

Analysis of Construction Costs For The KH Ahmad Dahlan Pohjentrek Road Section In Pasuruan City Considering Traffic Growth

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ABSTRACT

This study analyzes the impact of traffic growth on the structural lifespan and repair costs of the KH Ahmad Dahlan Pohjentrek road section in Pasuruan City. The primary aim is to assess traffic growth, calculate the equivalent single axle load (ESAL), and estimate construction costs using the 2024 Manual of Pavement Design (MDPJ) methodology. The research method involves calculating the ESAL for the road section, estimating construction costs, and recommending solutions to improve road performance. The results show that over a 10-year service life, the cumulative ESAL value is 26,047,040, indicating the need for a durable pavement design. The total construction cost is estimated at IDR 8.6 billion, with the majority of the costs allocated for pavement layers, including AC WC, AC BC, AC Base, and aggregate base courses. Additionally, the study emphasizes the importance of proper drainage management and regular maintenance to extend the lifespan of the pavement and reduce repair costs. In conclusion, the study recommends efficient resource procurement, road widening to alleviate congestion, integration of public transportation programs to reduce traffic dependency, and the implementation of modern monitoring technologies like Weight-in-Motion (WIM) systems to prevent overloading. These recommendations provide actionable insights for policymakers and stakeholders to enhance the road's performance, ensuring sustainable infrastructure development and minimizing future repair costs.

Keywords: traffic growth, construction cost, pavement design, kh. ahmad dahlan pohjentrek road, flexible pavement

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INTRODUCTION

The increase in the number of motorized vehicles from year to year has led to increasingly dense traffic volumes, especially in urban areas such as Pasuruan City. The road section of KH Ahmad Dahlan Pohjentrek is one of the strategic routes that serves as a link between regions, with a vital role in supporting community mobility and distribution of goods and services. Optimal road conditions are needed to maintain smooth traffic flow. However, major challenges arise due to traffic growth that is not proportional to the capacity and physical condition of the road, which often causes premature damage to the pavement (Nurkholis, 2018).

Flexural pavement is one of the most widely used pavement types in Indonesia due to its flexibility and ability to distribute traffic loads to the lower layers. However, rapid traffic growth and vehicle loads that exceed design standards often accelerate road deterioration, resulting in a shortened life span. In the 2024 Pavement Design Manual (MDPJ), the design life of a road has been designed by considering various parameters such as equivalent standard axle load (ESAL) and material characteristics. However, factors such as overloading, poor

drainage, material quality, and unexpected traffic growth remain the main causes of the road's inability to reach its planned life (Riduwan, Witjaksana, & Tjendani, 2023).

Previous research has shown that overloading has a significant impact on reducing pavement life. Al Faryzy et al. (2021) stated that pavement thickness greatly affects the ability of the road to withstand vehicle loads, especially on road sections with high traffic growth. Misdawati et al. (2021) added that overloading can cause a decrease in the planned life of up to 17.73%, which means that the road requires rehabilitation sooner than planned. This is reinforced by Batubara et al. (2023) who found that overloading on the Semarang ABC Toll Road accelerated the reduction of the planned life from 20 years to only 13 years.

Apart from overloading, traffic growth is also an important factor affecting road performance. Sihombing (2021) noted that a 5% increase in traffic can reduce the pavement life by up to 1 year from the planned life of 10 years. Hazifa et al. (2022) mentioned that traffic growth factors lead to an increase in maintenance cost requirements due to premature deterioration of the road. Therefore, it is relevant to analyze traffic growth and its impact on pavement life expectancy, especially in the context of cost-effective construction planning.

On the KH Ahmad Dahlan Pohjentrek road section, a preliminary survey showed a significant increase in traffic volume. Based on Average Daily Traffic (LHR) data, vehicle growth in this area continues to increase every year, which has implications for accelerating pavement damage. In line with that, Putra et al. (2021) in their research in Palangka Raya found that traffic growth affects the remaining life of the road, where sections with high traffic volumes tend to have a shorter remaining life. Thus, a thorough evaluation of the existing condition and remaining life of the road plan is needed to ensure its continued functionality (Aziz, Winarto, Poernomo, & Candra, 2019).

