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Pavement Performance Evaluation Using the Provincial and Kabupaten Road Management System (PKRMS) Method on the Parengan–Lakardowo Road Section, Mojokerto Regency

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Abstract: Road infrastructure plays a vital role in supporting socio-economic mobility, yet its performance often decreases due to overloaded traffic, inadequate drainage, and limited maintenance. The Parengan–Lakardowo Road Section in Mojokerto Regency, with a total length of 5.182 km, currently experiences significant pavement deterioration that affects driving comfort and road safety. **Objective**: This study aims to evaluate the pavement performance of the Parengan–Lakardowo Road Section using the *Provincial and Kabupaten Road Management System* (PKRMS) to determine road conditions and formulate appropriate maintenance recommendations. **Method**: This research employed a quantitative descriptive method. Primary data were collected through field surveys, visual pavement condition assessment, damage measurement, and road inventory recording. The collected data were processed and analyzed using the PKRMS method to classify road conditions and identify maintenance priorities. **Findings**: The results show that the road condition varies across segments. Good condition was identified at STA 0+000–0+200, STA 0+600–1+000, STA 1+600–2+000, and STA 4+400–5+182. Lightly damaged condition was found at STA 0+200–0+600, while severely damaged condition dominated STA 1+000–1+600 and STA 2+000–4+400. The dominant pavement distresses include potholes, longitudinal cracking, alligator cracking, ravelling, and rutting. **Implications**: The findings indicate that severely damaged segments require structural treatment through pavement reconstruction, supported by drainage system improvement to prevent recurring deterioration and maintain pavement service life. The study also demonstrates the importance of integrated road condition evaluation for supporting sustainable road maintenance planning. **Originality/Value:** The originality of this study lies in the application of PKRMS for integrated pavement condition evaluation, stripmap-based condition mapping, and data-driven maintenance prioritization on a district road section in Mojokerto Regency.

Keywords: pavement performance; PKRMS; road damage; road maintenance; Mojokerto.

INTRODUCTION

Road infrastructure plays a strategic role in supporting economic growth, logistics distribution, community mobility, and regional development. The availability of roads in good condition significantly affects the smooth operation of social and economic activities. However, many regional roads experience pavement deterioration due to high traffic volumes, overloaded vehicles, inadequate drainage systems, and limited periodic maintenance programs (Jihanny et al., 2021; Rokade, 2012). This condition also occurs on the Parengan–Lakardowo Road Section in Mojokerto Regency, which is classified as a two-lane two-way undivided local primary road (2/2 UD). Based on field observations, the road section exhibits various types of pavement distress, including potholes, longitudinal cracking, alligator cracking, ravelling, and rutting. These damages reduce driving comfort and traffic safety while increasing vehicle operating costs (Shahin, 2005). In addition, water ponding caused by poor drainage systems accelerates pavement structural deterioration. This phenomenon has become a critical issue because it directly affects community economic activities and the effectiveness of regional transportation networks, thereby requiring measurable and systematic road condition evaluation (Alfarizi et al., 2021). In addition, water ponding caused by poor drainage systems accelerates pavement structural deterioration because water infiltration can weaken the pavement layer and subgrade bearing capacity (Rokade, 2012). This phenomenon has become a critical issue because it directly affects community economic activities and the effectiveness of regional transportation networks, thereby requiring measurable and systematic road condition evaluation (Alfarizi et al., 2021; Sayers et al., 1986).

Previous studies on pavement condition evaluation can be classified into three main categories. The first category focuses on visual-based assessment methods, such as the Surface Distress Index (SDI) and Bina Marga method. These methods are commonly used to identify surface distress based on the type, extent, and severity of damage. Visual assessment is considered practical because it can be directly applied in the field and provides an initial overview of road conditions. Alfarizi showed that road damage assessment based on visual observation can identify the relationship between traffic volume and pavement deterioration (Alfarizi et al., 2021). Similarly, Labaso emphasized that SDI-based assessment can be used to evaluate pavement surface damage through crack area, crack width, potholes, and rutting parameters (Labaso et al., 2022). However, this approach still tends to be limited to surface damage identification and does not fully integrate road inventory data, traffic characteristics, and maintenance priority recommendations.

