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The Effect of Patimban Access Toll Road on Land Value Increase and Potential Application of Additional Toll Road Business Model as an Opportunity in Land Value Capture

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Abstract

Given the current significant increase in toll road construction costs and the considerable investment required for toll roads, a financing mechanism such as Land Value Capture is needed. Generally, Toll Road Business Entities (BUJT) do not consider the potential for land value uplift and value capture around toll road construction, which could be utilised for toll road financing in the future. The case study location for this research is the Patimban Access Toll Road connected to the Cikopo-Palimanan Toll Road at Km 89+400 leading to the Patimban Port. The objective of this study is to estimate land value increases and develop a suitable business model to optimise the potential for Land Value Capture. Currently, there are limitations in research regarding the calculation of increased investment viability through the application of Land Value Capture in toll roads. From the collection of primary and secondary data on land values around the toll road, the data was then calculated using a comparison with similar areas, namely the Difference in Differences method, resulting in an increase in land value of IDR 120.000,- /m² due to the presence of the toll road. To assess the increase in investment viability, a financial analysis method was used, considering the land purchase cost component relative to the increase in land value. There was an increase in the Internal Rate of Return (IRR) in the simulation of additional business models, including industrial area development, Rest Area and Service (TIP) development, billboard utilisation, and fibre optic utilisation on the toll road.

Introduction

The growth of toll road infrastructure in Indonesia has accelerated significantly, especially since 2015 as part of the national strategic project. One of the main objectives is to accelerate inter-regional connectivity and lower national logistics costs (Siahay et al., 2023; Menon, 2024; An et al., 2024). However, behind these achievements, there are major challenges, especially in terms of financing. The most prominent phenomenon is the increase in toll road construction costs by up to 33% from the initial plan. This increase has a direct impact on the financial viability of the project, triggering an increase in toll rates, and even forcing the government to provide direct support in the form of construction of some toll roads or state equity participation (Nguyen et al., 2018; Castelblanco et al., 2022; Mahmud et al., 2021; Gifford et al., 20240. This confirms that the conventional financing approach, namely the user pay principle, is increasingly difficult to apply exclusively (Ministry of PUPR) (Burhamtoro & Subkhan, 2024; Kusumasari, 2024).

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As a solution to these challenges, the Land Value Capture (LVC) approach is gaining attention. LVC is a financing strategy that utilizes the increase in land value due to public infrastructure development (Suzuki et al., 2015; Mittal & Berson, 2022; Walters, 2013; Korngold, 2022; Iskandar, 2021). Through this approach, the Toll Road Business Entity (BUJT) or the government can recapture a portion of the added value of land as a source of funding. Unfortunately, this approach is still very limited in its implementation in the toll road sector in Indonesia. BUJT generally only focuses on revenue from user fees, without considering the added value that arises around the infrastructure they build (Rahutami et al., 2011)

This study takes the case of the Patimban Access Toll Road connected to Patimban Port, a national strategic port designed to sustain manufacturing exports and strengthen national logistics. By connecting the existing Cikopo-Palimanan (Cipali) toll road to the port, a significant increase in land value is predicted. However, there is no formal scheme to capture the added value as an alternative source of financing. Therefore, it is necessary to conduct a comprehensive study to measure the potential land value uplift and develop a new LVC-based business model that can improve the feasibility of toll road investment (Anggara & Wijaya, 2024; Kurnia et al., 2024).

Previous studies have proven the successful application of LVCs, especially in the urban transportation sector and the development of transit-oriented areas. Mulley (2024), for example, noted that LVCs have contributed up to 30-43% of the total cost of railroad projects in several countries. The study by Li et al. (2024) emphasizes the importance of LVC integration within the PPP framework, especially in mass transportation projects. On the other hand, Yılmaz & Alkan (2024) through a PEST analysis shows that the implementation of LVCs in Turkey still faces institutional and social barriers, despite its huge potential.

Research in the Indonesian context is also starting to develop. The study by Anwar (2023) identifies the key success factors of LVC on the Trans Sumatra Toll Road project, while Purba (2019) proposes various scenarios for increasing IRR on low-performing toll projects. However, these studies are still theoretical in nature and have not directly linked the application of LVCs to the improvement of investment feasibility in toll road projects based on empirical data.

