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# Stochastic Analysis of Financial Feasibility In Toll Road Investment

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ABSTRACT

In making investment decisions for toll road infrastructure projects, financial feasibility is measured by Net Present Value (NPV) or Internal Rate of Return (IRR). This paper analyzes the financial feasibility of investing in the Pekanbaru-Dumai toll road infrastructure project through a stochastic method approach using the @Risk software application. The results of the analysis with the feasibility support from the government in the form of State Equity Participation (PMN) of 13% of construction costs with a concession period of 40 years obtained Net Present Value (NPV); minimum value of Rp (66,585.810,000); the average value of Rp. 153.573.12 million ; maximum value of IDR 1,218,854,320,000; probability of loss 5% 0 (positive). These results confirm that the Pekanbaru - Dumai toll road infrastructure project investment is financially feasible with a 95% confidence level.



## 1. Introduction

In the context of implementing the Master Plan for the Acceleration of Development and Economic Expansion of Indonesia 2010-2025, and supporting the growth of the national economy, as well as encouraging regional development on the island of Sumatra. The government plans the construction of a trans Sumatran toll road consisting of a 2,014 km Bakahueni-Banda Aceh main corridor and a 720 km feeder road, based on Presidential Regulation (Perpres) Number 100 of 2014 concerning the Acceleration of Toll Road Development on the Island of Sumatra. To accelerate the implementation of toll road construction in Sumatra, the government assigned the State-Owned Enterprise (BUMN) PT. Hutama Karya (Persero) as many as 24 toll roads along 2,765 km starting from Bakauheni to Banda Aceh through Presidential Regulation (Perpres) Number 117 of 2015, with the scope of assignments covering funding, technical planning, construction, operation and maintenance. The Internal Rate of Return (IRR) of the Pekanbaru-Dumai toll road segment is still low at 11.2% (BPJT, 2014).

Andreas Wibowo (2016), One of the challenges that must be faced by the government in providing infrastructure is the high cost of investment, so cooperation between the government and the private sector or business entities (KPS/ PPP) is needed. Ari Sandhyavitri et.al (2018) conducted a research on risk analysis and financial variable uncertainty in toll road infrastructure projects, financial variable uncertainty is a risk that cannot be ignored, but the risk can be allocated to the private sector or the government. What is done by the government in the PPP/PPP scheme is to provide feasibility support in the form of cash for project construction costs called the Viability Gap Fund (VGF), which aims to make a project that was previously not financially feasible but economically feasible to be financially viable. and economy (Hadi and Eko, 2015). The Pekanbaru-Dumai toll road segment is included in the characteristics of being economically feasible but not financially feasible (BPJT, 2014), so it requires feasibility support from the government in the form of State Capital Participation (PMN) whose procedures are regulated according to Government Regulation Number 72 of 2016. The government provides financial feasibility support for the Pekanbaru-Dumai toll road section in the form



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of State Capital Participation (PMN) for the period 2016 to 2020 amounting to Rp. 2,000. 000,000,000,- (two trillion rupiah) or 13% of construction costs (Tempo.co.id, July 2020; Republika.co.id, 15 July 2020).

The Pekanbaru – Dumai toll road section is in the Riau Province area which passes through Pekanbaru City, Siak Regency, Bengkalis Regency. This toll road has a length of 142,365 km, consisting of a main road of 131.475 km and an access road of 10,890 km. This toll road section is divided into six sections, namely section-1 (Pekanbaru-Minas), section-2 (Minas-Petapahan), section-3 (Petapahan-North Kandis), section-4 (North Kandis-South Duri), section -5 (Duri Selatan–Duri Utara), section 6 (Duri Utara–Dumai), there are 6 interchanges, 7 toll gates and 5 locations on the left side and 5 locations on the right side of rest areas. The map of the research location is shown as Figure 1 below:


**Fig 1.** Research Site Map
Source: PT. Hutama Karya (Persero); Researcher Process, 2020

This study analyzes the financial feasibility of investing in the Pekanbaru-Dumai toll road infrastructure project with an investment cost of 16.211 trillion rupiah (base year 2016) through a stochastic method approach with a weighted average cost of capital (WACC) as the discount rate using @Risk application software. There are several problems that can be identified and formulated, among others; how the stochastic method can analyze the financial feasibility of toll road infrastructure projects in base case conditions, what financial variables are very influential (sensitive), as well as how much influence and correlation they have in toll road infrastructure project investments, how to analyze alternative financial feasibility with government support in the form of State Capital Participation (PMN) in improving the financial feasibility of toll road infrastructure projects. The purpose of this study is to determine the financial feasibility of toll road infrastructure projects in base case conditions through a stochastic approach, determine the most influential (sensitive) financial variables on toll road infrastructure project investments, provide alternative financial feasibility through a stochastic approach with support from the government in the form of equity participation. State Capital (PMN), to assist in making investment decisions for toll road infrastructure projects.

Sensitivity analysis is carried out to identify the variables that have the most effect (sensitive) on the feasibility of project investment, sensitivity analysis can be done through deterministic and stochastic approaches. (Alfian, 2011) sensitivity analysis with a deterministic approach is presented using a spider diagram (spider diagram). Meanwhile, sensitivity analysis with a stochastic approach (probabilities) is analyzed using software@Risk whose results are presented with a tornado diagram. Ari Sandhyavitri et. al (2018), the results of the sensitivity analysis are used as the basis for preparing mitigation scenarios to assist in the decision support system process.

## 2. Research Methods

This study is planned to analyze financial feasibility scientifically through a stochastic approach (probabilities) using the @Risk software application. , BPJT, PT. Hutama Karya, and conducted in June–



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December 2020. The stages of research activities are presented in the form of a flow chart as shown in Figure 2 below:

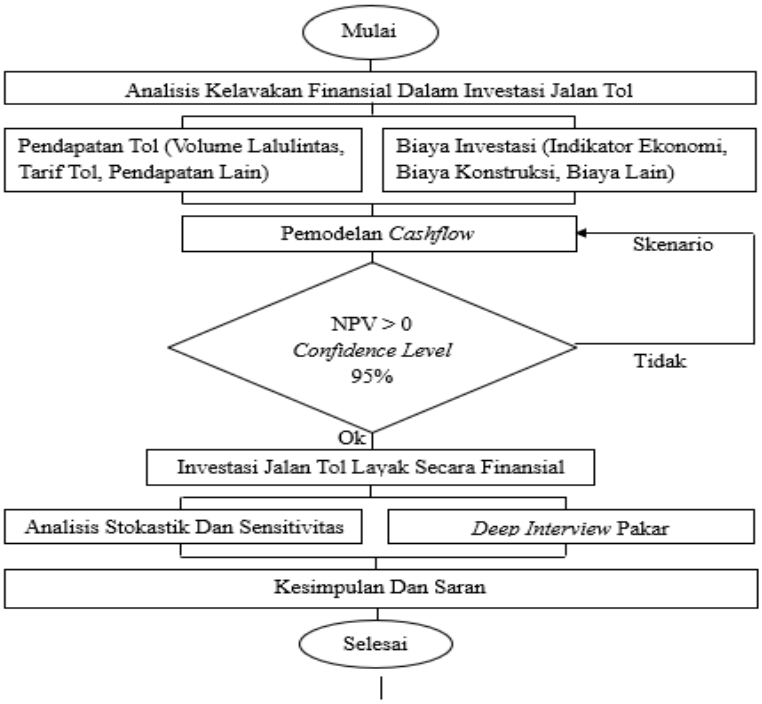


**Fig 2**. Research Flowchart
Source: Researcher Process, 2020

## 3. Results and Discussion

The Pekanbaru – Dumai toll road section is planned to operate in early 2020 with an initial traffic volume of 6,984 vehicles / day. The classification of vehicle types is based on the Decree of the Minister of Public Works of the Republic of Indonesia Number: 370 /KPTS/M/2007 The composition of traffic for Group I, II, III, IV, and V vehicles, respectively, is 73, 03 : 17,78 : 7,62 : 0,93, : 0.64 (in %). Thus, the composition of traffic at the beginning of the operation of the Pekanbaru – Dumai toll road for each group is; 5,100, 1,242, 532, 65 and 45 vehicles/day respectively for Groups I, II, III, IV and V. Normal and stable traffic growth is 7.00% (BPJT, 2014). Traffic growth during the ramp-up period can be calculated by justifying the traffic growth prediction error based on an empirical study conducted by Bain & Wilkins (2002) and simplified by Andreas Wibowo (2005a), as follows:

$$g_k = \begin{bmatrix} \left[1 - \left[\frac{\alpha M - \alpha 1}{\ln M} \ln k + \alpha 1\right]\right] \\ \left[1 - \left[\frac{\alpha M - \alpha 1}{\ln M} (\ln k - 1) + \alpha 1\right]\right] \end{bmatrix} g_F + \begin{bmatrix} \left[1 - \left[\frac{\alpha M - \alpha 1}{\ln M} \ln k + \alpha 1\right]\right] \\ \left[1 - \left[\frac{\alpha M - \alpha 1}{\ln M} \ln k - 1) + \alpha 1\right]\right] \end{bmatrix} - 1$$

*untuk k = 2,3, .... M*
*gf untuk k >M* ……(1)

Where :
gk = traffic growth in year k
gF = steady traffic growth
1 = traffic volume correction in the first year



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M = correction at the end of the ramp – up period
M = end of ramp – up period
gk = gF for k > M

The Pekanbaru – Dumai toll road section is planned for four divided two-way lanes (MW 4/2D) which can be increased to six divided two-way lanes (MW 6/2D), with a lane width of 3.60 meters. Based on the 1979 MKJI, the basic capacity is 2,300 pcu/hour/lane, where the adjustment factor due to the width of the traffic lane is 1.00 (one). The results of the calculation of the road capacity of 110,400 smp/day, by entering the passenger car equivalent factors of 1, 1.6, 1.7, 1.7, and 2.5 for each vehicle class, the capacity of the Pekanbaru toll road segment – Dumai is 98,729 vehicles/day. If the distribution of vehicles for each class is 73.03 : 17.78 : 7.62 : 0.93 : 0.64 (%) then the toll road capacity for each Group I, II, III, IV, and V is 72,102, 17,554 , 7,523, 918, and 632 vehicles/day. Prediction of traffic growth and achievement of toll road capacity starting from the beginning of operation for low, medium, and high risks as shown in Figure 3 as follows:

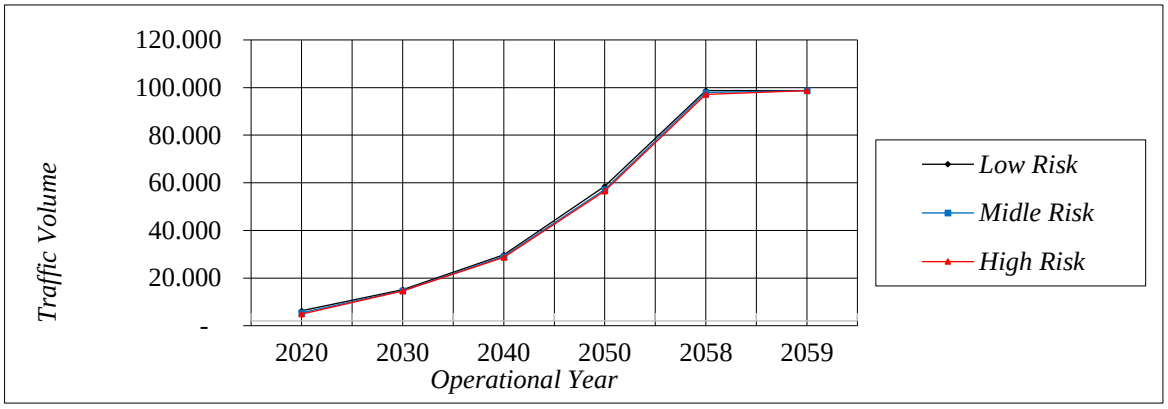


**Fig 3**. Traffic Growth of the Pekanbaru-Dumai Toll Road
Source: Processed by Researchers, 2020

This study uses the Weighted Average Cost of Capital (WACC) as the discount rate, Ye and Tiong (2000) calculate WACC using cash flow calculated before taxes, while Brealey and Myers (2000) in Andreas Wibowo (2006), WACC is the average weighted average cost of debt and cost of equity after calculating the reduction in cost of debt due to interest tax shield. The results of the calculation of the discount rate for the Pekanbaru-Dumai toll road are shown in Table 1 below:

**Table 1**
Calculation of the Discount Rate for the Pekanbaru-Dumai Toll Road

| Indikator | Nilai | Keterangan | Sumber |
|---|---|---|---|
| *Risk free rate* ($r_f$) | 5,07% | SBI (3 bulanan) (nilai *mean*) | Bank Indonesia (2016-2020) |
| *Risk premium* ($r_p$) | 6,70% | Selisih antara ekspektasi pengembalian pasar dengan *risk free rate* ( $r_m - r_f$ ) | Wibowo dan Kochendorfer (2005) |
| *Beta Equity* ($\beta_e$) | 0,99 | Sensitivitas pengembalian atas investasi *equity* terhadap pengembalian pasar | Wibowo (2006) |
| *Beta Debt* ($\beta_d$) | 0,43 | Sensitivitas pengembalian atas investasi pinjaman terhadap pengembalian pasar | Wibowo dan Kochendorfer (2005) |
| *Cost of Equity* ($r_e$) | 11,70% | $r_e = r_f + \beta_e ( r_m - r_f )$ | Hasil perhitungan |
| *Cost of Debt* ($r_d$) | 7,95% | $r_d = r_f + \beta_d ( r_m - r_f )$ | Hasil perhitungan |
| *Tax* | 25% | Pajak Penghasilan (PPh) | Undang – Undang |
| *weighted average cost of capital (WACC)* | 9,41% | $WACC = (1 - tax) \ r_d \frac{D}{D+E} + r_e \frac{E}{D+E}$ | Hasil perhitungan |
| *Interest During Construction (IDC)* | 9,69% | *JIBOR + 300 Poin* | Hasil Perhitungan |



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The modeling of financial variables that will be used as input in the simulation using @Risk software uses the normal probability distribution function and log normal, as shown in Table 2 below:

**Table 2**
Distribution Function of Financial Variable Probability Toll Road Pekanbaru-Dumai

| Variabel Finansial | Fungsi Distribusi Probabilitas( PDF ) | Parameter Statistik | Keterangan ( Sumber Data ) |
|---|---|---|---|
| Inflasi Riau (%) | Normal (*empiris*) | μ = 3,92 %<br>σ = 1,36 % | Bank Indonesia (Jan 2016 – Mei 202 ) |
| Sertifikat Bank Indonesia (SBI) | Normal (*empiris*) | μ = 5,07 %<br>σ = 0,59 % | Bank Indonesia (Jan 2016 – Mei 2020) |
| JIBOR / INDONIA | Normal (empiris) | μ = 6,69 %<br>σ = 0,97 % | Bank Indonesia (Jan 2016 – Mei 2020) |
| Volume Lalu Lintas Awal Operasi (Golongan I, II, III, IV, dan V) | Lognormal (*subjectif*) | μ :<br>Gol I = 5.100 kend / hari<br>Gol II = 1.242 kend / hari<br>Gol III = 532 kend / hari<br>Gol IV = 65 kend / hari<br>Gol V = 45kend / hari<br>COV = σ / μ = 10 % | *Mean* (μ) dari BPJT<br>COV, asumsi subyektif dari praktisi |
| Biaya Operasi dan Pemeliharaan | Lognormal (*subjectif*) | μ= 20 % dari pendapatan kotor per tahun ( % ) | Wibowo (2005a) |
| Biaya Pengadaan Lahan | Lognormal (*subjectif*) | μ = Rp. 449.255.218.692<br>COV = σ / μ = 20 % | Mean (μ) dari PUPR<br>COV, asumsi subyektif |
| Biaya Perencanaan (Amdal dan DED) | Lognormal (*subjectif*) | μ = Rp. 55.995.789.998<br>COV = σ / μ = 5 % | Mean (μ) dari PT. HK<br>COV, asumsi subyektif |
| Biaya konstruksi (tahun ke–1, tahun ke–2, tahun ke–3, tahun ke–4, dan tahun ke-5) | Lognormal (*subjectif*) | μ= Rp. 12.451.583.469.842<br>COV = σ / μ = 10 % | Mean (μ) dari PT. HK<br>COV, asumsi subyektif dari praktisi |

