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Developing Mobile Application for Land Value Capture Scheme to Finance Urban Rail Transit Projects

Mohammed Ali Berawi[1,2*], Nyoman Suwartha[1], Agatha Vania Salim[2], Gunawan Saroji[2,3], Mustika Sari[2]

[1]*Department of Civil and Environmental Engineering, Faculty of Engineering, Universitas Indonesia, Kampus UI Depok, Depok 16424, Indonesia*
[2]*Center for Sustainable Infrastructure Development, Faculty of Engineering, Universitas Indonesia, Kampus UI Depok, Depok 16424, Indonesia*
[3]*Department of Civil Engineering, Politeknik Negeri Bengkalis, Sungai Alam, Bengkalis, 28711, Indonesia*

Abstract. Land value capture (LVC) has shown great potential in financing urban rail system infrastructure, such as transit-oriented development (TOD). However, the government of Indonesia has not tapped this potential in order to close its infrastructure financing gap. This study aims to determine the incremental rate captured through a tax-based LVC mechanism and develop a property market-based mobile application to implement the scheme, with six TOD areas in seven stations of the Mass Rapid Transit (MRT) Jakarta Phase I project as the case study. This research used literature and benchmarking studies to collect data, followed by the calculations of the transport premium, total value increment, and value capture rate for the betterment tax implementation to obtain its research objectives. The results showed that a 5.82% value capture rate could recover 53.8% of the government's initial investment for the project. Based on that figure, betterment tax rates of 0.3% and 0.1% are proposed for residential properties within the radius of 100-400 m and 400-700 m from transit stations, respectively. Meanwhile, 2.5% and 2.4% tax rates are proposed for commercial properties within the radius of 0-300 m and 300-600 m, respectively. Furthermore, the activity workflow for a mobile application in which the government can issue tax invoices and taxpayers can make payments is also proposed to facilitate the implementation of LVC as an alternative source to finance TOD projects.

Keywords: Betterment tax; Land value capture; Mobile application; Transit-oriented development

1. Introduction

Cities in some developing countries are experiencing staggering growth driven by rapid urbanization (Kumara and Gopiprasad, 2019). However, cities' rapid growth is frequently accompanied by negative externalities, such as traffic congestion, pollution, and urban sprawl (Albalate and Fageda, 2019). To tackle those issues, many countries are investing in public transit infrastructure that could be further developed to form a compact, mixed-use, and pedestrian-friendly area organized around a transit station, known as Transit-Oriented Development (TOD).

*Corresponding author's email: berawi@eng.ui.ac.id, Tel.: +62-21-7270029, Fax. +62-21-7270028
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Indonesia has started developing its infrastructure in order to stimulate its national economic growth (Latief et al., 2016; Hansen et al., 2018). The prioritized projects outlined in Indonesia's National Strategic Projects are urban transit infrastructure, which includes the Mass Rapid Transit (MRT) Jakarta project, Light Rail Transit (LRT) Jabodebek project, and LRT Palembang project (Maimunah and Kaneko, 2016; Farda and Lubis, 2018; Sulaeman and Haryadi, 2018). However, the Indonesian government experiences a fiscal constraint as there is a 63% infrastructure-funding gap in meeting the total investment required. Therefore, an alternative funding source is needed so that the burden on the general taxations or fare-box revenue would not increase (Gunawan et al., 2020).

Land value capture (LVC) is an effort to monetize infrastructure capital investments to capitalize on land value (Suzuki et al., 2015; Huston and Lahbash, 2018) that has been widely considered one of the financing sources for the investment of infrastructure and urban development. It relies on the principle that all of the benefits from the added value of transit development must contribute to the cost of transit (Roukouni et al., 2018).

Abiad et al. (2019) has reported the difference between the land value uplift in Jakarta capital city areas. Land value uplift in the Dukuh Atas area serviced by the rail transit system reached 38.4% between 2015 and 2018, and the Harmoni area with no rail transit system service only had 14.3%. These figures implied that a transit-serviced area receives a more significant uplift in terms of land value. Moreover, Indonesia's tax-to-GDP ratio of 11.9% in 2018 was still under-collected compared to Malaysia (12.5%), Singapore (13.2%), the Philippines (18.2%), and Thailand (17.5%) (OECD, 2020). Hence, this research focused on tax-based value capture mechanisms for TOD projects in Jakarta as the capital city of Indonesia.

