_j is the

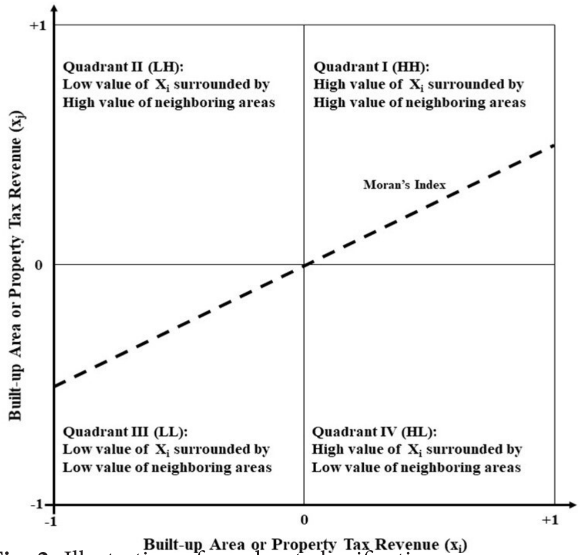

Fig. 2. Illustration of quadrant classification
Source: Own elaboration from Anselin (2005)

value of variable *x* in location *j*. W_{ij} is a weighting between locations *i* and *j*. In this study, *j* is the observed value of the neighboring area around *i* in the number of *n*. If the value of *Ii* is 0, there is no local spatial autocorrelation. However, if *Ii* is not equal to 0, there is local spatial autocorrelation. Cluster thematic maps based on LISA test follow Anselin (2005) classification which consists of HH (High-High), LH (Low-High), LL (Low-Low), and HL (High-Low) (see Fig. 2).

3. Results and discussion

3.1. The correlation between built-up area development and property tax performance

The result from Pearson Correlation analysis shows that, compared with 2014, the correlation coefficient in 2019 increases slightly from 0.42 (moderate) to 0.54 (moderate). Pearson Correlation scatterplots (Fig. 3 and Fig. 4) also illustrate a similar trend with the coefficients. In 2014, one hectare of additional built-up area causes an increase in property tax revenue of 4.45 million rupiah. Furthermore, in 2019, one hectare of additional built-up area causes an increase in property tax revenue of 15.56 million rupiah. Overall, the findings from the two periods reveal that the correlation between built-up area development and property tax performance is positive and moderate. Although these findings align with our hypothesis (the greater the built-up area development, the higher the property tax performance), property tax seems to have not functioned as an effective instrument for responding to built-up area expansion.

While some studies exhibit a significant role played by property tax in controlling urban residential development (Cozmei & Onofrei, 2012; England et al., 2013; Mendonca et al., 2020), it is indicated that our finding does not fully align with these studies. To further clarify this vignette, in the next section we used spatial analysis by comparing the spatial pattern of clustered villages between built-up area development and property tax performance.

