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Modeling Motor Vehicle Tax Revenue with a One-Time Payment Scheme: A Case Study of the Jombang Regional Government

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Abstrak

This study examines the effectiveness of Motor Vehicle Tax (PKB) collection by comparing the annual payment system, with an average compliance rate of 83.57%, to a one-time lump-sum payment scheme. The analysis employs time value of money concepts and Discounted Cash Flow (DCF) to calculate present values, alongside the Weibull distribution to estimate vehicle lifespan. For the lump-sum scheme, an annuity model over a 20-year period, reflecting the average vehicle life, results in a one-time PKB payment of IDR 2,556,467.50 per vehicle. The model further simulates the addition of new vehicles and estimates for existing vehicles. Findings reveal that, under the annual system, projected PKB revenue over the next 20 years—assuming a switch to the lump-sum scheme in 2026—would total IDR 991.4 billion, with realized revenue at IDR 828.5 billion and potential losses of IDR 162.8 billion due to arrears. In contrast, the lump-sum scheme would yield both potential and realized revenues of IDR 1.38 trillion, with no projected losses as taxes are paid upfront. Simulations indicate annual system revenue leakage could reach IDR 530 billion if all vehicles are unregistered. The study concludes that a lump-sum payment system reduces annual tax losses, increases revenue certainty, and strengthens regional fiscal resilience.

Keywords: *motor vehicle tax; lump-sum payment scheme; revenue leakage; fiscal resilience; compliance rate*

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INTRODUCTION

Motor Vehicle Tax (PKB) is a critical component of regional revenue (Pendapatan Asli Daerah, PAD) in Indonesia. In several regions, its contribution is particularly notable; for instance, PKB accounted for 38% to 46% of PAD in Bali Province from 2019 to 2023 (Paramananda et al., 2025), 31.8% in Central Java between 2017 and 2020 (Niayah & Danisya, 2022), and as much as 41.9% to 45.2% in Madiun City, East Java, from 2022 to 2024 (Fanida et al., 2025). Imposed on the ownership or use of motor vehicles, as outlined in Law No. 1/2022 regarding Financial Relations between Central and Regional Governments, PKB revenue plays a vital role in supporting governance, infrastructure projects, public services, and social facilities at the regional level.

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Population growth and rising Gross Regional Domestic Product (GRDP) have directly contributed to the expansion of the vehicle fleet (Ola, 2021). Data from the Badan Pusat Statistik East Java (2024) show a significant increase in the number of registered vehicles, from 6.7 million in 2022 to over 26.5 million by 2024, with motorcycles comprising nearly 80% of all vehicles. Despite such growth, actual PKB collection often falls short. According to the Directorate General of Fiscal Balance (DJPK), only 35.5% of owners pay their PKB on time and in full, highlighting persistent compliance challenges (Wildan, 2025).

International comparisons also underscore these issues. In 2023, Indonesia's tax-to-GDP ratio stood at just 12%, far below the Asia-Pacific average of 19.5% (OECD, 2025). Much of this gap is attributed to tax noncompliance, driven by factors such as low taxpayer awareness, forgetfulness, or a tendency to postpone payments (Meirayani, 2022). Although improvements in payment systems can enhance compliance (K. W. Putri et al., 2024), regulatory reforms alone have not been sufficient. This suggests the need to look beyond tax rates and focus on more effective payment mechanisms.

The current annual tax collection system carries the risk of losing potential tax revenue each year due to economic conditions and taxpayers' administrative negligence (Fatmawati & Haryono, 2024). Annual risks manifest as the number of vehicles in tax arrears and vehicles lost from the system, indicated by 'bodong' vehicles—those that do not possess and/or do not renew official documents or legal status (Musta'in, 2025). To address these challenges, regional governments have introduced tax amnesty and relief programs—for example, East Java's 2024 initiative aimed at 357,800 PKB accounts, offering a total exemption of IDR 238.5 billion. Some schemes allow owners to pay only for the most recent year or two without penalties (Aulia & Maulana, 2025), and discounts of up to 24.7% have been provided for non-progressive private ownership. While these policies ease the tax burden and can boost revenue in the short term, continuous reliance on them has not proven effective in the long run. Evidence suggests that service quality and sanction policies, on their own, have a limited impact on compliance (Listyowati et al., 2018).