The second category of previous studies applies quantitative index-based methods, particularly the Pavement Condition Index (PCI) and International Roughness Index (IRI). The PCI method provides a numerical value to classify pavement conditions, making it useful for comparing the severity of damage among road segments (International, 2020;

Shahin, 2005). The IRI method is also widely used as an indicator of pavement roughness and riding quality, as introduced in the International Road Roughness Experiment by the World Bank (Sayers et al., 1986). Several studies have applied PCI and IRI to support pavement condition evaluation and maintenance planning (Chen et al., 2022). Nevertheless, PCI- and IRI-based studies generally emphasize pavement surface performance and do not always provide an integrated maintenance management framework for local government road networks. As a result, the output of these methods often requires additional interpretation before it can be directly used for road maintenance planning and budgeting (Moazami et al., 2011).

The third category involves the development of digital road management systems, including the Provincial/Kabupaten Road Management System (PKRMS). This method integrates road inventory, pavement condition, traffic data, and maintenance planning into a more structured database system. Winanda explained that PKRMS can be used to analyze pavement damage and formulate district road maintenance programs in a more systematic manner (Winanda, 2025). Compared with conventional assessment methods, PKRMS has the advantage of producing condition mapping, priority classification, and maintenance recommendations through an integrated system. However, studies implementing PKRMS on district roads with severe pavement deterioration remain limited, particularly in Mojokerto Regency. Therefore, further research is needed to apply PKRMS to local road sections that experience significant structural and functional damage.

Based on these research gaps, this study aims to evaluate pavement performance on the Parengan–Lakardowo Road Section using the Provincial and Kabupaten Road Management System (PKRMS) method. The study was conducted through the identification of pavement distress types, measurement of damage severity for each road segment, input of road inventory and condition data into the PKRMS system, and road condition analysis based on the Condition Index (CI) and stripmap results. In addition, this study aims to formulate appropriate maintenance recommendations for each level of pavement distress to support effective, efficient, and sustainable road maintenance programs. Therefore, this research is expected to provide practical contributions to regional road infrastructure management and serve as a reference for related agencies in determining road maintenance priorities.

This study is based on the argument that the implementation of the Provincial and Kabupaten Road Management System (PKRMS) can provide more systematic, objective, and integrated road condition evaluations compared to conventional assessment methods. Through the integration of road inventory data, pavement distress identification, structural condition analysis, and stripmap visualization, the PKRMS method is expected to generate more accurate maintenance recommendations according to the level of damage in each road segment. Furthermore, this study argues that the dominant pavement distresses, including potholes, cracking, and rutting on the Parengan–Lakardowo Road Section, are influenced by a combination of overloaded traffic loads, inadequate drainage systems, and insufficient periodic maintenance. Therefore, the application of PKRMS is expected to become an effective approach in supporting sustainable decision-making for regional road maintenance management.

RESEARCH METHOD

The unit of analysis in this study is the pavement performance of the Parengan–Lakardowo Road Section in Mojokerto Regency. The observed road section has a total length of 5.182 km and is classified as a two-lane two-way undivided local primary road (2/2 UD). The main focus of this study is the physical condition of the pavement, including the type, extent, and severity of road damage found in each road segment. The analysis was directed at identifying pavement distress, evaluating the level of road condition, and determining appropriate maintenance recommendations based on the Provincial and Kabupaten Road Management System (PKRMS).

This study employed a quantitative descriptive research design. This design was selected because the research aimed to measure pavement damage objectively based on field data and convert it into numerical condition values through the PKRMS method. The PKRMS approach was used because it is capable of integrating road inventory data, pavement condition data, and maintenance priority analysis into a systematic road management framework. Therefore, this method is considered suitable for evaluating local road performance and supporting decision-making in road maintenance planning.