Previous studies regarding LVC mainly focused only on measuring the increase of land value as the impacts of the accessibility benefits gained by landowners and private sectors (Pagliara and Papa, 2011; McIntosh et al., 2014; Zhang and Xu, 2017). Therefore, this research attempts to determine a tax rate aligned with LVC scheme principles and propose a mobile application to implement the scheme to finance the initial investment to develop rail transit infrastructure, with the MRT Jakarta Phase I project as the case study. The findings of this study are expected to contribute insight for discussion among policymakers, practitioners, and researchers regarding LVC as a source of project finance for urban transit development.

2. Methods

To reach its objective, this study adopted the method that Zhang and Xu (2017) developed to estimate the potential of value capture in Wuhan (China). It did this by calculating the value increments caused by the provision of Wuhan MRT Line 2 transit services and simulating the captured value gained from a considered 0.5% tax on the properties' value increments. However, the reasoning behind the 0.5% value capture rate implemented in that study was not provided; hence, this study aimed to determine the basis of the value capture rate proposed for urban rail transit projects with MRT Jakarta Phase 1 development as the case study.

At the time this study was conducted (2018-2019), Perseroan Terbatas MRT Jakarta (PT MRTJ) as the developer and operator of MRT Jakarta project had prepared a master plan proposal for TOD area developments at seven out of 13 stations in the Phase 1 development, which consists of the Lebak Bulus Station, Fatmawati Station, Blok M Station, ASEAN Station, Istora Station, Senayan Station, and Dukuh Atas Station. The initial investment of these stations amounted to 53.8% of the total investment of MRT Jakarta (KPPIP, 2019). There were six TOD areas proposed in the master plan, including TOD Lebak

Bulus, TOD Fatmawati, TOD Blok M-ASEAN, TOD Istora, TOD Senayan, and TOD Dukuh Atas.

This research occurred in two stages in order to determine the incremental rate captured and the potential revenue generated through a tax-based LVC mechanism, as well as develop a mobile application for both the government and the taxpayers to use in the scheme implementation. In the first stage, literature and benchmark studies were conducted to collect data, including: (1) premium prediction around residential and commercial properties with sources from Wuhan (Zhang and Xu, 2017), Perth (McIntosh et al., 2014), and Jakarta (Berawi et al., 2019b; Berawi et al., 2020b); (2) average residential selling price per square meter (Berawi et al., 2020a; Salanto and Gobi, 2020); (3) average commercial selling price per square meter (Berawi et al., 2019b; Berawi et al., 2020a); (4) targeted land-use development around transit stations, and (5) targeted Gross Floor Area (GFA) (PT MRT Jakarta, 2019). These data were then processed to estimate the land area of each TOD project, Floor Area Ratio (FAR), and GFA, and calculate the Transport Premium (TP), total value increment, and value capture rate for the betterment tax implementation.

The estimations and calculations were conducted by following the steps below.

1. *Estimating land area for each residential and commercial parcel*
   The land area for each parcel was estimated based on the proposed land use and zoning of the TOD areas near the transit stations. The results were then tabulated into a table containing the parcels' code, land area, property type, and the radius segment relative to the transit.
2. *Estimating FAR*
   FAR for the commercial and residential properties in each TOD area was estimated using these equations:

$$FAR_{commercial} = \frac{Targeted\ total\ GFA_{commercial}}{Total\ land\ area_{commercial}} \quad (1)$$

$$FAR_{residential} = \frac{Targeted\ total\ GFA_{residential}}{Total\ land\ area_{residential}} \quad (2)$$

3. *Estimating GFA*
   The GFA for each catchment area segment was calculated by multiplying each land area in each segment by the estimated FAR. Furthermore, the commercial land area was multiplied by the FAR for commercial properties in the TOD area. The same was also used for residential properties.

$$GFA = Land\ area \times estimated\ FAR \quad (3)$$

4. *Calculating TP and total value increment*
   Transport premium is a benefit capitalized by property owners located close to transportation access and is calculated by multiplying the coefficient of distance variables (DV) resulting from the Hedonic Price Modelling (HPM) and the average selling property prices per square meter (see Equation 4). The DV coefficients for residential properties were obtained from Zhang and Xu (2017) and from Berawi et al. (2019b) for commercial properties. The total increment was calculated by multiplying the GFA and the TP for each catchment area's properties, as shown in Equation 5.

$$TP = DV\ Coeficient \times Avg.price/sqm \quad (4)$$

$$Total\ Increment = \sum_{0-100}^{900-1000} \text{GFA} \times \text{TP} \quad (5)$$

5. *Calculating the value capture rate (%)*

$$VC(\%) = \frac{53.8\%\ \text{x MRTJ's total investment}}{\text{Total increment}} \quad (6)$$

A benchmarking study of existing property market-based mobile applications was conducted in the second stage in order to define the activities carried out in the proposed mobile application and then develop the activity workflows. Lastly, in-depth interviews with experts occurred to strengthen and validate the research output. The framework of the research can be seen in Figure 1.

