The feasibility construction of Alas-Pedesi bridge in Kuta Cane Southeast Aceh district based on the analysis of the transportation economic value

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Abstract. Kutacane is a city located in Southeast Aceh district, the majority of the community's economic income comes from agricultural and plantation products, the production of corn and cocoa is distributed to the city center from several sub-districts located across the Alas river which is a river that separates some of these districts from the city center. Therefore, the Lawe Alas-Pedesi bridge was built, to facilitate the distribution of production results by reducing distance and travel time. The purpose of this study was to determine the effect of the Alas-Pedesi Lawe bridge, on the operational costs of vehicles, agricultural production, plantations based on producer surpluses, and calculate the economic viability of development including Benefit Cost Ratio (BCR), Net Present Value (NPV), Economic Internal Rate of Return (EIRR). The results of this study get a total time difference of IDR 68,583, - / vehicle, a total difference in vehicle operating costs (BOK) of IDR 4,441, / vehicle, the profit of farmers (corn) for 10 years can be as much as IDR 200,567,937,375, - / planting season, the total difference for the benefit of farmers (cocoa) for 10 years can be as much as IDR 3,919,484,400 / planting season. The economic feasibility of the construction of the Lawe Alas-Pedesi bridge obtained in 2030 has met the eligibility standards for all discount rates. In the BCR obtained a 10% discount rate is 1.74, a 12% discount rate is 1.46 and at a 15% discount rate is 1.12, and at the Net Present Value 10% discount rate is obtained NPV IDR 23,422,534,229, - discount 12% rate is obtained NPV IDR 13,491,749,019, and at a 15% discount rate is obtained NPV IDR 3,243,265,869. While the value of EIRR obtained at a discount rate of 16, 33 %, this shows the bridge Lawe Alas-Pedesi feasible to build the bank lending rate at 16.33%.

1. Preface
Kutacane is a district capital located in Aceh province, namely Southeast Aceh district, which has administrative boundaries west of GayoLues district, north of East Aceh district, south of Subulussalam District, and east borders directly with Tanah Karo, North Sumatra Province. This city is often called as Lembah Alas because the position of the city is located in the valley of the Bukit Barisan mountain range and crossed by several rivers, one of which is the largest river Alas, a river that divides from the north of the city extends to the south of the city so that several districts those found across the river must cross the bridge to move towards the city center to distribute their natural resource production or for other purposes.
The purpose of this study is to determine the time value and Vehicle Operating Costs (VOC) between the Mbarung bridge (existing) and the Lawe Alas - Pedesi bridge (alternative), to determine the effect of the construction project of the Lawe Alas - Pedesi bridge on agricultural production (corn) and plantation (cocoa) based on the producer surplus method, determining of economic feasibility is based on Benefit Cost Ratio (BCR), Net Present Value (NPV), Economic Internal Rate of Return (EIRR), on the construction of the Lawe Alas - Pedesi bridge (alternative).

2. Literature review

2.1. Basic theoretical
The Operation of public roads is done by giving priority to the development of road networks centered-production center and the roads that can be connecting production centers with the market area, the implementation of public road directed to the construction of the road network in order to strengthen the unity of the national territory in order to reach remote areas, the implementation of a public road directed to realize harmonious people's lives with the same level of progress that is evenly balanced as well as the efficacy and results of state defense and security efforts, the road technical requirements include speed of plan, width of the road body, capacity, intersection entrance, a plot of complementary buildings, road equipment, use road in accordance with its function and uninterrupted [1].

2.2. Traffic volume
The Traffic Volume is the number of vehicles passing through one point or the cross-section in a time unit expressed in vehicles/ hour/ lane. The number consists of various types of vehicles such as passenger cars, buses of all sizes, light or heavy trucks, two-wheeled vehicles, as well as vehicles that do not use engines such as bicycles, paddle rickshaws, carts, and pedestrians. Each vehicle is counted per unit in traffic flow [2]. The volume of traffic is also the number of vehicles passing, expressed in units of passenger cars (smp) multiplied with by using the following equivalence of passenger cars (PCE) for each type of vehicle, depending on the type of road and the current total traffic expressed in veh/h. Traffic volume calculation is done by using the following equation.

\[ Q = Q_{LV} + Q_{MHV}x_{emp_{MHV}} + Q_{LB}x_{emp_{LB}} + Q_{LT}x_{emp_{LT}} + Q_{MC}x_{emp_{MC}} \]  

(1)

2.3. Speed and travel time
Speed is defined as the average for the average speed of vehicle space along the road segment. Calculation of speed and travel time is done by using the following equation.

\[ V = L / TT \]

(2)

Where:  
\( V \) = average speed (km / h);  
\( L \) = Path length (km); and  
\( TT \) = Average travel time (hours).