From the review of previous literature, there are a number of research gaps that need to be bridged. First, most studies focus on the railway sector or transit-oriented development (TOD) areas, not on toll roads as the main object of study (Isa, 2014). Secondly, existing studies generally discuss LVC from the policy or instrument side, rather than quantitative results in the form of increased IRR or NPV due to LVC implementation. Third, there is no study that specifically examines the Patimban Access Toll Road and its effect on land value, even though this toll road is part of the strategic national transportation network. Fourth, most studies still use conventional analysis methods and have not applied quantitative approaches such as Difference in Differences (DiD) to estimate land value uplift (Yen et al., 2019; Dziauddin, 2023; Reades et al., 2019).

This research has several novelty aspects that can contribute to the development of science and practice of infrastructure development in Indonesia. First, this study specifically examines the impact of the Patimban Access Toll Road on land value increases using a quantitative approach based on the Difference in Differences method, which is rarely used in road infrastructure studies in Indonesia. Second, this study combines the economic valuation approach with financial models (NPV and IRR) to assess the investment feasibility of the toll road project when the LVC scheme is applied. Third, this study introduces additional business model scenarios for BUJT such as industrial estate development, rest and service area (TIP), billboard utilization, and fiber optic leasing as a concrete form of LVC implementation.

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Furthermore, this research becomes relevant along with the issuance of Presidential Regulation number 79 Year 2024 on Infrastructure Financing through the Management of Acquisition of Area Value Enhancement, which opens regulative space for the application of LVC in various infrastructure projects, including toll roads. This strengthens the urgency and contribution of this study as one of the first implementative references in the Indonesian context.

This study aims to estimate the increase in land value due to the presence of toll roads using the Difference in Differences (DiD) method that compares changes in land value in areas directly affected by development with comparison areas that do not experience similar interventions. In addition, this study also explores new business models that can be applied by BUJT, such as the development of industrial estates, construction of Rest and Service Areas (TIP), utilization of commercial space (billboards), and fiber optic networks. Financial simulations were conducted to assess the impact of these business models on investment feasibility parameters, particularly the rate of return on investment (IRR) (Ridwan et al., 2025; Björnsdóttir, 2010; Bresters, 2021; Harris & Wonglimpiyarat, 2020; Rubin & Patel, 2017).

With this approach, this study is expected to contribute to the discourse of managing toll road infrastructure financing in Indonesia in a more sustainable manner, as well as providing empirical evidence on the effectiveness of Land Value Capture implementation in improving the investment feasibility of toll road projects. The results of this study are also expected to be a reference for the government in formulating more progressive policies in utilizing the economic value of public infrastructure, as well as for toll road businesses in developing investment strategies that are more adaptive to market dynamics and national fiscal policy.

Methods

This research uses a quantitative approach with a case study design focused on the Patimban Access Toll Road, especially the area around the Cipendeuy Interchange Intersection. The quantitative approach was chosen because the main objective of this research is to objectively measure the impact of toll road infrastructure on increasing land value, as well as evaluate the feasibility of additional business models that can be applied through the Land Value Capture (LVC) mechanism.

In its implementation, this research was conducted through two main stages of analysis. First, the amount of land value increase that occurs as a direct result of the presence of toll roads is estimated. For this purpose, the Difference in Differences (DiD) method is used, which is a quantitative technique that compares land value changes between two groups of areas: areas directly affected by toll road construction (treatment) and unaffected areas (control). Comparisons are made before and after the construction of the toll road, so as to identify the extent to which the emerging influence can be causally attributed to the presence of the toll road.

The second stage of this research is a feasibility analysis of additional business models that could potentially be developed by the Toll Road Business Entity (BUJT). These business models include the development of industrial estates around toll exits, the construction of Rest and Service Areas (TIPs), and the utilization of commercial assets such as advertising space (billboards) and fiber optic networks. To assess the feasibility of each business model, financial simulations were conducted using several investment analysis indicators, namely Net Present Value (NPV), Internal Rate of Return (IRR), and Weighted Average Cost of Capital (WACC). The calculation was carried out by comparing the initial IRR of the project without additional business models, and the IRR after optimizing the potential of Land Value Capture.