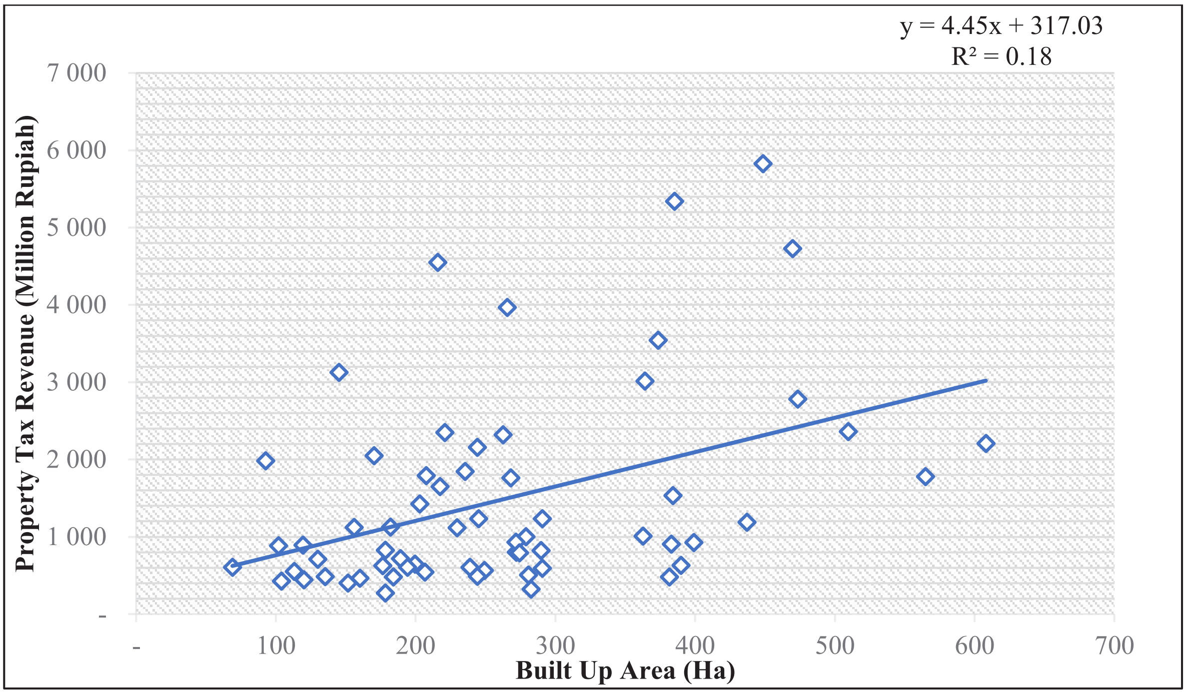

Fig. 3. Pearson correlation scatterplots between built-up area development and property tax revenue in 2014

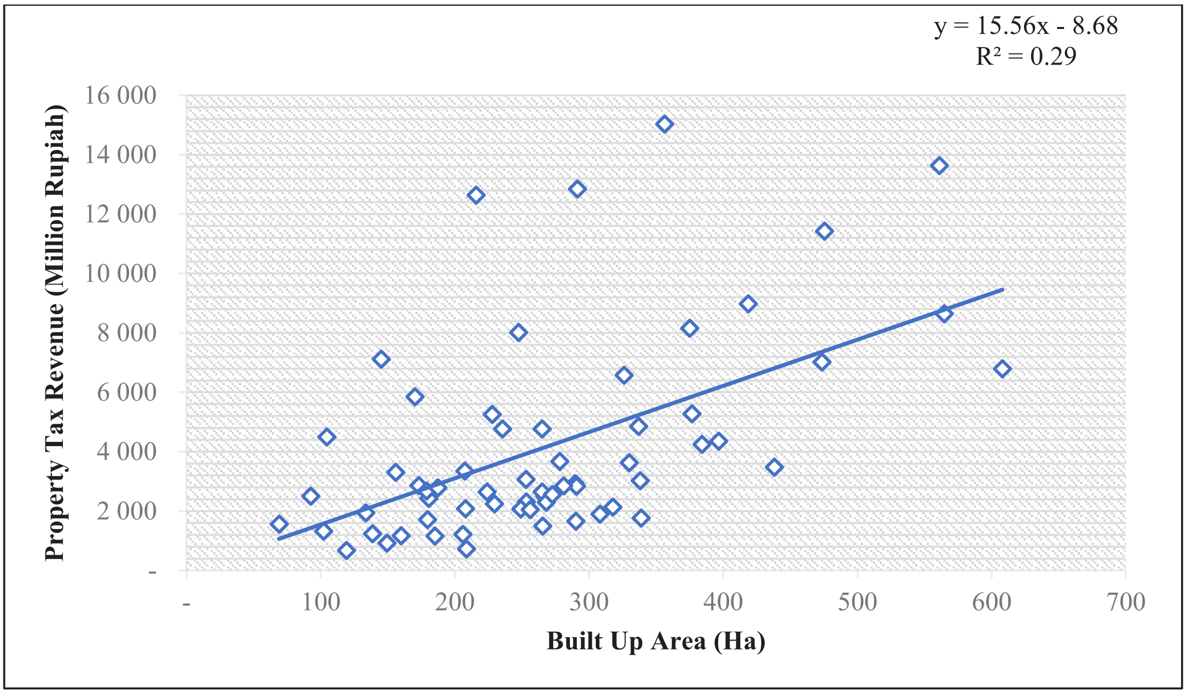

Fig. 4. Pearson correlation scatterplots between built-up area development and property tax revenue in 2019

3.2. Comparison of spatial distribution patterns between built-up area development and property tax performance

3.2.1. Global Moran's Index of built-up area development and property tax performance

The spatial distribution analysis between built-up area development and property tax performance in 2014 and 2019 based on Global Moran's Index displays the same positive values. In particular, the indexes for built-up area development are 0.32 in 2014 and 0.37 in 2019, while the indexes for property tax performance are 0.27 in 2014 and 0.19 in 2019. These results imply that built-up area development and property tax performance form clustered patterns in the two periods, with the indexes for built-up area development being relatively higher than those for property tax performance. These results imply that built-up area development in a particular village (x-axis) is affected by the lagged built-up area development in neighboring villages (y-axis) or forms a clustered pattern (Fig. 5 and Fig. 6), which also aligns with previous studies (Novoseltseva et al., 2019; Salvacion & Magcale-Macandog, 2015).