2.4. Time value
The savings of travel time value obtained from the difference calculation of travel time for the condition to the project and without the project (without project). The travel time in the base year for various types of vehicles obtained through field surveys. The time value used can be determined from the results of time value studies using productivity methods, stated preferences, or revealed preferences calculation of the time value using the equation.

\[ NW \text{ (people)} = \frac{GRDP}{(40\% \times 2100 \times JP)} \]  

(3)

Where:  
\( NW \) = time value of people;
GRDP = GRDP (without oil and gas);
JP = total population;
40% = proportion of working population; and
2100 = assumption as the number of hours worked in a year.

2.5. Vehicle operation cost
Vehicle Operational cost vehicle is the total cost required to operate the vehicle on road conditions for the types of vehicles per kilometer of distance traveled, the units of rupiah per kilometer. The cost of vehicle operation consists of two main components of variable cost and fixed costs. Equation conducted on multiple components of VOC, which includes Gasoline; Use of lubricating oil; Use of tires; Maintenance cost; Mechanical costs; Depreciation; Interest rate; Travel time of passengers; and unexpected costs (overhead); VOC can be calculated by using the following equation.

1. The equation of fuel consumption on the old road based on PCI are:
   Light Vehicles: \( Y = 0.05693.S^2 - 6.42593.S + 269.18576 \);
   Bus: \( Y = 0.21692.S^2 - 24.15490.S + 954.78824 \);
   Truck: \( Y = 0.21557.S^2 - 24.17699.S + 947.80882 \);

2. The equation of fuel consumption on the new road based on PCI are:
   Light Vehicles: \( Y = 0.04376. S^2 - 4.94078.S + 207.0484 \);
   Bus: \( Y = 0.14461. S^2 - 16.10285.S + 636.50343 \);
   Truck: \( Y = 0.13485. S^2 - 15.12463.S + 592.60931 \);

3. The equation of lubricating oil consumption on the old road based on PCI are:
   Light Vehicles: \( Y = 0.00037.S^2 - 0.04070.S + 2.20403 \);
   Bus: \( Y = 0.00209.S^2 - 0.24413.S + 13.29445 \);
   Truck: \( Y = 0.00188.S^2 - 0.13770.S + 7.54073 \);

4. The equation of lubricating oil consumption on the new road based on PCI are:
   Light Vehicles: \( Y = 0.00029.S^2 - 0.03134.5 + 1.69613 \);
   Bus: \( Y = 0.00131.S^2 - 0.00064667 \);
   Truck: \( Y = 0.00188.S^2 - 0.13770.S + 7.54073 \);

5. The equation of tire used on both roads based on PCI are:
   Light Vehicles: \( Y = 0.0008848.S - 0.0045333 \);
   Bus: \( Y = 0.001256.S - 0.0006467 \);
   Truck: \( Y = 0.0015553.S - 0.0059333 \);

6. Equation of maintenance costs on both roads based on PCI are:
   Light Vehicles: \( Y = 0.0000064.S + 0.0005567 \);
   Bus: \( Y = 0.000332.S + 0.00020891 \);
   Truck: \( Y = 0.0000191.S + 0.00015400 \);

7. The mechanical cost equation on both roads based on PCI are:
   Light Vehicles: \( Y = 12.5.S + 100 \);
   Bus: \( Y = 9.5.S + 315 \);
   Truck: \( Y = 6.S + 210 \);

8. The depreciation cost equation for both roads based on PCI are:
   Light Vehicles: \( Y = 1.S^{\frac{1}{5}} + 100 \);
   Bus: \( Y = 1.S^{\frac{1}{10}} + 150 \);
   Truck: \( Y = 1.S^{\frac{1}{15}} + 251.42857.S + 150 \);

9. The interest rate equation on both roads based on PCI are:
   Light Vehicles: \( Y = 150.S^{\frac{1}{150}} + 500.S^{\frac{1}{150}} \);
   Bus: \( Y = 2571.42857.S^{\frac{1}{150}} + 1714.28571.S^{\frac{1}{150}} \);
10. The equation vehicle crew travel time on both roads are:
   - Bus: $Y = \frac{1000}{5} S$
   - Truck: $Y = \frac{1000}{5} S$

