IMPROVED ROAD PERFORMANCE THROUGH THE IMPLEMENTATION OF ROUTINE ROAD MAINTENANCE MANAGEMENT SYSTEM

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Road infrastructure development is carried out to be able to serve the flow of goods and passengers smoothly, safely, and comfortably. Infrastructure maintenance is needed to keep roads always in good condition. The road infrastructure consumes a significant amount of budget, both for road maintenance and improvement. The Central Java Provincial Government, through the Public Works Service for Highways and Civil Works, has a prioritization sequence to maintain road conditions to facilitate smooth, safe, and comfortable traffic. Continuous and sustainable maintenance of constructed roads is necessary to ensure their stability. Therefore, a large budget is required to carry out this maintenance. In 2023, the budget requirement for routine road maintenance amounted to IDR 441.246.000.000,00. However, the actual budget realization for 2023 was only IDR 125.686.108.000,00, fulfilling just 28,48% of the calculation model using from using analysis for Planning, Programming, and Budgeting (P/KRMS analysis) application. Analysis results indicate that the budget realization for routine road maintenance in 2023 did not meet the requirement to maintain a stable road surface, as evidenced by a 1,61% decrease in road surface condition from 2022. The Central Java Provincial Public Works Service for Highways and Civil Works faces this challenge by maximizing the involvement of the Community Group for Highways Development (Mas BIMA) in expediting the handling process.

Keywords: routine, maintenance, road, budget, sustainable

1 INTRODUCTION

The road infrastructure in Indonesia in general, and in Central Java in particular, consumes a significant amount of budget, both for road maintenance and improvement. Infrastructure maintenance is needed to keep roads always in good condition economy [1, 6]. Road improvements and maintenance require a fairly large budget. Road construction that has been built must be maintained continuously and sustainably so that it remains in good condition. The Central Java Provincial Government, through the Public Works Service for Highways and Civil Works, has a prioritization sequence to maintain road conditions to facilitate smooth, safe, and comfortable traffic flow for both goods and passengers [7, 10].

However, infrastructure is often unable to serve the flow of goods and passengers due to damaged roads. Road infrastructure cannot reach the planned service life [11]. The available budget is not in line with the funding needs for road improvement and maintenance. The road construction that has been built cannot be sustainable in good condition due to a lack of road maintenance funds [12, 17].

Therefore, there is a need for a good management system to improve road performance. This research is important to ensure that road infrastructure is always in good condition even if maintenance funds are limited. This research was carried out by determining the priority scale in planning, programming, and budgeting for road preservation, especially routine maintenance work. In determining the priority scale, apart from using analysis for Planning, Programming, and Budgeting (P/KRMS analysis), we also pay attention to the number of public complaints submitted through the use of the "Jalan Cantik" application.

2 BASIC THEORY

2.1 Assessment of Road Performance

Evaluation of road performance is essential for enhancing the effectiveness of road maintenance and rehabilitation management. This evaluation involves both functional and structural assessments. The functional evaluation relies on the International Roughness Index (IRI) value, which is derived from the readings provided by the National Association of Australian State Road Authorities (NAASRA) for analyzing road handling and making recommendations. On the other hand, the structural evaluation is conducted by analyzing the deflection value using the Falling Weight Deflectometer (FWD) data, which aids in providing recommendations for road handling [18].

Sustainable maintenance of road infrastructure is essential to guarantee consistent road conditions. There is a 30,46% increase in road stability conditions associated with road maintenance costs. Various sensitivity analyses indicate that Fuzzy Spatial Analysis is a dependable and precise approach to decision-making. The methods and analyses proposed offer significant potential for sustainable infrastructure management on a network scale [19].

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2.2 Road Stability

One technique employed to assess the functional condition of road pavements is the International Roughness Index (IRI). The IRI represents the level of unevenness on the road surface, calculated based on the total length of surface irregularities per unit length. The IRI is determined through data collection using vehicles and the Roaddroid app. Developed by a Swedish company, the Roaddroid app is specifically designed for Android smartphones to measure road roughness.

The International Roughness Index (IRI) quantifies road surface flatness by measuring the vertical change of the road surface per unit of length (m/km). Roads with an IRI value of ≤ 8 are classified as stable, while those with IRI values > 8 are considered unstable. Enhancing public services, such as ensuring good road access, requires adequate financial support for road development, which in turn impacts the economic situation of a region. Studies [1, 20] have shown that the IRI value and maintenance funds play a crucial role in enhancing the modern economy in Russia. The IRI value influences various factors, including driver safety, traffic flow, driving comfort, fuel efficiency, air quality, and road conditions [21].