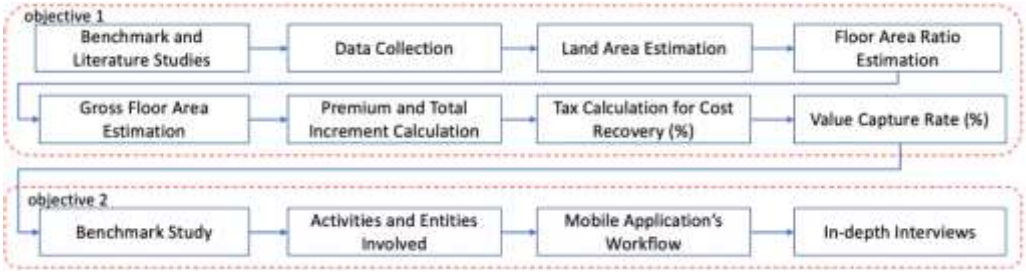

Figure 1 Research framework

3. Results and Discussion

3.1. Determining Value Capture Rate for Betterment Tax Implementation

The total increment calculation was based on the GFA of each property type in the investigated TOD areas, where a higher GFA would result in a higher increment. According to Berawi et al. (2019a), a minimum FAR of 6.57 is necessary for TOD development in Indonesia in order to conform with the density characteristics as one of the TOD principles. In retrospect, some of the planned commercial developments surrounding the MRT Jakarta stations already fulfilled the required FAR, such as Istora, Senayan, and Dukuh Atas stations. The minimum FAR was only fulfilled for the residential properties in the planned development around the Dukuh Atas station. However, some residential properties are still far below the minimum FAR suggested (see Table 1).

Table 1 Land area, FAR, and GFA for each type of property in the TOD areas

TOD Location	Radius (m)	Residential			Commercial		
		Land Area (m^2)	FAR	GFA (m^2)	Land Area (m^2)	FAR	GFA (m^2)
Lebak Bulus Station	0-100	-	5		791.14	5.7	4,528.56
	100-200	14,781.92		73,803.77	37,210.85		212,997.29
	200-300	23,551.27		117,587.71	10,608.28		60,722.48
	300-400	8,658.63		43,231.12	32,724.19		187,315.36
	400-500	15,145.88		75,620.92	33,418.96		191,292.25
	500-600	20,648.24		103,093.35	4,715.37		26,991.05
	600-700	8,765.38		43,764.13	-		-
	Total	91,551.32		457,101.00	119,468.78		683,847.00
Fatmawati Station	0-100	-	1.7	-	19,000.55	4.3	81,338.60
	100-200	42,451.06		70,604.56	26,318.71		112,666.57
	200-300	70,301.11		116,924.76	25,787.32		110,391.76
	300-400	69,007.98		114,774.01	36,760.54		157,366.53
	400-500	33,569.50		55,832.77	7,839.83		33,561.16
	500-600	-		-	11,230.79		48,077.39
Total		215,329.65		358,136.10	126,937.73		543,402.00
Blok M-ASEAN Station	0-100	53,945.36	2.7	148,024.41	145,415.53	3.5	502,654.84
	100-200	14,594.95		40,048.10	40,862.63		141,249.00
	200-300	63,321.34		173,751.82	181,603.48		627,744.99
	300-400	101,816.59		279,381.58	-		-
	400-500	-		-	49,745.05		171,952.67
	500-600	16,615.80		45,593.23	14,062.49		48,609.51
Total		250,294.04		686,799.13	431,689.17		1,492,211.00
Istora Station	0-100	-	4.24	-	33,874.04	6.86	232,427.01
	100-200	-		-	164,839.63		1,131,048.39
	200-300	20,656.33		87,662.68	18,280.18		125,429.63