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The data used in this study were obtained from two main sources. Primary data was obtained through direct observation in the field and a survey of the value of land around the toll road area. In addition, interviews were conducted with several related parties such as industrial estate developers, local governments, and BUJT parties involved in the project. Meanwhile, secondary data was collected from official documents, such as project feasibility study reports, Toll Road Concession Agreements (PPJT), land value zoning documents from the Ministry of ATR/BPN, as well as relevant policies and regulations regarding PPP and LVC schemes.

In developing the research framework, researchers used an operational model that contains a logical flow from the data collection process to the analysis of results. Starting from the collection of land value data, the value increase was estimated using the DiD method. Then, based on locations that showed a significant increase in value, an additional business model was developed. This business model was then tested for financial viability through simulation. The final result of this process is expected to provide a more comprehensive picture of the potential of Land Value Capture application to increase the investment value and sustainability of toll road projects.

Results and Discussion

Overview of the Cipeundeuy Interchange Intersection area Patimban Access Toll Road

The Patimban Access Toll Road has 4 (four) interchange locations, one of which is the Cipeundeuy Interchange located at Sta 2+650. The location of the Cipeundeuy Interchange Intersection is projected as an industrial area which is projected to become a developing area with a significant increase in land. The following is an overview of the Cipeundeuy Interchange location:

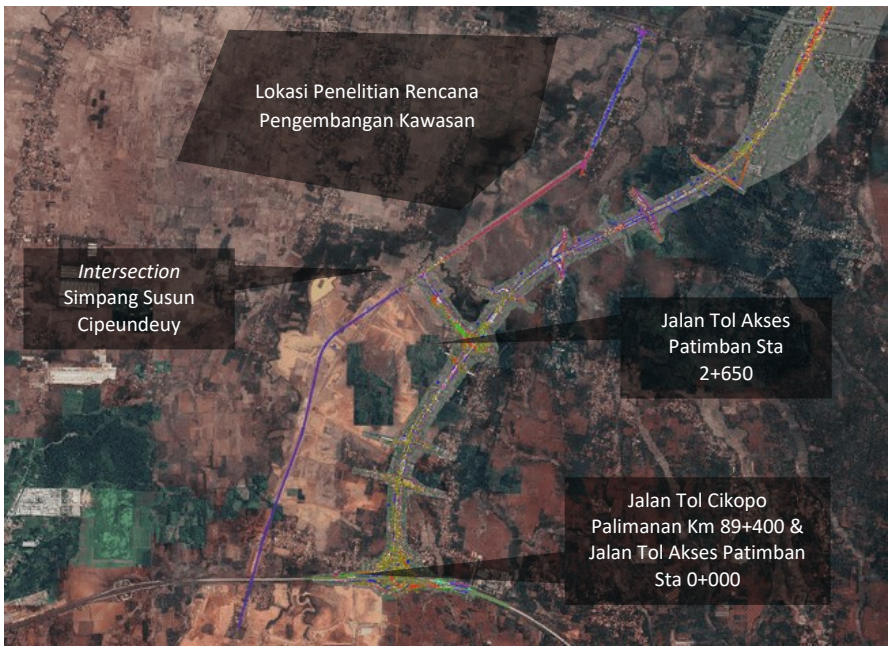

Figure 1. Delineation of the Research Area at Intersection Simpang Susun Cipendeuy Patimban Access Toll Road

Intersection Simpang Susun Cipeundeuy has a direct access plan to the Subang Smartpolitan industrial area and is directly connected to the Patimban port. In an area of ± 500 ha / ± 5.000.000 m². From the study location, research will be conducted whether there is an increase in land value influenced by toll road construction.

