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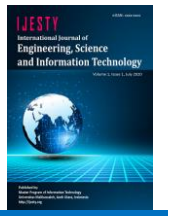

Feasibility Analysis for Economic Flyover in Bojonegoro District

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Abstract

The traffic jam that occurred in the city of Bojonegoro on the Rajekwesi – MT road section. Haryono, the leading cause of problems in the area, is at intersections and meetings with railroad tracks. Building a flyover is one solution to congestion that occurs at railroad crossings. An economic feasibility study must be carried out to assess the characteristics of a development project. This study aims to determine how much profit and costs are obtained and the extent of its economic feasibility. The project that will be examined in this study is the construction of a flyover in Bojonegoro district. Then, the feasibility of the Flyover construction project is based on the calculation of Net Present Value (NPV), Benefit Cost Ratio (BCR), and Internal Rate of Return (IRR). The results of this economic feasibility analysis There are three alternative route selection that are associated with economic feasibility where the first alternative with NPV: 2,121,743,718,000, BCR: 12.7499 and IRR: 57 then the second alternative with NPV value: 1,733,795,057,000, BCR: 10.3771, IRR: 50% and the third alternative with an NPV value: 1,395,424,941,000, BCR: 6,978 and IRR: 37%. Based on the economic feasibility analysis using process hierarchy analysis, the first alternative was chosen with a score of 0.571. With the construction of the flyover, it is hoped that it can break up the flow of traffic on the Bojonegoro - Cepu - Nganjuk section to encourage economic growth, trade, and regional development in the Bojonegoro district.

***Keywords**: Economic Feasibility, NPV, BCR, IRR*

1. Introduction

Bojonegoro City is a city that has various natural resource potentials, and the one with the most significant economic value is the oil content [1]. If exploited, the content of this petroleum source will considerably impact economic improvement, increasing the potential for development of the Bojonegoro area [2]. The development of the Bojonegoro area will affect other aspects, one of which is the transportation aspect [3].

Suppose the transportation aspect, which is closely related to regional development, must be handled more effectively. In that case, it will likely result in transportation problems, making the area unattractive. In the development of a road network in the Bojonegoro Regency area that is integrated, one of the plans is the construction of a flyover that connects the main roads of the city of Bojonegoro with the road network in the southern region and avoids level crossings with railroads [4]. In addition, the flyover is also an infrastructure facility that is useful for supporting human life and activities as well as a benchmark for the development of a region. Flyover is an influential facility, and the government needs to provide it in case of a severe traffic jam in a particular area [5].

Law Number 38 of 2004 states that roads as part of transportation infrastructure are essential in the environmental, economic, socio-cultural, political, defense, and security fields and are used to develop people's prosperity. Flyovers were built to facilitate traffic in developed areas and improve goods and services distribution services that support increased economic growth.

The many functions of the flyover and the construction must be planned as well as possible from a technical and non-technical perspective. One of the things to consider is the cost aspect. A project budget plan must be issued based on working drawings. The Budget Plan is a tool for controlling the total Cost of completing work sequentially based on what has been planned and the feasibility study. Feasibility studies are made to assess whether the project is feasible to implement. In addition, a feasibility study was well [6].

Carried out to find alternatives or solutions that can be taken for the project. Therefore, it is necessary to research the Cost of constructing a flyover to obtain an effective, efficient flyover cost plan that complies with applicable regulations and assess the feasibility of the project to be implemented. So, based on the phenomena in the field and previous research, this research is entitled Analysis of the Economic Feasibility of Flyover Bojonegoro Regency [7].

2. Literature Review

Benefit Cost Ratio compares Present Value Benefit divided by Present Value Cost. The B/C-R result of a project is said to be economically feasible if the B/C-R value is more than 1 (one).
This method is used to evaluate the feasibility of a project by comparing the total benefits to the total costs, discounted to the base year, using the discount rate during the plan year. BCR is ca [8]lculated using the formula:

B/C = Benefit/Cost ≥1 Benefit (manfaat) = Δ.B.O.K
B.O.K eksisting - B.O.K kondisi baru
Cost = road construction costs and maintenance costs

If the BCR value > 1, the benefits (benefits) that may arise from the development are more significant than the costs required, making the development economically feasible. Vehicle operating costs are road users' total costs from the origin zone to the destination zone using specific modes. Vehicle operating costs consist of two components, namely fixed costs (fixed costs), which are costs that do not change, and variable costs (running costs), which are costs that vary if there is a change in the volume of service production [9].
BOK calculations are intended to evaluate the increase in road construction project work according to economic criteria so that it can be seen that the allocated costs can provide a high level of benefits. The direct benefit is the savings in travel costs, namely the difference between the total travel costs with and without the project. According to Bina Marga, 2005 and ITB Public Transport Planning System, 1997, BOK operating costs consist of the following:

1. Fixed costs (standing costs or fixed costs)
   Fixed costs (standing costs or fixed costs) are fixed costs that must be incurred regularly for a certain period and are not affected by the operation of the vehicle, which include
   - Depreciation expense
   - Cost of capital interest interest cost)
   - Insurance fee
   - Overhead costs
2. Variable Cost or running cost
   - Cost of fuel consumption
   - Cost of oil consumption
   - Tire consumption costs
   - Maintenance cost
   - Cost of maintenance labor wages

In this study, the BOK calculation uses the PCI (Pacific Consultants International) model calculation method for non-toll roads. The PCI model is the sum of running and standing costs, which are affected by the vehicle's speed and the type of vehicle used. The PCI model equations in the BOK calculation are as follows:
To calculate vehicle operating costs, it is necessary to know the price list of the components used as units for calculating vehicle operating costs and use the equation:

BO = BTT + BT
BOK = Vehicle Operating Costs (Rupiah/km)
BTT = Variable Costs (Rupiah/km)
BT = Fixed Cost (Rupiah/km)

2.1. Fixed Cost

Fixed costs are the sum of the components of depreciation, vehicle crew, insurance, and capital interest costs. Fixed costs can be seen in the equation:
BT = Bpi + BKi + BP +BO
Where :
BT = Fixed Cost (Rupiah/km)
Bpi = Insurance Cost (Rupiah/km)
Bki = Capital Interest Cost (Rupiah /km)
BP = Depreciation Cost(Rupiah/km)
BO = Overhead Cost (Rupiah/km)
Source: Metod PCI (Pacific ConsultantsInternational)
Where S = average vehicle speed (km/hour)
Overhead costs, according to the PCI method, are calculated at 10% of the total direct costs and indirect costs or can be written as:
Bus = 10 % of sub-total vehicle operating costs (BOK)
Trucks = 10 % of sub-total

