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Investment Feasibility and Strategic Development Scenarios of Yogyakarta-Bawen Toll Road

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ABSTRACT

This study examines the feasibility of the investment in the Yogyakarta-Bawen toll road project by analyzing traffic conditions, expenditure costs, toll revenues, and investment value. Simulation using PTV Visum shows a significant increase in the volume-to-capacity ratio (VCR) on the national road sections around the toll road until 2061. The modeling result also indicates that the operation of the toll road reduces traffic loads on several surrounding national road sections with a decrease in VCR. The analysis results reveal a negative net present value (NPV) amounting to -Rp.506,560,648,100, and an internal rate of return (IRR) of 11.49% is under the discount rate (12.03%). In the tariff adjustment scenario, the project shows an IRR of 12.48% with an NPV of Rp 575,501 million, and the payback period (PBP) is achieved after 16 years. In the concession adjustment scenario, the IRR is 12.12% with an NPV of Rp 123,461 million, and the PBP is achieved after 17 years. Meanwhile, the tariff and concession adjustment scenario show an IRR of 12.48% with an NPV of Rp 652,033 million, and the PBP is achieved after 16 years. Based on the investment feasibility evaluation, the recommended best strategy is tariff adjustment. This strategy allows for an optimal increase in toll revenue and investment returns. It is expected that the Yogyakarta-Bawen toll road project can achieve better investment feasibility and provide long-term benefits to investors, road users, and the overall community.

1. Introduction

The development of the Yogyakarta-Bawen Toll Road, as a part of the National Strategic Program, aimed to enhance growth, equitable development, and the well-being of society, as regulated in [1]. The Yogyakarta-Bawen Toll Road holds strategic value in improving accessibility, connectivity, and the capacity of interregional road networks in Central Java and the Special Region of Yogyakarta [2]. The toll road project is expected to reduce costs and travel time, enhance productivity and competitiveness through the reduction of distribution costs, and provide access to regional and international markets [3]. Managed by PT. Jasamarga Jogja-Bawen (JJB), the toll road consists of six sections with a total length of 75.82 km. Section 1 is scheduled to be operational in early 2024 and will be connected to the Solo-Yogyakarta-YIA Kulon Progo Toll Road [4].

Planning for the construction of the Yogyakarta-Bawen Toll Road involves a concession agreement between the government and the Toll Road Business Entity (known as BUJT), which regulates various investment parameters that have been agreed upon. One of the parameters that has changed in the implementation of this project is the construction schedule. Changes to the construction schedule occur due to adjustments in field conditions, including the land acquisition process, the land acquisition budget, and the availability of land for construction purposes [5]. These changes demonstrate flexibility in facing challenges and changing circumstances that may arise during the project.

Parameters related to the construction schedule are part of the government's preparations for fulfilling its commitment to land provision. The government is responsible for ensuring the availability of land required for the construction of the toll road [6]. Factors that cannot be fully predicted, such as permitting processes, land dispute resolutions, or policy changes, necessitate adjustments to the construction schedule.

Changes to the construction schedule have impacts on various aspects of the project, including traffic estimates, costs, and return on investment [7]. The government and BUJT need to work effectively together to overcome barriers and challenges related to land acquisition. BUJT involved in the Yogyakarta-Bawen Toll Road

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development project faces risks associated with changes to the construction schedule. These changes affect the previously established traffic projections in the initial agreement between the BUJT and the government. If there are delays in the construction, the projected traffic volume may not align with the actual conditions on the ground. This leads to a mismatch between the planned toll road capacity and the actual traffic demand, potentially impacting project revenue and feasibility [7].

As a long-term investment, toll road development requires traffic estimation for the future [8]. These estimations are crucial for assessing investment feasibility and making strategic decisions regarding the design, capacity, toll rates, and toll road operations. Analysis methods such as forecasting models, transportation modelling, and traffic simulation are used to predict future traffic volumes. Historical data, growth trends, as well as social and economic factors, are used as a basis to develop accurate estimation models. A thorough and comprehensive traffic estimation process helps stakeholders plan for optimal investments, identify risks and opportunities, and optimize resource utilization in toll road development.

Traffic simulation modelling using PTV Visum is one of the methods used for traffic estimation. PTV Visum is specialized software designed for transportation modelling and traffic simulation [9]. With PTV Visum, detailed modelling is conducted regarding road characteristics, travel patterns, and interactions among vehicles on the planned toll road. In the estimation process, relevant data such as actual traffic data, travel data, and demographic data are used as inputs for the simulation modelling. PTV Visum then utilizes estimation methods like TFlowFuzzy and Least Square to generate traffic volume estimates for the planned toll road [10].