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Data Collection RQ1

Table 1. Land Value at the treatment location

Id	Area	When the Toll Road Has Not Been Built (t=0)	Toll Road Construction Start (t=1)
		2020	2024
		Value/Area (IDR/m²)	Value/Area (IDR/m²)
1	Area 1	514.700	1.052.157
2	Area 2	312.502	410.638
3	Area 3	325.000	362.155
4	Area 4	325.005	317.243
5	Area 5	325.016	328.215
6	Area 6	312.500	394.194
7	Area 7	312.501	331.859
8	Area 8	312.501	423.198
9	Area 9	312.501	431.006
10	Area 10	312.501	301462
11	Area 11	312.501	296.431
12	Area 12	1.125.007	431.006
13	Area 13	187.500	460.850
14	Area 14	157.501	609.195
15	Area 15	312.502	303.761
16	Area 16	550.015	729.250
17	Area 17	325.001	482.019
18	Area 18	325.001	570.167
19	Area 19	1.062.504	1.385.886
20	Area 20	1.062.812	1.638.526

Source: Data Proceed, 2025

The data presented is data for 2020 and 2024 where 2020 is when toll road construction has not yet begun and 2024 is when toll road construction begins. For Area 1 to Area 20 is a location where the increase in land value is influenced by toll road construction or called the treatment area.

To calculate the DiD model, similar location data is needed but not affected by toll road construction or untreated areas. The following are data on land values that are not treated, shown in Areas 21 to 40:

Table 2. Land Value at untreated locations

Id	Area	When the Toll Road Has Not Been Built (t=0)	Toll Road Construction Start (t=1)
		2020	2024
		Value/Area (IDR/m²)	Value/Area (IDR/m²)
1	Area 21	302.501	302.501
2	Area 22	312.502	330.000
3	Area 23	300.000	310.000
4	Area 24	200.000	220.000
5	Area 25	300.000	320.000
6	Area 26	350.000	360.000
7	Area 27	290.000	310.000
8	Area 28	330.000	330.000

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9	Area 29	335.000	340.000
10	Area 30	325.000	325.000
11	Area 31	180.000	187.500
12	Area 32	197.500	200.000
13	Area 33	187.500	187.500
14	Area 34	187.500	187.500
15	Area 35	187.500	190.000
16	Area 36	197.500	200.000
17	Area 37	197.500	207.500
18	Area 38	187.500	187.500
19	Area 39	207.500	209.000
20	Area 40	180.500	190.500

Source: Data Proceed, 2025

RQ1 calculation

DIFFERENCE-IN-DIFFERENCES ESTIMATION RESULTS

Number of observations in the DIFF-IN-DIFF: 80

	Before	After	
Control:	20	20	40
Treated:	20	20	40
	40	40	

Outcome var.	Nilai	S. Err.	|t|	P>|t|
Before				
Control	**2.5e+05**			
Treated	**4.4e+05**			
Diff (T-C)	1.9e+05	7.6e+04	2.51	0.014**
After				
Control	**2.6e+05**			
Treated	**5.6e+05**			
Diff (T-C)	3.1e+05	7.6e+04	4.03	0.000***
Diff-in-Diff	1.2e+05	1.1e+05	1.08	0.286

R-square: 0.24

* Means and Standard Errors are estimated by linear regression

**Inference: *** p<0.01; ** p<0.05; * p<0.1

Figure 2. Calculation Results of Difference in Difference in STATA Application

Single DiD without covariates submitted in the STATA application with the command "diff Nilai,treated(treated)period(t)" by taking into account 20 data as control variables and 20 data as variables that are treated so that the number of DID observations is 80, the following interpretation is produced: 1) Before the intervention there was an increase of IDR 190.000,- and after the intervention (treatment) there was an increase of IDR 310.000,- 2) From the DiD results the α value is 28,6%. so there is a significant difference because the α value> 10%. The p-value is accompanied by a star, which indicates the statistical conclusion at different significance levels, as shown below the table (*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$). In this case, the DiD estimates are significant at the 10% level; 3) These estimators are presented along with their standard errors, t-statistics, and p-values. The same information is shown for the follow-up period. The last row is the estimated DiD treatment effect, which implies an increase in land value of IDR 120.000,-

ISSN: 2716-3865 (Print), 2721-1290 (Online)