2.2. Running Cost

Variable Cost (running cost) is the sum of fuel, oil, spare parts consumption, maintenance, and tire costs. The equation for variable costs is stated as follows:
BTT = BiBBMj + BOi + Bpi +Bui + BBi
Where :
BTT = Amount of variable costs (rupiah/km)
BiBBMj = Cost of fuel consumption (Rupiah. km)
Boi = Cost of oil consumption (Rupiah/km)
Bpi = Maintenance Cost (Rupiah/km)
Bui = Wages for maintenance workers (Rupiah/km)

BBi = Prohibited consumption fee (Rupiah/km)

2.3. Net Present Velue

This method, known as the present worth method, determines whether a plan has benefits in the analysis period [10]. This is calculated from the difference between the Present Value of The Benefit (PVB) and the Present Value of The Cost (PVC). The basis of this method is that all future benefits or costs associated with a project are discounted to present values using a discount rate [11].

$$NPV = Benefit - Cost$$

The NPV value should be positive (+)because it indicates that the benefits obtained exceed the costs incurred. The project is feasible to implement if the benefits generated by the project are more significant than the costs required for realization (NPV value > 0) [12].

AHP (Analytical Hierarchy Process) was developed by Thomas L. Saaty [13]. AHP is a decision-making system using a mathematical model. AHP assists in determining the priority of several criteria by conducting a pairwise comparison analysis of each. In solving problems with the AHP method, there are fundamental principles in the Analytical Hierarchy Process (AHP), namely:

1. Decomposition In defining the problem, it is necessary to decompose, namely breaking the whole situation into its elements down to the smallest detail.
2. Comparative Judgment. This principle means making judgments about the relative importance of two elements at a certain level close to the above level. This assessment is the core of AHP because it will affect the priority of the elements.
3. Synthesis of Priorities. Each pairwise comparison vector eigenmatrix gets local priority because pairwise comparison exists at every level, so to do global, a synthesis must be carried out between local priorities. The procedure for carrying out the synthesis differs according to the form of the hierarchy.
4. Logical Consistency. Consistency has two meanings. First, similar objects can be grouped according to their diversity and relevance. The second is the level of relationship between objects based on specific criteria. Some of the advantages of using AHP as an analysis tool are:
   a. Can provide a single, easy-to-understand, flexible model for various unstructured problems.
   b. Can combine deductive design and system-based design to solve complex problems.
   c. Can handle the interdependence of elements in a system and does not impose linear thinking.
   d. Reflects the mind's natural tendency to sort out the elements of a system at various levels and group similar elements at each level.
   e. Gives a scale measuring things that do not materialize to get priority.
   f. Trace the logical consistency of the considerations used in setting priorities.
   g. Lead to an overall assessment of the policy of each alternative.
   h. Allows people to broaden their definition of an issue and improve their judgment and understanding through repetition.

AHP (Analytical Hierarchy Process) has many advantages in explaining the decision-making process because it can be described graphically so that it is easily understood by all parties involved in decision-making [14]. With AHP, complex decision processes can be broken down into decisions that can be handled easily [15]. In addition, AHP also tests the consistency of the assessment; if there is a deviation that is too far from the perfect consistency value, this indicates that the evaluation needs to be corrected or the hierarchy must be restructured. The principle of the AHP method is as follows:

1. Arrange a hierarchy
   The essential thinking of the AHP method is forming a numerical score to rank each decision alternative based on how best the alternative matches the decision maker's criteria.
2. Paired Matrix
   Create a pairwise comparison matrix that describes each element's relative contribution/influence on each criterion one level above it. This pairwise comparison matrix is symmetrical or often called a square matrix. Comparisons are made based on the judgment of decision-making by assessing the level of importance of elements compared to other components.
3. Determine the priority scale.
   For each criterion and alternative, it is necessary to perform pairwise comparisons, namely comparing each element with other elements at each level of the hierarchy in pairs to obtain an element's importance level as a qualitative opinion. A rating scale is used to quantify the qualitative opinion so that the value of the opinion will be accepted in the form of numbers (quantitative). The relative comparison values are then processed to determine the relative ranking of all alternatives.
4. Calculating the consistency of the hierarchy.
   The consistency ratio is measured in AHP by looking at the consistency index. The expected consistency is close to perfect to produce decisions that are close to valid. Although it is difficult to achieve perfection, the consistency ratio is determined to be less than or equal to 10%.
   $\pi - n$
   $CI = n - 1$
   Where n is the number of items from the system being compared, π is the result of multiplying the vector of priorities for each criterion by the total column of the pairwise matrix.
5. Calculating the Consistency Ratio
   Consistency Ratio / CR =CI/RI where RI is a random index obtained from the table. To find consistent results, the results of CR ≤ 0.10, if the results of CR > 0.10, then the decision matrix taken must be re-evaluated.
6. Weighting Criteria for Total Respondents
   Weighting criteria for each respondent have been calculated and followed by adding each criterion for each respondent.

In this study, researchers used the results of previous research as material for consideration for researchers in conducting this research[16]. The similarities and differences between previous research and this research are in the financial aspect; whether it is previous research or research that researchers are doing now, the financial aspect is one of the essential aspects of assessing its feasibility [17]. So, in carrying out a feasibility analysis, an economic aspect analysis must be carried out because the financial aspect is the main factor determining whether or not an investment is feasible [18].

However, the difference with previous research is that the researchers included the positive and negative impacts of the bridge infrastructure development and carried out a simple alignment selection analysis [19]. The following is a list of previous research tables that became a reference for researchers completing this bridge's feasibility study [20].

3. Methods

This thesis leads to the search for quantitative data. This research focuses on cost planning for flyover construction in Bojonegoro Regency. Several aspects are considered as a whole. Applicable regulations and field facts will support the identification of the relationship between the problem under study and the context.

The overall research time was carried out for 4 (four) months, starting from April 2023 to July 2023. At the same time, the field research was carried out for 2 (two) months from May to June 2023. The research location included determining the location of the flyover to be built in Bojonegoro and Kapas Districts Bojonegoro Regency, which already has the results of a feasibility study for the construction of an elevated road (flyover), is continued with a location survey related to the existing conditions at the study site. The object of research is the geographical conditions, topography, geometry, and soil carrying capacity of the location, which will affect the flyover design. Furthermore, the design results will be used as a reference to determine the Cost of building a flyover. Here are the study locations.

Fig 1. Study Location

The literature study aims to study and understand the general theories of budget planning and flyover design, which are used as a basis for solving every problem in the preparation of this thesis.