TFlowFuzzy is a method that combines fuzzy logic techniques with traffic flow to estimate traffic volume. Fuzzy logic is used to handle uncertainty and ambiguity in traffic data. TFlowFuzzy provides more accurate traffic volume estimates by considering complex and nonlinear traffic conditions [11]. Least Square is a statistical calculation used to find the best regression line or mathematical model that describes the relationship between dependent and independent variables in the data. The method searches for a model that has the least squared error between the observed data and the data estimated by the model. By using the Least Square method, parameter adjustments are made to the model to obtain more accurate traffic volume estimations [12].

Traffic simulation using PTV Visum allows PT. JJB to test various scenarios and different conditions, such as changes in travel routes, traffic distribution, and the influence of other transportation infrastructure. This helps identify potential congestion, traffic density, and toll road performance in different situations. By utilizing traffic simulation modelling using PTV Visum, more accurate and detailed traffic estimations can be made to support decision-making regarding the design, operation, and development of the Yogyakarta-Bawen Toll Road. This helps assess investment feasibility, plan optimal toll road capacity, and optimize resource allocation in the Yogyakarta-Bawen toll road development project.

The investment feasibility of traffic volume changes can be measured using several financial evaluation methods, such as Net Present Value (NPV), Payback Period (PBP and Internal Rate of Return (IRR) [13]. By using financial evaluation methods such as NPV, PBP, and IRR, the investment feasibility of traffic volume changes can be objectively assessed. If the toll road project can generate a positive NPV, achieve the PBP within a reasonable timeframe, and have an IRR exceeding the expected rate of return, then it can be considered a worthwhile investment. This investment feasibility evaluation assists stakeholders in making strategic decisions and ensuring that the Yogyakarta-Bawen Toll Road project provides optimal financial benefits.

The objective of this study is to assess the investment feasibility of the Yogyakarta-Bawen Toll Road development, including evaluating investment feasibility based on financial methods such as NPV, PBP, and IRR. This research will calculate and analyse the NPV, PBP, and IRR values of the project over the concession period of 40 years, starting from the land acquisition in 2021, to assess whether this project is financially viable and provides optimal returns on investment. The research results are expected to provide accurate recommendations based on data for decision-making regarding this project and contribute to improving the growth and connectivity of Central Java and the Special Region of Yogyakarta.

2. Method

The research method used involves traffic counting surveys on nine road sections relevant to the Yogyakarta-Bawen Toll Road project. These surveys were conducted by collecting data on traffic volume at various observation points during specific time periods. The identified traffic volume during peak hours through traffic counting surveys becomes an important input for traffic modelling using the PTV Visum software.

By utilizing the collected peak-hour traffic volume data, traffic modelling with PTV Visum is conducted by

inputting the volume data as parameters in the simulation. Road network depiction is done using secondary data provided by PT. JJB. In the road network modelling, zones are divided based on administrative regions that support the presence of the toll road. In total, there are 18 zones that serve as toll road support zones, as shown in Figure 1.

Through the Demand Matrix Correction procedure in the PTV VISUM software, the model will improve the origin and destination matrices by considering the available traffic survey data [13]. Fuzzy logic approaches and least square methods are used to fill in unmeasured values or correct inaccuracies in the traffic survey data [11], [12].

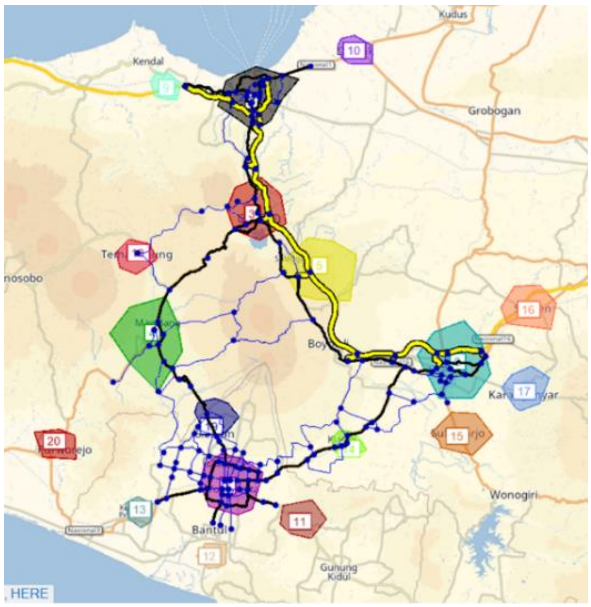

Figure 1. Zones in the model

After conducting traffic modelling with PTV Visum, the validity of the modelling results is assessed [10]. One method that can be used to test validity is by calculating the coefficient of determination (R-squared or R^2).

