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Financial feasibility analysis of cost and traffic volume: Case study on toll road investment project

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Abstract

This research was conducted to analyze the impact of construction costs and traffic volume as the main parameters to the feasibility of an investment project with a case study on part of the road of the Sumatran toll road network, located on the Island of Sumatera, which is one of the largest islands in Indonesia. Financial analysis uses indicators of Net Present Value (NPV), Internal rate of return (IRR) and Benefit Cost Ratio (BCR). Investment costs are based on current actual conditions, while revenue is derived from the realization of traffic volume crossing the toll roads. The results of the analysis show that due to the high increase in investment costs accompanied by a decrease in income due to the large difference in traffic volume projections, the project that was originally feasible change to financially not feasible. Therefore, further efforts possible are needed to make the investment feasible. The results show that the required increasing toll tariffs is 1.996 times higher than the initial one, while the extension of the concession does not show any improvement in financial feasibility. Therefore, a proposal is needed so that the tariff is according to the ability and ability of road users while maximizing the potential for non-tariff income.

Keywords: Cost increment, Traffic volume, Financial feasibility, Toll road investment

1. Introduction

Provisioning of reliable infrastructure facilities is needed to increase connectivity as well as supporting national economic growth. However in the implementation it has not been maximally fulfilled due to limited funds from the Government. Based on data from the Ministry of National Development Planning/Bappenas of Indonesia, the major project funding plan for five years (2020-2024) is around IDR 6,555.8 trillion. Financing from PPP/BUMN/Private/Community is estimated to be the largest source of funding with a contribution of 73.4 percent of the total funding needs or around Rp. 4,814.9 trillion. Therefore, a study on the evaluation of the feasibility of infrastructure projects, especially from a financial perspective, is important considering that one of the main requirements to attract the private sector to participate in its development and management is that the projects offered must be financially attractive.

From the point of view of the private sector involvement in the development of infrastructure project is to get a decent return on their investment. Therefore investments in infrastructure projects need to be carefully studied, especially for projects whose funding involves the private sector. Infrastructure projects can be classified as large-scale construction projects which use large resources in the form of money, materials, labor, equipment and time. The projects are often characterized with long term investment (20-50 years), sunk cost, requires large of financing at the beginning years with slow returns [1]. From a financial perspective, the biggest financing for infrastructure projects is the construction cost, while revenue estimation is the key to determining the feasibility of a project.

Estimating construction costs and initial traffic volume are an important element of a feasibility analysis. The risks associated with the feasibility analysis are the risk of cost increase because of unseen factors (e.g., geotechnical problems) and the risk of income where the projection is too excessive [2]. Inaccurate cost calculations and missed revenues may cause failure to infrastructure projects and changed the project that was originally feasible change to financially not feasible. According to Wirahadikusumah et al, errors in estimating construction costs and inaccuracies of traffic volume include risks with a high level of probability rating and having a major scale of impact which can affect costs, quality and schedule of project completion [3]. Infrastructure projects with combination problems of increasing costs together with a fairly significant amount of income reduction tend to cause serious problems for investors and end users, so that the resolutions often require direct intervention by the government or their funders. Studies on several projects regarding this problem have been carried out by [4-6].

There many effort to improve the financial viability of toll road. The Supported Built Operate and Transfer (SBOT) is effective to be granted for toll roads that need high investment cost and low revenue [7]. Other investment grant such as shadow toll could be used as alternative under certain condition [8]. However, any attempt that involves government assistance to increase the investment viability of a project is usually planned and evaluated from the start and requires special regulations before being established.

This research was made to provide an overview of how construction costs and revenues affect the financial feasibility of a toll road project, further effort would be suggested to improve investment feasibility, especially for projects that are already in the constructionstage. Furthermore, this research is expected to make all parties involved in the project, especially potential investors, to

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be more carefully at the feasibility stage when analyzing field conditions and predict realistic income before making investment decision.

2. Materials and methodology

2.1 Literature review

In order to attract the private sector to involve in infrastructure projects then the selected projects to be concerned must be financially viable. Financial feasibility is defined as the feasibility of a party to perform the chosen projects from a financial perspective. Investment costs incurred by investors must be able to deliver toll roads to meet the specification criteria or quality as required, return investment capital, operating and maintenance costs and a reasonable profit. Based on [9], the capital or cost invested must show the potential to generate economic returns to investors at least equal to those available from other investments with similar risk, i.e., the rate of return must be the same or higher. Therefore, the accuracy of the estimated operating costs and the expected traffic revenue forecast is very important to check the financial feasibility of an investment activity [2].