Based on the collection method, data consists of two types, namely primary data and secondary data.

1. Primary data
   Primary data, both technical and non-technical, is obtained directly in the field. When associated with the three aspects of research, the need for these data can be described as follows:
   a. Technical Aspect
      Efforts are being made to collect data by interviewing relevant stakeholders who handle the Flyover Development plan at the research location. Next is conducting field research and selecting the location of the Flyover plan to be surveyed, preliminary and orientation/field review, and containing an accurate work plan, method, and implementation volume based on field conditions for each survey activity. Next, the data will be evaluated and analyzed to determine the availability of data from the Feasibility Study and Detailed Engineering Flyover Design (Flyover) for analysis and evaluation.
   b. Financial aspect
      Efforts were made to collect data on the unit price of work and financing sources at the Bojonegoro Regency Government level. Direct interviews with suppliers or traders of building materials obtained this data. Funding sources were obtained through interviews with the relevant offices that handle infrastructure development in the flyover sector, namely the Public Works and Spatial Planning Office. The unit price of work and funding sources for infrastructure development in the flyover sector are used to allocate the required budget based on the planning design that has been made.
2. Secondary Data
   Secondary data is data obtained from existing sources in the form of data from BPS Bojonegoro Regency, Bappeda Bojonegoro Regency, Public Works Office for Bina Marga and Spatial Planning Bojonegoro Regency, and villages in the study area. These data include:
   - Data on the location plan for the construction of the Bojonegoro Regency Flyover will be collected by taking data from the Office of Public Works for Highways and Spatial Planning for the Bojonegoro Regency.
   - Map data of the Study Area, Topographical and Geometry Condition Data in Kanor District, Road Network Data, Drainage, and Public Facilities in the study area with data collection at the Bojonegoro Regency Regional Planning and Development Agency.
   - Data on financial allocations for the construction of flyovers (flyovers) was collected data at the Office of Public Works, Highways and Spatial Planning, Bojonegoro Regency.

   a. Technical Aspect
   b. The technical secondary data described above is used to calculate the Cost of constructing a flyover.
   c. Financial aspect
      The unit price data issued by the Regional Government through the Regent's regulation each year can be used as a reference for calculating the budget ceiling for the Cost of constructing an elevated road (flyover) from the infrastructure design that has been designed.
      Aspects of Economic Analysis
      - Analysis of Vehicle Operating Costs (BOK): The BOK value is obtained from the sum of variable costs and fixed costs.
      - Travel time value analysis
      - Benefit Cost Ratio (BCR) analysis

B/C =
Benefits/costs ≥ 1

- Net Present Value (NPV) Analysis
  NPV = Benefit – Cost
- Feasibility analysis

From the calculation of the feasibility analysis above, a conclusion can be drawn as to whether the construction of the Flyover in Bojonegoro is feasible from an economic standpoint.

3.1. Data Analysis and Discussion

This study uses BOK, NPV, BCR, and IRR analysis to conduct the data analysis process for the feasibility study of the flyover construction. The primary objective of this analysis and evaluation process is to identify the economic feasibility based on the benefits and return on investment in selecting alternative flyover developments. In principle, the criteria used in the financial analysis are to compare the benefits derived from saving vehicle operating costs with the investment, maintenance, and vehicle operating costs incurred to build a flyover over the service life of the flyover. The approach used in the process of analysis and evaluation of this study is qualitative.
Using purposive sampling, a sampling technique with specific considerations by the requirements implied in the research, is carried out because only some elements/members of the population understand this research topic from the Public Works Department of Binamarga, namely the construction and maintenance of roads and bridges and the physical and infrastructure section, Bappeda, communications including the road and bridge maintenance sector, road technical planning, and the regional spatial planning section to obtain perceptions regarding appropriate criteria and the level of importance between criteria. The following is a flowchart of the methodology used in this paper.

3.2. Feasibility Weighting Modeling

The Analytical Hierarchy Process (AHP) determines the Bojonegoro Fly Over's Feasibility weighting based on district road operators' perceptions. In deciding this road segment, pair weighting is carried out between regional development criteria and alternative district road segments, which are links between regions. Determination of the ranking of road segments is arranged in a hierarchical structure of the problem and its solution. The criteria for this study are determined by consensus among the decision-makers.
In planning the hierarchy and alternative feasibility studies for the construction of the Bojonegoro flyover, the authors draw from several studies that have been carried out, including the first related to the economic aspect referring to the ECONOMIC FEASIBILITY ANALYSIS OF BAY BRIDGESAWAIBU by Alfred sanny talaksoru, 2022 using the BOK, NPV, BCR, and IRR variables to calculate the feasibility of building the bridge, so that in this study the economic aspect in terms of flyover project investment exceed the projected costs incurred marked with NPV> 1, the benefits generated are more the large Amount of expenses incurred is indicated by B/C> 1 and the fast rate of return is characterized by an IRR of more than the interest rate. Then for the traffic aspect, it refers to the FEASIBILITY STUDY OF THE DEVELOPMENT OF THE APPROACH ROAD TO THE MAHKOTA BRIDGE – SIMPANG 4 PAMPANG by Muhammad Rezdiansyah et al., 2021 is viewed from the perspective of traffic movement and highway economy, where the main goal is to provide safe, efficient and economical traffic movement.
The parameters taken in this study were able to reduce the accident rate and be efficient; furthermore, the aspect of regional development refers to the vision and mission of the local government policy plan, namely the realization of a solid, valuable, and sustainable infrastructure that is included in the STRATEGY AND POLICIES OF THE SKPD FOR THE YEAR 2021-2041 namely the realization of adequate road infrastructure in the form of the development of the district ring road network and the valuable and sustainable functioning of all existing resources to create an increase in industrial areas so that the parameters taken can have an impact on the creation of industrial area development and the development of the district ring road network. And finally, on the location aspect based on the REGIONAL SPATIAL PLAN FOR 2021-2041 BOJONEGORO REGENCY in PERDA NO. 5 YEAR 2021 related to the suitability of land use based on the RTRW and RDTR and the ease of land acquisition. Based on previous research and local government regulations, the arrangement of the hierarchical structure can be seen in the following figure :