Routine and periodic maintenance is essential to maintain the durability of the road until the end of its planned life. However, maintenance and rehabilitation costs are often higher than initially estimated due to inaccurate traffic projections. Ibrahim (1994) mentioned that inappropriate cost estimation can lead to budget overruns and increase the financial burden on the government. Therefore, a comprehensive analysis is needed to optimize budget allocation while ensuring that road infrastructure is able to support people's mobility needs in a sustainable manner (Effendi, Purnama, Melani, & Mayah, 2021).

In this context, research using the 2024 Manual of Pavement Design (MDPJ) method is particularly relevant. Manuputty et al. (2022) showed that this method provides a systematic approach to pavement design based on actual traffic data, materials, and environmental conditions. The use of the MDPJ 2024 method also allows for more accurate estimation of pavement thickness, life expectancy, and repair cost requirements, as applied by Wibisono and Fitriani (2023) on the Kediri-Nganjuk road section.

Poor drainage is also one of the main causes of early pavement failure. Stagnant water can weaken the pavement structure so that it is more easily damaged when passed by heavy vehicles. Siregar (2020) revealed that inadequate drainage systems can reduce pavement life by up to 20%. This research emphasizes the importance of evaluating and improving drainage systems to support pavement durability.

Traffic loads that exceed capacity also affect the characteristics of pavement materials. The materials used must be of a quality that can withstand the pressure from heavy vehicle loads. However, in reality, the quality of materials is often not up to standard. This is exacerbated by the lack of supervision in the road construction process. Aulia et al. (2021) mentioned that less strict supervision can lead to discrepancies between design and realization, which in turn affects road performance (Mamari, 2017).

Modern technologies such as the use of traffic load measurement devices can also be integrated in the road planning and maintenance process. This technology enables real-time traffic data collection, so that traffic load projections can be more accurate. Thus, pavement

design can be adjusted to the actual needs in the field. Suherman and Widodo (2023) emphasize that the use of this technology can reduce the risk of premature damage to roads and improve the efficiency of maintenance budget allocation (Risman, 2017).

Based on the description above, this research aims to analyze the impact of traffic growth on the planned life of flexible pavement on the KH Ahmad Dahlan Pohjentrek road section. In addition, this research will also evaluate the construction costs needed to ensure the road can function optimally according to the planned life. The results of this research are expected to provide useful recommendations for future road planning and maintenance. With a comprehensive analysis, it is expected that road planning can be more effective and efficient in supporting community mobility and encouraging economic growth in urban areas.

The urgency of this research stems from the significant increase in traffic volume on the KH Ahmad Dahlan Pohjentrek road section in Pasuruan City, which is causing accelerated pavement deterioration and posing risks to transportation efficiency and road safety. Traffic growth has outpaced the road's design capacity, leading to increased wear and tear, higher maintenance costs, and the potential for premature failure. This research is crucial for providing timely data and analysis to help policymakers and infrastructure planners address these issues and develop effective strategies for road maintenance and expansion.

Although studies on the impact of traffic growth on road infrastructure have been conducted in other regions, there is limited research focusing on the KH Ahmad Dahlan Pohjentrek road section, a critical arterial road in Pasuruan City. Most studies address generalized traffic issues or large-scale infrastructure, while this study aims to provide localized insights specific to the challenges faced in Pasuruan. There is a gap in understanding the unique dynamics of traffic patterns, road wear, and cost implications for the specific area, making this study particularly relevant for future road planning.

This research introduces a novel application of the 2024 Manual of Pavement Design (MDPJ) methodology to evaluate the specific impact of traffic growth on road performance and construction costs for the KH Ahmad Dahlan Pohjentrek road section. While similar studies may have focused on general traffic impacts, this study provides a tailored approach by using real traffic data to estimate the equivalent single axle load (ESAL) and associated costs. The application of modern traffic load monitoring technologies such as Weight-in-Motion (WIM) systems further enhances the novelty of this research.

The primary objective of this research is to analyze the effects of traffic growth on the structural performance and cost implications of road construction for the KH Ahmad Dahlan Pohjentrek road section. The study aims to provide accurate estimates of future construction costs and necessary pavement designs to accommodate increasing traffic loads. The benefits of this research include offering actionable insights for effective road planning, maintenance strategies, and resource allocation. Additionally, the findings will help policymakers in Pasuruan City make data-driven decisions that balance budget constraints with the long-term sustainability of road infrastructure. This research will ultimately contribute to improving the quality of roads, ensuring safer and more efficient transportation for the community.