Aspects that affect financial feasibility are project costs, toll rates and operational-maintenance costs [10]. The overall project cost is the sum of all costs incurred by a project which in general includes, the cost of land acquisition, design, construction, supervision, concessionaire fee, loan interest costs, operating costs, maintenance and rehabilitation. Toll rates are set by referring to the previously obtained contractual agreements based on the ability and willingness approach from the prospective road user. The toll revenues are then obtained from the estimated traffic volume multiplied by the tariff for each vehicle class. Operational and maintenance costs are determined based on a certain percentage of income [11]. Project costs, traffic volume, income and financial structure as determinants of the composition of equity and debt financing are used as a primary data in the toll road financial model [12]. Financial cash flow in the form of disbursements of cash out and receivable cash in is then created during the analysis period (concession period) to produce financial analysis indicators.

For toll road project investment, the balance of cash flows requires a huge amount of financing in the first beginning years to complete the construction activities, after which revenue begin to start when construction is completed or part of the toll road could be operated. Toll revenue depends on the volume of traffic passing through the toll road. The accumulation of costs incurred and benefits obtained from an infrastructure project follows the curve pattern shown in Figure 1, the pattern shown at the figure is called the J curve. Its describes the large funding needs so that cash flow is negative in the first few years of the investment and then income or positive cash flow will gradually increase [13-15]. For a feasible investment project, the return on investment occurs when the income can cover all investment costs that were previously incurred before the concession period ended. The faster the returns, the longer the benefit period can be enjoyed by investors [16] as shown in Figure 2. Conversely, if there is a high increase in costs and a decrease in income, it is likely that the return will not occur during the concession period, as shown in Figure 3.

