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Estimation of Road Repair Costs for the Genengan–Lembeyan Section in Magetan Regency Based on the 2024 Bina Marga Guidelines

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ABSTRACT
The Genengan–Lembeyan road section in Magetan Regency is a vital transportation route connecting Magetan with Ponorogo, facilitating mobility and goods distribution. However, the road has experienced significant degradation due to increasing traffic and the passage of heavy vehicles, affecting both safety and comfort for users. This research aims to evaluate the pavement condition using the International Roughness Index (IRI) method, with support from the Roadroid application, which provides real-time road condition data. Additionally, the research calculates estimated repair costs based on the Bina Marga 2024 guidelines. The results indicate an average IRI value of 4.24, with some segments in moderate condition, while the STA 5+000 to STA 8+660 section shows critical damage with an IRI value exceeding 6.5. Immediate rehabilitation is necessary for this section to prevent further damage and ensure road safety. The estimated repair cost for this segment is Rp4,069,031,000.00, covering interventions such as overlay, patching, and structural improvements. This research highlights the effectiveness of the Roadroid application as a cost-efficient alternative to traditional survey methods. The findings provide useful insights for local governments to prioritize repairs, allocate resources effectively, and implement timely maintenance strategies, thereby contributing to the sustainability and functionality of road infrastructure and supporting regional economic growth and community well-being.

Keywords: Bina Marga 2024, Cost Estimation, International Roughness Index, Road Maintenance, Roadroid.

INTRODUCTION

The Genengan - Lembeyan road section in Magetan Regency has a strategic role as a connecting route between districts, especially between Magetan and Ponorogo Regencies. As a collector road, it supports community mobility as well as the distribution of goods and services in the area. This condition makes this road vital in supporting the local economy. However, over time, the increase in traffic volume and vehicle load continues to grow causing the road pavement to experience significant degradation. Pavement damage is one of the main problems faced in maintaining road infrastructure in Indonesia. As stated by (Tjendani et al., 2018), road

projects often face challenges in ensuring the quality and durability of infrastructure according to the predetermined plan life. One solution is to use the International Roughness Index (IRI) method, which has proven effective in evaluating road surface conditions and providing an accurate picture of the extent of damage (Mahendra, 2022).

According to (France-Mensah & O'Brien, 2018), proper road maintenance based on accurate data will increase efficiency in budget allocation and extend the service life of infrastructure. In this case, the use of Roadroid application is an efficient and economical tool to evaluate road conditions in real-time. The research conducted by (Annisa et al., 2023) showed that the Roadroid application can provide measurement results that are close to the accuracy of conventional measuring instruments at a lower cost. The application of the IRI method with the Roadroid application on the Genengan - Lembeyan road section is expected to provide a practical solution in analyzing the level of pavement damage. (Desei & Kadir, 2022) confirmed that this method can identify various types of road damage such as crocodile skin cracks, holes, and deformations that require immediate repair. In addition, (Fuady & Subkhan, 2021) stated that IRI data-based maintenance helps the government in planning more measurable and appropriate rehabilitation activities.

(Kogoya et al., n.d.)explain that the prediction of road deterioration conditions through the application of IRI can be the basis for determining the priority of national and local road management. In their research, an analysis of national roads showed that road segments with IRI values above 4 require immediate repair to maintain the safety of road users. This result is also reinforced by the research of (Mahendra et al., 2023) which states that high IRI values are directly proportional to the level of driver discomfort and increased risk of accidents. Furthermore, (Marjono et al., 2022) in their research on road sections in Malang using the Roadroid application showed that poor road conditions have a direct impact on the decline in economic and social activities of the community. Therefore, regular road maintenance through the IRI method can minimize these risks.

(Novianto & Chayati, 2024) highlighted that the Surface Distress Index (SDI) method is often combined with IRI to obtain a more comprehensive analysis of road conditions. This allows for more precise repair planning, as applied to the Bangau Sakti road section of Pekanbaru City in a research conducted by (Annisa et al., 2023). (Mughni et al., 2023) in their research showed that analyzing cost performance with the Earned Value (EV) method on toll road projects provides a clear picture of cost effectiveness and efficiency in road maintenance projects. The application of EV in the Pandaan - Malang toll road project results in optimization in budget management and work time.