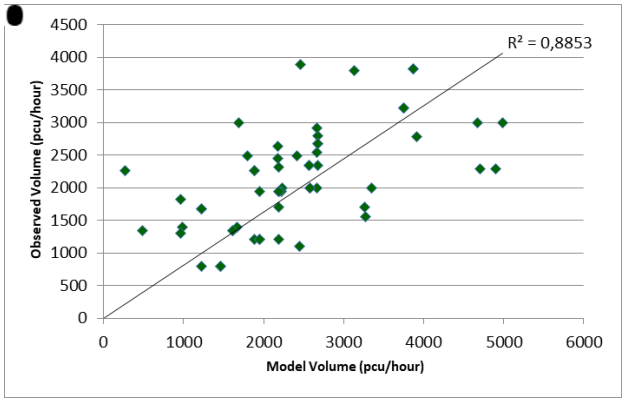

Figure 2. R^2 validation

Figure 2 indicates that approximately 88.53% of the variability in traffic volume can be explained by the model used in the study. This demonstrates that the modelling has a high level of accuracy in predicting traffic volume based on the available survey data.

In this study, traffic modelling was conducted to depict two different conditions: the do-nothing condition (without the toll road) and the do-something condition (with the toll road). This modelling was carried out for a time range starting from the existing year (2023) until the completion of the concession period of the Yogyakarta-Bawen Toll Road project, which is 40 years until 2061 from 2021.

In this study, to estimate future traffic volume, the average growth of Gross Regional Domestic Product (GRDP) from 2015 to 2021 was used. The data was obtained from 11 cities/districts, as sourced from publications by the Central Statistics Agency, as shown in Table 1.

Table 1. Toll road traffic flow

Regency/City	Average Annual Growth Rate (%)
Magelang Regency	4.2
Semarang Regency	4.2
Temanggung Regency	4.0
Magelang City	4.1
Salatiga City	4.4
Semarang City	5.1
Sleman Regency	4.3
Yogyakarta City	4.4
Kulon Progo Regency	5.8
Bantul Regency	4.3
Gunung Kidul Regency	4.4
Average Growth (%)	4.5
Standard Deviation	0.5

With the results of traffic volume modelling, the evaluation of VCR is carried out on the surrounding national road sections. The VCR is calculated by dividing the modelled traffic volume by the road capacity obtained from analysis based on the Indonesian Highway Capacity Manual (IHCM) 1997. If the modelling shows high traffic volume and a VCR exceeding 0.75, it indicates the roadway is saturated.

In traffic modelling using PTV Visum, the estimated number of vehicles on each road section is classified into categories I-V based on the provisions in Minister of Public Works and Public Housing Decree Number 370/KPTS/M/2007. Each vehicle Type has a different toll rate, which is used in toll revenue analysis. The toll rates are based on a study conducted by PT. JJB in 2021. The toll rate established is Rp. 1,875 per km with 3% tariff adjustment every two years.

The results of this modelling can be used as a basis for investment feasibility evaluation, including calculating the NPV, PBP, and IRR values, as well as considering the need for changes and adjustments in the planning and management of the Yogyakarta-Bawen Toll Road project. The planning and investment costs of the toll road project obtained from PT. JJB are accumulated as capital expenditure (CAPEX). On the other hand, operational expenses (OPEX) are also accumulated as part of the project's investment feasibility analysis. In the investment feasibility analysis of the toll road project, both data, namely planning and investment costs (CAPEX) and operational expenses (OPEX), are viewed from a cash flow perspective. Cash flow is the inflow (revenue) and outflow (expenditure) of money related to the project [14].

NPV is a method used to measure the present value of cash flows generated by an investment project, considering the expected rate of return. If the NPV is positive, it is considered feasible [15]. PBP is a parameter for evaluating the feasibility of an investment in a project that measures the time it takes to recover the initial investment from the cash flows generated by the project. PBP determines how long it takes for revenue to cover the invested capital. A shorter PBP means a quicker project can generate profits that can be reinvested or used for further development. The PBP can be visualized in the form of a graph [15]. The IRR is the internal rate of return that indicates the expected rate of return from an investment [15]. The IRR is the discount rate that makes the NPV of the project equal to zero. In the initial planning by PT. JJB, the discount rate used was 12.03%. If the IRR exceeds the expected rate of return, then the project is considered profitable.