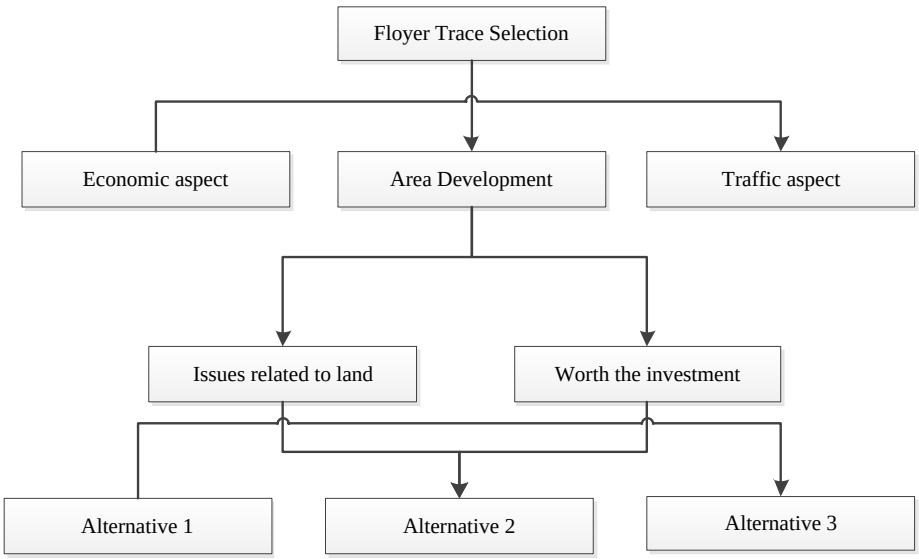

Fig 2. The Bojonegoro Flyover Feasibility Decision-Making Hierarchy

3.3. Research Flowchart

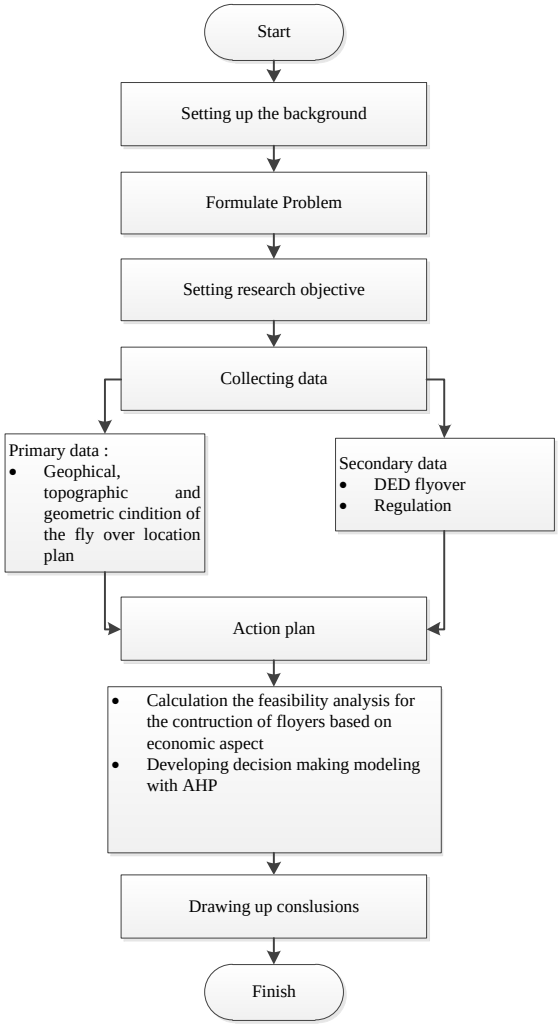

Fig3. Flowchart

4. Analysis and Discussion

In developing a road network in the Bojonegoro Regency area that is integrated, one of the plans that will be carried out is to build a flyover that connects the road network in the city of Bojonegoro with the road network in the southern region and avoids level crossings with railroads.
Flyover Trace Planning
Primary considerations for efforts to reduce traffic flow on roads leading to Bojonegoro City using flyovers are as follows:

1. There is a cross-rail network that passes through the planning area.
2. More directing and accelerating regional access for East Java Province and Central Java Province in building a balanced regional transportation system
3. Attract new developments in the economic field, especially in terms of accessibility for bonded and other functional areas.

With the construction of the flyover, it is hoped that traffic flow on the Bojonegoro-Cepu section will be split into two sections.
The flyover construction route that will be carried out to serve the regional transportation system has a direction from north to south, or vice versa, as follows:

1. The planned location can connect the HOS Cokroaminoto road section with the Bojonegoro-Cepu road section.
2. The location can avoid meeting plots with railroad crossings and reduce the number of points of conflict at intersections.
3. Can support national roads that connect Bojonegoro - Cepu and Bojonegoro - Nganjuk.

4.1. Trace Planning

Overpass (flyover) on the road MT. Haryono headed to HOS Cokroaminoto Bojonegoro, a bridge connecting the south to the district capital and the west of the district, and vice versa. The condition existing at the location of the flyover plan will cross the railroad tracks and avoid the intersection with the Rajekwesi, MT. Haryono, Pattimura, and H.O.S. Cokroaminoto. In this feasibility study, a Bojonegoro flyover is planned using precast concrete girder structures and slab on-pile concrete on the approach bridge with a design road width of 12 m and a flyover length of 720 m. Based on these alternative locations, three routes were determined with several considerations, including the area's condition, the direction of traffic movement, and the infrastructure condition in the alternative Bojonegoro flyover plan. The surveyed location is the Bojonegoro – Ngawi road with the HOS.

4.2. Trafic condition

To determine traffic conditions, a traffic survey was conducted to provide an overview of the number of vehicles passing through the study area and choose the distribution of traffic directions. This traffic survey was conducted at one intersection point with four approach roads. The location of the traffic volume survey was carried out at the HOS Cokroaminoto - Rajekwesi intersection with Pattimura - MT Haryono and on the HOS Cokroaminoto road, Rajekwesi road, MT Haryono road and Pattimura road. Pictures of traffic survey locations can be seen in the following figure.