Meanwhile, our results also indicate that property tax performance in a particular village (x-axis) is affected by the lagged property tax performance in neighboring villages (y-axis) (Fig. 7 and Fig. 8). Our finding supports similar studies that highlight a tax-mimicking pattern (Bocci et al. 2017; Delgado & Mayor, 2011; Małkowska et al., 2018). This pattern implies that villages in Depok have a strong tendency to mutually share their strategies to achieve the tax revenue targets. However, the trend is declining or indicates that the tax mimicking is weaker in 2019 than in 2014. To further clarify the clustered pattern, in the next part we discuss the findings of our LISA analysis.

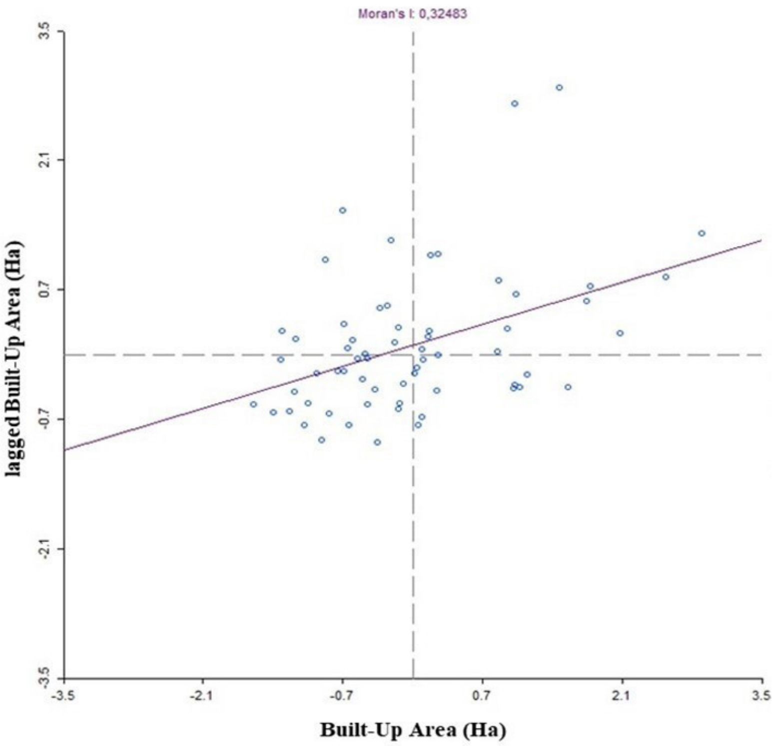

Fig. 5. Moran's scatterplot of built-up area development in 2014

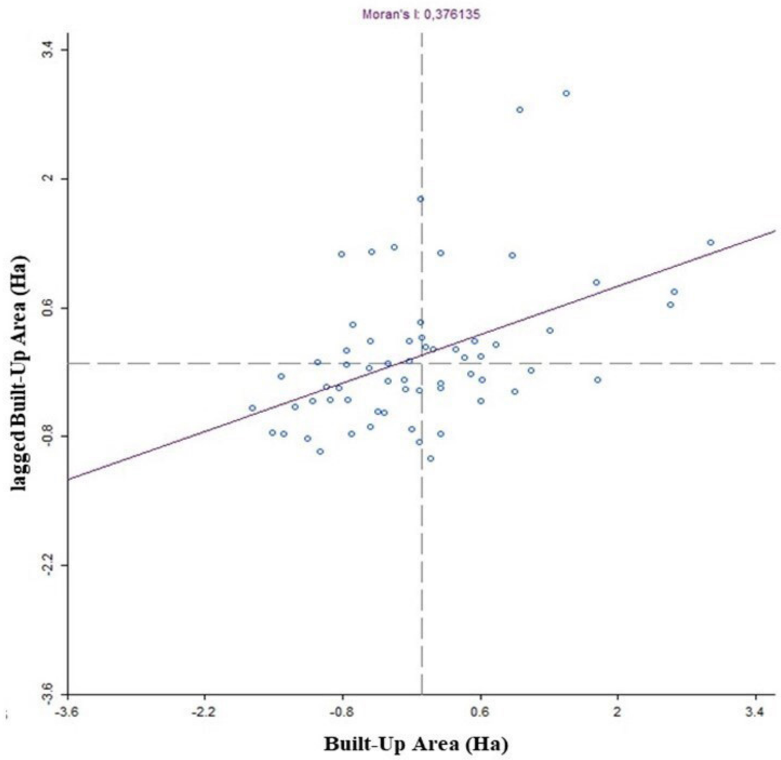

Fig. 6. Moran's scatterplot of built-up area development in 2019

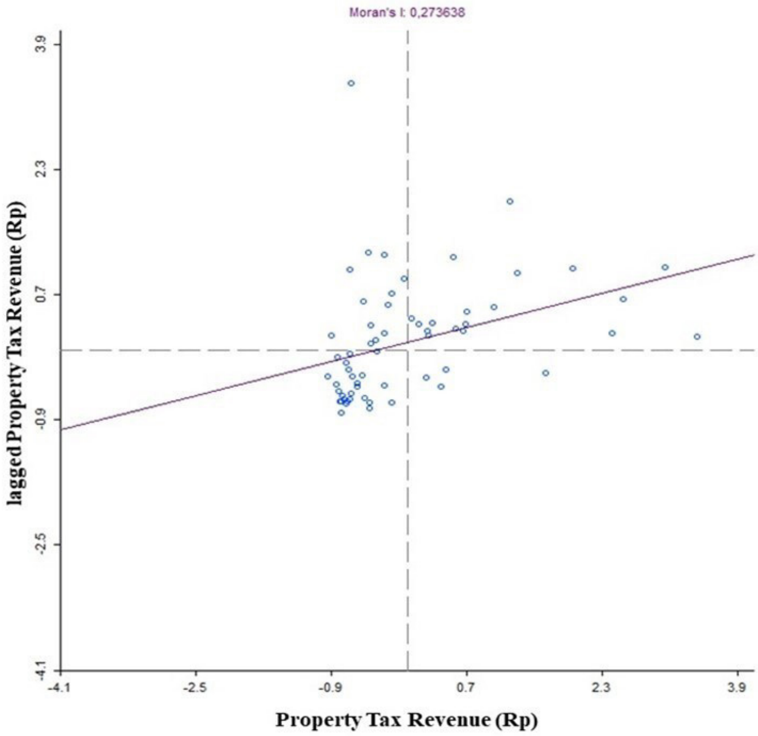

Fig. 7. Moran's scatterplot of property tax revenue

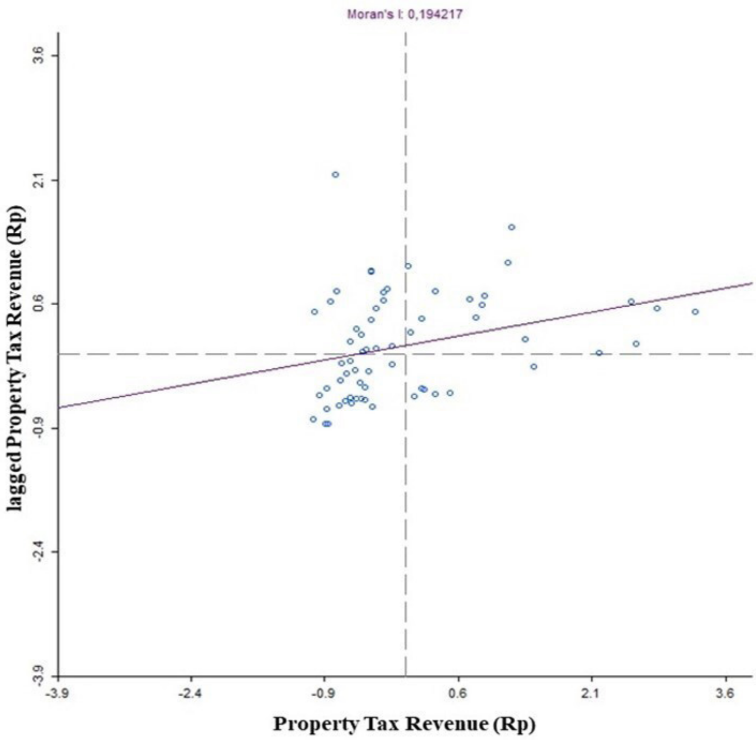

Fig. 8. Moran's scatterplot of property tax revenue

3.2.2. Local Moran's Index of built-up area development and property tax performance

The spatial distribution patterns of built-up area development in 2014 and 2019 based on LISA analysis tend to form clustered patterns, where the HH cluster is mainly located in the eastern part of the city (Fig. 9 and Fig. 10). In 2019, this HH cluster is located in the villages of Mekarsari (210), Tapos (1001), Leuwinanggung (1002), Sukatani (1003), Jatijajar (1005), Cilangkap (1006) and Ciampaeun (1007). This is because the eastern part of the city is a very accessible area that has direct access to a toll road. Meanwhile, the LL cluster is centered on the western part of the city, notably in the villages of Bojongsari (1101), Bojongsari Baru (1102), Serua (1103), Curug (1105) and Duren Mekar (1106). There is no sign of a significant HH cluster in the western and southern parts of the city, as these areas are mostly characterized by rural features, as also clarified by some studies concerning Depok's land-use pattern and change (Arifin et al., 2018; Utami & Hendarto, 2020; Winarso et al., 2015).