Local data from the Jombang Regency SAMSAT office indicate that compliance rates for motorcycle PKB payments have been high in recent years, but arrears persist and threaten to accumulate into substantial revenue losses. This points to the need for innovative solutions that can ensure more predictable and stable local revenues. In response, this study proposes a one-time PKB payment at the point of new vehicle registration. This approach could secure tax revenue up front, streamline administrative processes, and offer greater convenience for taxpayers.

By applying the time value of money concept, this model recognizes that future revenue is less valuable in real terms than immediate receipts (Sonbait & Oppusunggu, 2023). The lump-sum or one-time payment scheme, which uses a term-certain annuity model, has been widely adopted in other financial contexts such as loans and installments (Kustiawati et al., 2022; Adil et al., 2025). Although research on PKB payment system modeling remains limited, this proposed approach is mathematically robust and offers a practical solution to the persistent challenge of tax compliance. The single-payment system is similar to a lump sum contract, which is a type of agreement that sets a fixed and unchanging value for a specified period, as stipulated in Presidential Regulation No. 12/2021.

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Accordingly, this study models and compares the impacts of the annual and lump-sum PKB payment systems, focusing on Jombang Regency as a case study. The findings are expected to provide valuable insights into the fiscal implications of a lump-sum payment scheme, including its effects on revenue potential, actual receipts, compliance, arrears, leakage, and overall local government income. Ultimately, this research aims to inform the development of more effective and sustainable PKB management strategies, especially for regional governments in East Java.

METHODS

Data

The primary data for this study is secondary data obtained from the Samsat Jombang Report. Of the 14 vehicle categories available in the Samsat data, only the data for personal two-wheeled motorcycles (R2) is used, as this category has the highest number of vehicles in Jombang Regency. This data includes statistics on the number of taxable objects, potential tax revenue, and actual PKB (Motor Vehicle Tax) receipts. This data serves as the baseline to understand the actual tax compliance conditions in Jombang Regency.

Tax Compliance and Effectiveness

Tax compliance is defined as the extent to which taxpayers fulfill their tax obligations in accordance with applicable regulations. The quality of tax services and the tax system itself are also important factors influencing compliance behavior (Ramadhanty & Zulaikha, 2020). However, the implementation of tax amnesty incentives can trigger moral hazard, whereby taxpayers intentionally postpone payments in anticipation of future penalty waivers (Piningit et al., 2025). The level of compliance is measured according to the Equation (1) (S. M. Putri & Sulindawati, 2024).

$$\text{Measurement of Compliance} = \frac{(N - n)}{N} \times 100\%, \quad (1)$$

with N is total number of registered vehicles and n is total number of vehicles not paying tax. The compliance criteria in this study refers to the Table 1 (Ramadhan et al., 2021).

Table 1. Compliance Criteria

Compliance Level Interval	Compliance Level Criteria
$80\% - 100\%$	High
$61\% - 80\%$	Fairy High
$< 61\%$	Low

Meanwhile, the equation used to calculate the extent to which the realization of regional tax and retribution revenue achieves the target set for a given period is as Equation (2) (Febrianty et al., 2021).

$$\text{Effectiveness} = \frac{\text{Actual Revenue Realization}}{\text{Revenue Target (Potential)}} \times 100\%. \quad (2)$$

The indicators of effectiveness level used in this study are shown in Table 2 (Wahasusmiah, 2022).

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Tabel 1. Effectiveness Criteria

Effectiveness Level Interval	Effectiveness Level Criteria
$> 100\%$	Highly Effective
$90\% - 100\%$	Effective
$80\% - 90\%$	Moderately Effective
$60\% - 80\%$	Less Effective
$< 60\%$	Ineffective

Annual Motor Vehicle Tax Payment

In the current annual system, Motor Vehicle Tax (PKB) is collected every year. This study uses a fixed average rate as the basis for calculation. The principal amount of PKB payable is determined by multiplying the tax rate by the tax base, as shown in Equation (3), as stipulated in Law No. 1 of 2022 concerning Financial Relations between the Central Government and Regional Governments (HKPD), Article 11.

$$\text{Principal PKB} = \text{Tax rate} \times (\text{NJKB} \times \text{Weight}), \tag{3}$$

with NJKB is Motor Vehicle Sales Value.