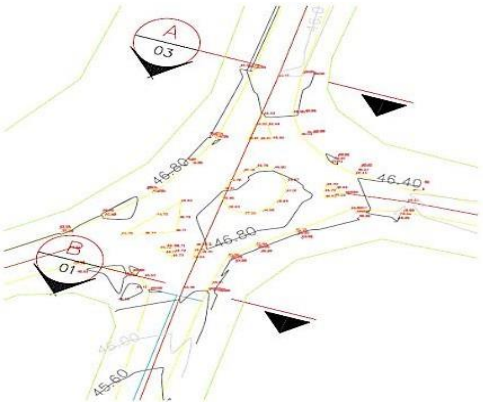

Fig 4. Traffic Survey Locations

The traffic volume survey (LHR) results, which were carried out for 40 hours starting in November 2015, showed that on the Rajekwesi road and MT roads, Haryono has a traffic volume of over 15,000 vehicles per day, while on the HOS Cokroaminoto road section, the traffic volume is ± 10,000 vehicles per day, and on the Pattimura road section, ± 6,500 cars per day. The recapitulation of the results of the traffic volume survey conducted can be seen in the following table :

Table 1. Traffic Volume

Number	Year	Street name					Vehicles /Day	EMP				JmlahSMP
			LV	HV	MC	BUS		LV	HV	MC	BUS	
								1	1,3	0,35	1,3	
1	2021	MT. Haryono	8867	5901	26793	198	41759	8867	7671,3	9377,55	257,4	26173,25
2	2021	HOS COKROAM-INOTO	6195	864	26793	198	32445	6195	1123,2	8876	33,8	16228
3	2021	RAJEKWESI	9714	5376	25909	211	41210	9714	6988,8	9068,55	274,3	26045,25
4	2021	PATIMURA	6605	133	21605	9	28352	6605	172,9	7561,75	11,7	14351,35

Description of the conditions on the roads studied include the following:

1. The existing road has an average width of 6.00 –14.00 meters, and the type of pavement on the current sections is Hotmix pavement.
2. The condition of the existing road crossing, the double-track railroad crossing, and adjacent to the intersection (junction four) Jl. HOS. Cokroaminoto - Jl. Rajekwesi with Jl. Pattimura– Jl. MT. Haryono.
3. The area around the road is relatively densely residential, with shops, street vendors, and limited free space between the road and permanent buildings.
4. Existing road sections need to be improved to accommodate future developments.
5. Heavy traffic flow with a mixed traffic composition consisting of trucks, passenger/sedan vehicles, motorcycles, and non-motorized vehicles. Traffic congestion occurs during rush hours.
6. Drainage channels do not function optimally and are not regulated by field conditions. It is necessary to construct drainage channels and additional auxiliary buildings in several places.

4.3. Economic Aspect

The economic aspect of this feasibility study is a study of the project cost components and the benefit-cost components that will be obtained/saved from the construction and improvement of district roads.

Estimated project costs are calculated based on the results of the initial planning and calculation of the volume of planning work and according to the type of work. The estimated unit price for every kind of work is calculated based on standardized prices for goods and services for FY 2021, and for materials that are not included in the list refers to the paramount activity unit price (HSPK) for Bojonegoro Regency for FY 2021. The analysis used to calculate unit prices is the Bina Marga Analysis (AHS) based on Binamarga Specifications for 2021. The benefit-cost component is calculated based on savings.

Vehicle Operating Costs (BOK) and saving time values. The BOK analysis is calculated based on the guidelines developed by PCI, while the time value is calculated based on the IRMS method with the income approach.

Table 2. Equation of Vehicle Operational Cost Analysis (BOK)

Number	Parameter Equation Description
1	Fuel consumption Y= 0.07629 × S2 – 8.45703 × S + 349.7911 Y = cost coefficient
2	Lubricant Consumption
3	Cost of using tires Y = 0.0008 × S + 0.0045333 Rp/1000km
4	Maintenance Cost (spare parts) Y = 0.00000064 × S + 0.0005567 S = speed in km/hour
5	Maintenance Cost (mechanic) Y = 0.00362 × S + 0.36267
6	Capital Interest Y= (0.15 × 1Ci000) ÷ (500 × S)
7	Insurance Cost Y = (0.35 × 1000 × 0.5) ÷ (500 × S)

4.3. Project Cost Components

The project cost components consist of construction costs, maintenance costs up to the project's life, planning costs, and supervision costs. The cost calculation is based on the estimated market price prevailing in the Bojonegoro district. The estimated Cost of constructing this flyover can be calculated in the following table.

Table 3. Estimated Development Cost Calculation Alternative Bojonegoro Flyover I

RECAPITULATION
FORECAST LIST OF QUANTITIES AND PRICES

Activity	: Review of FlyOver Alternative 3 Feasibility Study
Source of Funds	: 2021 APBD
Location	: Bojonegoro Regency

Number	Explain	Total price
I	**PREPARATORY WORK**	44,124,654,800.00
II	**FLY OVER JOB**	
A	EXCAVATION AND FILLING WORK	1,885,280,277.50
B	PILLING WORK	29,833,619,191.70
C	CONSTRUCTION WORK UNDER THE BRIDGE	16,426,809,551.14
D	CONSTRUCTION WORK ON THE BRIDGE	29,814,496,197.16
E	**COMPLETE WORK**	4,760,750,522.77
III	ACCESS ROAD WORK	
A	EARTHWORKS	2,114,556,180.00
B	GRAINED PAVEMENT WORK	2,525,597,944.34
C	DRAINAGE WORK	155,936,916.67
IV	**BRIDGE ROAD WORK**	
A	EARTHWORKS	554,809,474.01
B	WORK UNDER THE BRIDGE	2,586,071,638.03
C	WORK ON THE BRIDGE	3,293,276,599.49
D	COMPLETE WORK	4,072,023,391.80
(A)	AMOUNT	142,147,882,684.60

	ROUNDED	142,147,882,700.00

Says:
One Hundred Forty-Two Billion One Hundred Forty-Seven Million Eight Hundred Eighty-Two Thousand Seven Hundred Rupiah

From the calculation of the estimated development costs, as shown in the table above for the alternative location I above, it is obtained that the construction cost is Rp. 142,147,882,700,- (One hundred and forty-two billion one hundred and forty-seven million eight hundred and eighty-two thousand and seven hundred rupiah), excluding VAT and PPh taxes.

Table 4. Estimated Development Cost Calculation Alternative Bojonegoro Flyover II

RECAPITULATION
FORECAST LIST OF QUANTITIES AND PRICES

Activity	: Review of FlyOver Alternative 2 Feasibility Study
Source of Funds	: 2021 APBD
Location	: Bojonegoro Regency

Number	Explain	Total price
I	**PREPARATORY WORK**	44,124,654,800.00
II	**FLY OVER JOB**	
A	EXCAVATION AND FILLING WORK	1,885,280,277.50
B	PILLING WORK	29,833,619,191.70
C	CONSTRUCTION WORK UNDER THE BRIDGE	16,424,375,360.94
D	CONSTRUCTION WORK ON THE BRIDGE	28,736,090,952.61
E	**COMPLETE WORK**	5,248,570,253.28
III	ACCESS ROAD WORK	
A	EARTHWORKS	2,619,524,820.00
B	GRAINED PAVEMENT WORK	3,136,682,128.23
C	DRAINAGE WORK	186,193,333.33
IV	**BRIDGE ROAD WORK**	
A	EARTHWORKS	554,809,474.01
B	WORK UNDER THE BRIDGE	2,586,109,341.72
C	WORK ON THE BRIDGE	3,293,304,747.19
D	COMPLETE WORK	4,165,488,815.78
(A)	AMOUNT	142,794,703,496.27
	ROUNDED	142,794,703,500.00

Says:
One Hundred Forty-Two Billion Seven Hundred Ninety-Four Million Seven Hundred Three Thousand Five Hundred Rupiah

From the calculation of the estimated development costs, as shown in Table 5.4 for alternative location III above, it is obtained that the construction cost is Rp. 142,794,703,500,- (One hundred forty-two billion seven hundred ninety-four million seven hundred three thousand five hundred rupiahs), not including VAT and PPh taxes.