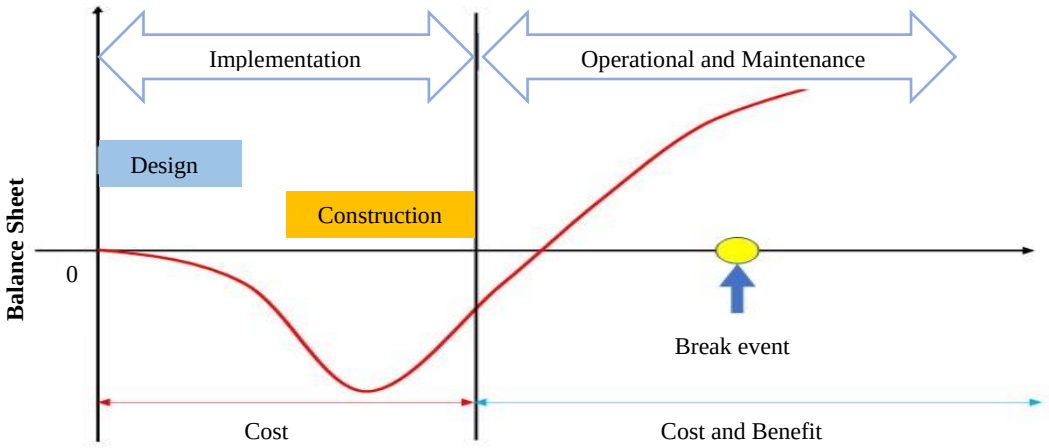

Figure 1 Infrastructure investment curve

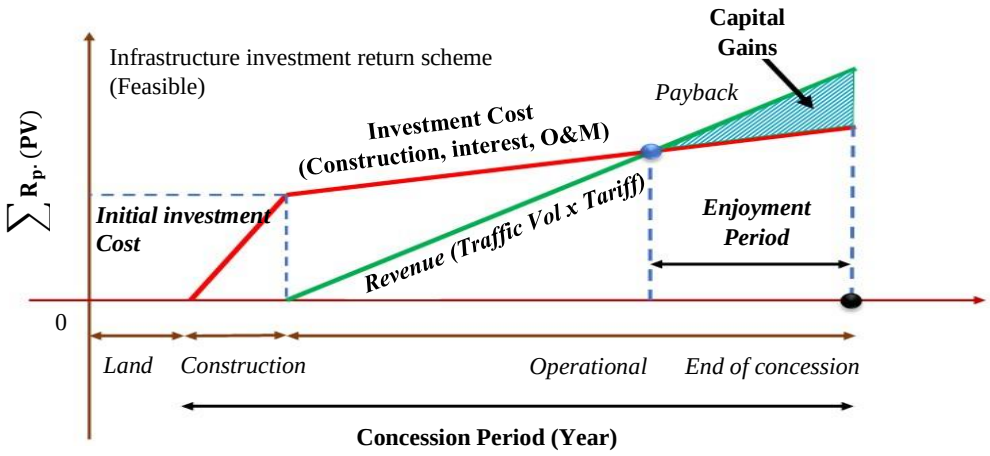

Figure 2 Decent infrastructure return scheme

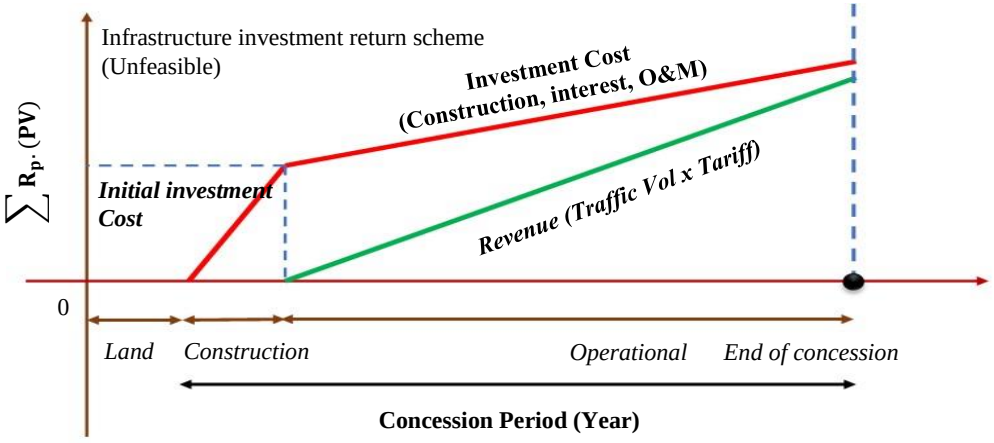

Figure 3 Non-feasible Infrastructure return scheme

There are two variables determining the financial feasibility of toll roads, that are to mention, investment costs and traffic volume passing through toll roads. These two variables must be considered carefully, especially during preliminary studies to reduce the risk of changing investment feasibility. Construction costs are the largest component of project costs, an increase in project costs that exceeds 20% so that it requires a large additional funding may threaten the project's success [3]. Another variable, traffic projection, is the weakest point in the analysis of a feasibility for a transportation project so that it can make the analysis invalid [2, 17] in their research for 170 highway projects, found that 50% of them had traffic prediction errors of more than 20%. Errors in traffic predictions cause the benefits or income in cash flow to decrease because there are fewer toll road users than expected [18].

A notable increase in project costs and a decrease in revenue realization can cause a project that was originally feasible to become financially unfit. Tsukada given example for some toll road project in Mexico, Chille, United States and China, which suffering from rising construction cost and falling revenues [5]. Kumaraswamy and Zhang examined a case with the same problem for a bridge infrastructure project in Laos [4]. Chen et al. examines a high-speed rail construction project in Taiwan which is experiencing a decline in the number of passengers [6]. For the above cases the solution of the problem often requires government or main stake holder interventions or renegotiation with the financier [4-6].

This research specifically discusses the effect of construction costs and traffic volume on the financial feasibility of an ongoing toll road project, and provides general suggestions how to improve financial viability.

2.2 Methodology

The method used in this research is quantitative methods with financial analysis. Financial feasibility analysis using indicators of Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit Cost Ratio (BCR). Although each party may have its own specific tools to analyze the robustness of a project and the best way of structuring the financing, the aforementioned indicators are the most used and recognized for project finance [9]. The supplementary BCR added to address aspect form economic evaluation. The equations for operating cash flows before financing (OCFBF), NPV, the IRR and the BCR are presented in Equations 1-4, respectively [11]. The NPV is the sum of the present values of cash flows during the life cycle of a project using the time value of money, which reflect the value of money of the project in present value terms. The IRR is a rate of return used to measure the probability of capital investment. The BCR is to summarize the overall relationship between the relative costs and benefits of a proposed project.