11. The equation of unexpected costs on both roads are:
   - Bus: 10% from total sub;
   - Truck: 10% from total sub.

2.6. Producer surplus method
Producer surplus analysis is an evaluation parameter of project feasibility. In this case, the benefits used are all surpluses enjoyed by producers of goods and services sold in the area of Project’s influence. The surplus producer approach is carried out by paying attention to certain surrounding areas (for example agriculture and certain products). For these products, it is necessary to pay attention to various production data, production factors and selling prices from year to year, some assumptions used in the surplus producer method are as follows [3]:
   a. With the existence of new road construction projects, resulting in an increase in planted area or increase in production;
   b. Transportation costs are reduced because of good accessibility from the investments;
   c. Products are sold at the same prices at the same specified distance (on average) throughout the reviewed area;
   d. Additional production will not result in a collapse in market prices, in other words, fixed selling prices, so farmers can sell as much production as possible;
   e. Household consumption remains unaffected by production; and
   f. Transportation and production costs are the same for all farmers.

Surplus producer calculation is done by using the following equation:

$$FS_2 - FS_1$$

Where: $FS_1 =$ Farmer Surplus Before the Bridge, and $FS_2 =$ Farmer Surplus After The Bridge.

2.7. Analysis of the economic value of transportation

2.7.1. Benefit cost ratio
The benefit cost ratio is the ratio between the Present Value Benefit divided by the present value cost. The BCR results of a project are declared financially feasible if the BCR value is greater than 1 (> 1). This value is done based on the present value, namely by comparing the difference in benefits and costs smaller than zero [3]. This method is used to analyze the economics of project development by comparing the total profits against the total costs that have been equivalent to the base year using the applicable discount rate. Calculation of benefit cost ratio is using the following equation:

$$BCR = \frac{\text{Present value benefit}}{\text{present value cost}}$$

2.7.2. Net present value
The Net present value (NPV) is the difference between the present value benefit reduced by the present value cost. The NPV results from a project is stated to be financially feasible are those that produce a positive NPV value [3]. The Calculation of net present value using the following equation:

$$NPV = \sum_{t=0}^{n} \frac{Bt-Ct}{(1+r)^t}$$

Where: $NPV =$ net present value;
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**Bt** = total amount of project benefit components in year t;

**Ct** = total amount of cost component in year t;

**n** = the economic age of the project being studied;

**r** = interest rate (\%/year); and

**t** = economic life of the project, starting from the planning stage to the end of the life of the road plan.

### 2.7.3. Economic internal rate of return

Economic Internal Rate of Return (EIRR) is a rate of return based on the determined value of the discount rate, where all future benefits that are valued now at a certain discount rate are the same as the cost of capital or the present value of the total cost. In order to calculate the EIRR value the way is to try some of the interest rates. The calculation of the EIRR value is calculated based on the interest rate that produces the smallest positive NPV and the interest rate that produces the smallest negative NPV[3]. Then interpolation is carried out using the equation:

\[
EIRR = i_1 + \left( i_2 - i_1 \right) \frac{NPV_2}{NPV_2 - NPV_1}
\]

Where:
- **EIRR** = economic internal rate of return;
- **i_1** = discount rate that produces the smallest negative NPV;
- **i_2** = discount rate that produces the smallest positive NPV;
- **NPV1** = current value and use i_1; and
- **NPV2** = present value and using i_2.

### 3. Research methodology

#### 3.1. Research object

In this research object, the traffic volume is calculated covers all types of vehicles includes the motorcycle (MC); Light Vehicle (LV); Medium Heavy Vehicle (MHV); Large Bus (LB); and Large Truck (LT), which passes through the location of the object of research as basic data to get the movement of people from the area to the city center.

#### 3.2. Data type and sources

**3.2.1. Primary data**

a. Traffic Volume Survey ;

b. Vehicle Speed Survey ;

c. Vehicle Travel Time Survey.

**3.2.2. Secondary data**

a. The population number is obtained from the Badan Pusat Statistik of Southeast Aceh District.

b. Gross Regional Domestic Product (GRDP) from the Badan Pusat Statistik of Southeast Aceh District;

c. Percentage of vehicle growth from the DinasPerhubungan of Southeast Aceh District;

d. Regional Spatial Planning from BAPPEDA, Southeast Aceh District;

e. Long Term Development Plan (RPJP) from BAPPEDA, Southeast Aceh District ;

f. Annual data of agricultural and livestock production from the Badan Pusat Statistik of Southeast Aceh;

g. Road Network Map of the Southeast Aceh from Bina Marga; and

h. Planning, physical work and supervision costs from the Bina Marga of Southeast Aceh.