The weight can be found in Article 16, paragraph (2) of the Permendagri No. 7/2025, in which the weight for two-wheeled motorcycles is set at 1.00. Meanwhile, the tax rates are regulated by each regional regulation. According to East Java Provincial Regulation No. 9/2010, the tax rate for private vehicles was set at 1.5%. However, this rate was updated with the issuance of East Java Provincial Regulation No. 8/2023, which will take effect on January 5, 2025, and sets the rate at 1.2%. East Java also provides a reduction in the 2025 Motor Vehicle Tax (PKB) for private vehicles through Governor's Decree No. 100.3.3.1/722/KPTS/013/2024, amounting to 24.7%.

Equation (4) and (5) used to calculate the total annual PKB revenue.

$$\text{Potential Revenue} = \text{PKB} \times \text{Number of Motorcycles} \tag{4}$$

$$\text{Actual Revenue} = \text{PKB} \times \text{Compliance} \times \text{Number of Motorcycles} \tag{5}$$

Meanwhile, Equation (6) used to calculate the total loss of Regional Original Revenue (PAD) in the annual system while accounting for the risk of non-compliance.

$$\text{Loss of PAD} = \text{PKB} \times \text{Loss} \tag{6}$$

$$\begin{aligned} \text{Loss} = {} & \text{Registered Last Year} \\ & + \text{New Motorcycles This Year} \\ & - \text{Registered This Year} \end{aligned}$$

Modeling of One-Time PKB Payment

The modeling of Motor Vehicle Tax (PKB) payment uses a one-time upfront payment model calculated based on the principle of Annuity Due using Equation (7). In this study, the interest rate is set at the average BI-Rate of 5%, enabling the calculation of both present value (PV) and future value (FV) using the adjusted equation from (Brusov et al., 2024).

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$$\mathrm{PKB_S} = \mathrm{PKB_t} \times \left(\frac{1-(1+i)^{-n}}{i}\right) \times (1+i), \tag{7}$$

with $\mathrm{PKB_S}$ is one-time upfront payment of PKB, n is estimate vehicle lifespan, and i is BI-rate.

The determination of the interest rate (i) in public finance models refers to valid economic indicators such as the BI-Rate to reflect an appropriate discount rate (Sari et al., 2025) This interest rate serves as a balancing factor between inflation and the potential economic growth lost by taxpayers as a result of making early payments (Kemu & Ika, 2016). Meanwhile, the concept of the time value of money states that one rupiah today is worth more than one rupiah in the future (Sonbait & Oppusunggu, 2023). When evaluating fiscal revenue or losses occurring over multiple periods, the government needs to convert all future cash flows into present value. The approach used is the Discounted Cash Flow (DCF) method as shown in Equation (8) (Brealey et al., 2022).

$$PV = \frac{C_1}{(1+i)} + \frac{C_2}{(1+i)^2} + \frac{C_3}{(1+i)^3} + \cdots + \frac{C_n}{(1+i)^n} \tag{8}$$

with C_t is the cash flow in period t.

Vehicle Reliability Analysis (Survival Rate)

Every motor vehicle has a limited technical lifespan, beginning from the time of production until it is no longer suitable for use. Vehicle age can be an important consideration in the taxation system. The analysis of vehicle physical durability is conducted using the Weibull Distribution. This distribution is frequently employed to assess the durability of materials (Susiswo, 2017) and is also widely used in addressing survival or lifetime issues (Nufus & Sutarman, 2022). The Weibull Distribution is highly flexible, as it can model various life spans or failure phases, ranging from the early failure (infant mortality) phase to the wear-out phase (Aziz et al., 2025). The Weibull Distribution has scale and shape parameters, which allow for accurate estimation even with small sample sizes (Nufus & Sutarman, 2022). By using y to represent the age of two-wheeled motorcycle engines, the CDF based on the basic equation of the Weibull Distribution (Walpole et al., 2012).