The International Roughness Index (IRI) value serves as a tool for assessing national road conditions, aiding in the planning and execution of road rehabilitation and maintenance projects [1]. The International Roughness Index (IRI) is determined based on the National Cooperative Highway Research Program (NCHRP) guidelines [22]. The IRI values are categorized as follows:

– Good Condition: 0 - ≤4

– Fair Condition: 4 - ≤8

– Poor Condition: 8 - ≤12

– Very Poor Condition: >12

– (Source: NCHRP, 2001)

2.3 Routine Road Maintenance

Road maintenance involves activities that are necessary and planned to upkeep and repair roads, ensuring they remain in optimal condition to serve traffic throughout their designated lifespan. The maintenance of road construction is a crucial task as it represents a significant capital investment [23, 25]. Neglecting this maintenance can result in costly reconstruction expenses to restore the road's performance standards and bring it back to an appropriate condition. Every road user desires a comfortable and safe journey, with smooth and convenient roads that prioritize their physical safety.

Over time, the condition of roads deteriorates due to the continuous stresses caused by traffic loads, leading to minor damage to the pavement. In addition to traffic loads, roads are also affected by water, climate, weather, humidity, and the environment, which further contribute to the decline in road conditions. It is crucial to always prioritize and maintain road conditions considering these factors.

By conducting regular road maintenance, operating costs can be reduced. The extent of these costs depends on the vehicle type, road geometry, and road conditions. When the road is in good condition, vehicle operating costs will not increase. Therefore, road users, who are most concerned about their vehicle operating costs do not maintain the road, but they are rather interested in good road conditions, should be particularly interested in maintaining the road conditions.

Road maintenance activities can be classified as follows:

1. Routine Maintenance

   Road maintenance is an ongoing process that takes place throughout the year. This type of maintenance focuses on repairing minor damages, patching holes, smoothing the road surface, fixing pavement edges, maintaining sidewalks, ensuring proper drainage, and taking care of road shoulders. These activities are carried out regularly to ensure the overall upkeep of the road network.

2. Periodic Maintenance

   Periodic maintenance is conducted at specific intervals when the road conditions start deteriorating. This type of maintenance involves repairing, leveling, resealing, and overlaying asphalt roads. In the case of cement concrete roads, it may include regrooving or overlaying. By addressing these issues periodically, the road's functionality and safety can be maintained.

3. Rehabilitation (Urgent Maintenance)

   Rehabilitation maintenance is performed in response to sudden and urgent situations caused by severe local damage. Examples of such situations include road breakage due to floods, landslides, earthquakes, and other emergencies. The primary objective of rehabilitation maintenance is to restore the road to its original condition as quickly as possible, ensuring the smooth flow of traffic. This comprehensive approach aims to address the immediate needs and ensure the safety of road users.

2.4 Maintenance Funding

Road maintenance funds play a crucial role in covering the expenses related to road repairs. The availability of these funds can greatly impact the overall condition of road networks within districts or cities in Central Java Province [26]. Moreover, the allocation of maintenance funds has a substantial influence on traffic flow as it contributes to the efficient management of road networks and enhances transportation services [1]. Ultimately, road maintenance funds are essential for enhancing infrastructure quality and ensuring that roads meet their intended service life.

3 RESEARCH METHODS

3.1 Research Sites

The study was conducted in 2022 using quantitative methods by analyzing the provincial roads in Central Java, Indonesia. This research was carried out by determining the priority scale in planning, programming, and budgeting for road preservation, especially routine maintenance work. In determining the priority scale, apart from using analysis for Planning, Programming, and Budgeting (P/KRMS analysis), we also pay attention to the number of public complaints submitted through the use of the "Jalan Cantik" application.

Fig. 1. Research location at the road network of Central Java Province

3.2 Descriptive Analytical Methods

Research methods involve the collection and processing of data to address research problems. The chosen research method is descriptive analysis, which aims to provide a description or overview of the object of study using collected data or samples without conducting analysis or drawing conclusions that apply to the general public. In analytical descriptive research, the focus is on the existing problems at the time of the research, and the results are subsequently processed and analyzed to conclude. [27], [28].