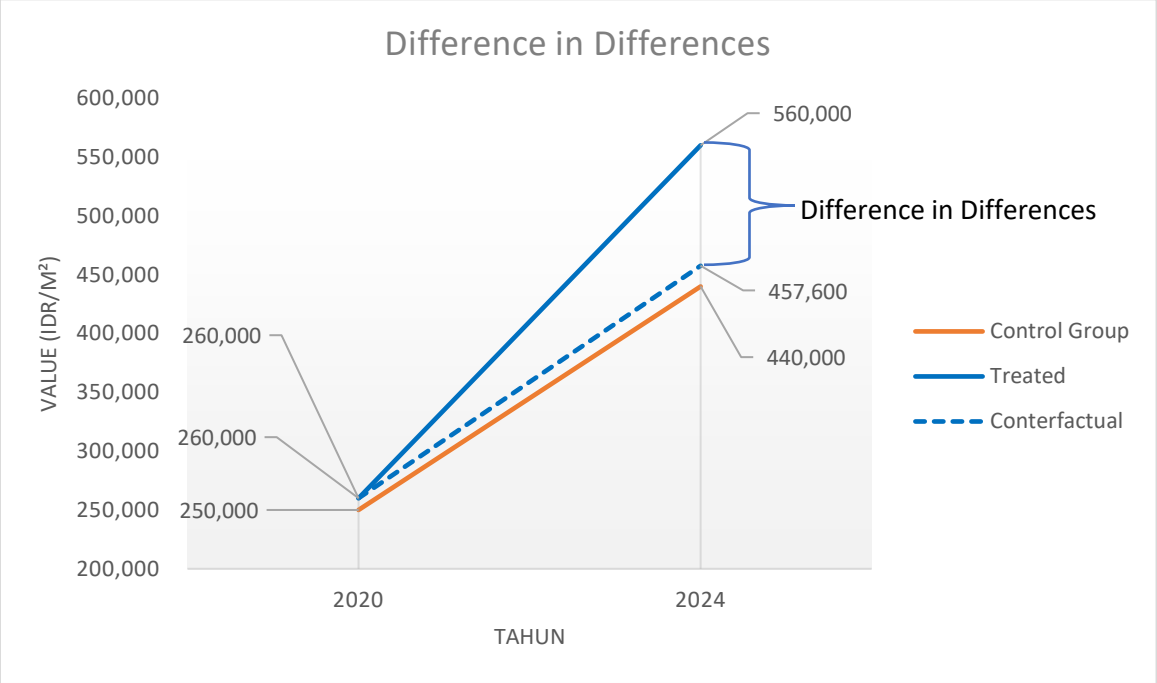

Figure 3. Difference in Differences Calculation Result Chart

Table 3. Difference in Differences Calculation Results Table

	Time	Control Group	Treated	Conterfactual
Pre - Treatment	2020	250.000	260.000	260.000
Post - Treatment	2024	440.000	560.000	457.600
Difference pre-treatment		190.000		
Difference post-treatment		310.000		
Difference in Differences		120.000		

Source: Data Proceed, 2025

In the table the results of the DiD calculation show that the treated area has an increase of IDR 310.000,- /m² and has a significant difference with the difference in locations that are not treated, namely IDR 120.000,- /m² or this value can be called Difference in Differences.

RQ 2 data collection

From the results of RQ 1, it was found that the land value increase was IDR 310.000,- in the period 2020 to 2024 so that this study can estimate the level of increase in land value that will be used as additional land to estimate the additional benefits of purchasing land around the toll road. Knowing the potential increase in the value of land to be purchased is one of the important things in estimating the potential business that can be generated, especially related to estimating the sale and purchase value of land and determining the value of land rental costs as an additional business model plan that can be applied as a Land Value Capture opportunity. The benefits of this increase in land value can certainly provide benefits from land buyers and buildings that will be built can provide more benefits to the government related to additional tax value. The resulting tax value fee can be allocated for the development of the surrounding area and can be felt directly by the community.

RQ2 Calculation

Table 4. Recapitulation of Patimban Access Toll Road Investment Feasibility Calculation

Toll Road Investment Component	Description

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Investment Value	IDR 5.308.692.728.117,-
Loan Interest	10,9%
DER	70:30
NPV	IDR 1.397.085.126.825,-
IRR	12,30%
Pay Back Period	19 years
Feasibility	>0 investment feasible

Source: Data Proceed, 2025

The results of the financial feasibility calculation on the Patimban Access Toll Road project show that this project is investment feasible with an NPV of IDR 1,39 trillion and an IRR of 12,30%, higher than the loan interest rate of 10.9%. The financing structure uses a Debt to Equity Ratio (DER) composition of 70:30. Although the payback period is relatively long at 19 years, with a positive NPV and IRR that exceeds the WACC, the project still meets the financial feasibility criteria.