Similarly to the pattern of built-up area development, the spatial distribution pattern of property tax performances in 2014 and 2019 tends to form clustered patterns, albeit showing a somewhat different geographical concentration (Fig. 11 and Fig. 12). In 2019, the HH cluster is distributed in the eastern (Mekarsari [210]), central (Mekarjaya [504]) and northern parts (Gandul [902]) of the city. The geographical distribution of this cluster may result from the strategic location and/or status of the particular villages. As previously explained, the eastern part is a residential area supported with easy access to a toll road, while the central part is Depok's CBD. Meanwhile, the northern part is arguably the most favorable place to reside (particularly for commuters) because it is located directly adjacent to Jakarta, the urban core of the JMA. Meanwhile, the LL cluster is centered on the southern part of the city, notably in the villages of Pasir Putih (301), Bedahan (302), Pengasinan (303), Sawangan (310), Cipayung Jaya (702), Bojong Pd. Terong (704), Pondok Jaya (705) and Duren

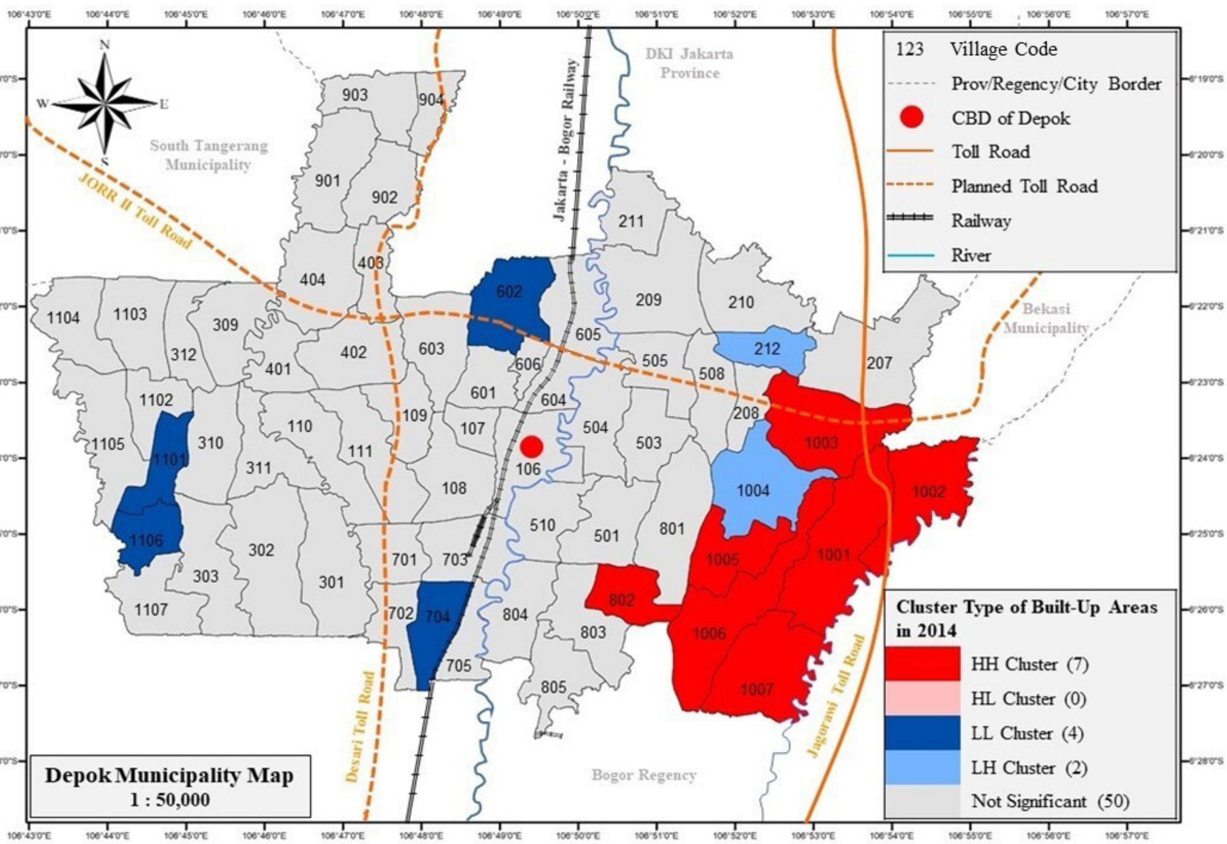

Fig. 9. LISA cluster maps of built-up area development in 2014

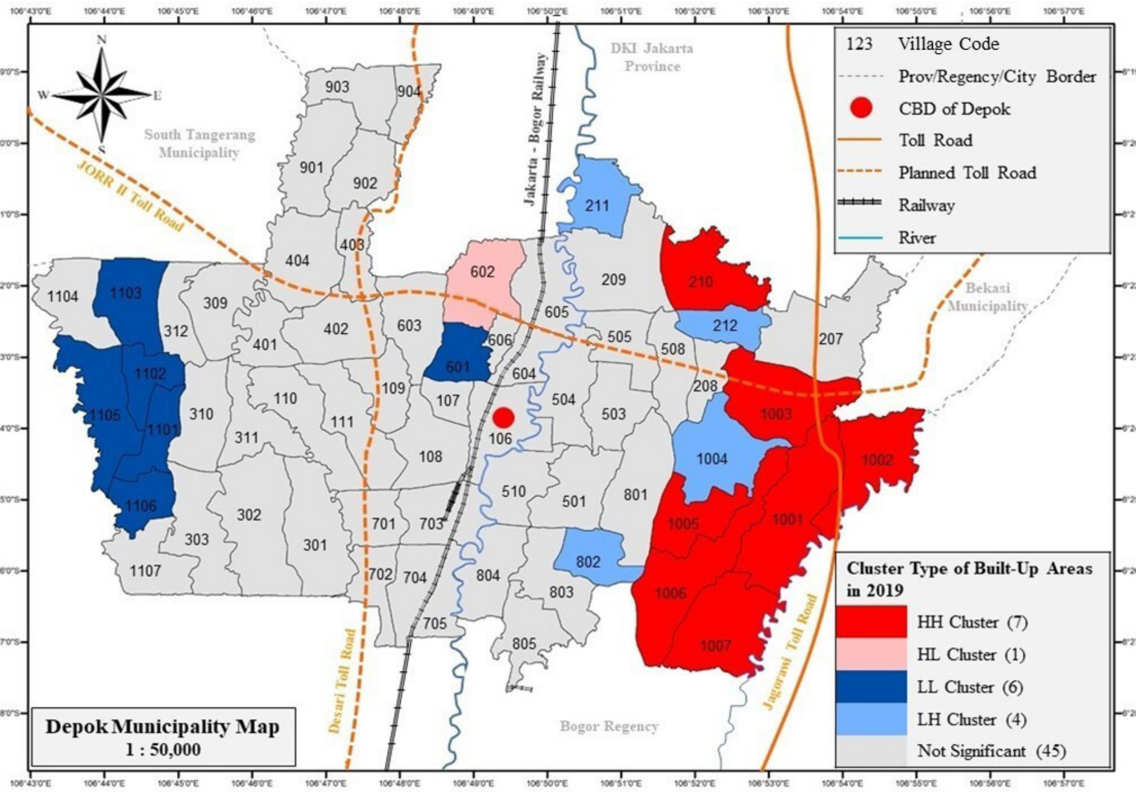

Fig. 10. LISA cluster maps of built-up area development in 2019

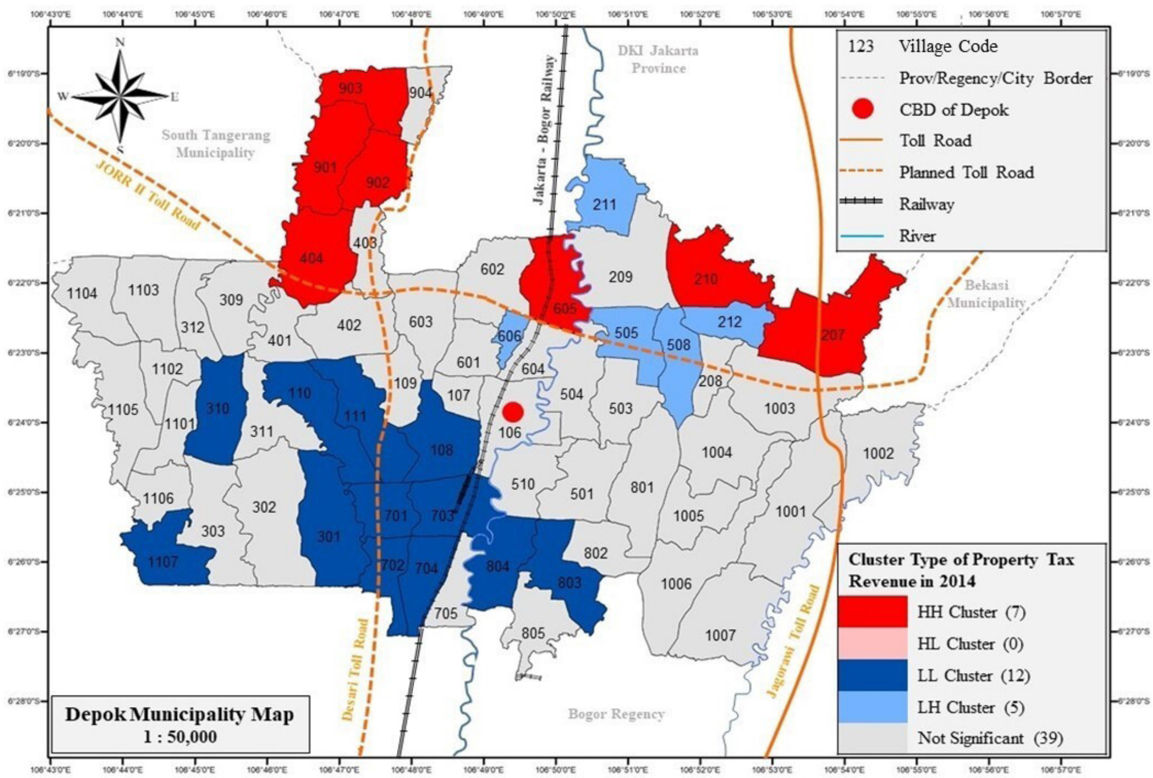

Fig. 11. LISA cluster maps of property tax revenue in 2014

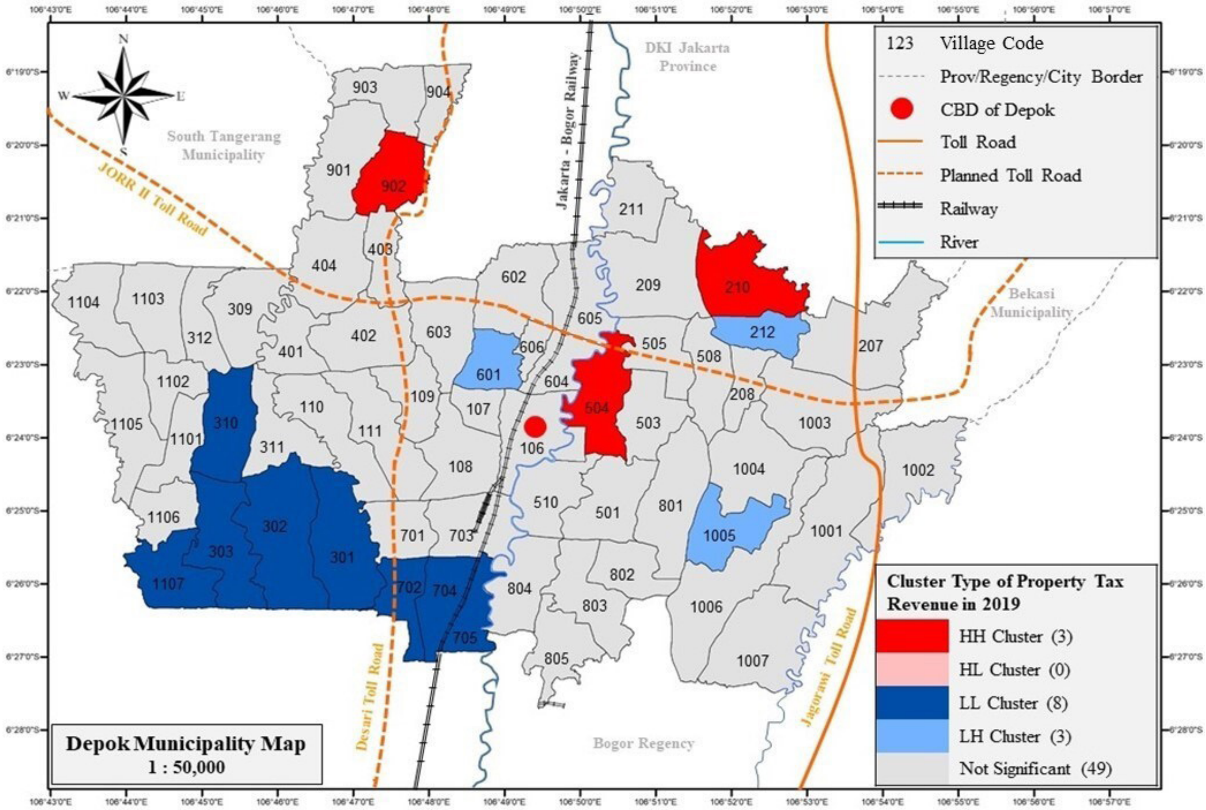

Fig. 12. LISA cluster maps of property tax revenue in 2019

Seribu (1107). There is no sign of a significant HH cluster in the western and southern parts of the city because these parts are mostly characterized by rural features. The possible explanation of the HH and LL clusters distribution is that tax officers tend to perform better (in terms of tax revenue generation) in areas with a higher potency of tax revenue, i.e. areas with higher land and building prices, which are located in the eastern, central and northern parts of Depok (see Elmanisa et al., 2018).