Literature Review

Impact of Traffic Growth on Road Construction Costs

Traffic growth has a significant impact on road construction costs, especially on major arterial roads that experience rapid increases in vehicle volumes. As the number of vehicles, especially heavy vehicles, increases, the stress on the pavement structure also increases, potentially shortening the life of the road and accelerating deterioration. Hazifa et al. (2022) noted that roads with high traffic will require significantly higher construction and maintenance costs compared to roads with stable traffic. For example, the construction cost of high-traffic roads can double due to the increased pavement thickness required to withstand greater vehicle loads. On Jalan KH Ahmad Dahlan Pohjentrek, the significant growth in traffic, especially

heavy vehicles, indicates that construction costs need to be carefully considered to match the load the road is facing. Therefore, it is important to take into account the average daily vehicle volume (LHR) and vehicle load distribution to design a pavement structure that matches the actual needs (Prasetya & Marleno, 2020).

Manual of Pavement Design (MDPJ) 2024 Approach to Cost Calculation

The Pavement Design Manual (MDPJ) 2024 provides a comprehensive analytical approach to pavement planning and design, including pavement thickness calculation methods that refer to cumulative traffic loads. One of the main methods applied in MDPJ 2024 is the CESAL (Cumulative Equivalent Single Axle Load) method, which allows planners to estimate the cumulative load of vehicles that will pass over the road during the plan life. Al Faryzy et al. (2021) explain that this method provides higher accuracy in designing pavement thicknesses that match actual traffic characteristics. In the context of Jalan KH Ahmad Dahlan Pohjentrek, the application of the CESAL method can help design a pavement that is more durable against the increasing heavy vehicle loads. It also allows for more efficient construction cost planning as it can minimize errors in thickness estimation and material selection. The CESAL-based approach is expected to reduce the risk of planning errors and ensure that the road structure can withstand the long term.

Projected Construction Costs Due to Traffic Growth

The projected cost of road construction is strongly influenced by the projected traffic growth that will occur during the planned life of the road. According to Ibrahim (1994), construction cost estimation must take into account various variables such as pavement thickness, quality of materials used, and the projected number of vehicles that will cross the road in a certain period of time. Batubara et al. (2023) added that inaccuracies in the calculation of traffic projections can cause budget overruns of up to 25%, which often results in project waste or delays. On the KH Ahmad Dahlan Pohjentrek Road section, traffic projections that do not match reality can result in large changes in the cost estimate, given the larger-than-expected increase in vehicle volumes. Therefore, it is important to use more accurate data and planning methods based on realistic traffic growth projections, so that construction costs can be calculated more precisely and efficiently.

Case Study: Construction Cost Analysis on Jalan KH. Ahmad Dahlan Pohjentrek

Jalan KH Ahmad Dahlan Pohjentrek is one of the main arterial routes in Pasuruan City that is facing major challenges due to rapid traffic growth, especially from heavy vehicles passing through daily. Based on preliminary surveys, the volume of vehicles on this section is increasing far beyond existing projections, which puts great pressure on pavement structures designed for specific loads. In the face of this reality, it is important to re-evaluate the original design of the road, including pavement thickness and materials, in order to adapt it to heavier traffic conditions. The CESAL method used in the 2024 Pavement Design Manual can provide a more accurate estimate of the pavement thickness required to withstand the growing traffic loads. Putra et al. (2021) emphasized that the application of CESAL data in road planning can reduce the likelihood of early deterioration and extend the planned life of the road. By considering these factors, the construction cost analysis of Jalan KH. Ahmad Dahlan Pohjentrek will provide more realistic and efficient results, helping budget management and minimizing unexpected additional costs due to rapid traffic growth.