3. Result

3.1. Trip Generation and Trip Attraction

The visualization of movement between desire line zones is performed based on the travel patterns generated by the simulation model (Figure 3). Desire line zones provide information about the expected or desired travel patterns of road users within the road network affected by the construction of the Yogyakarta-Bawen Toll Road [16]. This helps to consider the desired flow of travel by road users, predict traffic congestion levels at various points, and evaluate the impact of road design changes on travel movements.

Figure 3 shows that zones with characteristics of national tourism areas also have high desire lines. This indicates a significant demand for travel between zones represented by the brown-colored lines.

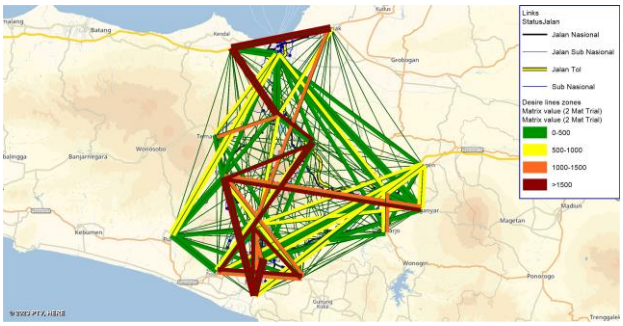

Figure 3. Desire link zones in PTV Visum

3.2. Performance of the National Road Network Before Toll Road Development

The visualization of road network assignment in PTV Visum utilizes the survey data of the existing conditions in 2023, as shown in Figure 4. In this visualization, the road network assignment is displayed in the form of a graph, with the thickness of the link bars representing the level of VCR.

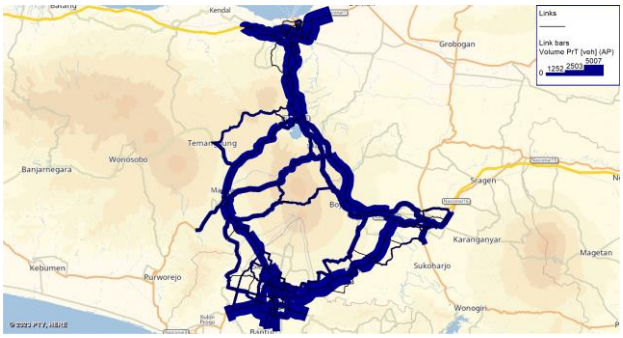

Figure 4. Road network assignment

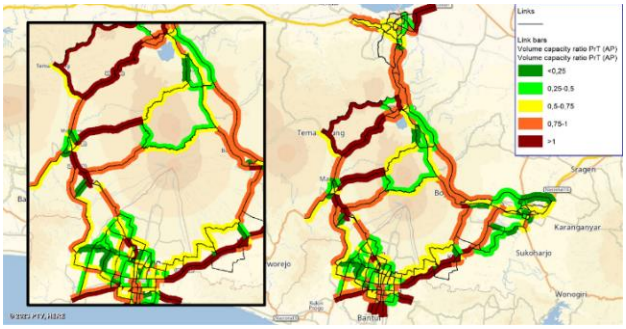

Figure 5. Existing road network performance

The visualization of saturation levels in PTV Visum utilizes color coding, with orange indicating saturated conditions (0.75-1.00) and maroon indicating highly saturated conditions (≥1.00), as shown in Figure 5. Road sections with a VCR greater than 0.75 are predominantly found on major intercity roads and around areas with high population density, as well as economic centers such as markets.

3.3. Performance of the National Road Network After Toll Road Development

The construction of the Yogyakarta-Bawen Toll Road is a phased project planned to be completed in 2026. Network performance analysis is also conducted in the years 2024, 2025, 2026, 2031, 2036, 2046, and 2061, covering a period of 40 years (the concession period). The detailed timeline of project is shown in Figure 6.