(1) For OCFBF,

OCFBF = Operating Cash flow before financing
= Operating revenues+Other revenues-Construction cost-Fixed operating
Cost-Variable operating cost-Corporate Tax (w/o interests of debt and subsidy)-Other tax Equation 1

(2) For the project NPV

$$NPV = \sum_{i}^{N} \frac{(OCFBF)_i}{(1+r)^{i-i_0}} \quad \text{Equation 2}$$

Where, r = the minimum project IRR for different financial market, N = the end year of concession, I = the first year of construction, i_0 = base year.

(3) For the IRR

$$\sum_{i}^{N} \frac{(OCFBF)_i}{(1+IRR)^{i}} = 0 \quad \text{Equation 3}$$

Where, i = the *i th* year of concession, $1 \leq i \leq ni$, N = the end year of concession.

(4) For the BCR

$$BCR = \frac{\sum_{i=0}^{N} \frac{B_i}{(1+r)^i}}{\sum_{i=0}^{N} \frac{C_i}{(1+r)^i}} \quad \text{Equation 4}$$

Where, i = the *i th* year of concession, 1 ≤ i ≤ ni, N = the end year of concession, Bi = benefit at the i year, Ci = cost at the i year.

The investment cost component comprises land costs, design costs, construction costs and toll facilities, toll equipment costs, supervision costs, escalation costs, VAT, overhead costs, financial costs and interest costs during the construction period (IDC). For the variable component of income, it is obtained from the average volume of daily traffic multiplied by the tariff fee for each class of vehicles (traffic revenue) and other income, assuming the amount of 1.5% of traffic revenue. Investment cost and income data are secondary data for calculating financial analysis. The analysis period is according to the concession period given that is 40 years. The analytical conceptual framework for calculating financial analysis is shown in Figure 4.

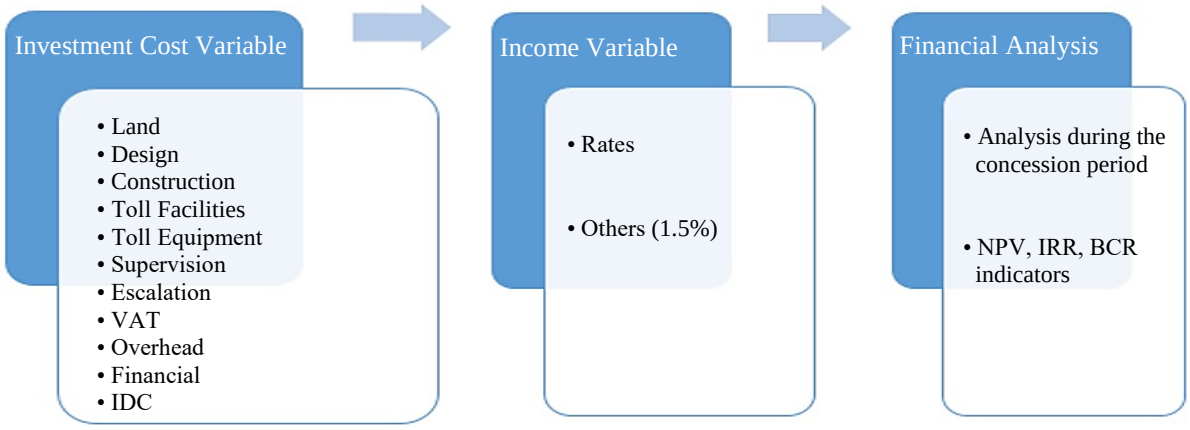

Figure 4 Conceptual framework of financial analysis.

Evaluation is done by comparing the planned financial analysis with the actual results. The actual condition in which investment costs have increased and the volume of traffic passing through toll roads has decreased. If the results of the indicators show inadequacy, further attempts are needed to improve financial feasibility. The simulation of feasibility improvements that may be carried out in this case study are three options, that is to mention 1) increasing tariffs; 2) concession extension and 3) tariff increase according to the willingness and ability of the prospective users with additional non-tariff revenue optimization.

3. Result and discussion

This research was conducted with a case study of an investment projects which is part of the Trans Sumatra Toll Road network, located on the Island of Sumatra as one of the largest islands in Indonesia. This infrastructure project in reality utilize funds that comes entirely from state owned business entities. Table 1 presents the assumptions required for the purposes of financial analysis applicable to the case studies. The assumptions based on Toll Road Concession Agreement (PPJT).