METHOD

Research Approach

The approach used in this research is a descriptive quantitative approach. This approach aims to provide an overview of the phenomena that occur on the KH. Ahmad Dahlan Pohjentrek road section of Pasuruan City related to traffic growth and its impact on construction costs. Quantitative data is processed to produce relevant numbers, such as average daily traffic

volume (LHR), traffic growth rate, and the estimated construction costs required. Descriptive research was conducted by collecting primary and secondary data. Primary data was obtained through direct field surveys, while secondary data was obtained from relevant documents and literature, such as the 2024 Pavement Design Manual (MDPJ). The results of this approach are expected to provide a thorough understanding of the relationship between traffic growth and road construction costs.

Location and Time of Research

This research was conducted on the road segment KH Ahmad Dahlan Pohjentrek Pasuruan City, which has a role as a connecting road between areas in the region. The research location covers the road segment from STA 00+000 to STA 01+290. The selection of this location was based on the high intensity of traffic that occurred and the need to determine the impact of traffic growth on the planned life of the road. The study period covered a three-month period from January to March 2024. This period included field survey, secondary data collection, data analysis, and report preparation. The survey was conducted in stages to ensure the accuracy of the data obtained.

Data Collection

Primary data was obtained through surveys of average daily traffic (LHR), observations of road conditions, and interviews with relevant parties, such as the transportation department and road users. Secondary data included official documents such as the 2024 Manual of Pavement Design (MDPJ), traffic data from related agencies, and maps of the study location. In addition, relevant previous studies were also used to support the data analysis. The collected data were processed to obtain information on traffic volume, vehicle distribution, and other design parameters needed to calculate construction costs.

Data Analysis Technique

The LHR data is processed to calculate the traffic growth factor using the formula specified in MDPJ 2024. These growth factors are then used to project traffic volumes over the planned life of the road. The road plan life is calculated based on the equivalent single axle load (ESAL) values obtained from survey data and vehicle load distribution calculations. This process involves analyzing the cumulative value of vehicle loads over the plan life. The construction cost was calculated based on the pavement layer thickness designed according to the MDPJ 2024 design chart. The cost per unit of work was calculated using an analysis of the unit price of work applicable in the Pasuruan City area.

Data Validation

Field survey results were compared with secondary data to identify concordance and eliminate data discrepancies. The results of the calculations and data analysis were consulted with transportation and pavement experts for feedback and recommendations for improvement. With systematic methods and thorough validation, the results of this study are expected to provide an accurate picture of the construction costs required due to traffic growth on the KH. Ahmad Dahlan Pohjentrek road in Pasuruan City.

RESULTS AND DISCUSSION

Results

Traffic Analysis

The results of the traffic analysis showed a significant increase in the average daily traffic volume (LHR) on the KH. Ahmad Dahlan Pohjentrek road section, Pasuruan City. Based on survey data, annual traffic growth reached 7.2%, which was dominated by light and heavy vehicles. The commercial vehicle category contributes a considerable amount, which is about 40% of the total traffic. These vehicles cause uneven load distribution on each lane, which is a major concern in calculating the cumulative Equivalent Single Axle Load (ESAL). The ESAL value greatly affects the planned life of the road because the higher the cumulative load, the

faster the pavement deteriorates. In this case, the lane distribution factor (DL) illustrates that commercial vehicles are often concentrated in certain lanes. As a result, heavy loads are concentrated on only part of the pavement, leading to premature deterioration of some road segments. Visual observations also revealed damage such as cracks and potholes at certain points, which were further exacerbated by the existing condition of inadequate drainage. Poor drainage causes waterlogging, accelerates the weathering process, and reduces pavement durability.

Based on these conditions, a cumulative projection of ESAL over the 10-year plan life was conducted. The results showed a value of 26,047,040, which falls into the >15-30 million category according to the Manual of Pavement Design (MDPJ) 2024 guidelines. This value indicates that the road should be designed to withstand high loads in the long term. The vehicle directional distribution factor (DD) of 0.5 also emphasizes the need for a pavement design that can optimally accommodate two-way traffic. In this case, attention to design and the materials used are important aspects for the road to meet transportation needs. In addition, the survey noted a significant increase in traffic volume due to vehicles entering and exiting the toll road. This adds to congestion and affects transportation efficiency. In response, mitigation measures such as road widening are needed to increase capacity and reduce pressure on existing sections.

