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Research Paper

A Cost Benefit Analysis (CBA) Implementation in Waingapu – Melolo National Road Reconstruction Project – Indonesia

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ABSTRACT : *The Waingapu – Melolo national road section in East Sumba Regency plays a strategic role in supporting regional connectivity and local economic activities. Unfortunately, its geometrical and road pavement condition which has not able to meet the standards of national road and having repeated damage requires appropriate and efficient reconstruction. This study has a purpose to evaluate the economic feasibility of the Waingapu – Melolo section reconstruction project by applying Cost Benefit Analysis (CBA) method to determine the best road pavement alternative based on the economic workperformance and sensitivity analysis. Three pavement alternatives analyzed in this study were:* (a) *Laston AC-WC* (Asphalt Concrete-Wearing Coures), (b) *Laston Asbuton* (Asbuton AC-WC incorporates Buton Asphalt) and (c) *Laston HRS-WC* (Hot Rolled Sheet-Wearing Course).

Analysis was conducted by calculating components of investment and maintainance costs as well as benefits in the form of cost savings in the Vehicle Operating Cost (VOC) and Value of Travel Time (VoT) over a 15 – 20 year analysis period. Data used include the road condition surveys, traffic surveys, construction cost data and traffic growth projection. While the feasibility evaluation was conducted using the Net Present Value (NPV) and Benefit Cost Ratio (BCR) value indicators with a discount rate of 5.27 %.

The result of the study revealed all alternatives produce negative NPV and BCR values <1 under baseline condition and make them economically unfeasible. However, Laston HRS-WC alternative has the best economic workperformance with an NPV reached closest value to zero and has the highest BCR value. Result of the sensitivity analysis indicate the project feasibility most influenced by changes in costs. For a 25 % cost reduction scenario, the HRS-WC alternative becomes economically feasible with a BCR value of 1.057 and a positive NPV of Rp. 482.342.183,34. This study comes into conclusion that although the project is not yet feasible under baseline condition, the HRS-WC alternative is the most efficient and potentially feasible option when significant cost controls are implemented.

KEYWORDS: *Cost benefit analysis, value of time, vehicle operating cost, road reconstruction, sensitivity analysis.*

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I. INTRODUCTION

A Cost Benefit Analysis or CBA method is used to assess economic feasibility of a project by taking several considerations such as investment cost, operational cost, and maintenance cost, as well as benefits in aspects of vehicle operational cost savings, travel time savings (value of time/VoT) and reduced accident costs for 15-20 years analysis period time. The previous studies related to this matter generally focused on road projects in urban areas, and there are rarely studies on national road reconstruction in island regions with heavy traffic and repeated damage to their roads. Therefore, this study is expected to give significant contribution through a feasibility analysis based on field data and current costs to determine the best pavement alternatives for the Waingapu-Melolo section.

Several previous studies have applied the Cost Benefit Analysis (CBA) method to road infrastructure projects. As found from Zuhdi with CBA used for assessing the financial feasibility of constructing a flyover road for the reason of increased traffic volumes that cause road congestion while Qodar analyzed the economic feasibility of constructing a duplication of Kapuas I Bridge in Pontianak through a financial analysis on its Vehicle

Operating Costs (VOC). In line with these studies, Dwilarasati used CBA method to assess the financial feasibility and benefits of a coal haul road concreting plan at Banko Tengah Block B location of PT. Bukit Asam Tbk., by comparing the existing road condition to the planned coal haul road construction project using concreting method. [1,2,3]

According to the described background study postulates research questions of: (1) How is the Cost Benefit Analysis application to the Waingapu–Melolo road reconstruction? and (2) How is the sensitivity analysis of costs, traffic growth, Vehicle Operating Cost (VOC)/Value of Time (VoT)?