The average age of vehicles, particularly motorcycles, in Indonesia is similar to that in other Asian countries. This is due to the dominance of global manufacturers from Japan—such as Honda, Yamaha, and Suzuki—which apply high standards to engine durability (Yuliansyah, 2025). Additionally, Indonesia shares similar geographic conditions and highly intensive motorcycle usage as a primary mode of transportation, especially with other Southeast Asian countries, which influences the average vehicle age (Fikri, 2026).

This study adopts the Weibull Distribution model from (Kurogi et al., 2021), using vehicle characteristics representative of Southeast Asia, specifically Vietnam. The parameters applied are as follows:

1. The average service life is set at 17 years, based on comparative studies of motorcycle user behavior in Southeast Asia, which shares similar economic and geographic characteristics with Jombang Regency.

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2. The shape parameter is set at 3.6. This value is the industry standard for high-quality manufactured engines, indicating a low failure rate in the early years that increases significantly as the engine approaches its economic lifespan.

To determine the percentage of the motorcycle population that physically survives as it ages, the survival function is calculated using the Equation (9) (Kurogi et al., 2021).

$$R(y) = \exp\left[-\left(\frac{y}{\bar{y}}\right)^{\beta} \cdot \left\{\Gamma\left(1+\frac{1}{\beta}\right)\right\}^{\beta}\right], \quad (9)$$

with $R(y)$ is probability that a motorcycle is still operational in year y, y is motorcycle age, $\bar{y}$ is average motorcycle lifespan, α is scale parameter, β is shape parameter, and Γ is Gamma function.

Research Problem Boundaries

The research object is limited to the principal motor vehicle tax (PKB) for privately owned, first-ownership two-wheel vehicles in Jombang Regency. Calculations use average PKB rates and values, assumed to be constant aside from vehicle depreciation, to simplify the simulation. In addition, it is assumed that no changes in tax regulations occur during the simulation period. The simulation model is also structured to follow a time cycle identical to the five-year vehicle plate tax payment schedule.

RESULTS AND DISCUSSION

Average Annual Motor Vehicle Tax (PKB)

The average annual motor vehicle tax (PKB) in Jombang Regency was calculated using Equation (4), adjusted in accordance with the Governor of East Java's decision, which stipulates a 24.7% tax reduction and a weight factor of 1.2% specifically for the year 2025. The results of the PKB and NJKB calculations are presented in Table 3.

Tabel 3. Calculation of PKB and NJKB (in rupiah)

Year	NJKB (IDR)	PKB (IDR)
2022	16,654,923	199,859
2023	16,192,818	194,313
2024	16,688,343	200,260
2025	15,586,951	187,043
	Mean	195,369

In this study, the average annual motor vehicle tax (PKB) value used is Rp195,369.

Compliance Rate and Revenue Leakage

Based on data analysis using Equation (1), the PKB compliance rate was found to be 83.57%. Using the average annual motor vehicle tax in Jombang Regency of Rp195,369.11 and an average of 66,903 motorcycles in arrears each year, the potential annual revenue loss can be determined using Equation (6).

$$\text{Potential Annual Revenue Loss} = 66{,}903 \times \text{Rp}195.369 = \text{Rp}13{,}070{,}772{,}207.$$

Thus, there is a revenue potential loss of Rp13,070,772,207 per year due to non-compliance.

In addition to the arrears recorded in the system, it is also observed that there are new motorcycles that have exited the system and are no longer registered.

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Table 2. List of Registered Motorcycles

Year	Registered Last Year	New Registered	Registered This Year	Lost
2022	406.881	23.917	409.430	21,368
2023	409.430	24.553	405.796	28,187
2024	405.796	25.831	407.611	24,016
2025	407.611	22.863	406.236	24,238
		Mean		24,452

Thus, an average of 24,452 motorcycles are lost from the system each year.

Single Payment PKB Modeling

The single payment PKB is calculated using Equation (7), with the average annual motor vehicle tax in Jombang Regency set at Rp195,369.11, an interest rate of 5%, and n years for simulating government revenue from motorcycle PKB. The results of the single payment PKB simulation for several scenarios are presented in Table 7.