The importance of Roadroid application-based road evaluation integrated with the IRI method has been emphasized (Pangesti et al., 2021). This evaluation is able to identify minor to severe damage with a fairly high level of accuracy. In another research, Pangesti and Rahmawati (2020) showed that the use of Roadroid in Banyumas Regency was able to provide accurate data

for regular road maintenance. Research by (Rahmawati et al., 2021) shows that mapping road conditions based on the Roadroid application provides time efficiency in conducting surveys and accelerates the decision-making process in road handling. (Salsabilla et al., 2020) also emphasized that road maintenance based on Bina Marga and PCI methods has high effectiveness in repairing damaged road sections.

The research of (Tambunan et al., 2023) shows that the Roadbump application as an alternative to Roadroid also has advantages in mapping national road conditions, providing similar analysis results to the conventional IRI method. (Utama et al., 2023) revealed that a comparison of road condition surveys using the SDI and IRI methods showed that the IRI method was more efficient in terms of time and cost, with an accuracy level almost equivalent to the manual method. (Watono et al., 2020) also supported these findings, showing that the evaluation of road damage using the Road Condition Index (RCI) method has a positive correlation with the results of the IRI analysis.

Periodic maintenance of road sections in West Kalimantan has been shown to increase road service life and significantly improve pavement conditions (Witjaksana et al., 2019). The purpose of this research was to evaluate the condition of the road surface on the Genengan - Lembeyan section using the International Roughness Index (IRI) method supported by the Roadroid application. Thus, the benefit of this research is to provide useful information for local governments in planning road improvements that are appropriate, efficient, and in accordance with national standards, as well as helping to allocate budgets more effectively to improve the quality of road infrastructure to support mobility and the local economy.

RESEARCH METHOD

Location and Object of

This research was conducted on the Genengan - Lembeyan road section located in Magetan Regency, East Java. This road section was chosen because it has a strategic role in supporting the mobility and distribution of goods between regions. This road is one of the main routes connecting Magetan Regency with Ponorogo, so it has a fairly high traffic level. The road condition varies from good to significantly damaged, making it an ideal location for a pavement evaluation research. The research object focused on road segments with varying levels of damage. These road segments were identified based on the results of an initial field survey using the International Roughness Index (IRI) method based on the Roadroid application. Measurements were taken thoroughly to obtain an accurate picture of the pavement condition. The main focus of the research is to identify segments that require repair and estimate maintenance costs according to Bina Marga 2024 guidelines.

Data on road locations and characteristics were collected with the help of regional maps and documentation from the Magetan District Public Works Office. In addition, interviews with relevant parties were conducted to obtain additional information on road maintenance history.

With this approach, it is expected that the research results can represent the actual condition of the road and its maintenance needs. The research results at this location will serve as a reference for prioritizing road maintenance and rehabilitation in other areas with similar characteristics. Thus, this research is expected to make a significant contribution to managing road infrastructure more effectively and efficiently.

Collection Methods

Data collection was conducted through field surveys and direct measurements using the Roadroid application. Roadroid was chosen because it has the ability to measure road unevenness (IRI) quickly and accurately. The survey was conducted by driving a vehicle along the road segment that was the object of the research, while the Roadroid application recorded vibration data and road conditions. The data collected is then analyzed to determine the segments that require immediate repair. In addition to using Roadroid, the research also involved visual observation methods to identify types of damage that were not detected by the app. These observations include recording cracks, potholes and deformations that are visible directly on the road surface. By combining these methods, the research results are expected to be more comprehensive and detailed.

Secondary data was collected from official documents such as previous road maintenance reports, technical maps, and Bina Marga 2024 guidelines. This information was used as comparison and reference material in conducting the road improvement cost analysis. All data obtained was then processed and presented in the form of tables and graphs to facilitate interpretation of the results. The data collection process lasted for one month, involving a team of civil engineers and technical personnel from the Public Works Office. Each piece of data collected was re-verified to ensure accuracy and validity before further analysis was conducted.