TOD Location	Radius (m)	Residential			Commercial		
		Land Area (m^2)	FAR	GFA (m^2)	Land Area (m^2)	FAR	GFA (m^2)
	300-400	-		-	32,880.86		225,612.30
	400-500	21,830.23		92,644.55	61,532.50		422,205.71
	500-600				13,739.48		94,273.52
	600-700				18,287.39		125,479.09
	Total	42,486.56		180,307.22	343,434.08		2,356,475.65
Senayan Station	0-100	-		-	67,374.66		462,291.78
	100-200	-		-	20,554.08		141,031.96
	200-300	109,484.72		405,763.80	132,239.33		907,361.20
	300-400	11,108.77	3.71	41,170.46	64,527.68	6.86	442,757.20
	400-500	-		-	-		-
	500-600	-		-	-		-
	600-700	-		-	27,813.16		190,840.21
Total		120,593.49		446,934.27	312,508.91		2,144,282.35
Dukuh Atas Station	0-100	-		-	12,753.71		91,432.74
	100-200	-		-	42,011.12		301,182.37
	200-300	25,583.31		226,172.68	71,233.86		510,683.43
	300-400	45,565.54		402,828.29	37,701.27		270,284.63
	400-500	54,028.53	8.84	477,646.44	45,939.08	7.17	329,342.35
	500-600	51,987.49		459,602.36	9,339.03		66,952.56
	600-700	10,532.19		93,111.27	112,746.44		808,291.75
	700-800	14,473.81		127,957.62	7,085.31		50,795.38
	800-900	-		-	102,193.25		732,634.79
	Total	202,170.87		1,787,318.65	441,003.07		3,161,600.00

The average asking prices per square meter for residential properties in South Jakarta (IDR 39,121,166/m^2 or ±USD 2,781/m^2) and Central Business District (IDR 52,249,863/m^2 or ±USD 3,714/m^2) were used to calculate the price premium. Selling price data that was collected in a study Berawi et al. (2019b) conducted were used and further classified into several groups of administrative regions to determine the commercial properties' average selling price in South Jakarta (USD 2,915/m^2), CBD (USD 4,815/m^2), and Central Jakarta (USD 2,826/m^2).

Calculating the price premiums in each area and then multiplying them by the GFA shown in Table 1 resulted in the potential increment in each TOD area. The total increment that property owners can accrue due to the accessibility benefit could approximately reach IDR 157.2 trillion (USD 11,180.18 million). Table 2 shows the details of the value increment for each TOD area.

Table 2 Total value increment

TOD Area	Increment (million USD)	
	Residential Property	Commercial Property
TOD Lebak Bulus	30.23	666.90
TOD Fatmawati	15.96	533.72
TOD Blok M-ASEAN	18.89	1,470.83
TOD Istora	17.53	3,636.57
TOD Senayan	56.91	3,199.69
TOD Dukuh Atas	13.68	1,519.25
Sub-Total	153.21	11,026.97
Total		11,180.18

With the total investment of IDR 17 trillion (USD 1.21 billion) for the initial investment of seven MRT stations and a total increment of IDR 157.27 trillion (USD 11,180.18 million), the percentage of value capture rate needed to cover the investment cost is as follows:

$$VC(\%) = \frac{53.8\% \text{ x } 1{,}209.45 \text{ million}}{\text{USD } 11{,}180.18 \text{ million}} = 5.82\% \quad (7)$$

Without any significant changes in the current taxation, the property owners would gain all of the predicted windfalls. However, the government could already cover 53.8% of the total investment made for seven stations in the MRT Jakarta Phase I by capturing only 5.82% of the estimated increment. This finding can be the basis for the government to implement the value capture rate. The tax rates resulting from multiplying the premium coefficient and the value capture rate (5.82%) can be seen in Table 3. The proposed tax mechanism is similar to the zonal value capture charges that Transport for London proposed (TfL & GLA, 2017), in which the payment is made one time when the property transaction occurs.

Table 3 Tax rate

Distance Ring (m)	Residential	Commercial
Ring 0-100		2.5%
Ring 100-200	0.3%	2.5%
Ring 200-300	0.3%	2.5%
Ring 300-400	0.3%	2.4%
Ring 400-500	0.1%	2.4%
Ring 500-600	0.1%	2.4%
Ring 600-700	0.1%	

3.2. Developing Mobile Application for LVC Tax Scheme Implementation

A benchmark study was conducted on some existing mobile applications providing tax payment services, including e-commerce, Annual Tax Return e-filling, and tax applications. The results showed that there are several necessary steps in the mobile application to facilitate paying land value capture taxes allocated to help finance the provision of infrastructure or supporting facilities in the TOD area (see Table 4).