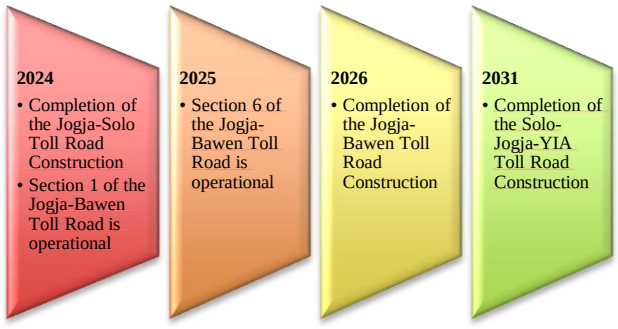

Figure 6. Timeline of Yogyakarta-Bawen toll road

Based on the modelling results using PTV Visum in the do-nothing scenario, it is evident that the traffic conditions on the toll road tend to increase each year. As a result, almost all national road sections within the area become saturated, with vehicle volumes exceeding the maximum capacity. On the other hand, based on the modelling results in the do-something scenario, the traffic conditions on the road sections affected by the Yogyakarta-Bawen Toll Road project experience a decrease in VCR. This decrease indicates that the operation of the toll road helps alleviate the traffic burden on the related road sections, resulting in improved traffic flow and better road capacity. With the toll road in place, the volume that was previously causing saturation on the national road sections is redirected to the toll road, providing a more efficient and faster transportation alternative.

3.4. Traffic Flow Analysis

Traffic flow is categorized into Flow A and Flow B. Flow A indicates traffic heading towards Bawen, while Flow B indicates traffic heading towards Yogyakarta. The traffic volume data is then converted into pcu/year units using a conversion factor of 11% or AADT (Annual Average Daily Traffic) based on the conversion value from IHCM 1997. Table 2 shows the traffic flow analysis for each section of the Yogyakarta-Bawen Toll Road.

The traffic flow resulting from the modelling with PTV Visum is then used to calculate the composition of toll vehicles as the basis for revenue analysis, as shown in Table 3. Considering the composition of each vehicle Type on the sections of the Yogyakarta-Bawen Toll Road, the total number of vehicles for each type on the entire toll road sections is presented in Table 4.

Table 2. Toll road traffic flow

Year	Traffic Flow (pcu/hour)			AADT (pcu/year)
	Flow A	Flow B	Total	
2024	111	113	224	2,035
2025	305	300	605	5,498
2026	1,000	1,076	2,077	18,878
2027	1,130	1,194	2,324	21,129
2028	1,260	1,311	2,572	23,380
2029	1,390	1,429	2,820	25,632
2030	1,521	1,546	3,067	27,883
2031	1,651	1,664	3,315	30,134
2036	2,360	2,335	4,695	42,686
2041	3,089	3,084	6,173	56,122
2046	3,818	3,834	7,651	69,557
2051	3,232	4,225	8,457	76,886
2056	4,646	4,617	9,264	84,214
2061	5,060	5,001	10,061	91,467

Table 3. Toll road traffic flow

Section	Section 1 (Yogyakarta-Banyurejo)				
Type	I	II	III	IV	V
Composition (%)	74.26	18.21	3.22	3.18	1.12
Section	Section 2 (Banyurejo-Borobudur)				
Type	I	II	III	IV	V
Composition (%)	76.07	18.75	3.36	1.60	0.23
Section	Section 3 (Borobudur-Magelang)				
Type	I	II	III	IV	V
Composition (%)	66.35	29.78	2.39	1.13	0.35
Section	Section 4 (Magelang-Temanggung)				
Type	I	II	III	IV	V
Composition (%)	81.77	16.15	1.25	0.69	0.14
Section	Section 5 (Temanggung-Ambarawa)				
Type	I	II	III	IV	V
Composition (%)	81.77	16.15	1.25	0.69	0.14
Section	Section 6 (Ambarawa-Bawen)				
Type	I	II	III	IV	V
Composition (%)	84.37	13.30	2.10	0.16	0.08

3.5. Toll Tariff Analysis

The toll rates are divided into three categories: Type I includes sedans, SUVs, pickups, small trucks, and buses; Type IIA includes trucks with 2 axles (Type II) and trucks with 3 axles (Type III); Type IIB includes trucks with 4 axles (Type IV) and trucks with 5 axles (Type V). The 21 tariff per km for each vehicle type is presented in Table 5.

3.6. Toll Revenue

Toll revenue in the project feasibility is based on multiplying the AADT particularly the estimated heavy road traffic load with the applicable toll rates. The AADT used is an estimation of the number of vehicles expected to pass through the toll road in one year, based on the modelling results from PTV Visum. The total toll revenue per vehicle type is presented in Table 6.