II. LITERATURE REVIEW

2.1. The Concept of Cost Benefit Analysis (CBA)

2.2.1. Definition of Cost Benefit Analysis (CBA)

A Cost Benefit Analysis (CBA) is an economic analysis method used to assess the feasibility of a project by making a comparison between total benefit gained with total costs incurred. The basic principle of CBA is a project is considered feasible if the benefits are greater or at least equal to the costs incurred. [4]

2.2.2. Components of Cost

Within a context of road infrastructure projects, the costs analyzed in CBA usually divided into two main categories of initial investment cost (Capital Expenditure/CAPEX) and operating maintenance cost (Operational Expenditure/OPEX).

1. The Capital Expenditure (CAPEX)

This cost covers all expenses required to construct or reconstruct road to the point it is read for use. CAPEX is usually a one-time expense process done at the beginning of a project with relatively large in size.

The road construction costs are include study and planning costs of initial surveys, feasibility studies, engineering design and permit administration; along with construction costs include earthworks, foundation layer construction, asphalt or concrete coating, drainage construction, road shoulders, and road equipment such as signs, markings, and guardrails; while land acquisition costs are required for widening or making new road construction projects which include land compensation and utility relocation costs; the project supervision costs are include supervisory consultant services, project management, and quality monitoring; and contingency costs are costs that generally around 5-10% of total construction costs for anticipating any design changes, material price fluctuation and unforeseen technical risks.

In other words, CAPEX is the cost of providing new road asset or for improving old asset to make these assets to be more reliable and functional.

2. The Operational Expenditure (OPEX)

Once a road is built and get operated, recurring costs are required to maintain service quality of this road. OPEX (Operating Expenses) are the recurring expenses throughout the design life of a road where its components are listed in the following explanation:

Road maintenance costs cosist of: (a) routine maintenance cost in forms of small, repetitive tasks such as pothole patching, road shoulder repair, road marking painting, drainage maintenance, and traffic sign maintenance, (b) periodic maintenance costs which carried out at certain intervals of time for example every five (5) to seven (7) years including overlays (asphalt resurfacing), rehabilitation of certain layers, and light structural repairs, (c) traffic operation costs include managing traffic flow during the work through provision of a traffic management system, temporary signs, and traffic control personnel, (d) labor and equipment costs for field maintenance teams, equipment operators, and the use of road repair machinery; (e) administrative and management costs that support the management of maintenance, reporting and technical audit programs.

OPEX becomes crucial part in Cost Benefit Analysis despite its smaller value when compared to CAPEX because it is recurring and occurs thoughout the road’s design life. When this cost not properly calculated, then a road project can experience a more rapid decline than planned.

3. The Importance of CAPEX and OPEX Separation

For an economic analysis of a road project, CAPEX describes the amount of initial investment must be made by the government or infrastructure provider. Initial investment (CAPEX) for tangible cost convering physical construction costs as include mobilization and SMKK costs, drainage work cost, earthwork cost, granular pavement work cost, asphalt work costs and daily work costs. Meanwhile the intangible costs include technical planning cost, supervision cost, and unforeseen cost. The Operational Cost (OPEX) reflects the ongoing costs must be provided to ensure the road’s planned lifespan can be achieved. These components are then accumulated by considering values that required to obtain the total cost within the analysis period.

OPEX becomes crucial in Cost Benefit Analysis although its value is smaller than CAPEX, it is recurring and occurs throughout the road's design life. If not properly calculated, a road project can experience a more rapid decline than planned.

III. RESEARCH METHOD

3.1. Type of Research Data

This study is using primary and secondary data, where the primary data includes of result from road condition survey to determine the type severity, and extent of road pavement damage as well as the existing traffic data in the form of Average Daily Traffic (ADR) and vehicle composition (motorcycle, light vehicles, buses, light trucks, and heavy trucks) which are used to describe condition of road service, capacity, and technical needs of the reconstruction. For the secondary data in this study, it was obtained from relevant agencies such as BPJN of East Nusa Tenggara, BPS, local police, and Bina Marga technical documents which include road geometric data, historical traffic data and traffic growth projections, construction cost data (AC-WC, AC – WC Asbuton, and HRS – WC), vehicle operating costs (*Biaya Operasi Kendaraan/*BOK) and traffic accident data. In addition, references to regulation and technical guidelines also included such as regulation Number 13 of 2024 from Minister of PUPR, and the road pavement guidelines from Directorate General of Bina Marga. [5]