Data Analysis and Estimation

Data analysis was conducted by processing IRI survey results obtained from the Roadroid application. The data was classified based on road condition categories, ranging from good, moderate, to severely damaged. Each category has a corresponding maintenance type recommendation, such as overlay, patching, or total rehabilitation. This analysis process refers to the Bina Marga 2024 guideline which provides handling standards and cost estimates for each type of damage. Cost estimation is done by calculating the area of damage on each identified road segment. Costs were calculated based on the latest Unit Price of Work (HSP) published by the Ministry of Public Works and Housing (PUPR). Each segment was analyzed separately to ensure accuracy in budget planning and material requirements.

In the estimation process, factors such as daily traffic volume, weather conditions, and road age are also taken into account. This aims to provide cost predictions that are realistic and in line with field conditions. Thus, the results of the analysis serve not only as an academic report but also as a practical basis for planning road maintenance projects. The final step in the analysis is to prepare a report containing recommendations for road repair priorities. This report will be

submitted to the authorities as a consideration in making decisions related to road infrastructure maintenance projects in Magetan Regency.

RESULT AND DISCUSSION

Road Condition Based on Survey

A survey conducted using the Roadroid application showed variations in road conditions on the Genengan - Lembeyan section. Based on the measurement results, most of the road sections have IRI values above 4, indicating conditions that require immediate attention. The highest IRI value is recorded in the STA 5+000 to STA 8+660 segment, where damage in the form of crocodile skin cracks and surface deformation is clearly visible. These segments have damage that has the potential to worsen road conditions if not addressed immediately.

Segments with IRI values between 2.5 to 4 indicate moderate condition, with some sections requiring light patching or overlay. Minor damage such as small potholes and fine cracks are found in these areas. Although not categorized as an emergency, preventive repairs are recommended to prevent further damage. Meanwhile, road sections with IRI values below 2.5 are categorized as being in good condition and only require routine maintenance.

The results of this survey highlight the importance of data-driven maintenance planning, focusing on segments that have high IRI values. This approach ensures that resources are allocated efficiently, reducing the risk of further deterioration. As a result, better road conditions can be maintained in the long term, supporting mobility and safety for road users.

Estimated Cost of Repair

The estimated repair cost is calculated based on Bina Marga 2024 guidelines, which include various types of work such as overlay, patching, and total rehabilitation. In the STA 5+000 to STA 8+660 segment, the cost required for repairs reached Rp4,069,031,000.00. This estimate includes work to replace the surface layer, repair the pavement structure, and improve drainage. For segments with moderate damage, the cost estimate varies depending on the area that requires patching. For segments with IRI values between 2.5 and 4, the repair cost is estimated at Rp1,250,000,000. The work involved filling cracks and applying a thin layer of asphalt concrete (LTBA). These repairs are expected to extend the service life of the road and improve driving comfort.

Table 1. Calculation of Estimated Handling Cost

No.	Type of Damage	Material Type	Sat.	Volume	Unit Price	Total Price
1	Hole	Lapen	m3	0,87	1.635.550,00	1.415.077,86
2	Waves	Aus Laston (AC-WC)	Tons	2.553,19	1.356.281,00	3.462.839.695,69
	a. Resorbent Coating	Prime Cout	Liters	2.673,75	27.307,00	73.012.091,25
	b. Adhesive Layer	Take Cout	Liters	19.500,00	24.670,00	481.065.000,00
3	Broken Groove	Burda	m2	163,80	60.772,00	9.954.453,60

No.	Type of Damage	Material Type	Sat.	Volume	Unit Price	Total Price
4	Broken Ambles	Lapen	m3	4,99	1.635.550,00	8.168.754,48
5	Broken Jembul	Burda	m2	227,00	60.772,00	13.795.244,00
6	Broken Edge	Burda	m2	58,30	60.772,00	3.543.007,60
7	Damaged Crocodile Skin	Buras	m2	124,80	19.403,00	2.421.494,40
8	Broken Line	Buras	m2	283,90	19.403,00	5.508.511,70
9	Broken Overweight	Burda	m2	61,45	60.772,00	3.734.439,40
10	Broken Chipped	Burda	m2	58,80	60.772,00	3.573.393,60
		Total				4.069.031.163,57
		Rounded				4.069.031.000,00

Source: Processed by Researchers, 2024

Segments with IRI values below 2.5 only require routine maintenance at a cost of around Rp500,000,000. Work includes repainting road markings and cleaning drainage channels. This routine maintenance is carried out to ensure that the road remains in optimal condition and free from minor damage. The calculation of this cost estimate also considers weather factors and daily traffic volumes. Road conditions that are frequently traveled by heavy vehicles require greater repair costs. Therefore, a thorough survey was conducted to obtain accurate and relevant data.