This study employs descriptive analytical techniques utilizing a quantitative methodology. Quantitative research methods are employed when the objective is to elucidate or interpret a current event or occurrence through significant numerical data. Consequently, research findings are derived from the computation of research variable indicators and subsequently articulated.
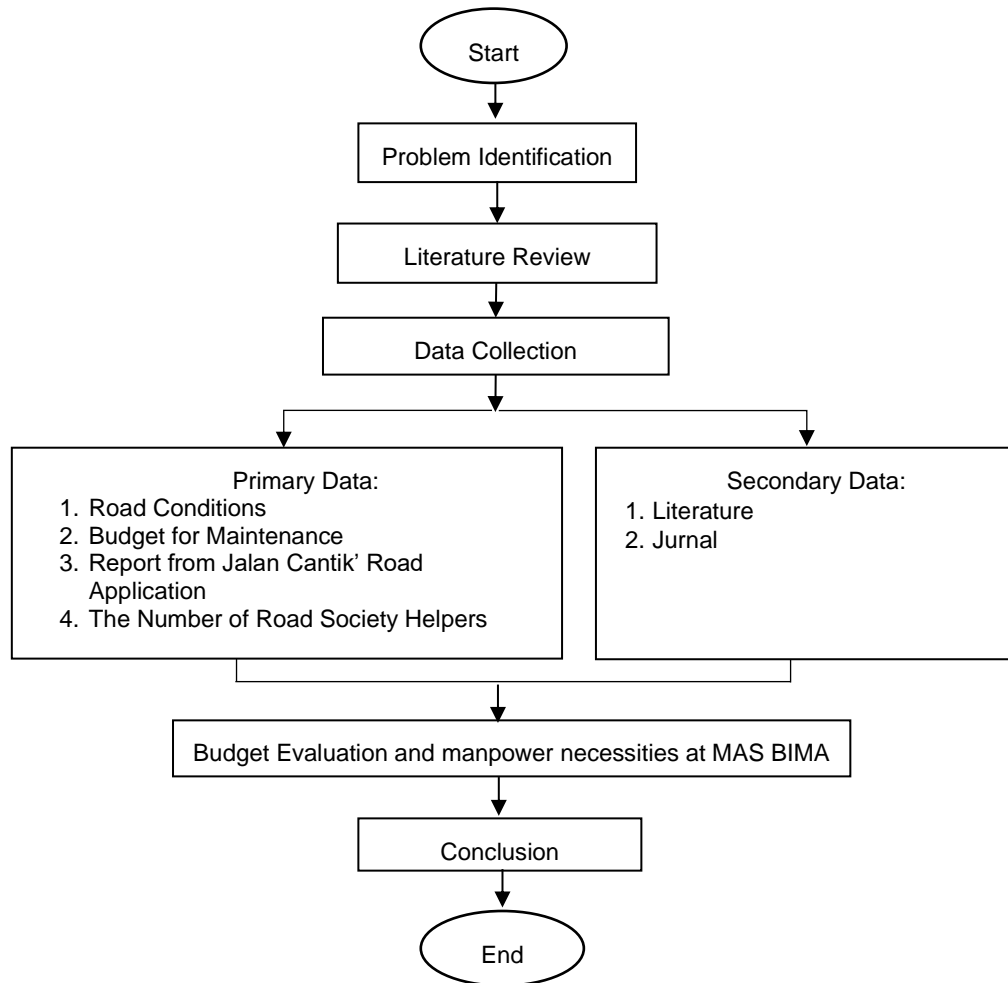
The steps taken in this research are as follow:

Fig. 2. The flow chart of the development models

The descriptive analysis method with a quantitative approach provides a clear and structured way to describe and interpret the current state of the research subjects. This method ensures that the collected data is relevant and accurately represents the phenomena being studied. This study focuses on calculating the ideal budget output of the P/KRMS Application, which is a specific area that may be less explored. These findings can provide new insights into the effectiveness of budget allocation for routine road maintenance. The research questions are highly relevant to the current needs of the Department of Public Works for Roads and Spatial Planning in Central Java Province. By addressing these questions, the research provides valuable information that can assist in budget planning and allocation decisions in the future. The use of quantitative data and a structured approach in data collection and analysis enhances the reliability of the research findings. By focusing on measurable indicators, this study ensures that the results are based on objective and verifiable data.