3.2. Research Variables

3.2.1. Cost Variable

Cost variables which put into calculation in a Cost Benefit Analysis (CBA) include all expenditures over the life of the project during the construction and the post-operational phases. Cost components in this section are included:

1. Initial Investment Cost is all costs incurred during project implementation phase, including preparatory work, earthworks, paving, drainage, road equipment and general implementation costs. These costs are usually obtained from Cost Budget Plan (*Rencana Anggaran Biaya/RAB)* or work contract documents.
2. Routine Maintenance Cost is costs incurred annually to maintain the road in good working condition. These costs are included drainage cleaning, minor patching, painting markings and other minor repairs.
3. Periodic Maintenance Cost is cost incurred periodically, such as in every five (5) to ten (10) years to repair light or medium structural damage to the road pavement so the service life of that road can be maintained according to plan.

3.2.2. Benefit Variable

The benefit can be earned from a road project is calculated as direct benefits enjoyed by road users. Details of benefit components are included:

1. Cost saving on the Vehicle Operational Costs (*Biaya Operasional Kendaraan/BOK)* has benefits in the form of reduced costs for fuel, lubricants, tires and vehicle maintenance due to improved road surface conditions.
2. Cost saving on Travel Time Value as calculated based on the reduction in vehicle travel time after the project is implemented. The travel time value reflects the economic value of the time saved by road users.

3.3. Investment Feasibility Assessment Parameter

In the application of Cost Benefit Analysis or CBA. The investment feasibility will be assessed by using several economic indicators of: (a) Net Present Value (NPV), (b) Benefit Cost Ratio (BCR), (c) Internal Rate of Return (IRR), and (d) Payback Period (PP).

1. Net Present Value (NPV) is a method for assessing the feasibility of a project by calculating difference between present value of total benefits and total costs of the project. This concept works with consideration that money today is more valuable than money in the future due to inflation risk and lost opportunities.

$$NPV = \sum_{t=1}^{n} \frac{Bt - Ct}{(1+i)^t} \quad (1)$$

2. Benefit Cost Ratio (BCR) is a feasibility indicator used to compare the Present Value of Benefits with Present Value of Costs. The BCR value indicates how many times the benefits are obtained for each unit of cost incurred. If the BCR value is greater than 1, then the project is considered economically feasible because the benefits are greater than the costs. In converse, if the value is less than 1, then the project is not feasible to be proceed.

$$NPV = \frac{\sum_{t=1}^{n} \frac{Bt}{(1+i)^t}}{\sum_{t=1}^{n} \frac{Ct}{(1+i)^t}} \quad (2)$$

3. Internal Rate of Return (IRR) is the return rate on a project where the NPV is equal to zero (NPV = 0). IRR value indicates how efficient a project able to generate profits. If the value of IRR higher than the value of discount rate, then the project is feasible; if the value is lower, then the project is not feasible to be proceed.

$$NPV = \sum_{t=1}^{n} \frac{Bt-Ct}{(1+IRR)^t} \quad (3)$$

4. Payback Period (PP) is the required time for the benefits or the revenues from a project to fulfill or cover the initial investment costs. The quicker the time for return on investment, the more viable the project, especially when quaranteed repayment is becomes one of the requirements.

3.4. Analysis of Feasibility Sensitivity

A feasibility sensitive analysis is conducted to assess the extent to which uncertainty in the implementation of a road reconstruction project can impact the impact the result of the economic evaluation. The primary objective of this analysis is determining the impact of changes in key factors on feasibility parameters such as Net Present Value (NPV), Benefit Cost Ratio (BCR), Internal Rate of Return (IRR), and Payback Period (PP).