Table 1 Case study data assumptions

Asumption		Quantities
Ratio tariff Gol I:II:III:IV:IV	:	1.0:1.5:2.0;2.5:3
Initial tariff of Gol I	:	833 Rp/km
Tariff increases	:	13%
Interval of tariff increases	:	Every 2 years
Escalation of construction cost	:	6.5% per year
Concession periods	:	40 years
Traffic growth	:	12.59% first year
		13.50% second year
		9.61% Third year
		4.30% 4th to 18th year
		3.80% 19th to 22nd year
		3.00% 23rd to 28th year
		2.00% 29th to 33rd year
		1.80% 34th to 38th year
		1.60% 39th to 40th year
Cost of O&M		15% from the toll income
Other revenues		1.5% from the toll income

Due to changes in construction methods caused by unpredictable field condition resulted in an increase of project costs and delayed work completion. Changes in project costs as shown in Table 2, with project investment costs increased by 36.53%.

Table 2 Investment costs (in Rp. million)

Desription	Initial	Actual	% increase
Investment cost	14,398,930	19,658,430	36.53

Revenue data is obtained based on the volume of average daily traffic crossing toll roads. The actual percentage towards forecast data is shown in Table 3. Based on the actual condition, the daily traffic volume on the toll road has decreased. The actual traffic volume data is obtained from part of section length of the toll roads that have been operated, which is 38%. Although the data is only obtained from partially operated sections, by comparing the estimated traffic volume and the actual volume it is clear that the actual traffic volume is much lower than expected. The financial analysis will then be calculated based on the assumption that traffic volume decreases by 50% of the estimated volume.

Table 3 Percentage of actual to the projected daily traffic in the case study project

Volume of traffic	Average daily traffic of year 2020 (Vehicle/day)		
	Projected	Actual*	Percentage**
April	21,344	7,303	34.22%
May	21,344	6,804	31.88%
June	21,344	9,288	43.52%
July	21,344	11,040	51.73%
August	21,344	12,692	59.46%
September	21,344	11,580	54.25%
October	21,344	11,970	56.08%
November	21,344	10,159	47.60%
December	21,344	10,039	47.03%

* Based on counting by the toll road operator
** Percentage of actual to the projected daily traffic

Investment cost and income data over the next 40 years concession period is used to generate cash flows to calculate the financial viability. The results of the cash flow calculation are shown in Figure 5.

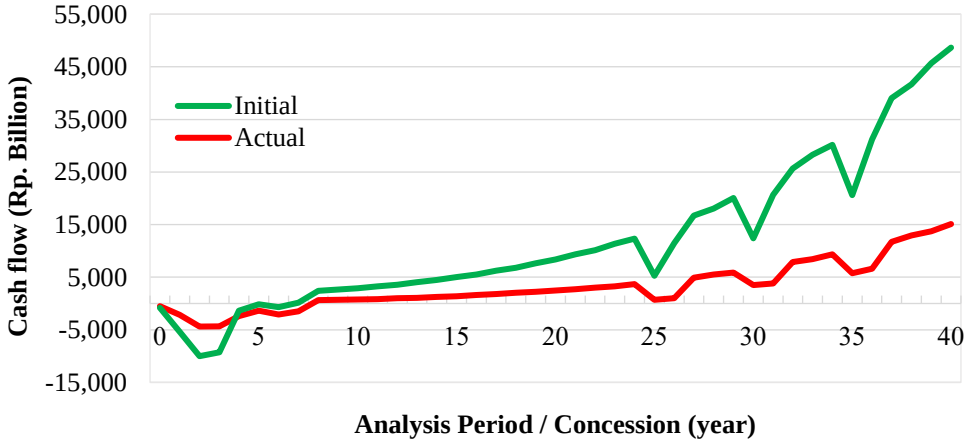

Figure 5 Investments cash flow of actual to the initial.

Figure 5 shows that the initial cash flow plan starts to be positive in year 4 while the actual conditions shift in year 8. As the actual condition where the cost investment increases with delayed construction completion and vehicle volume fell below initial prediction causes the reduction of annual net cash flow. This happened due to smaller cash income each year but have to cover the investment cost that is greater than the initial estimate. This is in line with [19] where the investment cash flow curve that produces high returns will cut the x-axis earlier, on the other hand, the investment returns will be lower and the cash flow curve will be closer to the x-axis.