This data includes detailed calculations of annual CESAL values, which form the basis for further analysis. Using this data, it can be seen that consistent traffic growth has a significant impact on the cumulative load of the pavement. Therefore, road planning should take this trend into account so that the design can adapt to future needs. Mitigation efforts such as road widening, improved drainage systems, and the use of more durable pavement materials are solutions that cannot be ignored. Overall, this analysis demonstrates the importance of a holistic approach in road infrastructure planning and design to ensure optimal road plan life, transportation efficiency and user comfort.

Construction Cost Calculation

The results of the construction cost calculation show that the total cost required for road widening and improvement is IDR 8,599,657,783.62. This cost includes various types of work, such as excavation, transportation, and procurement of materials for pavement layers. The thickness of the designed layers follows the technical standards, namely 40 mm thick AC WC, 60 mm thick AC BC, 80 mm thick AC Base, 200 mm thick class A aggregate foundation layer, and 150 mm thick class B aggregate foundation layer. The design is based on the load category of more than 15 million to 30 million in the 2024 Manual of Pavement Design (MDPJ), which is used as the main reference. With this calculation, the project is expected to be able to handle high traffic loads over a period of time without compromising the quality of the infrastructure.

The largest component in the budget comes from material procurement, which accounts for about 60% of the total construction cost. These materials include asphalt, aggregates and other additives needed to create a strong and durable pavement. The unit price of the work was calculated using local price analysis in Pasuruan City, allowing for a more realistic calculation. In addition, labor costs and the use of heavy equipment accounted for 20% and 15% of the total budget, respectively. Meanwhile, other additional costs, such as drainage management, only accounted for about 5% of the total budget. Despite its small proportion, drainage management plays an important role in ensuring that roads remain functional and do not deteriorate quickly due to waterlogging.

A sensitivity analysis was conducted to assess the impact of fluctuating material prices on the total construction cost. The analysis found that a 10% increase in material prices would result in an increase in total costs to around IDR 9 billion. This highlights the importance of cost control through efficient material procurement strategies, such as working with local suppliers or bulk purchasing to obtain price discounts. Such efforts can reduce the risk of cost overruns due to unexpected changes in market prices.

The field survey also noted the urgent need for improved drainage around the project area. Adequate drainage is essential to prevent premature deterioration of the pavement due to waterlogging, which can accelerate the degradation of road materials and structures. If drainage is properly managed, the planned life of the pavement can be extended up to 20% longer than without proper drainage management. Therefore, budget allocation for drainage management is one of the top priorities in the planning of this project. Effective drainage not only reduces road damage, but also improves road user safety.

To aid decision-making, Table 1, which lists the calculation results of the Cost Budget Plan, is included in the report. This table provides a detailed overview of the allocation of construction costs by work type, such as excavation, transportation, material procurement, and pavement layer installation. Through this table, relevant parties can easily identify the main cost components that affect the total budget and evaluate the efficient use of funds. With careful planning and proper budget allocation, the project is expected to run smoothly, meet the set quality standards, and provide maximum benefits to the community.

Table 1. Cost Budget Plan Calculation Results

Payment Item No.	Description	Unit	Estimated Quantity	Unit Price (IDR)	Total Price (IDR)
DIVISION 3. EARTHWORKS AND GEOSYNTHETICS					
3.1.(1)	Regular Excavation	M ³	2.575	30,781.94	79,277,950.80
3.3.(1)	Road Body Preparation	M ²	5.512	3,104.49	17.111.036.05
Total price of work DIVISION 3	(entered in the Recapitulation of Estimated Price of Work)				96,388,986.85
DIVISION 5. GRADED PAVEMENT					
5.1.(1)	Class A Aggregate Foundation Layer	M ³	1,97	472.306.90	930,600,462.13
5.1.(2)	Class B Aggregate Foundation Layer	M ³	772	312.333.71	241,212,198.06
Total price of work DIVISION 5	(entered in the Recapitulation of Estimated Price of Work)				1,171,812,660.19
DIVISION 6. ASPHALT PAVEMENT					
6.1 (1)	Resilient Binder Layer - Liquid Asphalt/Emulsion	Liters	3,353.8	18,185.73	60,991,302.58
6.1 (2a)	Adhesive Layer - Liquid Asphalt/Emulsion	Liters	8,767.56	17,827.23	156,301,341.37
6.3(5a)	Wear Layer Laston (AC-WC)	Tons	1,350.20	1,338,893.39	1,807,773,856.14
6.3(6a)	Intermediate Layer Laston (AC-BC)	Tons	3.407.16	1,261,636.30	4,298,596,742.88