Table 3. Single Payment PKB Simulation

n	PKB_S (Rp)	n	PKB_S (Rp)
1	195.369	21	2.630.100
2	381.434	22	2.700.226
3	558.640	23	2.767.013
4	727.407	24	2.830.619
5	888.138	25	2.891.197
6	1.041.215	26	2.948.890
7	1.187.002	27	3.003.836
8	1.325.847	28	3.056.165
9	1.458.081	29	3.106.002
10	1.584.017	30	3.153.467
11	1.703.957	31	3.198.671
12	1.818.185	32	3.241.722
13	1.926.974	33	3.282.724
14	2.030.583	34	3.321.772
15	2.129.257	35	3.358.962
16	2.223.233	36	3.394.380
17	2.312.734	37	3.428.112
18	2.397.973	38	3.460.238
19	2.479.153	39	3.490.834
20	2.556.467	40	3.519.973

For example, according to Table 7, if it is assumed that the lifespan of a motorcycle is only one year, then the owner will only pay the motor vehicle tax (PKB) once, resulting in a one-time PKB payment of Rp195,369. If the motorcycle's lifespan is assumed to be 20 years, then the PKB would be paid 35 times. If these 35 PKB installments are paid as a lump sum, the one-time PKB payment would be Rp3,358,962.

In this study, the one-time PKB is determined based on the average vehicle lifespan of 17 years and the license plate replacement, which occurs every five years. Accordingly, the one-time PKB payment is set at Rp2,556,467 for each new motorcycle.

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Using Equation (9), the probability of a motorcycle surviving until the twentieth year is calculated as follows:

$$R(20) = \exp\left[-\left(\frac{20}{17}\right)^{36}\left\{\Gamma\left(1+\frac{1}{3{,}6}\right)\right\}^{3{,}6}\right] \approx 29{,}12\%$$

This indicates that the survival rate of motorcycles in the twentieth year is 29.12%.

Potential Revenue from One-Time PKB Payment

Based on the available data, there were 406,236 registered motorcycles in 2025. Assuming an annual decrease of approximately 22,000 motorcycles, the potential revenue from existing motorcycles is calculated using Equations (4) and (7), as presented in Table 8.

Table 8. Simulation of One-Time PKB Revenue from Registered Motorcycles

Year	Number of Motorcycles	Remaining Payments (times)	PKB Paid (Rp)	Potential Revenue (Rp)
2025	22,863	19	2,479,153	56,680,882,041
2024	25,831	18	2,397,973	61,942,051,038
2023	24,553	17	2,312,734	56,784,570,418
2022	23,917	16	2,223,233	53,173,079,665
.....	.....	.....	.....	.....
2010	12,859	4	727,407	9,353,735,046
		Total		645,599,363,107

The potential one-time PKB revenue from already registered motorcycles is estimated at Rp645,599,363,107.

Subsequent PKB revenue will be derived from new motorcycles. Based on the available data, the average number of new motorcycles per year is 24,291 units. If the one-time PKB payment is set at Rp2,556,467.50, the potential annual government revenue is as follows:

Revenue from New Motorcycles = Rp2.556.467,50 × 24.291 = Rp62.099.151.981.

In the same manner, the potential revenue from new motorcycles can also be calculated through various government target simulations for annual new motorcycle numbers, for example:

Table 9. New Motorcycle Simulation

Annual Target for New Motorcycles (units)	Potential Revenue (Rp)
25.000	63.911.687.437
20.000	51.129.349.949
15.000	38.347.012.462

Thus, the total potential revenue from the one-time PKB payment in 2026 is Rp645,599,363,107 from existing motorcycles already registered in the system and Rp62,099,151,981 from new motorcycles registered in 2026. Therefore, the total potential revenue amounts to Rp707,698,515,088.

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Threat of Revenue Loss Due to Leakage

On average, each year there are 24,452 motorcycles that were registered in the system the previous year but are no longer present or have exited the system, which can also be assumed to be unregistered or illegal motorcycles. Based on flow data, an average of 24,452 motorcycles leave or leak from the system and stop paying taxes annually. The arithmetic series formula is used to calculate the cumulative leakage over 20 years with $n = 20$ and average 24,452, resulting in a potential loss of 5,134,920 motorcycles over the 20-year period.