#### 3.3. Data collection technique

a. Field Survey;
b. Documentation;
c. Data Collection from related agencies.

3.4. Analysis technique
After data from the field were collected in the form of traffic volumes, documentation and data from relevant agencies, an analysis is carried out on that data using the help of Microsoft Office Excel Software. The results of the field survey were analyzed using the productivity method, stated preference or revealed preference, to obtain the time value, and with MKJI 1997 and the PCI method (2000) in order to obtain the VOC value, while the data from the related agencies mentioned above were analyzed using the producer surplus method, after obtaining the results of the three methods, then it is entered into an analysis of the economic value of transportation to get the value of Benefit Cost Ratio (BCR), Net Present Value (NPV), at a discount rate of 10%, 12%, 15%, so that it will get an Economic Internal Rate value of return (EIRR) later, as a reference to the construction of the Lawe Alas - Pedesi bridge (alternative) to find out the percentage of loan interest at the bank.

4. Results and discussion

4.1. Time value
From the research on Mbarung Bridge (existing), total use values while passenger cars, buses, and trucks on the bridge Mbarung (existing) is IDR 102,850,-/vehicle, while assuming total time value of passenger cars, buses and trucks on the bridge Lawe Alas -Pedesi (alternative) is IDR 34,267,-/vehicle, the difference in the time value of the vehicle is the time value of the vehicle on the existing Mbarung bridge minus the time value of the vehicle on the Alas-Pedesi bridge (alternative) obtained at IDR 68,583,-/vehicle. The results of calculating the time value can be seen in the following table.

| No | Road     | Travel Time (hour) | Time Value       | Total of Time Value |
|----|----------|-------------------|------------------|---------------------|
|    |          | LV  | BUS  | TRUK | PC     | BUS     | TRUCK | (IDR/Veh) | (IDR/Veh) | (IDR/Veh) | (IDR/Veh) |
| 1  | Existing | 0.285 | 0.354 | 0.385 | 21.225 | 61.667 | 19.957 | 102,850    |
| 2  | Alternative | 0.114 | 0.114 | 0.114 | 8.483  | 19.872 | 5.912  | 34,267     |
|    | Difference in Value | 0.171 | 0.240 | 0.271 | 12.743 | 41.795 | 14.045 | 68,583     |

4.2. Vehicle operational costs
From the results of the research on the existing (bridge Mbarung) for passengers cars amounted to IDR 1.875,-/veh/km, the bus is IDR 5.631,-/veh/km and for trucks IDR 4.480,-/veh/km, while for alternative roads (the Lawe Alas-Pedesi bridge) for passenger cars is IDR 1.439,-/veh/km, buses IDR 3.382,-/veh/km and trucks obtained IDR 2.724,-/veh/km. The total savings of VOC or difference in VOC obtained between existing roads and alternative roads for passenger cars is IDR 435,-/veh/km, for buses obtained IDR 2.250,-/veh/km and for trucks is IDR 1.756,-/veh/km. The calculation of VOC can be seen in the following table.

| No | Type of Vehicle | VOC of existing bridge (IDR/veh./km) | VOC of alternative bridge (IDR/veh./km) | Difference in VOC (IDR/veh./km) |
|----|----------------|-----------------------------------|---------------------------------------|---------------------------------|
| 1  | Passenger Car  | 1.875                             | 1.439                                 | 435                             |
4.3. Surplus producer

4.3.1. Surplus of corn farming. Corn production in the sub-districts of Lawe Alas and Tanoh Alas is 58,215,600 kg or (58,215.6 tons), with an average production of 12.56 tons/ha. While the planting area of these two districts is 5,571 Ha, with a harvesting area of 4,635 ha in 2021. The farmers' profit (without project) is IDR 979,469,446,500 / season for 10 years, while the farmers' profit (with project) is obtained for IDR 1,180,037,383,875/ planting season, the difference in profit is IDR 200,567,937,375. The results of the calculation of producer surplus on corn production can be seen in the following table.