4 RESULTS

4.1 Provincial Road Condition

Road Condition Survey Data in 2019-2021 used the Surface Distress Index (SDI) and International Roughness Index (IRI) while in 2022-2023 the Province Road Management System Application and then analyzed to determine the percentage of road surface conditions. From the Province Road Management System there are two methods for calculating road conditions, namely Treatment Trigger Index (TTI) and Surface Distress Index (SDI).

Table 1. The condition of road surfaces in central java province from 2019 to 2023 based on pavement condition

Year	Good		Fair		Slightly Damaged		Heavily Damaged	
	km	%	km	%	km	%	km	%
2019	2.041,46	84,89	244,11	10,15	119,17	4,96		-
2020	1,852,19	77,02	312,13	12,98	240,43	10,00		-
2021	965,61	40,15	1.219,45	50,71	219,68	9,14		-
2022	2.010,27	83,60	213,89	8,89	68,33	2,84	112,25	4,67
2023	1.671,36	69,50	514,14	21,38	130,81	5,44	88,42	3,68

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Table 2. The condition of road surfaces in central java province from 2019 to 2023 based on road stability condition

Year	Stable		Unstable	
	km	%	km	%
2019	2.285,57	95,04	119,17	4,96
2020	2.164,32	90,00	240,43	10,00
2021	2.185,06	90,86	219,68	9,14
2022	2.224,16	92,49	180,58	7,51
2023	2.185,50	90,88	219,23	9,12

4.2 Budget for Routine Provincial Road Maintenance

The Model of the Province Road Management System output becomes a guideline for routine road maintenance budgeting planning in 2023 in Central Java Province. The following is a budget graph of the modeling output from the P/KRMS Application. However, it is below the budget required by the model in Figure 3. The need for funds for routine road maintenance in Central Java Province in 2023 is IDR 316,941 billion, while the availability of maintenance funds is only IDR 124,305 billion in that year. Consequently, the road condition cannot be increased to steady condition, so the road user can make a complaint through the application of "Jalan Cantik".
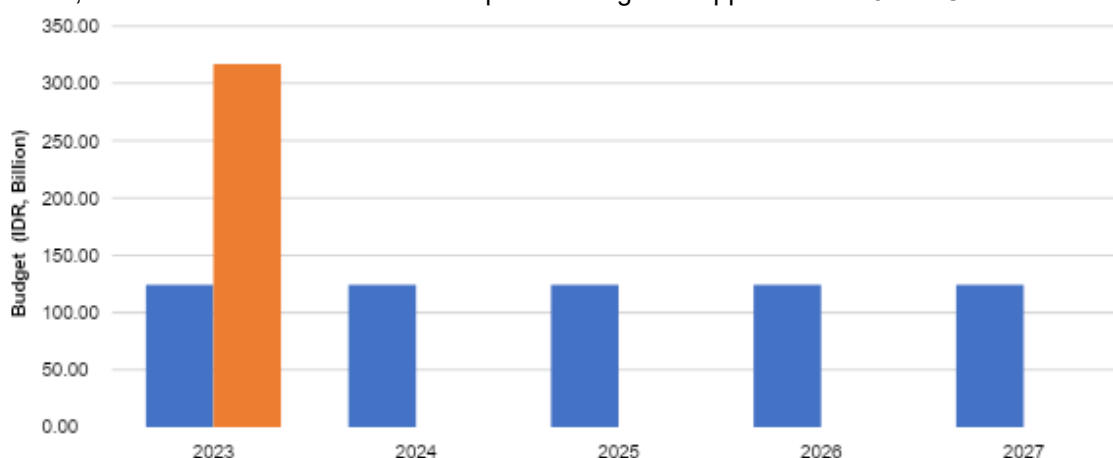