Table 5. Recapitulation of Investment Feasibility Calculation for Industrial Estate Development

Investment Component	Description
Investment Value	IDR 5.023.220.000.000,-
Loan Interest	10,9%
DER	70:30
NPV	IDR 1.504.455.617.323,-
IRR	15,64%
Pay Back Period	11 years
Feasibility	>0 investment feasible

Source: Data Proceed, 2025

The development of industrial estates around the Patimban Access Toll Road also shows very promising prospects. With an investment value of IDR 5,02 trillion, the project generates an NPV of IDR 1,50 trillion and an IRR of 15,64%, well above the lending rate used in the simulation, which is 10,9%. With a payback period of only 11 years, this investment is considered very financially viable and has a strong attraction for investors, while contributing to the optimization of the economic benefits of the toll road.

Table 6. Recapitulation of TIP Development Investment Feasibility Calculation

Investment Component	Description
Investment Value	IDR 80.000.000.000,-
Loan Interest	10,9%
DER	0:100
NPV	IDR 62.912.089.482,-
IRR	23,12%
Pay Back Period	11 years
Feasibility	>0 investment feasible

Source: Data Proceed, 2025

Investment in the TIP development also showed excellent financial performance with an IRR of 23,12% and NPV of IDR 62,91 billion from a total investment of IDR 80 billion. With a fully self-financed structure (DER 0:100), the project was able to pay back the capital within 11 years. This high rate of return makes TIP an attractive additional business model and has the potential to provide stable long-term revenue for BUJT.

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Table 7. Recapitulation of Billboard Development Investment Feasibility Calculation

Investment Component	Description
Investment Value	IDR 3.809.694.152,-
Loan Interest	10,9%
DER	0:100
NPV	IDR 3.115.358.658,-
IRR	23,37%
Pay Back Period	12 years
Feasibility	>0 investment feasible

Source: Data Proceed, 2025

The utilization of space along the toll road for billboard installation also proved to be profitable, despite the relatively small investment value of IDR 3,8 billion. With an IRR of 23,37% and NPV of Rp 3.11 billion, as well as a payback period of 12 years, this project is categorized as highly viable. Funding comes entirely from own capital, showing that even with a small investment scale, the project still provides a high profit margin.

Table 8. Recapitulation of Fiber Optic Application Investment Feasibility Calculation

Investment Component	Description
Investment Value	IDR 4.631.250.000,-
Loan Interest	10,9%
DER	0:100
NPV	IDR 3.144.131.386,-
IRR	21,19%
Pay Back Period	16 years
Feasibility	>0 investment feasible

Source: Data Proceed, 2025

The fiber optic network application on the toll road section provides positive investment results with an NPV of Rp 3,14 billion and an IRR of 21,19%. From a total investment of IDR 4,63 billion and with full funding from equity (DER 0:100), the project takes 16 years to payback. Although the payback period is longer than other business models, the high IRR indicates that the investment is still feasible and suitable to be developed as a sustainable source of additional income.

The feasibility evaluation was conducted using a financial analysis approach, with the main indicators being Net Present Value (NPV) and Internal Rate of Return (IRR). Simulations were conducted on four business model combination scenarios:

Table 9. Additional Business Models

Simulation	Additional Business Model	IRR	NPV (IDR)	Investment Value (IDR)
Simulation 1	Toll Road + Industrial Estate + TIP + Billboard + FO	13,20%	2.970.711.323.673,-	10.420.353.978.117,-
Simulation 2	Toll Road + TIP + Billboard + FO	12,50%	1.466.256.706.350,-	5.397.133.978.117,-
Simulation 3	Toll Road + TIP	12,48%	1.459.997.216.307,-	5.388.692.728.117,-
Simulation 4	Toll Road only (baseline/without LVC)	12,30%	1.397.085.126.825, -	5.308.692.728.117, -

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Source: Data Proceed, 2025

These results show that the application of additional business models, particularly when they include industrial park development and other commercial uses, can markedly improve the financial viability of the project. The IRR increases from a baseline of 12.30% to 13.20% in the most complete scenario. This increase not only demonstrates financial viability, but also opens up opportunities for infrastructure financing without relying solely on toll tariffs.