Table 3. Corn production (without project).

| No | Year | Sub-district                  | Planted area (Ha) | Harvest area (Ha) | Corn Production (ton/ha) | Corn Production (kg) | Production Results (@ IDR, 3800/kg) | Intensification costs/Operational (IDR) | Farmer’s Benefits (IDR) |
|----|------|-------------------------------|-------------------|------------------|-------------------------|----------------------|---------------------------------|---------------------------------|-----------------------|
| 1  | 2021 | Lawe Alas + Tanoh Alas        | 5.571             | 4.635            | 12.6                    | 58.216               | 2.212.193                      | 1.880.364                      | 331.829               |
| 2  | 2022 | Lawe Alas + Tanoh Alas        | 5.571             | 4.635            | 12.6                    | 58.216               | 2.212.193                      | 1.880.364                      | 331.829               |
| 3  | 2023 | Lawe Alas + Tanoh Alas        | 5.571             | 4.635            | 12.6                    | 58.216               | 2.212.193                      | 1.880.364                      | 331.829               |
| 4  | 2024 | Lawe Alas + Tanoh Alas        | 9.170             | 7.864            | 16.7                    | 131.486              | 4.996.471                      | 4.247.000                      | 749.471               |
| 5  | 2025 | Lawe Alas + Tanoh Alas        | 9.170             | 7.864            | 16.7                    | 131.486              | 4.996.471                      | 4.247.000                      | 749.471               |
| 6  | 2026 | Lawe Alas + Tanoh Alas        | 9.170             | 7.864            | 16.7                    | 131.486              | 4.996.471                      | 4.247.000                      | 749.471               |
| 7  | 2027 | Lawe Alas + Tanoh Alas        | 13.542            | 12.69/4          | 20.1                    | 255.022              | 9.690.853                      | 8.237.225                      | 1.453.628             |
| 8  | 2028 | Lawe Alas + Tanoh Alas        | 13.542            | 12.69/4          | 20.1                    | 255.022              | 9.690.853                      | 8.237.225                      | 1.453.628             |
| 9  | 2029 | Lawe Alas + Tanoh Alas        | 15.073            | 14.11/9          | 21.3                    | 301.158              | 11.444.014                     | 9.727.412                      | 1.716.602             |
| 10 | 2030 | Lawe Alas + Tanoh Alas        | 16.221            | 15.18/7          | 22.3                    | 338.063              | 12.846.380                     | 10.919.423                     | 1.926.957             |
|    |     | Amount                        | 10.260            | 9.219            | 17.2                    | 171.837              | 6.529.809                      | 5.550.338                      | 9.794.714             |

Note:
- Assuming seed price of IDR 92,000/kg

Table 4. Corn production (with project).

| No | Year | Sub-district                  | Planted area (Ha) | Harvest area (Ha) | Corn Production (ton/ha) | Corn Production (kg) | Production Results (@ IDR, 4500/kg) | Intensification costs/Operational (IDR,) | Farmer’s Benefits (IDR) |
|----|------|-------------------------------|-------------------|------------------|-------------------------|----------------------|---------------------------------|---------------------------------|-----------------------|
| 1  | 2021 | Lawe Alas + Tanoh Alas        | 5.571             | 4.635            | 12.6                    | 58.216               | 2.619.702                      | 2.226.747                      | 392.955               |
### Surplus of cocoa plantation

Cocoa production in the sub-districts of Lawe Alas and Tanoh Alas is 2,134,800 kg or (2,134,8 tons), with an average production of 1.80 tons/ha. While the planting area of these two districts is 2,475 Ha, with a harvesting area of 1.186 ha in 2021. Farmer profits (without project) is IDR 29,047,502.100/planting season for 10 years, while farmers profits (with project) is IDR 32,966,986.500/planting season, the difference in profit is IDR 3,919,484,400. The results of the calculation of producer surplus on cocoa production can be seen in the following table.