There are several aspects focused on the sensitivity analysis include:

1. Variations in investment and operational costs (CAPEX and OPEX) which may increase or decrease when compared to the initial assumptions;
2. Changes in traffic volume or traffic growth as a representation of fluctuations in demand for road use;
3. Value of Time (VOT);
4. Vehicle Operating Cost (VOC)

Uncertainty aspect for these variables can arise from differences when assuming material price, exchange rate fluctuation, changes in traffic volume due to regional economic developments, or delays in project implementation. Through sensitivity analysis, assessment on the extent of project tolerance on changes in these parameters can be conducted.

A sensitivity analysis of Waingapu-Melolo road reconstruction project plan is important to do for anticipating uncertainty in construction and maintenance cost estimation, variations in traffic projections over 15-20-year analysis period, and any changes in utility values such as VOT and VOC. Thus, sensitivity analysis results provide not only an overview of the project's basic economic feasibility but also level of robustness of the investment decisions to changing conditions in the future.

IV. RESULT AND DISCUSSION

4.1. Cost Benefit Analysis (CBA)

4.1.1. Capital Expenditure/CAPEX

In this study, the investment costs used are the costs of road construction work, supporting work and other costs which have direct relationship to the project implementation. The investment costs are put in groups into tangible cost group consisting of construction cost and supporting work cost, and tangible cost group for type of costs which cannot be measured directly. All investment costs are assumed to occur in the initial years of the analysis and calculated based on estimation from planning documents and available technical data. The construction cost calculations are carried out for three alternative types of road pavements: (a) *Laston AC-WC* (Asphalt Concrete-Wearing Coures), (b) *Laston Asbuton* (Asbuton AC-WC incorporates Buton Asphalt) and (c) *Laston HRS-WC* (Hot Rolled Sheet-Wearing Course) each of which has different material characteristics and implementation method which later resulting different costs. The calculation results showed the Asbuton pavement has the most expensive/highest construction cost (Rp. 11,328,490,000), followed by AC-WC pavement (Rp. 10,892,780,000) and the least expensive or lowest construction cost is HRS-WC pavement (Rp.7,543,972,000). These values difference become the basis for arranging investment costs (CAPEX) for the Cost Benefit Analysis (CBA).

Details of investment costs for the road reconstruction project within the research setion are presented in the following table (Table 1) which then is used as input in calculating the present value of costs in the economic feasibility analysis.

Table 1. CAPEX value of Waingapu – Melolo road reconstruction

No.	Description	Cost Amount (Rp.)		
		Alternative 1 Laston Lapis Aus AC-WC	**Alternative 2 Laston Lapis Aus Asbuton**	**Alternative 3 Laston Lapis Aus HRS-WC**
		(Rp.)	**(Rp.)**	**(Rp.)**
A.	**CAPEX Tangible Asset**			
1	Mobilization and SMKK costs	333.431.273,00	333.431.273,00	333.431.273,00
2	Drainage cleaning cost	1.010.737.141,00	1.010.737.141,00	1.010.737.141,00
3	Geosynthetic and earthwork costs	927.579.683,00	927.579.683,00	927.579.683,00
4	Granuler pavement work and concrete pavement work costs	2.243.657.685,00	2.243.657.685,00	2.243.657.685,00
5	Asphalt pavement cost	5.176.383.957,00	5.568.916.110,00	2.159.440.165,00
6	Miscellaneous and daily work costs	121.525.590,00	121.525.590,00	121.525.590,00
(a)	Total Work Costs	9.813.315.329,00	10.205.847.482,00	6.796.371.537,00
(b)	Value Added Tax (PPN) = 11%*A	1.079.464.686,19	1.122.643.223,02	747.600.869,07
(c)	Total Work Costs (A+B)	10.892.780.015,19	11.328.490.705,02	7.543.972.406,07
Total of tangible cost		**10.892.780.000,00**	**11.328.490.000,00**	**7.543.972.000,00**
B.	**CAPEX Intangible Asset**			
1	Technical planning cost	163.391.700,00	169.927.350,00	113.159.580,00
2	Supervising cost	217.855.600,00	226.569.800,00	150.879.440,00
3	Miscellaneous cost	1.089.278.000,00	1.089.278.000,00	754.397.200,00
Total of intangible cost		**1.470.525.300,00**	**1.529.346.150,00**	**1.018.436.220,00**
C.	**Total CAPEX**	**12.363.305.300,00**	**12.857.836.150,00**	**8.562.408.220,00**