Table 4 The activity steps carried out contained in the LVC mobile application

No.	Steps	Description
1.	Detailed entry of the property offered	The seller or developer manually enters details regarding the offered property, used as the basis for land value capture tax.
2.	Seller's document upload	After inputting the details of the offered property, the sellers are asked to upload documents related to property ownership and rights. This is intended to prevent fraud and ensure the credibility of both the seller and the property offered.
3.	Seller's document verification	The verification is conducted by checking the information contained in these documents and comparing it with the database owned by the relevant government institutions.
4.	Booking fee payment	The booking fee payment process performed after the documents the seller and buyer uploaded, such as ID cards and Tax ID numbers, are verified.
5.	LVC tax bill payment	The app facilitates bill payment with several payment methods, such as debit card, credit card, or a virtual account.

The property details inputted into the application in the first step are used to calculate the LVC tax to be paid. If the property is within 100 m-400 m from the nearest station, the buyer needs to pay 0.3% of the listing price. The tax levy is 0.1% of the listing price for property located 401 m-700 m from the nearest station. However, if it is in these two distance categories, the buyer is exempted from value capture tax. This tax rate calculation will be the input for the tax bill the government issued when the property rental transaction was completed. Nevertheless, the seller needs to upload the documents regarding the ownership and rights beforehand to be verified (see Figure 2).

The payment process starts with the buyer choosing the payment method; either by debit/credit card or transfer to a virtual account (VA). If the buyer decides to use a debit/credit card, the card information inputted will go through a payment gateway to

ensure the security of the user's data, which will then be relayed to the concerned bank to verify the information's validity.

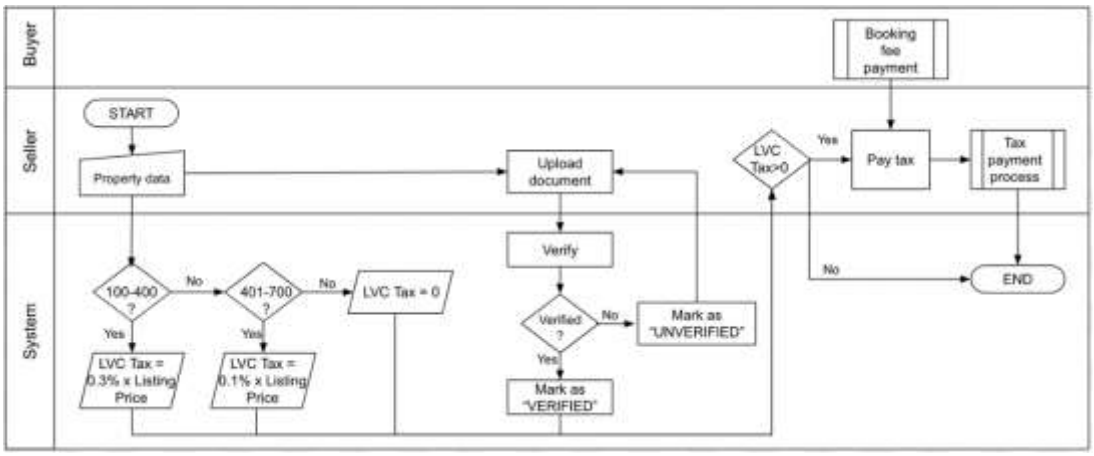

Figure 2 Workflow diagram of seller's and buyer's activities for LVC tax payment process

On the other hand, to make transactions via a VA, the buyer must transfer the agreed amount to the VA number that the bank generated. The bank will confirm and provide proof of payment if the transaction is successful (see Figure 3).