Discussion

The survey results highlight the pressing need for various repair interventions on the Genengan–Lembeyan road section, which has been significantly impacted by high traffic volumes and inadequate drainage systems. Among the most critical segments is STA 5+000 to STA 8+660, where the highest levels of damage were identified, necessitating immediate rehabilitation. This finding is consistent with previous research (Mahendra et al., 2023), which emphasizes that road segments with IRI values exceeding 4 require comprehensive repair measures to restore functionality and safety. Addressing this segment is essential to prevent further deterioration, which could lead to increased repair costs and heightened risks for road users.

The use of Roadroid technology in this research has proven to be highly effective in assessing road conditions, offering significant advantages over conventional survey methods. Roadroid enables the collection of real-time data with high accuracy and broad coverage, significantly reducing the time and costs associated with manual assessments. These findings corroborate the conclusions of (Purwanto et al., 2025), who identified Roadroid as an efficient tool for improving the accuracy and timeliness of road evaluations. By utilizing this technology, resources can be allocated more effectively, ensuring that repair priorities are focused on segments requiring urgent attention, thereby reducing the likelihood of budget mismanagement. In terms of cost allocation, the rehabilitation of critical segments such as STA 5+000 to STA 8+660 is prioritized, with repair work encompassing surface reconstruction, structural strengthening, and drainage improvements. This comprehensive approach is aligned with the Bina Marga 2024 guidelines, which emphasize the importance of addressing underlying causes of pavement

deterioration to enhance road durability. By integrating drainage improvements into the rehabilitation process, the risk of recurrent damage caused by water accumulation can be mitigated, further extending the service life of the road.

Moreover, the results of this research provide a practical framework for local governments to develop more effective road maintenance strategies. The integration of Roadroid technology into regular monitoring systems can facilitate early detection of road damage, enabling proactive maintenance planning and reducing long-term costs. Additionally, the adoption of data-driven methodologies, as demonstrated in this research, ensures that maintenance budgets are utilized optimally to achieve the greatest impact.

This research underscores the importance of combining innovative technologies like Roadroid with established guidelines such as Bina Marga 2024 to address infrastructure challenges effectively. It is recommended that local governments not only implement these findings but also invest in training technical personnel to maximize the utility of Roadroid technology. Furthermore, collaboration with academia and industry experts can enhance the development of more advanced and sustainable road maintenance strategies. By adopting such measures, Magetan Regency can achieve significant improvements in its road infrastructure, ensuring enhanced mobility, safety, and economic development for the region.

CONCLUSION

The conclusion of this research shows that the condition of the Genengan - Lembeyan road segment in Magetan Regency ranges from good to heavily damaged, with the segment from STA 5+000 to STA 8+660 being the most affected and in need of total rehabilitation as indicated by an International Roughness Index (IRI) value exceeding 4. This research highlights the effectiveness of the Roadroid application in providing accurate and efficient road condition assessments, enabling faster evaluation and cost estimation. The estimated repair cost for the severely damaged segment is IDR 4,069,031,000.00, based on the 2024 Bina Marga guidelines. This research contributes to better road management by showing how the Roadroid application can streamline road condition monitoring, enabling more effective budget allocation and prioritization of repairs. It is recommended that the Magetan District Government prioritize high-damage roads for rehabilitation, while maintaining roads in good condition to prevent further damage. Future research should focus on integrating this technology into a routine monitoring system for early detection of road damage, thereby reducing long-term repair costs. In addition, training technical personnel in the use of the Roadroid application and IRI evaluation will improve the accuracy of surveys, and collaboration with experts can produce more sophisticated maintenance strategies that ensure the sustainability of road infrastructure, support community mobility, and encourage local economic growth.

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