Researcher Process, 2020

The sensitivity analysis of the Pekanbaru – Dumai toll road section in this study was carried out on low risk traffic with a concession period of 40 years, showing the results that there are 5 (five) input variables that are the most sensitive (influential) according to the level of steepness of the line, namely: (1) Bank Certificates Indonesia, (2) Initial tariff plan, (3) Category I traffic volume, (4) 4th year construction, (5) Riau Province inflation, as shown in Figure 4 below:

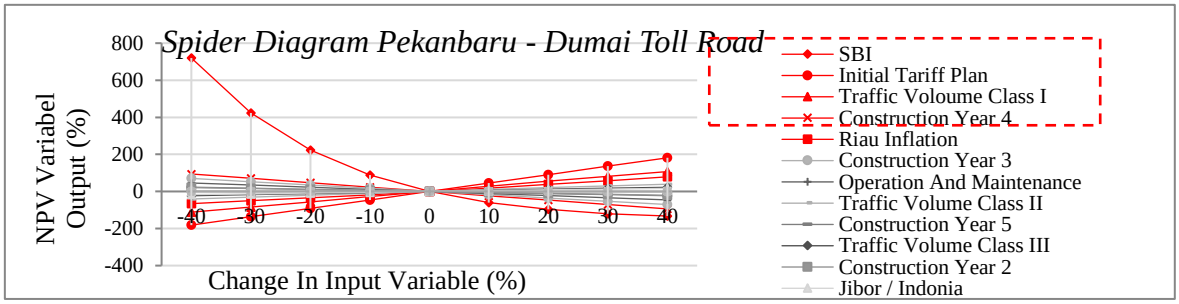


**Fig 4.** Base Case Spider Diagram, Pekanbaru – Dumai Toll Road Section Concession Period 40 Years Low Risk Traffic
Source: Researcher Process, 2020

The simulation results in this study provide 4 (four) alternative scenarios for calculating the financial feasibility of low-risk traffic through a stochastic approach to the Pekanbaru-Dumai Toll Road, as shown in Table 3 below:



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**Table 3**
Calculation Results of Low Risk Traffic Financial FeasibilityThrough the Stochastic Approach of the Pekanbaru-Dumai Toll Road

| Low Risk Traffic Financial Eligibility Calculation Results Through the Stochastic Approach of the Pekanbaru-Dumai Toll Road | | | | |
|---|---|---|---|---|
| Parameter Statistik | *Alternative 1* *Base Case* 30 Tahun (Rp. Juta) | *Alternative 2* *Base Case* 40 Tahun (Rp. Juta) | Alternative 3 PMN 13% 30 Tahun (Rp. Juta) | Alternative 4 PMN 13% 40 Tahun (Rp. Juta) |
| *Minimum* | (544.254,45) | (160.780,99) | (405.342,88) | (66.585,81) |
| *Maximum* | 420.152,27 | 1.114.308,93 | 836.178,54 | 1.218.854,32 |
| *Mean* | (182.232,03) | 97.929,38 | (50.429,13) | 153.573,12 |
| *Std Dev* | 107.825,51 | 115.846,66 | 112.159,93 | 122.736,30 |
| *Left X* | (344.805,73) | (39.303,01) | (207.591,14) | 7.646,08 |
| *Left P* | 5% | 5% | 5% | 5% |
| *Right X* | 6.429,42 | 309.694,73 | 151.464,81 | 387.519,06 |
| *Right P* | 95% | 95% | 95% | 95% |