4.1.2. Operational Expenditure

Estimation of road maintenance cost in this study was prepared to support the Operating and Maintenance Cost (OPEX) cost analysis over the life of the project. Maintenance cost itself is divided into routine maintenance cost which performed annually and periodic maintenance cost which performed every five years.

Routine maintenance cost in this study is assumed to be the same for all road pavement alternatives (including plant control activities in road space and cleaning the drainage system), so this cost is not affected by type of road pavements used in the study.

Meanwhile, the periodic maintenance cost is set differently for each pavement alternative (Laston AC-WC, Laston Asbuton, and Laston HRS-WC) according to the material characteristics and its handling needs. Details of the estimated price from routine and periodic maintenance work are listed in the following table (Table 2).

After performing the calculation of annual routine maintenance cost and five-year periodic maintenance cost, all cost components are then summarized into one maintenance cost table (Operational Expenditure/OPEX).

The annual routine maintenance cost in this study was calculated by putting the inflation factor into consideration where the basic routine maintenance cost was multiplied by average inflation rate of East Sumba Regency (2.6 % per year based on data of 2020-2024 period from Central Statistics Agency of East Sumba Regency. Application of this inflation rate to this study aims to represent the possibility of changes in prices of equipment, materials, and wages from year to year, to make the obtained OPEX value reflects a more realistic maintenance cost condition over the analysis period.

Table 2. OPEX for Waingapu – Melolo Road reconstruction project

Year		Cost Maintenance		Total of Maintenance Planning Year
		Routine (Rp.)	Periodic (Rp.)	(Rp.)
0	2025			
1	2026	116.346.000,00		116.346.000,00
2	2027	119.487.342,00		119.487.342,00
3	2028	122.713.500,23		122.713.500,23
4	2029	126.026.764,74		126.026.764,74
5	2030	129.429.487,39	282.205.000,00	411.634.487,39
6	2031	132.924.083,55		132.924.083,55
7	2032	136.513.033,80		136.513.033,80
8	2033	140.198.885,72		140.198.885,72
9	2034	143.984.255,63		143.984.255,63
10	2035	147.871.830,53	344.233.000,00	492.104.830,53
11	2036	151.864.369,96		151.864.369,96
12	2037	155.964.707,95		155.964.707,95
13	2038	160.175.755,06		160.175.755,06
14	2039	164.500.500,45		164.500.500,45
15	2040	168.942.013,96	428.807.000,00	597.749.013,96
16	2041	173.503.448,34		173.503.448,34
17	2042	178.188.041,44		178.188.041,44
18	2043	182.999.118,56		182.999.118,56
19	2044	187.940.094,76		187.940.094,76
20	2045	193.014.477,32	364.862.000,00	557.876.477,32

4.1.3. The Benefit Analysis

In this study, the economic benefit analysis began with calculation of Vehicle Operating Cost (VOC) to identify magnitude of travel cost savings because of the improved road conditions which are then be used as a benefit component in CBA analysis with calculation refers to the Pre-Feasibility Study Guidelines for Road and Bridge Project Pd T – 15 – 2005 – B.