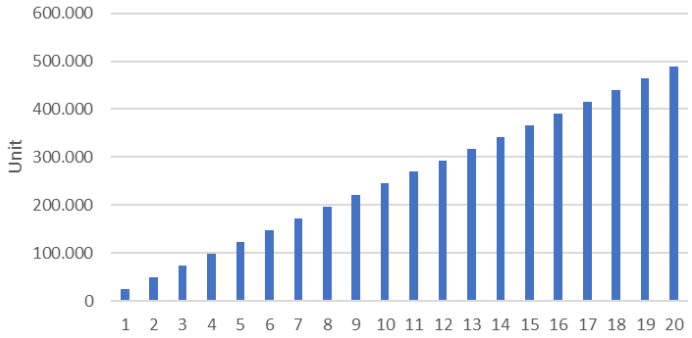

Figure 1. Twenty-Year Leakage Potential

Figure 1 shown twenty year leakage potential of registered motorcycles. Thus, using the average annual PKB, the revenue leakage over 20 years amounts to Rp1.003.204.753.097.

Analisis Sensitivitas

This analysis was conducted to assess the sensitivity of the One-Time Payment model to changes in economic variables.

1. Changes in PKB rate

If the regional government changes the PKB rate (for example, from 1.2% to 1.1% or 1.3%), the amount of the one-time payment will change linearly. However, since the payment is made upfront, the risk of revenue decline due to regulatory changes midway can be minimized. The same applies if the NJKB (vehicle sales value) and weight factor are changed, as PKB will also change linearly. For instance, if the NJKB and weight factor data are based on the Ministry of Home Affairs regulation for 2025, with a total of 1,003 motorcycle types listed in the appendix, the average PKB group calculated with a 1.2% rate and a weight of 1.00 will also change. Thus, the greater the PKB, the greater the regional revenue.

2. Changes in Interest Rate

An interest rate of 5% is used as a simulation based on the BI-Rate. If the average PKB of Rp195,369.11 is maintained, it can be simulated that if the interest rate rises, the taxpayer's burden in the One-Time Payment model will be lighter in terms of future value. Conversely, if the interest rate decreases, the government receives a greater benefit from the net present value received upfront.

3. Fiscal Impact Analysis and Model Advantages

With the one-time payment model, it can be concluded that this system better accounts for the tax potential over the vehicle's lifespan, thereby reducing the risk of fiscal potential loss due to noncompliance in the annual scheme. This model can eliminate vehicle leakage by 24,452 units per year and suppress potential arrears by

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66,903 units per year because the tax is paid upfront. Furthermore, the Jombang Regency government achieves stronger fiscal resilience, as revenue is no longer dependent on fluctuating annual compliance rates. From an administrative perspective, this model is also more efficient as it reduces the need for collection costs and tax amnesty programs. On the other hand, this scheme remains flexible, as the government can adjust various parameters such as PKB rates, weight factors, interest rates, and tax periods according to fiscal policy needs.

CONCLUSIONS

This study demonstrates that modeling motor vehicle tax (PKB) revenue using the time value of money, Discounted Cash Flow (DCF), and Weibull distribution approaches can be used to estimate the potential revenue and fiscal loss from PKB payments. The analysis shows that the annual PKB system, rather than the one-time payment scheme, has an average compliance rate of 83.57% per year, resulting in a potential loss of 16.43% annually. In contrast, the one-time PKB payment scheme modeled using an annuity due ensures no potential loss of PKB revenue for regional income. The one-time PKB payment scheme can eliminate leakage, increase revenue certainty, and strengthen regional fiscal resilience. However, further attention is needed for other aspects, such as public outreach and community opinion.

Future research is recommended to examine regulatory aspects, administrative readiness, and socioeconomic impacts, particularly the taxpayers' ability to pay upfront. Regional governments may consider the one-time PKB payment scheme as an alternative to enhance revenue effectiveness and reduce leakage, while still providing flexible options such as rate adjustments, payment periods, and integration with other policies. Subsequent research is also expected to incorporate additional variables for improved results.

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