Source: Researcher Process, 2020

The sensitivity analysis of the Pekanbaru – Dumai toll road section in this study was carried out on low risk traffic with a concession period of 40 years, showing the results that there are 5 (five) input variables that are the most sensitive (influential) according to the level of steepness of the line, namely: (1) Bank Certificates Indonesia, (2) Initial tariff plan, (3) Category I traffic volume, (4) 4th year construction, (5) Riau Province inflation, as shown in Figure 4 below:

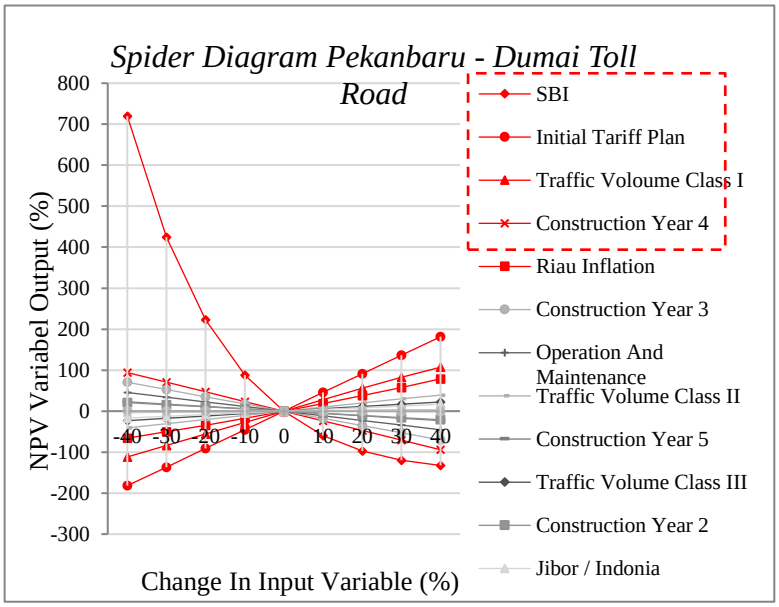


**Fig 5**. Base Case Spider Diagram
Pekanbaru – Dumai Toll Road Section
Concession Period 40 Years Low Risk Traffic
Source: Researcher Process, 2020

The simulation results in this study provide 4 (four) alternative scenarios for calculating the financial feasibility of low-risk traffic through a stochastic approach to the Pekanbaru-Dumai Toll Road, as shown in Table 3 below:



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**Table 4**
Calculation Results of Low Risk Traffic Financial Eligibility
Through the Stochastic Approach of the Pekanbaru-Dumai Toll Road

| Low Risk Traffic Financial Eligibility Calculation Results Through the Stochastic Approach of the Pekanbaru-Dumai Toll Road | | | | |
|---|---|---|---|---|
| Parameter Statistik | *Alternative 1* *Base Case* 30 Tahun (Rp. Juta) | *Alternative 2* *Base Case* 40 Tahun (Rp. Juta) | Alternative 3 PMN 13% 30 Tahun (Rp. Juta) | Alternative 4 PMN 13% 40 Tahun (Rp. Juta) |
| *Minimum* | (544.254,45) | (160.780,99) | (405.342,88) | (66.585,81) |
| *Maximum* | 420.152,27 | 1.114.308,93 | 836.178,54 | 1.218.854,32 |
| *Mean* | (182.232,03) | 97.929,38 | (50.429,13) | 153.573,12 |
| *Std Dev* | 107.825,51 | 115.846,66 | 112.159,93 | 122.736,30 |
| *Left X* | (344.805,73) | (39.303,01) | (207.591,14) | 7.646,08 |
| *Left P* | 5% | 5% | 5% | 5% |
| *Right X* | 6.429,42 | 309.694,73 | 151.464,81 | 387.519,06 |
| *Right P* | 95% | 95% | 95% | 95% |