#### Table 5. Cocoa production (without project).

| No | Year | Sub-districts | Planted Area (Ha) | Harvest Area (Ha) | Cocoa Production (ton/ Ha) | Cocoa Production (kg) | Production Results (@ IDR. 22000/ kg) | Intensification /Operational cost (IDR.) | Farmer’s Benefits (IDR) |
|----|------|---------------|-------------------|------------------|---------------------------|----------------------|--------------------------------------|----------------------------------------|------------------------|
| 1  | 2021 | Lawe Alas + Tanoh Alas | 2.475             | 1.186            | 1.8                       | 2.135                | 46.966                               | 39.921                                 | 7.045                  |
| 2  | 2022 | Lawe Alas + Tanoh Alas | 2.475             | 1.186            | 1.8                       | 2.135                | 46.966                               | 39.921                                 | 7.045                  |
| 3  | 2023 | Lawe Alas + Tanoh Alas | 2.475             | 1.186            | 1.8                       | 2.135                | 46.966                               | 39.921                                 | 7.045                  |
| 4  | 2024 | Lawe Alas + Tanoh Alas | 4.316             | 1.321            | 3.0                       | 3.950                | 86.895                               | 73.861                                 | 13.034                 |
| 5  | 2025 | Lawe Alas + Tanoh Alas | 4.316             | 1.321            | 3.0                       | 3.950                | 86.895                               | 73.861                                 | 13.034                 |
| 6  | 2026 | Lawe Alas + Tanoh Alas | 4.316             | 1.321            | 3.0                       | 3.950                | 86.895                               | 73.861                                 | 13.034                 |
| 7  | 2027 | Lawe Alas + Tanoh Alas | 6.550             | 1.490            | 4.5                       | 6.690                | 147.182                              | 125.105                                | 22.077                 |

Note:
- Assuming seed price IDR. 92,000/kg

### 4.3.2. Surplus of cocoa plantation

The difference in profits of farmers = corn production (with project) – corn production (without project) = 2,005,589

#### Amount

| 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
|------|------|------|------|------|------|------|
| 10,413 | 9,362 | 17,2 | 174,819 | 7,866,868 | 6,686,838 | 11,800,303 |

Note:
- Assuming seed price IDR. 92,000/kg
Table 6. Cocoa production (with project).

| No | Year | Sub-districts       | Planted Area (Ha) | Harvest Area (Ha) | Cocoa Production (ton/ Ha) | Cocoa Production (kg) | Production Results (@ IDR 31000/kg) | Intensification /Operational (IDR) | Farmer’s Benefits (IDR) |
|----|------|---------------------|-------------------|-------------------|---------------------------|-----------------------|------------------------------------|-----------------------------------|----------------------------|
| 1  | 2021 | Lawe Alas + Tanoh Alas | 2.475             | 1.186             | 1,8                       | 2.135                 | 66.179                             | 56.252                            | 9.927                       |
| 2  | 2022 | Lawe Alas + Tanoh Alas | 2.475             | 1.186             | 1,8                       | 2.135                 | 66.179                             | 56.252                            | 9.927                       |
| 3  | 2023 | Lawe Alas + Tanoh Alas | 2.475             | 1.186             | 1,8                       | 2.135                 | 66.179                             | 56.252                            | 9.927                       |
| 4  | 2024 | Lawe Alas + Tanoh Alas | 4.316             | 1.321             | 3,0                       | 3.950                 | 122.443                            | 104.077                           | 18.367                      |
| 5  | 2025 | Lawe Alas + Tanoh Alas | 4.316             | 1.321             | 3,0                       | 3.950                 | 122.443                            | 104.077                           | 18.367                      |
| 6  | 2026 | Lawe Alas + Tanoh Alas | 4.316             | 1.321             | 3,0                       | 3.950                 | 122.443                            | 104.077                           | 18.367                      |
| 7  | 2027 | Lawe Alas + Tanoh Alas | 5.401             | 1.423             | 4,5                       | 6.389                 | 198.067                            | 168.357                           | 29.710                      |
| 8  | 2028 | Lawe Alas + Tanoh Alas | 5.401             | 1.423             | 4,5                       | 6.389                 | 198.067                            | 168.357                           | 29.710                      |
| 9  | 2029 | Lawe Alas + Tanoh Alas | 6.124             | 1.491             | 5,5                       | 8.186                 | 253.753                            | 215.690                           | 38.063                      |
| 10 | 2030| Lawe Alas + Tanoh Alas | 6.667             | 1.542             | 6,2                       | 9.622                 | 298.284                            | 253.542                           | 44.743                      |
|    |     | **Amount**          | **5.067**         | **1.379**         | **3,5**                  | **5.096**             | **112.115**                       | **95.298**                       | **168.172**                |