Fig. 3. The Routine Road Maintenance Budget predicted for the next 5 years

In 2022-2023, the budget for routine road maintenance at the Public Works Department of Highways and Human Settlements of Central Java Province will increase by 8,91%. This, when compared with the ideal budget requirements from the results of the P/KRMS Application, still does not meet the budget requirements for routine road maintenance. In 2023, the budget for routine road maintenance is IDR 441.246.000.000,00 while the realization of the 2023 budget is IDR 125.686.108.000,00 or fulfilled only 28,48% of the P/KRMS Application calculation modeling. The yearly budget, however, tends to increase by year as performed in Figure 4.
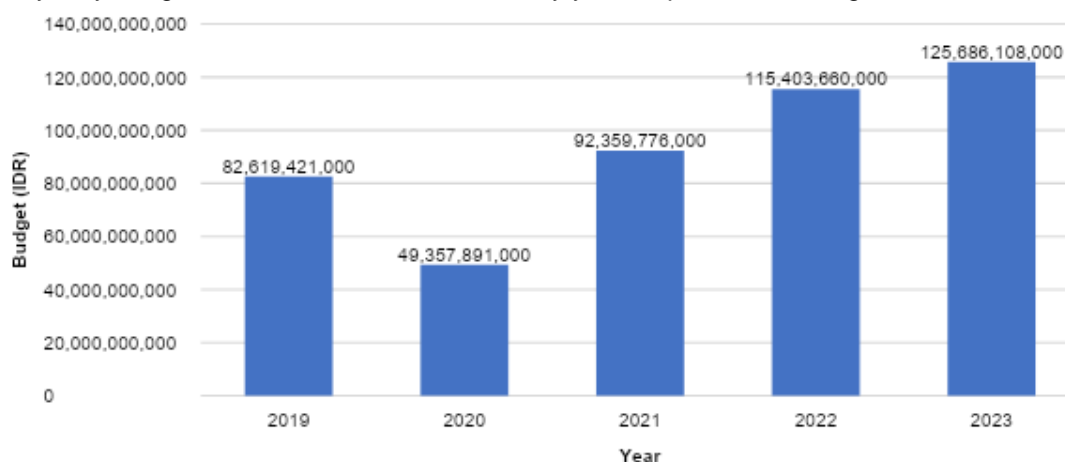

Fig. 4. The Actual Budget for Routine Road Maintenance for Central Java Road Networking for the past 5 years

4.3 Jalan Cantik" and "Mas Bima" Innovative Programmed

The limited budget available for routine road maintenance resulted in a decrease in road performance as described above. The need for large road maintenance funds is not supported by the availability of road maintenance funds, making the Central Java Provincial government innovate the "Jalan Cantik" application so that the public can take

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part and report damaged road conditions in a short time. With the "Jalan Cantik" application, the government can choose priority roads for maintenance and handling. To minimize the consequently low budget in routine road maintenance there is an application provided to get information from society regarding the road condition so that quick repair could be conducted to minimize the progressive deterioration of the road. The application that is available on the internet is "Jalan Cantik"

The Public Works Department of Bina Marga Cipta Karya, Central Java Province, Indonesia is implementing change projects, one of which is "Mas Bima", an abbreviation for Masyarakat Bina Marga. A kind of labor-intensive project to lift people out of poverty. Mas Bima also invited or involved the community to care about provincial highways in their area. So that provincial roads that cross 35 cities in Central Java can be well maintained, durable, and not easily damaged.

The results of the recapitulation of public complaints via the Jalan Cantik Application in 2019-2023 show a fluctuating graph as presented in Figure 5. This can be caused by several factors, including, there are similar applications that have the same function as a road damage complaint service, and the community's unequal ability to use technology. However, there are nearly 2000 complaints reported in 2023 and the tendency is to increase by year.

The "Mas Bima" program is dedicated to lifting poverty as well as to getting a quick response in the maintenance of road damage in Central Java. The members of the Mas Bima area were the workers or farmers who dedicated their spare time to helping the government to do road maintenance as fast response. The number of Mas Bima members has significantly increased by the year and already proven they can quickly respond to the complaints reported in the "Jalan Cantik" Application. Figure 5 shows the number of Mas Bima Workers that increased in three years.
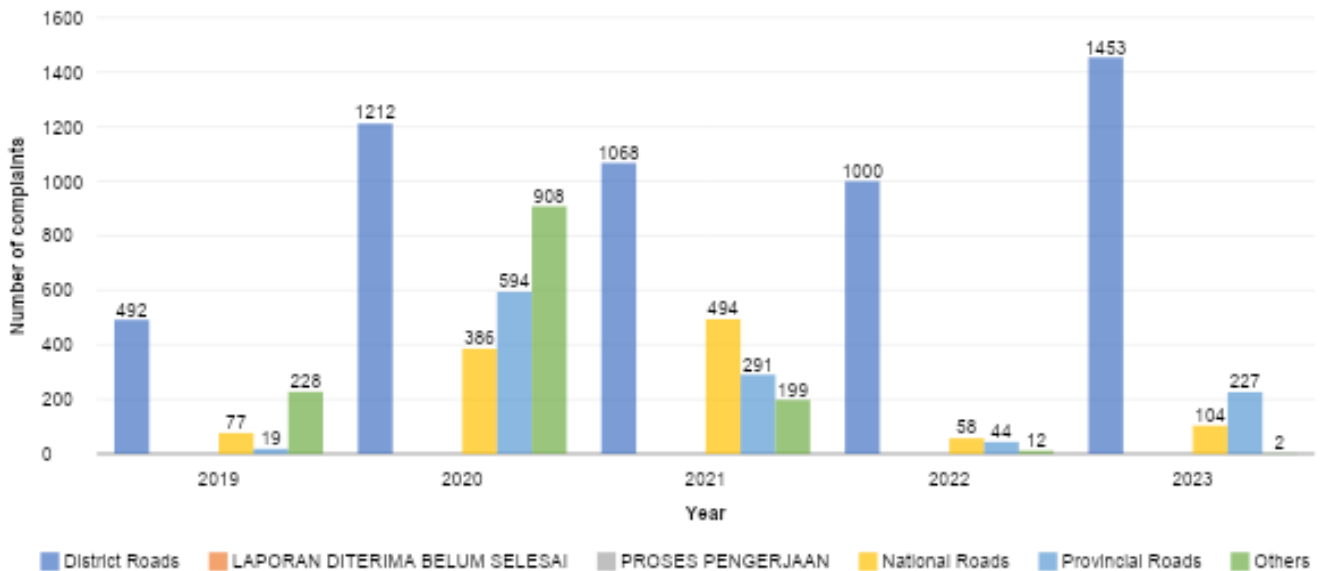