Source: Researcher Process, 2020

The results of the calculation of the financial feasibility of the Pekanbaru-Dumai toll road alternative 4, namely: With the State Capital Participation (PMN) of 13% of construction costs and a concession period of 40 years at low traffic risk, the Pekanbaru-Dumai toll road segment is the most feasible alternative choice, shown as Table 4 as follows:

**Table 5**
Statistical Parameters of NPV PMN 13% Concession Period 40 Years
Low Risk Traffic Toll Road Pekanbaru – Dumai

| NPV PMN 13% Concession Period 40 Years Low Risk Traffic Pekanbaru - Dumai Toll Road (Rp. Million) | | | |
|---|---|---|---|
| *Statistics* | | *Percentile* | |
| *Minimum* | (66.585,81) | 5% | 7.646,08 |
| *Maximum* | 1.218.854,32 | 10% | 26.480,77 |
| *Mean* | 153.573,12 | 15% | 41.284,62 |
| *Std Dev* | 122.736,30 | 20% | 54.892,18 |
| *Variance* | 15064198344 | 25% | 67.348,65 |
| *Skewness* | 1,52353139 | 30% | 78.936,94 |
| *Kurtosis* | 7,090062503 | 35% | 91.091,32 |
| *Median* | 127.949,21 | 40% | 103.024,86 |
| *Mode* | 99.682,87 | 45% | 115.837,84 |
| *Left X* | 7.646,08 | 50% | 127.949,21 |
| *Left P* | 5% | 55% | 140.423,67 |
| *Right X* | 387.519,06 | 60% | 155.536,97 |
| *Right P* | 95% | 65% | 172.864,15 |
| *Diff X* | 379.872,97 | 70% | 191.476,70 |
| *Diff P* | 90% | 75% | 212.364,34 |
| *#Errors* | 0 | 80% | 236.913,62 |
| *Filter Min* | *Off* | 85% | 266.127,53 |
| *Filter Max* | *Off* | 90% | 309.966,65 |
| *`#Filtered* | 0 | 95% | 387.519,06 |

Source: Researcher Process, 2020



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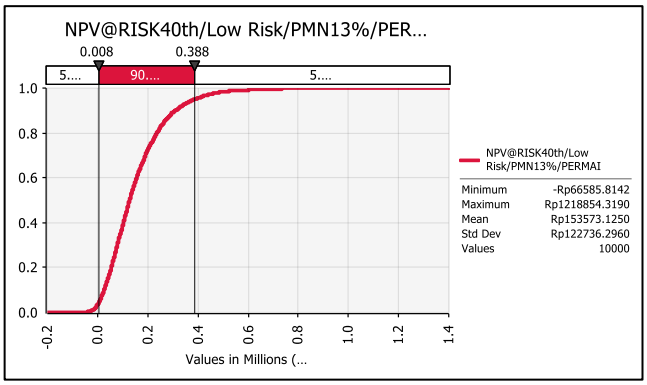