Note: 
Assuming seeds price of IDR 3,000/stick

4.4. Feasibility analysis

4.4.1. Benefit cost ratio. BCR is a comparison of the value of benefits with costs. BCR value obtained in 2030 is an analysis since the road was opened or the 10th year at a 10% discount rate is 1,74, the 12% discount rate is 1,46 and at a 15% discount rate is 1,12. Based on the value of the BCR it has been in accordance with the eligibility requirements ( BCR requirements > 1), showing that the construction of the Lawe Alas-Pedesi bridge ( alternative ) began to provide benefits in the 10th year for the three discount rates.
4.4.2. **Net present value.** Net present value is the value of net profit or value the benefits of the project after deducting the cost of the project. NPV value obtained in 2030, since the road opened or year to 10 at a discount rate of 10% was obtained NPV IDR23,422,534,229,- discount rate of 12% was obtained NPV IDR13,491,749,019,- and at a discount rate of 15% was obtained NPV IDR3,243,265,869,-. Based on the three-discount rate of the n use values NPV at year 10 analysis for a third discount rate at the above all are positive (+).

4.4.3. **Economic internal rate of return.** Economic Internal Rate of Return is a sizes that shows the rate of return on investment due to the implementation of the construction of the Lawe Alas-Pedesi bridge (alternative) based on the interest rate that produces BCR equal to 1 (one), the result is at a value of NPV = 0, - obtained at a discount rate 16.33 %. So, the construction of the Lawe Alas-Pedesi Bridge (alternative) is feasible to be built with a bank loan interest rate at 16.33%. The results of calculating the economic feasibility of transportation can be seen in the following table.

### Table 7. Economic feasibility analysis with interest rate of 10%, 12%, 15% using the BKBOK equation calculation (Part 1 of 4).

| Year | To | Cost estimation and benefits | BKBOK and Time value | Benefits (corn) | Benefits (cocoa) |
|------|----|-----------------------------|----------------------|----------------|-----------------|
|      |    | Project                     |                      |                |                 |
| 2013 | 0  | 1,238,103,806               |                      |                |                 |
| 2014 | 1  | 6,721,134,950               |                      |                |                 |
| 2015 | 2  | 5,895,732,412               |                      |                |                 |
| 2016 | 3  | 5,895,732,412               |                      |                |                 |
| 2017 | 4  | 5,895,732,412               |                      |                |                 |
| 2018 | 5  | 5,895,732,412               |                      |                |                 |
| 2019 | 6  | 5,895,732,412               |                      |                |                 |
| 2020 | 7  | 5,895,732,412               |                      |                |                 |
| 2021 | 8  | 206,350,634                 | 219,483,684          | 6,112,638,000  | 224,154,000     |
| 2022 | 9  | 206,350,634                 | 230,200,800          | 6,112,638,000  | 224,154,000     |
| 2023 | 10 | 206,350,634                 | 241,513,787          | 6,112,638,000  | 224,154,000     |
| 2024 | 11 | 206,350,634                 | 253,455,776          | 13,806,038,400 | 414,727,950     |
| 2025 | 12 | 412,701,268                 | 266,061,740          | 13,806,038,400 | 414,727,950     |
| 2026 | 13 | 206,350,634                 | 279,368,595          | 13,806,038,400 | 414,727,950     |
| 2027 | 14 | 206,350,634                 | 293,415,312          | 26,777,358,300 | 499,400,250     |
| 2028 | 15 | 206,350,634                 | 308,243,026          | 36,437,132,550 | 499,400,250     |
| 2029 | 16 | 206,350,634                 | 323,895,161          | 36,748,870,425 | 510,048,450     |
| 2030 | 17 | 412,701,268                 | 340,417,555          | 40,848,546,900 | 493,989,600     |
|      |    | Total                       | 45,809,840,835       | 2,756,055,436  | 200,567,937,375 |

| Year | To | Present Value |
|------|----|--------------|
|      |    | Discount Rate 10.00% | Discount Rate 12.00% |
|      |    | Cost | Benefits | Cost | Benefits |
| 2013 | 0  | 1,238,103,806 | 1,238,103,806 |
| 2014 | 1  | 6,110,122,682 | 6,001,013,348 |
### Table 7. Economic feasibility analysis with interest rate of 10%, 12%, 15% using the BKBOK equation calculation (Part 3 of 4).