The investment cash flow data during the concession period is then used for financial analysis. The results of the evaluation of the actual financial indicators towards the plan are shown in Table 4. From Table 4, the financial analysis shows the infeasibility where the IRR fell by 48.33% against the initial IRR, the NPV turned into a negative value and the BCR value below 1. The result of financial indicators shows that the project investment requires efforts to restore the financial eligibility.

Further improvement efforts to improve the financial indicators will be made by the three simulation. The result shown in Table 5.

Table 4 Actual financial indicators to the initial

Description	Initial	Actual
Financial Ratio		
• Equity	30%	100%
• Loan	70%	0%
Interest rates	13%	11.50%
Initial average daily traffic		
• Section 1	21,344	10,672
• Section 2	27,972	13,986
• Section 3	19,795	9,898
Base year of operation	2017	2020
IRR	16.45%	8.50%
NPV (Rp. Million)	7,000,502	-5,744,980
BCR	1.87	0.61

Table 5 Improving financial indicators

Condition	NPV (Rp. Million)	IRR	BCR
Increasing initial tariff	2,493,445	12.50%	1.17
Extending the concession periods	-4,129,969	9.83%	0.72
Setting initial tariff based on ATP and WTP limits	-586,476	11.25%	0.96

The first simulation, i.e. changing the initial tariff rates for each vehicle. From these three financial indicators in this research, IRR was chosen as the main reference for financial feasibility, with a more measurable consideration in percentage according to investor management decisions. By setting the minimum IRR at 12.5% according to the business plan for this toll road then the required of tariff increases will be 1.996 higher than the initial one.

The second simulation is by extending the concession period scheme for a maximum of 50 years which is most suite under Government Regulation of Indonesia (PP) No. 27 of 2014 regarding Management of State Property. Concession extensions can be carried out if the risk factors determined by realization are worse than expected or shortened otherwise, for example, if market demand is lower than estimated, the concession extension can be extended so that investors can get additional income and vice versa [20]. According to Zhang, the concession period must be sufficient for investors to obtain a reasonable IRR [21]. The financial feasibility indicator is calculated based on the extension of the concession. With the concession extension scheme, road users and the government hope that the initial tariff will not increase, therefore the analysis in this scheme uses the initial tariff according to plan, but the initial traffic volume of vehicles is assumed to decrease by 50% close to the actual condition. The investment cost outflows and net cash flow of income during the 50-year concession extension are shown in Figure 6.

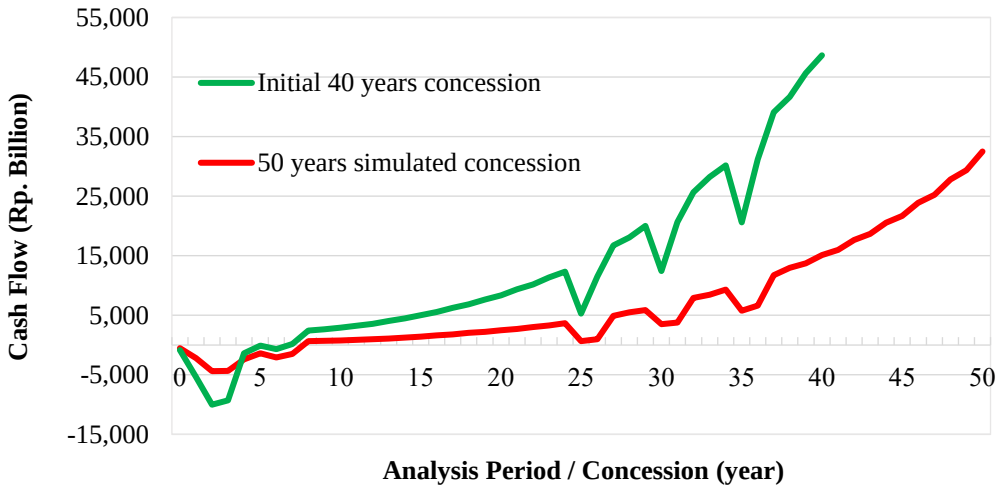

Figure 6 Net cash flow conditions for concession extension

Based on Figure 6, the additional concession makes the revenue period 10 years longer than the original concession, but still the actual investment curve is closer to the x-axis than the initial plan and tends to produce lower returns. As shown from Table 5, it can be seen that extending the concession period to 50 years could not make the investment return feasible, with the sign of negative NPV, IRR still smaller than the discount rate of 11.50% with BCR value less than 1. Concession extensions are generally not attractive to investors because the reduction in tariffs on concession extensions is very small, meaning that after the first 50-year concession period, it does not bring a significant effect.