Table 5. Estimated Development Cost Calculation Alternative Bojonegoro Flyover III

Number	Description	TOTAL PRICE (Rp.)
I	WORK PREPARATION	68.445.000.000,00
II	Work Fly over	
A	Excavation And Landfill Work	4.981.337.968,46
B	Work Erection	9.210.990.000,00
C	Under construction work Bridge	16.997.190.358,00
D	Work Bridge Building	65.872.103.910,49
E	Complementary Work	2.983.000.000,00
III	Access Road Works	
A	Earthworks	2.418.598.215,00
B	Pavement Workgrained	2.267.619.610,77
C	Work Drainage	279.290.000,00
D	Work Complementary	1.278.958.758,00
(A) Amount Rounded		**174.734.088.820,72** **174.734.088.800,00**

Spelled out:
One Hundred Seventy-Four Billion Seven Hundred Thirty-Four Million Eighty-Eight Thousand Eight Hundred

From the calculation of the estimated construction costs, as shown in Table 5.2 for the alternative location I above, it is obtained that the construction cost is Rp. 174,734,088,800,- (One hundred seventy billion seven hundred thirty-four million eighty-eight thousand eight hundred rupiahs), excluding VAT and PPh taxes.

4.4. Benefit Cost Components

1. Savings in Vehicle Operational Costs Based on the results of calculating vehicle operating costs (BOK) using variable cost components and the parameters of existing road conditions, the amount of vehicle operating costs before the project is obtained, as described in the following table.
2. Time Value
   The value of time is the cost savings of travel time. These savings are another critical component of the benefits to road users. IRMS estimates the unit value of travel time (Rp/hour/vehicle) according to 2006 prices based on the "income approach method" traditional. The factors considered in calculating the unit time value per vehicle for IRMS are as follows.
   a. Passenger monthly income by vehicle group
   b. Shadow wage rate (=0.85%)
   c. Monthly work time (=191 hours)
   d. Rest time value (=28% of work time value),
   e. Percentage of travel purposes for work and non-work trips by vehicle group and
   f. Number of passengers per vehicle (Average Occupancy)

The amount of time value can be calculated using the IRMS method with the traditional income method approach.

Table 6. Amount of Travel Time Value

Component	Sedan	Public transportation	Goods Transportation	Small Bus	Big Bus	Truck	Motorcycle
Income/month	4,520,000	1,356,000	1,221,000	1,356,000	1,356,000	1,221,000	1,808,000
Income according to SWR (shadow wage rate 85%)	3,842,000	1,152,600	1,037,850	1,152,600	1,152,600	1,037,850	1,536,800
Working time/month (7 hours a day)	191	191	191	191	191	191	191
TTC Passengers per Hour							
Working time value	20,115	6,035	5,434	6,035	6,035	5,434	8,046
Assess rest time	5,632	1,690	1,521	1,690	1,690	1,521	2,253
% Work travel	50%	30%	75%	30%	30%	75%	50%
% Travel is not for work	50%	70%	25%	70%	70%	25%	50%
Passenger	2	8	1	16	32	1	1.2
TTC/passenger/hour	12,874	2,317	5,216	2,317	2,317	5,216	5,149
ITC/vehicle/hour	25,747	18,538	5,216	37,076	74,153	5,216	6,179

Table 7. Value of Travel Time based on HLIP and IRMS

Category	Category Value Time/hour/person		Transportation type	Time/clock/vehicle value	
	HLIP	IRMS		HLIP	IRMS
Car use, work	9.735	11.749	Transport car	11.56	15.038
Bus use, work	3.809	3.72	Goods	12.85	14.763
Car use, not work	2.920	3.290	Medium Bus	26.226	29.525
Bus use, not work	1.143	1.042	Big Bus	53.996	59.050

*: Heavy Loaded Road Improvement Project II, Master Plan Review Study for National Network Roads, Final Report Volume 2 December 2001

**: IRMS: Updating the VOC Equation Coefficients,2006

4.5. Economic Feasibility Analysis

Economic feasibility analysis aims to assess the extent to which the project is economically acceptable and sensitive to changes in conditions that may affect investment. The criteria used to determine investment feasibility are NPV, BCR, and IRR. Meanwhile, optimistic and pessimistic conditions are used to test the investment sensitivity.

The results of the economic analysis carried out on this flyover construction project can be seen in the following table:

Table 8. Investment Costs and Benefits Costs of Alternative I

Year	Construction costs, planning supervision	Operation & Maintenance Costs	Costs	Saving BOK	Saving the Value of Time	Benefit
2022	29.282.464		29.284.464			

2023	73.206.160		73.206.160			
2024	43.923.696		43.923.696			
2025		1.000.000	1.000.000	126.328.125	17.464.430	143.792.554
2026		1.000.000	1.000.000	132.644.531	18.337.651	150.982.182
2027		1.000.000	1.000.000	139.276.738	19.254.534	158.531.291
2028		1.000.000	1.000.000	146.240.595	20.217.260	166.457.856
2029		2.000.000	2.000.000	153.552.652	21.228.123	174.780.749
2030		1.000.000	1.000.000	161.230.256	22.289.530	183.519.786
2031		1.000.000	1.000.000	169.291.769	23.404.006	192.695.775
2032		1.000.000	1.000.000	177.756.358	24.574.206	202.330.564
2033		1.000.000	1.000.000	186.644.176	25.802.917	212.447.092
2034		2.000.000	2.000.000	195.976.384	27.093.063	223.069.447
2035		1.000.000	1.000.000	205.775.204	28.447.716	234.222.919
2036		1.000.000	1.000.000	216.063.964	29.870.102	245.934.065
2037		1.000.000	1.000.000	226.867.162	31.363.607	258.230.769
2038		1.000.000	1.000.000	221.727.399	26.454.158	248.181.557
2039		2.000.000	2.000.000	250.121.046	34.578.376	284.699.42
2040		1.000.000	1.000.000	262.627.09	36.307.295	298.934.393
2041		1.000.000	1.000.000	275.758.453	38.122.660	313.881.113