6.3(7a)	Foundation Layer Laston (AC-Base)	Tons	666.81	1,151,442.89	767,793,636.08
Total price of work DIVISION 6	(entered in the Recapitulation of Estimated Price of Work)				7,091,456,879.06
DIVISION 7. STRUCTURE					
7.1 (7a)	Structural concrete, fc'20 MPa	M ³	436.50	1,319,918.65	576,144,491.46
Total price of work DIVISION 7	(entered in the Recapitulation of Estimated Price of Work)				576,144,491.46
TOTAL					8,935,803,017.55

Source: Calculation Results

Table 2: Daily Traffic Volume in 2023

Time	Traffic Volume (kend)				
	SM	KR	BB	KBM	TB
	0.25	1	1.2	1.2	1.2
06.00-07.00	1,368	174	1	4	44
07.00-08.00	1,285	240	7	8	75
08.00-09.00	936	279	2	16	58
09.00-10.00	947	280	2	15	60
10.00-11.00	1,010	302	0	14	81
11.00-12.00	1,001	288	1	17	87
12.00-13.00	1,000	724	2	14	71
13.00-14.00	1,142	272	2	13	89
14.00-15.00	1,106	264	1	14	78
15.00-16.00	1,466	261	2	8	77
16.00-17.00	1,843	261	3	7	83
17.00-18.00	1,135	258	3	4	95
18.00-19.00	1,252	225	4	6	76
19.00-20.00	1,090	234	3	0	55
20.00-21.00	746	155	4	2	71
21.00-22.00	966	170	1	4	60
22.00-23.00	540	99	2	5	61
23.00-24.00	391	78	1	3	67
00.00-01.00	211	55	1	1	61
01.00-02.00	110	46	2	3	43
02.00-03.00	119	42	3	10	35
03.00-04.00	132	45	1	6	58
04.00-05.00	214	62	0	3	96
05.00-06.00	652	106	4	3	94
06.00-07.00	1,389	247	9	8	61
07.00-08.00	1,364	273	8	9	53
08.00-09.00	968	252	5	8	55
09.00-10.00	946	264	2	19	74
10.00-11.00	975	280	2	21	59
11.00-12.00	1,020	323	4	19	97
12.00-13.00	1,001	295	2	12	92
13.00-14.00	1,178	316	3	20	80
14.00-15.00	1,039	266	6	17	77
15.00-16.00	1,100	307	6	15	125
16.00-17.00	1,228	266	5	21	108

Time	Traffic Volume (kend)				
	SM	KR	BB	KBM	TB
	0.25	1	1.2	1.2	1.2
17.00-18.00	1,160	244	6	18	95
18.00-19.00	1,292	242	4	18	74
19.00-20.00	1,130	233	3	13	72
20.00-21.00	796	167	6	8	38
21.00-22.00	589	115	3	8	58

Source: Research Site Survey

Table 3. Flexural pavement planning for road widening

	ESA5 >15 - 30 (million)
ACWC	40 mm
ACBC	60 mm
AC-Base	80 mm
Class A Aggregate Foundation Layer	200 mm
Coarse Grained Preferred Stockpile (Class B)	150 mm
Subgrade CBR	2%

Source: Pavement Design Manual 2024

Discussion

Significant traffic growth on Jalan KH Ahmad Dahlan Pohjentrek, Pasuruan City, has become a major challenge in planning and maintaining road infrastructure. The increase in vehicle volume, especially commercial vehicles carrying heavy loads, causes accelerated road damage so that the planned life of the road is not achieved. This problem is made more complex by uneven load distribution, poor drainage conditions, and inadequate road capacity to accommodate the increasing volume of vehicles. As a result, roads often experience premature deterioration such as cracks, potholes, and deformation, which results in a decrease in the quality of transportation services in the region.