Comparing LISA cluster maps of built-up area development and property tax performance in 2019 reveals that three villages have the same type of cluster, thus confirming our hypothesis: the greater the built-up area development, the higher the property tax performance. Mekarsari (210) village experiences high built-up area development (HH) with high property tax performance (HH). Meanwhile, the villages of Cisalak Pasar (212) and Beji (601) experience low performance of property tax (LH) because the built-up area development in those villages is also low (LH and LL). As previously explained, tax officers are more interested in generating tax revenue in areas with high revenue potential, such as Mekarsari village (210), as compared to areas with low revenue potential, such as the villages of Cisalak Pasar (212) and Beji (601). However, Jatijajar (1005) village, as a case in point, has high built-up area development (HH) but low property tax performance (LH). Taken together, from the spatial pattern lens, this indicates that the property tax has not been able to fully act as an effective instrument in responding to built-up area expansion.

The “spatial mismatch” can be caused by several factors, including the incapability of the local tax authority to optimally generate tax revenue and the inaccuracy of property data leading to misinformation for the tax authority. Another possible explanation would be that the formulation of the property tax does not align with the land-use plan or zoning policy (Mahyeda & Buchori, 2020). Instead, the formulation solely takes into account the two categories of property tax rate (0.125% or 0.25%) based on the property price (NJOP), irrespective of the type of land use where a certain property is located.