Table 4. Toll traffic flow by vehicle type

Year	Traffic Flow by Type (pcu/year)				
	I	II	III	IV	V
2024	1,511	371	66	65	23
2025	29,772	7,059	1,124	1,462	89
2026	111,970	29,104	3,649	3,273	451
2027	125,255	32,589	4,085	3,656	504
2028	141,336	36,735	4,626	4,178	563
2029	154,882	40,282	5,072	4,575	617
2030	171,941	44,659	5,649	5,145	678
2031	185,762	48,271	6,105	5,555	732
2036	278,918	71,636	9,240	8,683	1,070
2041	390,920	99,404	13,035	12,652	1,439
4046	530,983	133,805	17,875	18,014	1,862
2051	631,962	158,075	21,452	22,196	2,139
2056	772,492	191,694	26,501	28,342	2,492
2061	910,071	224,610	31,437	34,346	2,833

Table 5. Tariff per km

Year	Tariff per km (Rp)		
	Type I	Type II & III	Type IV & V
2024	1,875	2,813	3,750
2025	1,875	2,813	3,750
2026	1,875	2,813	3,750
2027	1,988	2,981	3,975
2028	1,988	2,981	3,975
2029	2,107	3,160	4,214
2030	2,107	3,160	4,214
2031	2,233	3,350	4,466
2036	2,509	3,764	5,018
2041	2,988	4,483	5,977
2046	3,358	5,037	6,716
2051	3,999	5,999	7,998
2056	4,494	6,740	8,987
2061	5,352	8,028	10,704

Table 6. Toll road revenue

Year	Revenue (million rupiah)				
	Type I	Type II	Type III	Type IV	Type V
2024	8,532	3,138	555	740	258
2025	40,892	11,442	1,899	2,532	461
2026	808,282	290,889	31,304	42,479	5,873
2027	904,366	325,887	35,755	47,673	6,574
2028	1,060,476	382,538	41,281	56,039	7,711
2029	1,162,324	419,636	46,158	61,544	8,454
2030	1,340,023	484,137	52,342	71,072	9,749
2031	1,447,982	523,461	57,681	76,908	10,536
2036	2,445,562	878,723	95,718	130,034	17,835
2046	5,344,257	1,901,136	207,913	282,543	38,336
2051	6,642,021	2,353,620	263,803	351,737	47,526
2061	10,585,687	3,728,758	421,281	561,708	75,265

3.7. CAPEX and OPEX

CAPEX in toll road feasibility refers to the capital expenditure required to build the toll road infrastructure. The total CAPEX is Rp.15,446,882,320,000 and consists of various components of capital costs that need to be considered in the toll road feasibility study.

OPEX refers to the operational costs associated with the operation and maintenance of the Yogyakarta-Bawen Toll Road. In toll road feasibility, calculating OPEX is an important factor to evaluate the sustainability and profitability of the project, as shown in Table 7.

Table 7. Toll road OPEX

Year	OPEX (Million Rupiah)
2024	3,313
2025	15,762
2026	46,933
2031	178,694
2036	293,125
2046	702,471
2061	1,581,514

Effective management of CAPEX and OPEX is crucial for ensuring the sustainability of toll road projects. Controlling costs during the construction and development phase (CAPEX) helps ensure efficient initial investments, while controlling operational costs (OPEX) ensures that the toll revenue generated is sufficient to cover operational expenses and ensures the long-term viability of the toll road.

3.8. Net Present Value (NPV)

In the NPV analysis, all cash flows related to the toll road project, such as toll revenue, operational costs, initial investment, and maintenance expenses, are collected and adjusted with the desired discount rate. Subsequently, the present value of all these cash flows is calculated and subtracted from the initial investment. Considering the schedule, discount rate, and generated cash flows, the NPV analysis provides a more comprehensive view of the economic value of the toll road project. The NPV analysis is presented in Table 8.

The result of the NPV analysis for the Yogyakarta-Bawen toll road project until 2061 shows -Rp 675.823.962.560 which indicates that the project does not generatea present value of cash flows that exceeds the initial investment made.

3.9. Payback Period (PBP)

The PBP refers to the time required to reach a point where revenue equals the initial investment amount by changing the cash flow value from negative to positive, as presented in Figure 7. The achievement of PBP in the 17th year indicates that the project has reached the expected level of financial feasibility within that time frame. This suggests that the project can begin generating profits after surpassing the initial period, which may require significant investment for infrastructure development.

3.10. Internal Rate of Return (IRR)

In this study, cash flows with a return period corresponding to the concession period of 40 years were used. The IRR of 11.49% indicates the internal rate of return of the investment project. The IRR is the discount rate that makes the present value of investment cash flows equal to zero. Practically, this means that the project is considered feasible if the actual rate of return (the actual rate of return obtained from the project) exceeds 12.03% (the assumed value used). If the actual rate of return is lower than 12.03%, the project may be considered unfeasible or yield less favorable returns.