In a policy context, the implementation of the LVC scheme through the above business model can also support BUJT's role in regional development. For example, the development of industrial estates will expand the regional economic base, increase the volume of toll road traffic (especially logistics vehicles), and strengthen the synergy between transportation and spatial planning. Similarly, leasing land for fiber optics and billboards provides long-term passive income with minimal risk.

Discussion

The results showed that the construction of the Patimban Access Toll Road had a significant impact on increasing the value of the surrounding land. This is evidenced through the Difference in Differences (DiD) method, which shows an increase in land value of IDR 120.000,-/m² due to the presence of the toll road. This increase reflects the Land Value Uplift (LVU) phenomenon, which is an increase in land value that occurs due to infrastructure development, not solely due to market activity. In this context, the added value should ideally be reused to finance the infrastructure itself through the Land Value Capture (LVC) scheme.

This finding is consistent with the results of previous research conducted by Mulley (2024), which states that the development of public transportation infrastructure in various countries has resulted in significant funding contributions through LVC, such as in the UK and Australia, where funding for railway projects can be obtained up to 43% of the increase in surrounding land values. Although the context is different (rail vs. toll road), the basic principle is similar: infrastructure creates new economic value that can be recaptured by the government or infrastructure operator.

In practical terms, the additional business model feasibility simulation results show an increase in IRR from the baseline of 12,30% to 13,20% when BUJT implements the LVC strategy through the development of industrial estates, TIPs, billboard utilization, and fiber optics. This increase supports the argument put forward by Xinjian Li et al. (2024), who emphasized that integrating LVCs into PPP schemes can increase the project's economic value and strengthen BUJT's negotiating position towards financing from financial institutions.

Furthermore, Anwar (2023) in his study on Critical Success Factors (CSF) of LVC implementation in the Trans Sumatra Toll Road project, also found that one of the indicators of the success of LVC implementation is BUJT's ability to read regional development opportunities around the project. This research proves that if BUJT has access to the potential for non-fare box revenue development, then infrastructure projects that were previously marginal (only 12,3% IRR) can become more attractive in terms of investment.

However, there are implementation challenges. As stated by Yılmaz & Alkan (2024) through the PEST analysis approach, the success of LVC implementation is influenced by many factors such as regulation, political support, and institutional structure. In the Indonesian context, the regulatory framework regarding LVCs has only been strengthened with the issuance of Presidential Regulation number 79 of 2024, so implementation in the field is still very limited and requires validation from pilot projects such as the Patimban Access Toll Road.

ISSN: 2716-3865 (Print), 2721-1290 (Online)

In theory, this finding is also in line with the Virtuous Value Cycle concept developed by Suzuki et al. (2015) and supported by the Asian Development Bank (ADB). This concept explains that public infrastructure not only creates value for direct users, but also creates indirect value through rising land prices, increased economic activity, and the formation of new growth centers. By capturing some of this value, infrastructure projects can become more fiscally sustainable without burdening the state budget or users through high tariff increases (Greenstone & Looney, 2011).

From a local perspective, the context of the Patimban Access Toll Road is relevant because it is integrated with other national strategic projects such as Patimban Port and the Subang industrial area which is part of the Rebana Metropolitan area. The existence of transportation nodes (port and toll road) in one location strengthens the agglomeration effect and makes this area very potential to be developed with the LVC approach.

Therefore, the implementation of LVC in Patimban Access Toll Road can be an important precedent that not only strengthens BUJT's business model, but also provides alternative infrastructure funding in the future. This is important considering that reliance on user pay revenue (toll tariff) has limitations, especially if the actual traffic volume does not match projections.

Conclusion

Conclusion RQ 1

There is an increase in land according to the results of the DiD calculation showing that the treated area has a significant increase of IDR 310.000,- /m² and has a significant difference with the difference in locations that are not treated, namely IDR 120.000,- /m² or this value can be called Difference in Differences.

Conclusion RQ 2

In the LCC simulation, simulation 1 has the highest IRR increase from 12,30% to 13,20% but has the largest additional investment capital value due to additional development of the area around the toll road. Simulation 2 and simulation 3 have an insignificant increase in IRR but the value of investment capital is not too high.

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