As a measure to address these issues, the proposed pavement design has considered various technical aspects, including the cumulative ESAL (Equivalent Single Axle Load) value of 26,047,040 for a 10-year period. This corresponds to a load category of >15-30 million in the 2024 Pavement Design Manual (MDPJ). The pavement design includes various layers with thicknesses adjusted to withstand high traffic loads. The layers include 40 mm thick AC-WC (Asphalt Concrete Wearing Course), 60 mm thick AC-BC (Asphalt Concrete Binder Course), 80 mm thick AC-Base, as well as 200 mm thick class A and 150 mm thick class B aggregate foundation layers. With this design, the road is expected to be able to provide optimal carrying capacity for vehicle loads passing through the section.

However, despite the pavement design, the successful implementation of the project is highly dependent on regular maintenance. Maintenance is key to keeping the road performing up to the set quality standards. Without adequate maintenance, the potential for premature deterioration remains, resulting in increased rehabilitation costs in the future.

In terms of budget, the construction cost is estimated at IDR 8.6 billion. This figure reflects the significant investment needed to improve the quality of roads in the area. This cost includes various work components, from excavation, transportation, material procurement, to pavement layer installation. The largest cost component comes from material procurement, which accounts for about 60% of the total budget. This shows that efficiency in the management of material resources is very important to keep construction costs under control. In addition, labor costs and the use of heavy equipment accounted for 20% and 15% of the total budget, respectively, while the rest was allocated to ancillary costs such as drainage management.

In an effort to anticipate the potential risk of cost increases, a sensitivity analysis was conducted to assess the impact of material price fluctuations on the total budget. The analysis

showed that a 10% increase in material prices would increase the total construction cost by close to IDR 9 billion. This demonstrates the importance of careful procurement strategies, such as entering into long-term contracts with suppliers or utilizing bulk procurement to obtain more competitive prices. These strategies not only help control costs but also minimize the risk of project delays due to material shortages.

In addition to technical and financial issues, drainage maintenance is a key factor that should not be overlooked. Poor drainage is one of the main causes of road damage, especially in areas with high rainfall intensity such as Pasuruan City. Standing water that is not properly handled can seep into the pavement layer, weaken the road structure, and accelerate deterioration. Therefore, drainage management should be an integral part of road planning. Measures such as installation of new drainage channels, repair of existing channels, and periodic cleaning can significantly increase the planned life of the road. Studies show that effective drainage can extend road life by up to 20% longer, reducing future maintenance costs.

In addition to improving drainage, road widening is one of the prioritized solutions to overcome congestion that often occurs in several segments of the KH. Ahmad Dahlan road. Road widening not only aims to increase road capacity but is also expected to increase the level of service. With greater capacity, vehicle travel time can be shortened, increasing transportation efficiency. However, road widening also brings its own challenges, such as the reduction of green space and potential social impacts on surrounding communities. Therefore, this measure should be planned with environmental and social aspects in mind, such as replacing lost green space with new green areas or providing fair compensation to affected communities.

The conclusion of this analysis is that effective road planning should include a comprehensive approach. A detailed traffic analysis is required to understand the future capacity requirements of the road. Durable pavement design should be accompanied by efficient cost management strategies to keep the project within budget limits. In addition, optimized drainage maintenance and well-planned road widening will contribute greatly to the success of this project. With an integrated approach, the KH Ahmad Dahlan Pohjentrek road section can optimally and sustainably meet the transportation needs of the community. The project is expected to not only improve the current road condition but also provide long-term positive impacts for road users and the surrounding community.

CONCLUSION

Based on the analysis, significant traffic growth on the KH Ahmad Dahlan Pohjentrek road section in Pasuruan City resulted in a cumulative ESAL value of 26,047,040 over the 10-year plan life. This condition shows that the road is facing high traffic loads that require a pavement design that is able to withstand heavy loads. The total construction cost required for road widening and improvement is IDR 8,599,657,783.62. This budget includes excavation work, transportation, material procurement, and drainage management to extend the planned life of the road. The pavement design includes 40 mm AC WC, 60 mm AC BC, 80 mm AC Base, 200 mm Class A Aggregate Foundation Layer, and 150 mm Class B Aggregate Foundation Layer. High traffic growth and poor drainage conditions are the main factors that accelerate road deterioration, making road widening and drainage management a priority to support mobility and reduce congestion.

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