Table 9. Investment Costs and Benefits Costs of Altern

Year	Construction costs, plan-ning supervi-sion	Operation & Maintenance Costs	Costs	Saving BOK	Saving the Value of Time	Benefit
2022	29.415.709		29.415.709			
2023	73.539.272		73.539.272			
2024	44.123.563		44.123.563			
2025		1.000.000	1.000.000	101.883.290	17.464.420	119.347.720
2026		1.000.000	1.000.000	106.977.433	18.337.631	125.315.106
2027		1.000.000	1.000.000	112.326.328	19.254.534	131.580.861
2028		1.000.000	1.000.000	117.942.644	20.217.260	138.159.904
2029		2.000.000	2.000.000	123.839.776	21.228.123	145.067.900
2030		1.000.000	1.000.000	130.031.763	22.289.530	152.921.293
2031		1.000.000	1.000.000	136.533.353	23.404.006	159.937.359
2032		1.000.000	1.000.000	143.360.021	24.574.206	167.934.227
2033		1.000.000	1.000.000	150.528.022	25.802.917	176.330.939
2034		2.000.000	2.000.000	158.054.423	27.093.063	185.147.486
2035		1.000.000	1.000.000	165.957.144	28.447.716	194.404.860
2036		1.000.000	1.000.000	174.255.001	29.870.102	204.125.103
2037		1.000.000	1.000.000	182.967.751	31.363.607	214.331.338
2038		1.000.000	1.000.000	178.276.989	26.454.158	204.731.147
2039		2.000.000	2.000.000	201.721.946	34.578.376	236.300.322
2040		1.000.000	1.000.000	211.808.043	36.307.295	248.115.338
2041		1.000.000	1.000.000	222.398.473	38.122.660	260.521.103

Table 10. Investment Costs and Benefits Costs of Alternative III

Year	Construction costs, planning supervision	Operation & Maintenance Costs	Costs	Saving BOK	Saving the Value of Time	Benefit
2022	35.995.222		35.995.222			
2023	89.988.050		89.988.050			
2024	53.992.833		53.992.833			
2025		1.000.000	1.000.000	82.509.735	17.464.430	99.974.165
2026		1.000.000	1.000.000	86.635.222	18.337.651	104.972.073
2027		1.000.000	1.000.000	90.966.983	19.254.534	110.221.516
2028		1.000.000	1.000.000	95.515.332	20.217.260	115.732.592
2029		2.000.000	2.000.000	100.291.098	21.228.123	121.519.222
2030		1.000.000	1.000.000	105.305.653	22.289.530	127.595.183
2031		1.000.000	1.000.000	110.570.936	23.404.006	133.974.942
2032		1.000.000	1.000.000	116.099.483	24.574.206	140.673.689
2033		1.000.000	1.000.000	121.904.457	25.802.917	147.707.374
2034		2.000.000	2.000.000	127.999.680	27.093.063	155.092.742
2035		1.000.000	1.000.000	134.399.664	28.447.716	162.847.380
2036		1.000.000	1.000.000	141.119.647	29.870.102	170.989.749

2037	1.000.000	1.000.000	148.175.629	31.363.607	179.539.236
2038	1.000.000	1.000.000	141.119.647	26.454.158	170.352.415
2039	2.000.000	2.000.000	163.363.631	34.578.376	197.942.008
2040	1.000.000	1.000.000	171.531.813	36.307.295	207.839.108
2041	1.000.000	1.000.000	180.108.404	38.122.660	218.231.063

4.6. Feasibility Analysis of Floyer Construction Bojonegoro

Several parameters can be used as benchmarks for tangible and intangible feasibility calculations to determine the feasibility of constructing a flyover. In this study, the benchmark for assessing the feasibility of building a flyover emphasizes three essential aspects: regional development, the economic aspect of the highway, and traffic safety. Regarding area development and traffic safety aspects, the feasibility of development is based on whether there are benefits that can be provided to road users, where these benefits are difficult to measure based on the economic aspect of the road. In principle, the criterion used in the financial analysis is to compare the benefits derived from savings in vehicle operating costs with the investment, maintenance, and vehicle operating costs incurred to build the toll road over the life of the toll road.

Three basic methods can be used to carry out economic evaluations, namely:

1. Net Present Value (NPV) or Net Present Value.
   In an economic evaluation, if the NPV is positive, the benefits will be more significant, which means that the project is justified or feasible to implement. Based on financial considerations, the limit value of NPV = 0, which means that it is a threshold for a project to be considered viable to build. If the NPV = negative, then the project cannot be justified to be implemented or is not feasible based on economic feasibility considerations.
2. Benefit Cost Ratio (B/C Ratio).
   Benefit Cost Ratio is a comparison between the Amount of profit (benefit) = the Amount of Cost (Cost) according to the level of present value (present value). The project is feasible if the B/C Ratio value is greater than 1 (BCR > 1). The threshold value of the B/C Ratio is = 1; if it is smaller than 1 (BCR < 1), then the project is not feasible.
3. Internal Rate of Return (IRR)
   The Internal Rate of Return (IRR) method is a quantity expressed by a discount rate where the present value of the benefits is equal to the current value of the costs incurred. In other words, the IRR is the discount rate where the NPV = 0. If the IRR exceeds the prevailing interest rate, the project is feasible, and vice versa.

4.7. Highway Economic Aspects

The BCR and NPV methods are used as parameters to calculate the feasibility of the flyover in terms of the economic aspect of the highway. In this calculation, the benefits are obtained from savings in vehicle operating costs, calculated using the Jasa Marga method.