The increasing tariff should be compared with the maximum tariff limit by considering the ability to pay (ATP) and willingness to pay (WTP) of the prospective road users obtained from the consultant data [22]. The comparison of the initial rates, proposed and based on the relationship between ATP and WTP is shown in Table 6.

Table 6 Simulation of changes in toll rates on plans and ATPWTP relationships

Tariff based	Vehicle tariff (Rp. /km)					Change of tariff
	Gol I	Gol II	Gol III	Gol IV	Gol V	
Initial	833	1,250	1,666	2,083	2,499	
ATP WTP	1,350	2,035	2,700	3,350	4,050	1.620 times
Match IRR	1,662	2,495	3,325	4,157	4,987	1.996 times

Based on the results shown in Table 6, it is found that the increase in rates to meet the investor's IRR has exceeded the ATP and WTP tariff limits, where the tariff has increased by 1.996 compared to 1.620 times the initial rate.

Efforts to improve feasibility by increasing tariffs can be made up to a certain limit that is acceptable to prospective road users. Determination of toll road rates is related to studies of the willingness and ability to pay from potential user [23-25]. Therefore, for the third simulation, financial feasibility improvements were carried out with the assumption that the initial tariff determined as closed with the obtained from the ATP WTP relationship. As shown in Table 5, it is found that the financial indicators still show inadequacy. The NPV calculation shows a deficiency of Rp. 3,091,208,000,000 to achieve an IRR of 12.50%. Therefore further attempts are needed to improve financial viability. One of the attempts that can be taken is by optimizing potential revenue outside of tariffs or developing non-toll road businesses. Non-toll business development is carried out by optimizing assets through business development in toll road corridors or business development by utilizing investor resources.

Non-toll business development is carried out by making all assets owned by investors, both tangible and intangible assets, to generate profits. Business development can be done alone or in collaboration with strategic partners. Business development that can be taken, among others:

1. Toll road corridor area development
2. Development of rest areas and services and tourist service Places.
3. Advertising and utilities installation.
4. Providing solar power plants.

4. Conclusions and suggestions

One of several ways to attract the role of the private sector to be involved in infrastructure projects is that investment in projects must have a higher rate of return which is reflected in the feasibility of financial indicators. Project costs act as the largest investment component which expended at the beginning of the year of implementation and the relatively slow recovery of toll revenues are key components that play an important role in evaluating whether or not an investment project is feasible. Inaccuracies in the preparation of construction costs and missed revenue predictions have an impact on investment projects that lead the initially feasible to become unfeasible. More attempts need to be made if the investment project becomes financially viable. Attempts to increase the initial tariff cannot be implemented without paying attention to the willingness or abilities of road users and the approval of the government. Meanwhile, the extension of the concession period may not necessarily make the investment feasible if the difference of investment costs and revenue between actual compared to initial are found too large.

Although the research has reached its aim, still there are some unavoidable limitations. First, because of the project still under construction therefore the assumptions for the actual traffic volume applied to all of the toll road segment tends to be conservatively low. So to improve the estimated financial feasibility the research should be continued until the toll has been fully operated. Second, the proposed business development should be undergo through separate research to obtain more quantitative result. Finally, the research also designed to explore that the estimated construction costs and revenues cannot be taken lightly since both aspects can drastically change the financial feasibility of toll roads.