Table 8. NPV analysis

Year	Operating Profit (Loss)	Annual Maintenance	Initial Investment	Operating Investment	Operating Cash Flow	Free Cash Flow	NPV
2021	-	-	(143,823)	-	-	(143,823)	(128,379)
2022	-	-	(547,600)	-	-	(547,600)	(436,309)
2023	-	-	(1,822,714)	-	-	(1,822,714)	(1,296,330)
2024	(452,144)	-	(4,701,764)	(4,100)	-	(4,705,864)	(2,987,460)
2025	(433,414)	-	(6,434,060)	(4,100)	-	(6,438,160)	(3,648,296)
2026	548,510	-	(1,796,921)	(4,100)	548,510	(1,252,511)	(633,542)
2027	637,989	2,468	-	(6,568)	637,989	631,421	285,088
2028	834,714	1,605	-	(5,705)	834,714	829,009	334,106
2029	961,860	25,953	-	(30,053)	1,176,253	1,146,200	412,336
2030	1,159,537	5,002	-	(9,102)	1,325,020	1,315,919	422,557
2031	1,311,146	58,741	-	(62,841)	1,453,214	1,390,373	398,523
2036	2,508,471	53,368	-	(315,080)	2,354,169	2,039,089	331,197
2046	5,580,527	98,943	-	(98,943)	5,058,948	4,960,005	258,696
2061	(540,038)	891,136	-	(891,136)	1,520,914	629,778	5,977

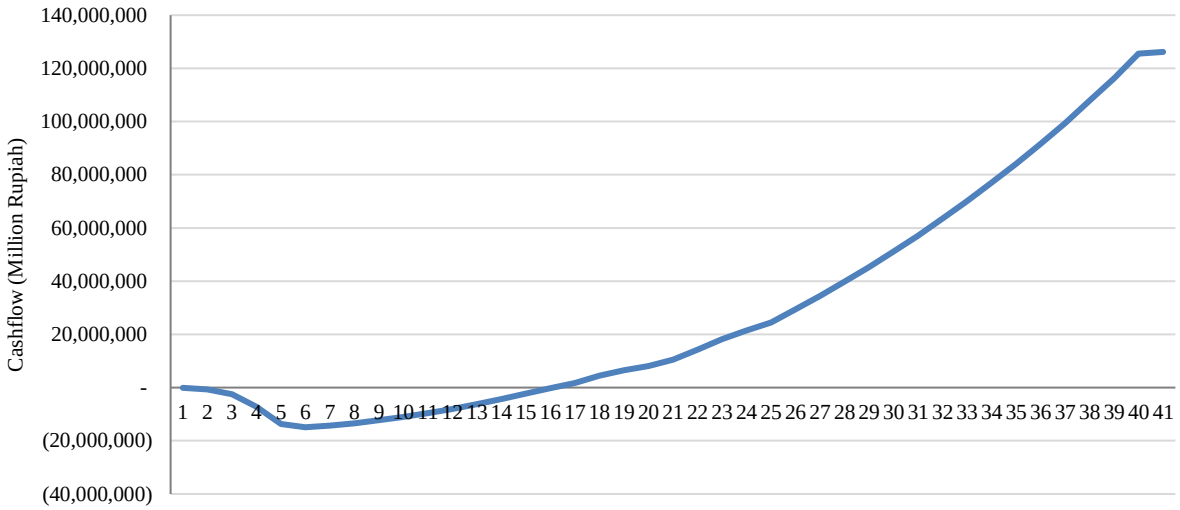

Figure 7. PBP of Yogyakarta-Bawen toll road

3.11. Feasibility Strategy Scenarios

Based on the research findings, it was found that the NPV value of the Yogyakarta-Bawen toll road project until 2061 is -Rp 675,823,962,560. The negative NPV value indicates that the project currently does not generate a present value that exceeds the initial investment. To make the project feasible, the implementation of appropriate development strategies is required. The following scenarios were conducted:

Scenario 1 = Tariff Adjustment
Scenario 2 = Concession Period Adjustment (Extended to 50 years)
Scenario 3 = Tariff and Concession Period Adjustment (Extended to 50 years)

Based on Table 9, the best scenario to choose is the tariff adjustment. In this scenario, the Yogyakarta-Bawen toll road project shows an IRR of 12.48% (returning to the original feasible rate by >12.03%) indicated a good rate of return on the investment. Additionally, NPV reached Rp 575.501 million, indicated that the present value of the project's cash flows exceeds the initial investment. PBP in this scenario is achieved after 16 years.