4. Conclusion

The purpose of this research was to arrive at a better understanding of the effectiveness of property tax in controlling built-up area expansion in the context of rapidly growing peri-urban areas in developing countries. By zooming in on Depok Municipality, a peri-urban area of the JMA, Indonesia, we deployed two lenses of analysis: (I) Pearson correlation between built-up area development and property tax performance and (II) Global and Local Moran's Indexes to compare the spatial distribution patterns of the two variables. First, the correlation coefficients between built-up area development and property tax performance in 2014 and 2019 are moderately positive, implying that property tax does not seem to work as an effective instrument for responding to built-up area development in Depok Municipality. Second, the results from spatial distribution patterns analysis in 2014 and 2019 indicate that both built-up area development and property tax performance have clustered patterns. High built-up area development tends to cluster in the eastern part of the city, while high property tax performance tends to cluster in the eastern and northern parts of the city. By comparing LISA cluster maps of built-up area development and property tax performance in 2019, property tax does not seem, from as spatial perspective, to be an effective instrument for responding to the expansion of the city's built-up area. So, although the villages of Mekarsari (210), Beji (601) and Cisalak Pasar (212) have the same type of cluster in terms of the spatial matching of built-up area to property tax, other villages exhibit a contrasting pattern. Jatijajar (1005) village, for instance, has high built-up area development but low property tax performance.

So, while similar studies situated in Western cities do show the role of certain taxes in controlling urban land development, the case of Depok provides a different picture. Speaking more broadly, although the imposition of taxes has been formally recognized in the country's spatial planning law as a fiscal instrument for steering land development, its function can be argued to be still ineffective. This relates to the issue of sectoral "silos" (particularly between spatial plan division, tax division and land division in our study context) that has become a recurring problem hampering urban and regional development in decentralizing Indonesia. Given the pressing threat of rapid urbanization, such as the one occuring in Depok and in Jabodetabek in general, there is an urgent need to bridge such a sectoral divide. At least, from our view, the function of property tax in directing built-up area expansion (and land development more generally) can work better if the formulation of the tax rate includes the zoning status in which a certain property is located. As such, the rate can vary among observation areas depending on the land-use type and/or zoning status.

While this study offers some empirical insights, it also recognizes its main limitation. In particular, this study is unable to statistically explain the determinants of the clustered pattern on the two variables. Future studies can consider using spatial econometric modeling like Geographically Weighted Regression (GWR), Spatial Autoregressive Model (SAM) or Spatial Error Model (SEM) to better explicate this matter.

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