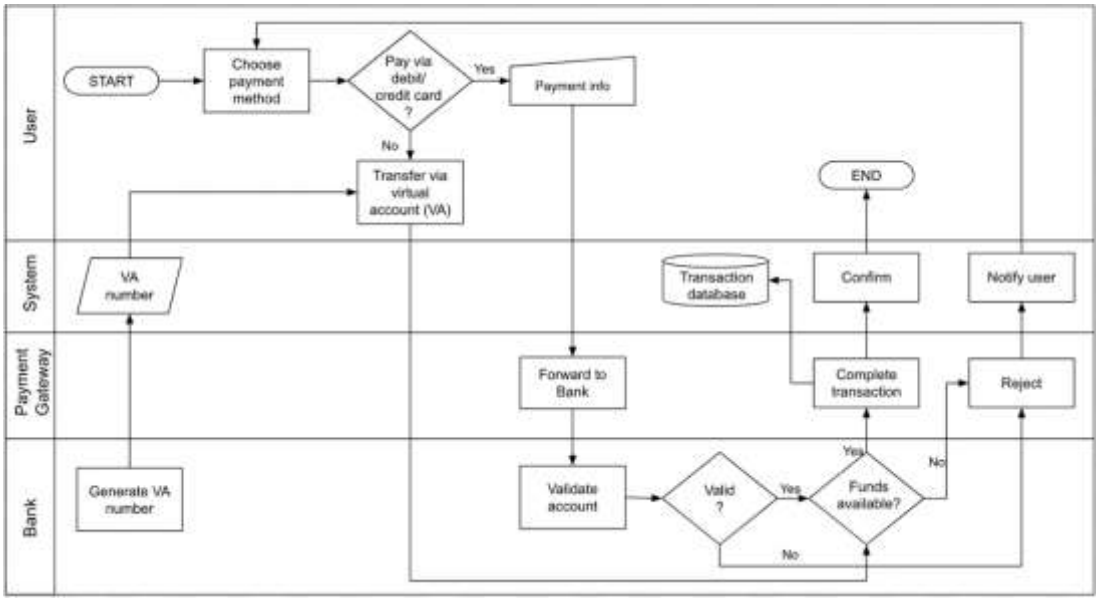

Figure 3 Workflow diagram for the LVC tax payment process in the mobile application

Experts from the mobile application development field were then consulted via in-depth interviews regarding the proposed mobile application. Based on these interviews, the entities and the workflows defined are in line with the application's programming flow. However, some improvements are needed, particularly regarding the legal entity that manages this application. Its cooperation with the government also needs to be detailed since it requires government databases to verify both sellers' and buyers' documents. The user interface of the proposed mobile application can be seen in Figure 4.

(a) (b) (c) (d)

Figure 4 User interface of the proposed LVC mobile application: (a) user profile; (b) list of tax billings; (c) tax billing payment; and (d) LVC tax calculation details

Figure 4 illustrates the LVC tax payment process and shows that the property sellers could check for the tax billing through the Profile feature in the application. It would only show up on the Tax Billing feature if the property transaction has been carried out and the relevant government agency has been notified. The seller could then see the details of the tax billing, which shows the LVC tax rate corresponding to their property type and the distance between the property and the MRT stations. After checking the details, the property owners could pay for their tax billing and choose the preferred payment method available.

The mobile application workflows could simplify the conventional administrative process, in which payers were manually identified and the issued tax payment notifications were sent by post. By utilizing the proposed mobile application for betterment tax implementation, government could automatically identify taxpayers, calculate their respective tax billings, and send payment notifications of the issued tax billing through the mobile application. Moreover, it also provides a wide variety of payment methods for taxpayers, thereby increasing payment flexibility and ease of transaction.

4. Conclusions

The LVC can be used as an alternative source to finance the initial investment of public infrastructure, such as TOD projects. Therefore, this study aimed to determine the tax rate for the betterment tax mechanism aligned with the principles of LVC. This study's findings showed that, by capturing 5.82% of the projected increment capitalized by the property owners once they sell or lease their properties, the government could recover 53.8% of the investment costs required to develop seven stations of the MRT Jakarta Phase I project. Though the exact taxation rate calculated in this study might only be appropriate for Jakarta, considering that the land value uplift might vary across different locations worldwide, the methodology used in this study could serve as a basis for reinforcing a reasonable tax rate, which the municipal or local government in other cities across the globe could justify.

Furthermore, the proposed mobile application workflows show that the application enables the government to issue a tax bill once they have been notified that the property sale and leasing transactions were carried out. The buyer can pay the tax invoice through

the payment gateway provided in the application, thereby supporting the implementation of the LVC mechanism.

This paper encourages future studies to investigate further regarding the implementation and benefits of other LVC mechanisms, such as Tax Increment Financing (TIF), Development Rights Auction, and other institutional schemes specializing in LVC in TOD projects.

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