Calculation of Vehicle Operating Cost (VOC) carried out under two traffic conditions: normal existing condition and existing condition with the activities of PT. Muria Sumba Manis (PT. MSM). The normal existing condition represents the traffic flow without influence operational activities of PT. MSM while the PT.MSM existing condition reflects additional vehicle movements due to the company activities.

Calculation of VOC motorcycle value in this study was carried out by referring to previous research conducted by Chairul Mubin, who calculated motorcycle operating cost using an approach and parameters adapted to the method in the PU guidelines, where in this study the component of motorcycle maintenance labor wages was not explicitly calculated referring to limitation of the method in previous research and was considered not to have a significant impact on the results of the overall economic benefit analysis.

In addition, economic benefit analysis also includes calculation of savings in travel time (Value of Time/VOT) for road users as a further benefit variable that represents travel time efficiency because of improved road section workperformance. [6]

4.2. Sensitivity Analysis

Sensitivity analysis is conducted to test sensitivity of economic feasibility result to changes in key parameters that influence the calculation of project benefits and costs. This analysis aims to determine extent to which changes in assumption that able to affect values of economic feasibility indicators, in particular for Net Present Value (NPV) and Benefit Cost Ratio (BCR) indicators, also to identify conditions with potentiality able to improve the project's economic feasibility.

Table 3. Sensitivity analysis for economic feasibility of Waingapu – Melolo Road reconstruction

No	Changes	BCR			NPV		
		Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 2	Alternative 3
1	Baseline	0.603	0.584	0.810	5.901.535.926,21	6.396.066.776,21	2.100.638.846,21
2	Scenario 1: (CAPEX & OPEX ↑ 25%)	0.488	0.472	0.657	9.433.740.225,75	10.051.903.788,25	4.682.618.875,75
3	Scenario 2: (CAPEX & OPEX ↓ 25%)	0.791	0.726	1.057	2.369.331.626,66	3.383.121.571,66	482.342.183,34
4	Scenario 3: Traffic Growth ↑ 25%	0.635	0.615	0.615	5.426.808.767,61	5.921.339.617,61	1.625.911.687,61
5	Scenario 4: Traffic Growth 110%	0.858	0.830	1.002	2.115.815.220,39	2.610.346.070,39	17.540.193,97
6	Scenario 5: Discount Rate ↓ 25%	0.670	0.649	0.892	5.031.998.986,04	5.526.529.836,04	1.231.101.906,04

Table 3 is showing result of sensitivy analysis conducted in this study where the interpretation is stated in the following explanation.

Baseline : All alternatives are not economically feasible (BCR<1 and NPV<0). Alternative 3 has the best workperformance in relative term.

Scenario 1 : Increased costs significantly reduce the feasibility of all alternatives. All alternative is far from fulfilling requirement to being feasible.

Scenario 2 : Alternative 3 becomes economically feasible (BCR>1 and NPV>0) meanwhile alternatives 1 and 2 are still not feasible.

Scenario 3 : Increased traffic is not enough to significantly boost the economy. All alternatives remain unfeasible.

Scenario 4 : Alternative 3 is economically feasible, with a BCR value of 1.0002 and a positive NPV of Rp. 17.540.193, 97, making it economically feasible. However, the BCR value which is very close to 1 and the relatively small NPV, indicate that the feasibility of alternative 3 is at a marginal level. Alternative 3 can be considered for implementation, provided there is certainty of long-term traffic growth and strict cost controls. Lowering the discount rate increases the economic value, but not enough to make the alternative viable. Alternative 3 is still the most visible option to choose from all scenarios.

Scenario 5 : Lowering the discount rate increases the economic value, but not enough to make the alternative viable. Alternative 3 remains the best.

Based on sensitivity analysis result to many changes at the main assumptions, a general conclution revealed all treatment alternatives not yet feasible from economic perspective in the baseline condition, as indicated by BCR value < 1 and NPV value < 0. However, alternative 3 consistently showed best economic workperformance when compared to alternative 1 and alternative 2 in all scenarios analyzed.