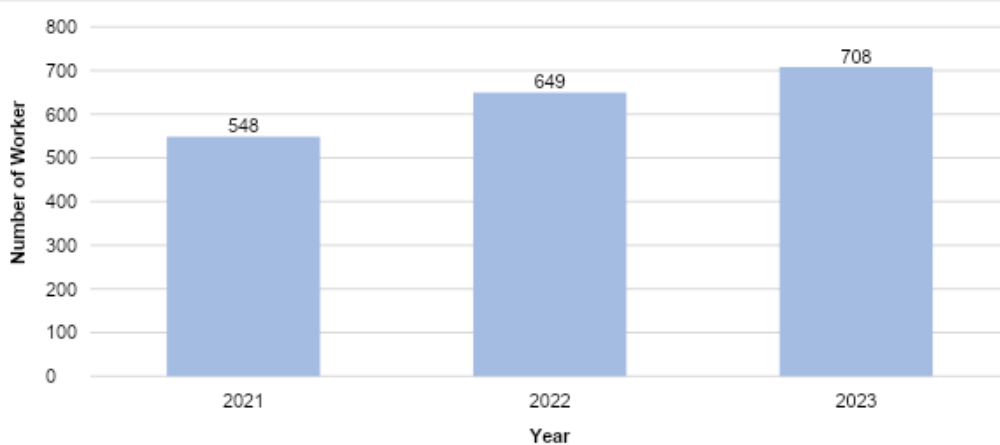Fig. 5. Road Complaints reported from "Jalan Cantik" Application" Based on Road Status

Fig. 6. The number of "Mas BIMA" workers increase in three years and get involved in maintaining the provincial road

5 CONCLUSIONS

The Central Java Provincial government has developed the "Jalan Cantik" application to address the lack of sufficient road maintenance funds. This innovative app allows the public to report damaged road conditions, enabling the government to prioritize roads for maintenance and handling. The "Jalan Cantik" application aims to minimize the

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impact of a limited budget on routine road maintenance by facilitating quick repairs based on information provided by the public. This application is accessible on the internet. In 2022 there were 44 complaints via the "Jalan Cantik" Application, for 2023 there were 227 complaints, an increase of 5,16 times greater. The actual budget in 2023 used for routine road maintenance cannot accommodate the modeling results produced by the P/KRMS Application, resulting in a decrease in the road stability value of 1,61% from 2022. To maximize the participation of the Bina Marga Community Group (Mas BIMA) in routine road maintenance, the government needs to conduct outreach to the public to contribute to reporting complaints through the "Jalan Cantik" application regarding road damage.

The uniqueness of this research lies in its focus on budget output calculation, presenting new perspectives that can potentially enhance future budget management practices. It offers valuable insights that can guide future budget planning and allocation decisions, as well as improve the efficiency of road maintenance activities. The reliability of the data is ensured through objective and verifiable information, laying a strong foundation for policy recommendations and the implementation of road maintenance programs.

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