Table 11. Calculation of Alternative Economic Analysis I

Year	Cost	Benefit	Discount factor	PV	NPV
2022	29.282.464				-29.282.464
2023	73.206.160	0	0,95923		-70.221.736
2024	43.923.696	0	0,92013		-40.415.388
2025	1.000.000	143.792.554	0,88262	126.913.613	126.030.997
2026	1.000.000	150.982.182	0,84663	127.826.661	126.980.027
2027	1.000.000	158.531.291	0,81212	128.746.277	127.934.158
2028	1.000.000	166.457.856	0,77901	129.672.509	128.893.49
2029	2.000.000	174.780.749	0,74725	130.605.405	129.110.899
2030	1.000.000	83.519.786	0,71679	131.545.012	130.828.223
2031	1.000.000	192.695.775	0,68757	132.491.379	131.803.811
2032	1.000.000	202.330.564	0,65954	133.444.554	132.785.017
2033	1.000.000	212.447.092	0,63265	134.404.587	133.771.938
2034	2.000.000	223.069.447	0,60686	135.371.527	134.157.810
2035	1.000.000	234.222.919	0,58212	136.345.423	135.763.304
2036	1.000.000	245.934.065	0,55839	137.326.325	136.767.938
2037	1.000.000	258.230.769	0,53562	138.314.284	137.778.661
2038	1.000.000	248.181.557	0,51379	127.512.420	126.998.633
2039	2.000.000	284.699.422	0,49284	140.311.576	139.325.894
2040	1.000.000	298.934.393	0,47275	141.321.012	140.848.263
2041	1.000.000	313.881.113	0,45348	142.337.710	141.884.234
				2.274.490.274	2.121.743.718
				NPV	2.121.743.718
				BCR	12,7499

Table 12. Calculation of Alternative Economic Analysis II

Year	Cost	Benefit	Discount factor	PV	NPV
2022	29.415.709				-29.415.709
2023	73.339.272		0,95923		-70.541.268

2024	44.123.563		0,92013		-44.123.563
2025	1.000.000	119.347.720	0,88262	105.338.210	104.455.594
2026	1.000.000	125.315.106	0,84663	106.096.039	105.249.405
2027	1.000.000	131.580.861	0,81212	106.859.320	106.047.201
2028	1.000.000	138.159.904	0,77901	107.628.092	106.849.081
2029	2.000.000	145.067.900	0,74725	108.402.395	106.907.889
2030	1.000.000	152.321.295	0,71679	109.182.268	108.465.479
2031	1.000.000	159.937.359	0,68757	109.967.752	109.280.185
2032	1.000.000	167.934.227	0,65954	110.758.887	110.099.350
2033	1.000.000	176.330.939	0,63265	111.555.714	110.923.064
2034	2.000.000	185.147.486	0,60686	112.358.273	111.144.556
2035	1.000.000	194.404.860	0,58212	113.166.606	112.584.488
2036	1.000.000	204.125.103	0,55839	113.980.754	113.422.367
2037	1.000.000	214.331.358	0.53562	114.800.759	114.265.137
2038	1.000.000	204.731.147	0,51379	105.188.170	104.674.384
2039	2.000.000	236.300.322	0,49284	116.458.511	115.472.828
2040	1.000.000	248.115.338	0,47275	117.296.342	116.823.592
2041	1.000.000	260.521.105	0,45348	118.140.200	117.686.724
				1.887.178.294	1.773.795.057
				NPV	1.773.795.057
				BCR	10,3771

Table 13. Calculation of Alternative Conomic

Year	Cost	Benefit	Discount factor	PV	NPV
2022	29.415.709				-29.415.709
2023	73.339.272		0,95923		-86.319.478
2024	53.992.056		0.92013		-49.680.275
2025	1.000.000	99.974.165	0.88262	85.238.800	87.556.184
2026	1.000.000	104.972.873	0.84663	85.873.611	88.026.977
2027	1.000.000	110.221.516	0.81212	59.512.990	88.700.871
2028	1.000.000	115.732.592	0.77901	90.256.968	89.377.957
2029	2.000.000	121.519.222	0.74725	90.805.580	89.311.074
2030	1.000.000	127.595.183	0,71679	91.458.857	90.742.068
2031	1.000.000	133.974.942	0.68757	92.116.834	91.429.267
2032	1.000.000	140.673.689	0,65954	92.779.546	92.120.000
2033	1.000.000	147.707.374	0.63265	93.447.024	92.814.375
2034	2.000.000	155.092.742	0.60686	94.119.305	92.905.589
2035	1.000.000	162.847.380	0,58212	94.796.422	94.214.304
2036	1.000.000	170.989.749	0,55839	95.478.411	94.920.024
2037	1.000.000	179.559.236	0,55562	96.165.306	95.629.683
2038	1.000.000	170.352.415	0.51379	87.524.830	87.011.043
2039	2.000.000	197.942.008	0,49284	97.553.957	96.565.275
2040	1.000.000	207.839.108	0,47275	98.255.784	97.783.035
2041	1.000.000	218.231.063	0.45348	95.952.650	98.509.183
				1.580.246.885	1.395.424.941
				NPV	1.395.424.941
				BCR	6,9780

From the results of the analysis, it was obtained that the IRR value for alternative location I with an NPV of 2,121,743,718,000 IRR value of 57% for alternative location II with an NPV of 1,733,795,057,000 an IRR value of 50% and for alternative location III with an NPV of 1,395,424,941,000 IRR value by 37%.

4.8. Regional Development Aspect

From the regional development perspective, constructing a flyover will benefit regional development. One of the benefits obtained is as follows:

1. This flyover can support access from the southern region of Bojonegoro Regency to the north, where a plan for constructing a cargo terminal, industrial area, and a salak fruit production center will be developed.
2. In terms of regional development in general, a flyover will provide benefits in forming a ring road network for the Bojonegoro Regency in the west of the Bojonegoro region.

4.9. Traffic Safety Aspects

From the aspect of traffic safety, the construction of this flyover can benefit road users, reducing the potential for accidents between trains and vehicles because there is no level meeting between the two modes. In addition, the construction of this flyover is by the Law on Railways number 13 of 1992, which states that the meeting between the highway and the railroad is not in the same area.

4.10. Decisions on Selection Floyer Trace Alternative

After calculating the economic analysis of the three flyover alignments, the next step is to conduct a study using AHP to determine the appropriate alignment. In this case, the respondents were policymakers, including the Bojonegoro Regency Regional Development Planning Agency (BAPPEDA), the Bojonegoro Regency Public Works Office for Highways, and the Bojonegoro Regency Transportation Service. The following is a sample questionnaire conducted on one of the respondents.

5. Conclusion

Based on the analysis and discussion, the conclusions drawn are :

1. The aspects considered in this study are location issues related to land acquisition, traffic performance, and economic factors, such as connecting BOK with return on capital IRR, NPV, and benefit-cost ratio.
2. There are three alternative route selections related to economic feasibility where the first alternative with NPV: 2,121,743,718,000, BCR: 12,7499, and IRR: 57, then the second alternative with NPV: 1,733,795,057,000, BCR: 10.3771, IRR: 50% and the third alternative with an NPV value: 1,395,424,941,000, BCR: 6,978 and IRR: 37%
3. Based on the economic feasibility analysis using process hierarchy analysis, the alternative chosen is the first alternative with a score of 0.571

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