Tariff adjustment provides the potential for increased toll revenue and optimizes the investment return. With the appropriate tariff adjustment, it is expected to enhance the financial profitability of the Yogyakarta-Bawen toll road project. This scenario indicates that tariff adjustment can have a positive effect on investment feasibility, with more favorable NPV, PBP, and IRR compared to other scenarios.

4. Discussion

4.1. Modelling for Traffic Condition Update in Tollroad

To gain a more accurate understanding of future changes in traffic volume, the study utilizes PTV Visum, a well-known and reliable traffic simulation software [8]. This modeling involves the use of TFlowFuzzy and Least Square estimation methods, enabling a more comprehensive and in-depth analysis of traffic patterns around the Yogyakarta-Bawen toll road.

Table 9. Feasibility development strategy scenarios

Description	Tariff Adjustment Scenario	Concession Adjustment Scenario	Tariff + Concession Adjustment Scenario
I. Operational Aspect			
1. Initial Toll Rate for Type I per km	Rp2,076	Rp1,875	Rp1,954
II. Financial Aspect			
1. Investment Cost (Million Rupiah)	15,446,882	15,446,882	15,446,882
2. Investment Feasibility			
a. Concession Period	40 Years	50 Years	50 Years
b. IRR	12.48%	12.12%	12.48%
c. NPV (Million Rupiah)	575,501	123,461	652,033
d. PBP (years)	16	17	16

The utilization of PTV Visum in the modeling process offers the advantage of obtaining a clearer picture of traffic saturation levels and changes in traffic flow in the future [16]. The modeling also considers other factors that can influence traffic volume, such as incorporating GRDP data from 11 cities and regencies, which enables a more accurate estimation of future traffic volumes. In this process, the modeling considers the complex relationship between economic growth and mobility rates, thereby providing a more realistic portrayal of traffic changes along the toll road.

Regarding validation using R^2, the result demonstrates the quality and reliability of the models in predicting traffic volume on national and toll road segments. The R^2 validation provides an indication of how well the observed data aligns with the modeled results [17]. By achieving high R^2 values (close to 1), it can be confirmed that the modeling results have good accuracy and can be relied upon as an effective tool for predicting traffic volume in the future.

4.2. NPV, PBP and IRR as Tollroad Investment Feasibility

The NPV is a method used to measure the present value of cash flows generated by the project. In this research, the analysis indicates that the NPV value of the project until 2061 is negative at -Rp.675,823,962,560. This suggests that initially, the project does not generate a present value exceeding the initial investment. However, it is important to note that a negative NPV does not always indicate project infeasibility. Further analysis should consider other factors, such as economic and social benefits, that are not represented solely by NPV.

The PBP represents the point at which the project's revenue equals the costs incurred. In this study, the PBP for the Yogyakarta-Bawen toll road project is achieved after 17 years. This means that within the first 17 years of toll road operation, the revenue will be sufficient to cover the costs incurred. The PBP is an important measure in evaluating the time required for the project to reach the break-even point and become profitable.

The IRR is the internal rate of return that indicates the return rate generated by the project. In this research, the IRR of the Yogyakarta-Bawen toll road project is 11.49%. Although this IRR is below the discount rate (<12.03%). This suggests that while the project may not achieve optimal profitability, it can still generate a reasonable return compared to other investment alternatives.

The investment feasibility analysis using NPV, PBP, and IRR parameters is essential in evaluating the viability of the Yogyakarta-Bawen toll road project [15]. Although a negative NPV indicates challenges in generating positive present value, achieving PBP after 17 years and a positive IRR indicate potential worthwhile returns in the long run.

5. Conclusion

The investment feasibility of the Yogyakarta-Bawen toll road project shows that the traffic conditions on the national roads surrounding the toll road experience a significant increase in congestion, with the number of heavily congested road sections rising from 24 in the existing conditions to 44 in 2061. After considering various operational scenarios for the toll road, the analysis of the financial impact of traffic congestion revealed an initial unfavourable NPV and IRR below the interest rate. However, with the implementation of suitable measures on multiple national roads, there was a noticeable shift in traffic towards the toll road, leading to enhanced traffic flow and a subsequent improvement in the project's financial prospects. With tariff adjustment, the project can achieve a positive NPV (Rp. 575,501 millions) and a good IRR above the discount rate assumption (12.48%>12.03%). The results of this investment feasibility study can serve as a basis for the government and BUJT to make decisions regarding the development and management of the toll road project.

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