| Year | To | Present Value | | | |
|------|----|---------------|---|---|---|
|      |     | Discount Rate 15.00% | IRR = 16.33% | | |
|      |     | Cost | Benefits | Cost | Benefits | |
| 2013 | 0   | 1,238.103.806 | 5.777.782.926,56 | 1,238.103.806,00 | |
| 2014 | 1   | 5.844.465.174 | 4.356.873.751,42 | 5.777.782.926,56 | |
| 2015 | 2   | 4.458.020.727 | 1.626.056.583 | 4.356.873.751,42 | |
| 2016 | 3   | 3.876.539.763 | 3.745.360.115,81 | 3.745.360.115,81 | |
| 2017 | 4   | 3.370.904.142 | 3.219.676.125,00 | 3.219.676.125,00 | |
| 2018 | 5   | 2.931.220.993 | 2.767.775.068,18 | 2.767.775.068,18 | |
| 2019 | 6   | 2.548.887.820 | 2.379.301.063,41 | 2.379.301.063,41 | |
| 2020 | 7   | 2.216.424.191 | 2.045.351.739,53 | 2.045.351.739,53 | |
| 2021 | 8   | 67.456.388 | 61.539.597,83 | 2.143.258.151 | 1,955.266.921 |
| 2022 | 9   | 58.657.729 | 52.902.142,31 | 1.866.749.213 | 1,683.580.908 |
| 2023 | 10  | 51.006.721 | 45.477.006,03 | 1.626.056.583 | 1,449.773.360 |
| 2024 | 11  | 44.353.670 | 39.094.032,62 | 3.111.135.950 | 2,742.204.863 |
| 2025 | 12  | 77.136.818 | 67.213.896,43 | 2.707.691.754 | 2,359.372.840 |
| 2026 | 13  | 33.537.747 | 28.890.009,36 | 2.356.677.304 | 2,030.083.582 |
| 2027 | 14  | 29.163.258 | 24.835.121,46 | 3.896.455.672 | 3,318.180.338 |
| 2028 | 15  | 25.359.355 | 21.349.361,65 | 4.577.177.552 | 3,853.403.178 |
| 2029 | 16  | 22.051.613 | 18.352.849,36 | 4.016.278.768 | 3,342.619.846 |
| 2030 | 17  | 38.350.631 | 31.553.831,45 | 3.873.425.467 | 3,186.946.609 |
| Total|     | 26.931.640.546 | 25.921.432.444 | 30.174.906.414 | 25.921.432.445 |

### Table 7. Economic feasibility analysis with interest rate of 10%, 12%, 15% using the BKBOK equation calculation (Part 4 of 4).

| Criteria Feasibility of Economy | Discount Rate 10.00% | Discount Rate 12.00% | Discount Rate 15.00% | Discount Rate 16.33% |
|--------------------------------|----------------------|----------------------|----------------------|---------------------|
| Benefit-Cost Feasibility Ratio | BCR                  | 1.74                 | 1.46                 | 1.12                | 1.00                |
| Net Present Value (Rp.)        | NPV                  | 23.422.534.229       | 13.491.749.019       | 3.243.265.869       | 0                   |
| Economic Internal Rate of Return| EIRR                 | 16.33%               |                      |                     |                     |

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5. Conclusions and recommendations

5.1. Conclusions
1. The total time difference obtained in the research or at the Alas-Pedesibridge (alternative) is IDR 68,583/vehicle, and the total difference in the operational costs of the vehicle (VOC) is IDR 4,441/vehicle.
2. The total difference in profits of corn farmers for 10 years in Lawe Alas and Tanoh Alas district, in the amount of IDR 200,567,937.375,-/planting season, and the total difference in profits for cocoa farmers for 10 years can be as much as IDR 3,919,484.400,-/growing season.
3. The economic feasibility of the construction of the Lawe Alas-Pedesi bridge (alternative), Southeast Aceh district in 2030 or the 10th year, has met the economic feasibility standard for all discount rate. That’s proved by BCR at a discount rate of 10% is 1,74, a discount rate of 12% is 1,46 and the discount rate of 15% is 1,12, then to Net Present Value at a discount rate of 10% was obtained NPV of IDR 23,422,534.229,- discount rate of 12% was obtained NPV IDR 13,491,749.019,- and at a discount rate of 15% was obtained NPV IDR 3,243,265.869,-. Then obtained value of values EIRRs at the discount rate of 16.33, it indicates that the construction of the Lawe Alas-Pedesi bridge is very feasible to be carried out, with bank loan rates up to 16,33%.

5.2. Recommendations
1. The need to accelerate the completion of the construction of the Lawe Alas-Pedesi bridge (alternative), in the Southeast Aceh, because it can save time and operational costs of the community in distributing agricultural and plantation products in the two sub-districts, so as to improve the economy and standard of living of the people in the region; and
2. The need for more studies on this research by increasing the variable or using methods such as modeling, APV, and others.

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