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5. References

[1] Wibowo A. Perkembangan terkini dalam pembiayaan infrastruktur yang melibatkan partisipasi badan usaha. Konferensi Nasional Teknik Sipil 10; 2015 Oct 26-27; Yogyakarta, Indonesia. p. 1-10. (In Indonesia)
[2] Hyari KH, Kandil A. Validity of feasibility studies for infrastructure construction projects. Jordan J Civ Eng. 2009;3(1):66-77.
[3] Wirahadikusumah RD, Sapitri, Susanti B, Soemardi B. Risk in government's estimate for toll road: based on investors' perspective. Int J Adv Sci Eng Inform Tech. 2018;8(2):475-82.
[4] Kumaraswamy MM, Zhang XQ. Governmental role in BOT-Led infrastructure development. Int J Proj Manag. 2001;19(4):195-205.
[5] Tsukada S. Global experiences of public private partnership for highway development. State College: Penn State University; 2005.
[6] Chen BL, Liou FM, Huang CP. Optimal financing mix of financially non-viable private-participation investment project with initial subsidy. Inzinerine ekonomika Eng Econ. 2012;23(5):452-61.
[7] Tamin RZ, Mahani I, Marzuki PF. Supported built operate transfer effectiveness analysis to improve financial feasibility of toll roads in Indonesia. Jurnal HPJI. 2017;3(2):128-9.
[8] d' Arcier BF. Can shadow toll pricing be alternative to investment grant?. European transport conference; 2003 Oct 8-10; Strasbourg, France. United Kingdom: Association for European Transport; 2003. p. 1-17.
[9] Bjornsdottir AR. Financial feasibility assessments. Building and using assessment models for financial feasibility analysis of investment projects [thesis]. Iceland: University of Iceland; 2010.
[10] Rahmalia A, Hasani FA, Purwanto D, Kushardjoko W. Analisa Kelayakan Pembangunan Jalan Tol Pemalang Batang. Journal Karya Teknik Sipil. 2016;5(1):11-24. (In Indonesia)
[11] Hine J, Queiroz C, Chelliah T. Toolkit for public-private partnership in roads and highways. United States: PPIAF; 2009.

[12] Yuwen W, Zhang Z. Simulation of investment returns of toll projects. Texas: University of Texas at Austin; 2013. Report No: SWUTC/13/600451-00075-1.
[13] Nouvellon E, Pirotte H. Private equity performance and asset allocation: impact of low rates and the J curve of cash flows [Internet]. 2008 [cited 2021 Feb 2]. Available from: http://risk-callforpapers.institutlouisbachelier.org.
[14] Snyman HA, Kennon D, Schutte CSL, Von Leipzig K. Formulating a strategy framework to promote SME development. SAIIE25 Proceedings; 2013 Jul 9-11; Stellenbosch, South Africa. p. 8171-20.
[15] Diller C, Herger I, Wulf M, Dynamics C. The private equity J-Curve: cash flow considerations from primary and secondary points of view. United States: Capital Dynamics; 2009.
[16] Sunito FS. Tantangan dan peluang percepatan pembangunan infrastruktur Indonesia. Research & Industrial Linkage for Sustainable Infrastructure; 2016 Oct 13; Bandung, Indonesia. (In Indonesia)
[17] Flyvbjerg B, Skamris MK, Buhl S. How (In) accurate are demand forecasts in public works projects?: the case of transportation. J Am Plann Assoc. 2005;71(2):131-46.
[18] Wahyudi R, Nahdalina. Analisis kelayakan investasi jalan tol akibat risiko keterlambatan proyek dan kesalahan prediksi lalu lintas. Journal Proyek Teknik Sipil. 2019;2(2):14-23. (In Indonesia)
[19] Demaria C. The predictive power of the J-Curve. ACRN J Finance Risk Perspect. 2014;3(4):1-63.
[20] Carbonara N, Costantino Ni, Pellegrino R. Concession period for PPPs: a win-win model for a fair risk sharing. Int J Proj Manag. 2014;32(7):1223-32.
[21] Zhang X. Win-Win concession period determination methodology. J Constr Eng Manag. 2009;135(6):550-58.
[22] Ganes Consultant. Kajian ability to pay dan willingness to pay proyek Jalan Tol Kayu Agung-Palembang Betung Provinsi Sumatera Selatan. Palembang: CV.Ganes Consultant; 2018. (In Indonesia)
[23] Dalimunthe ATPKS, Hermadi, M. Analisis tarif jalan tol dengan pendekatan ability to pay (atp) dan willingness to pay (wtp) (studi kasus jalan Tol Jagorawi). Jurnal Sains dan Teknologi Teknik Utama. 2020;1:93-110. (In Indonesia)
[24] Armijaya H, Annisa. Kajian ATP dan WTP Tol Kanci-Semarang. Planners Insight. 2019;2(2):26-9. (In Indonesia)
[25] Jou RC, Chiou YC, Chen KH, Tan HI. Freeway driver's willingness to pay for distance based toll rate. Transp Res Part A Policy Pract. 2012;46(3):549-59.