Changes in components of cost bring the most significant impact on project feasibility. For 25 % cost increase in CAPEX and OPEX scenario, all alternatives experience significant decline in feasibility condition with no scenario able to approach the feasibility level. Conversely, when 25 % cost decrease applied into scenario, alternative 3 becomes economically feasible with a BCR value of 1.057 and a positive NPV value of Rp.482.342.183,34 while alternative 1 and alternative 2 remain unfeasible.

Table 4. A Comparison of baseline condition with sensitivity condition of BCR>1, scenario CAPEX & OPEX ↓ 25%

Description	Alternatif 3 Lataston Lapis Aus HRS-WC Baseline	Alternatif 3 Lataston Lapis Aus HRS-WC ↓ 25%
CAPEX tangible cost	7.543.972.000,00	5.657.979.000,00
CAPEX intangible cost	1.018.436.220,00	763.827.165,00
Total	8.562.408.220,00	6.421.806.165,00

Table 4 is showing a comparison of Average Annual Daily Traffic/ADR (*Lalu Lintas Harian Rata-Rata Tahunan/LHRT)* projection between the baseline condition and a scenario that applied 110 % traffic growth during the analysis period.

In a baseline condition, ADR/LHRT increases gradually following the assumption of normal traffic growth. While in a scenario with 110 % growth, ADR/LHRT shows much more significant increase each year of the analysis with traffic volume at the end of the period reaching approximately 2.1 times from the initial level.

Therefore, this scenario is used as a threshold to identify the minimum traffic volume level for the project to approach viable economic condition.

Table 5. A comparison of baseline condition with sensitivity condition of BCR>1, scenario of 110 % traffic growth

Year	Year -	ADR/LHRT Projection	
		Baseline	Up 110%
2025	0	4513	4513
2026	1	4671	4845
2027	2	4834	5201
2028	3	5004	5583
2029	4	5179	5993
2030	5	5360	6434
2031	6	5548	6907
2032	7	5742	7414
2033	8	5943	7959
2034	9	6151	8544
2035	10	6366	9172
2036	11	6589	9846
2037	12	6819	10570
2038	13	7058	11347
2039	14	7305	12181
2040	15	7561	13076
2041	16	7825	14038
2042	17	8099	15069
2043	18	8383	16177
2044	19	8676	17366
2045	20	8980	18642

V. CONCLUSION

According to result of discussion and analysis sections of this study, there are several conclutions as stated below:

1. The application of Cost Benefit Analysis (CBA) method in this study, with benefit components are in the form of Vehicle Operating Cost (VOC) saving and Travel Time Value Savings (VOT) can be used to evaluate the economic feasibility of road reconstruction projects on the studied road sections. The result of the project cash flow calculation using a discount rate of 5.27% showed the analyzed three road pavements alternatives (Laston AC-WC, Laston Asbuton, and Laston HRS-WC) produce a negative Net Present Value (NPV) and a Benefit Cost Ratio (BCR) value of less than 1, so these values are not economically feasible to be implemented under basic condition. However, result from relative comparison between alternatives revealed that Laston HRS-WC has the best economic workperformance when compared to the other alternatives as indicated by NPV brought value closest to zero and has highest BCR value.
2. Result of sensitivity analysis also indicates the economic feasibility of this project has the most sensitive condition found in cost changes (especially in investment cost and operating cost). In a 25 % cost reduction scenario, Laston HRS-WC alternative showed significant change to make this alternative able to reach economically feasible condition, while changes in traffic growth and discount rate do not have significant effect on the project's feasibility. For a 25 % cost reduction scenario, alternative 3 becomes economically feasible with a BCR value of 1.057 and a positive NPV value of Rp. 482.342.183,34 while alternative 1 and alternative 2 remain unfeasible. In a 110 % growth scenario during the analysis period, this feasibility value is considered as a marginal value since the BCR value is very close to 1 and the NPV value is relatively small number so making these values become very sensitive to any change's assumption.

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