**Fig 6.** CDF Curve, PMN 13% Low Risk 40th Concession Period
Source: Researcher Process, 2020

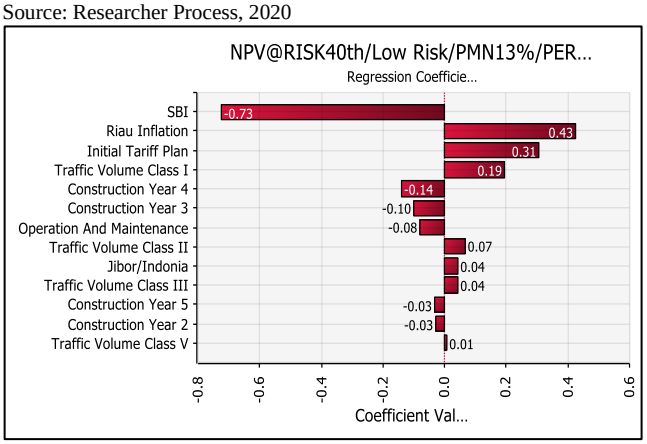


**Fig 7**. PMN Regression 13% Low Risk Traffic 40th . Concession Period
Source: Researcher Process, 2020

The development of the results of the NPV calculation through a stochastic approach to low-risk traffic with a PMN of 13% during the 40-year concession period of investment for the Pekanbaru-Dumai toll road section can be shown as Figure 6 below:

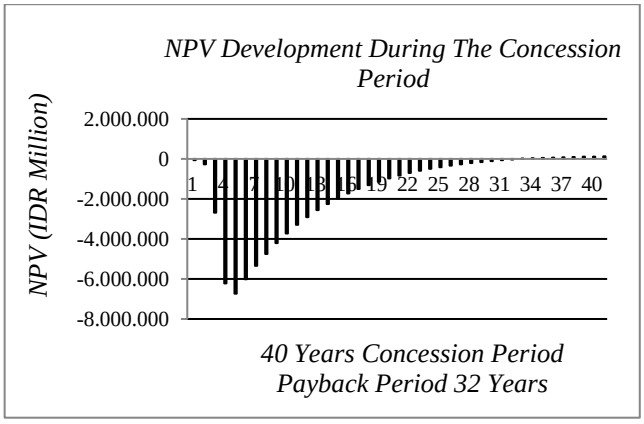


**Fig 8.** Low Risk Traffic NPV Development PMN 13% Concession Period 40 Years
Source: Researcher Process, 20204.



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## 4. Conclusions

a. Results of stochastic analysis of Net Present Value (NPV) of low risk traffic with WACC as the discount rate in base case conditions (concession period 40 years, initial tariff for Group I vehicles Rp. 900 per km, traffic growth 7%, traffic volume 6,984 vehicles per day, and land acquisition is fully implemented by the government) , showing the results of the Net Present Value (NPV) as follows:
Minimum Value = IDR (160.780.990.000)
Mean Value = IDR 97,929,380,000
Maximum Value = IDR 1,114,308,930,000
Left X = Rp (39,303,010,000)
Left P = 5%
Right X = IDR 309,694,730,000
Right P = 95%
Based on the statistical parameters of the calculation of the Net Present Value (NPV) in the base case conditions mentioned above, it is confirmed that the Pekanbaru-Dumai toll road is financially feasible but still has a probability of loss of Rp. (39,303,010,000).

b. Based on the results of the sensitivity analysis using the stochastic method, there are 5 (five) financial variables that are very influential (sensitive) on the financial feasibility of investing in the Pekanbaru - Dumai toll road infrastructure development project, namely; (1) Bank Indonesia Certificate (SBI), (2) Riau Province Inflation, (3) Planned Initial Tariff for Category I vehicles, (4) Category I traffic volume, (5) construction costs in the 4th year.

c. Alternative financial feasibility of the Pekanbaru-Dumai toll road infrastructure project through a stochastic approach with feasibility support from the government in the form of State Capital Participation (PMN) of 13% of construction costs with a concession period of 40 years on low-risk traffic obtaining Net Present Value (NPV) with the following statistical parameters:
Minimum Value = IDR (66,585.810,000)
Mean Value = IDR 153.573.12 million
Maximum Value = IDR 1,218,854,320,000
Left X = Rp (7,646.080,000)
Left P = 5%
Right X = IDR 387,519,060,000
Right P = 95%
These results confirm that the Pekanbaru – Dumai toll road infrastructure project investment is financially feasible with a 95% confidence level.

## 5. References

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