The data used in this study consisted of primary and secondary data. Primary data were obtained through direct field surveys on the Parengan–Lakardowo Road Section. These data included pavement distress types, damage dimensions, pavement width, segment length, road surface condition, drainage condition, and supporting road inventory data. Secondary data were obtained from related agencies, including administrative road data, regional codes, road section identity, and technical documents related to road maintenance planning and PKRMS procedures. Literature sources, such as scientific journals, civil engineering references, previous research reports, and technical guidelines, were also used to strengthen the theoretical basis of the study.

Data collection was conducted through field observation, visual pavement condition survey, measurement, documentation, and road inventory recording. The road section was divided into several segments based on stationing to facilitate damage identification and analysis. In each segment, the observed damage included potholes, longitudinal cracking, alligator cracking, ravelling, rutting, bleeding, patching, and other surface distresses. The dimensions of each damage type were measured to determine the percentage of damaged area compared with the total pavement area of the segment. Field documentation was also carried out to support the validation of visual observations and to ensure that the collected data represented the actual pavement condition.

Data analysis was carried out using the PKRMS method. The collected field data were first checked, cleaned, and validated to avoid recording errors, duplication, or inconsistency. The validated data were then input into the PKRMS format, including road inventory data, administrative data, pavement condition data, and damage characteristics for each segment. The system processed these data to produce road condition values, condition mapping, and stripmap visualization. The results were then interpreted to classify road segments into condition categories, such as good, lightly damaged, or severely damaged. Based on these classifications, maintenance recommendations were formulated. Road segments with severe damage were recommended for structural treatment or pavement reconstruction, while drainage improvement was also considered an important supporting treatment to prevent repeated pavement deterioration.

RESULT

Identification of Pavement Distress

Based on the field survey conducted on the Parengan–Lakardowo Road Section in Mojokerto Regency, several types of pavement distress were identified along the observed road segments. The identification process was carried out through visual observation, direct measurement of damaged areas, and documentation of pavement conditions. The measured parameters included the type of distress, the extent of damage in square meters, and the severity level of damage in each stationing segment. This process was conducted to obtain measurable data on pavement conditions before being processed using the PKRMS method.

Classification of Pavement Distress

The field observation results show that pavement distress on the Parengan–Lakardowo Road Section can be classified into several dominant categories. The first type is cracking, which includes alligator cracking and longitudinal cracking. This type of distress indicates structural fatigue of the pavement layer or a decrease in the bearing capacity of the subgrade. The second type is potholes, which appear as bowl-shaped depressions with varying depths. Potholes are critical because they directly affect driving comfort, traffic safety, and road serviceability. The third type is ravelling, which occurs when aggregate particles are detached from the asphalt binder, causing the road surface to become rough and uneven. The fourth type is rutting, which is characterized by surface depression along the wheel path due to repeated heavy vehicle loading.

Damage Level Analysis

Based on the visual survey results, the pavement damage level was analyzed by comparing the damaged area with the total pavement area in each road segment. For example, in the STA 0+000 to STA 0+200 segment, the segment length was 200 m, while the road width was 3.2 m at STA 0+000 and 3.0 m at STA 0+200. Therefore, the average road width was 3.1 m, resulting in a total pavement area of 620 m². In this segment, longitudinal cracking was identified as the dominant damage. The percentage of damage was calculated by dividing the total area of longitudinal cracking by the total pavement area of the segment.

Based on field measurements, four longitudinal cracking areas were found in the STA 0+000 to STA 0+200 segment. The total damaged area was 0.58 m². Therefore, the percentage of longitudinal cracking was calculated as follows:

$$\text{Percentage of Longitudinal Cracking} = \frac{0.58}{620} \times 100\% = 0.09\%$$

This result indicates that the level of longitudinal cracking in the STA 0+000 to STA 0+200 segment is relatively low. However, the same calculation procedure was applied to all road segments to obtain the percentage of damage for each stationing section. The results of this analysis were then used as input data in the PKRMS system to determine the pavement condition category and appropriate maintenance recommendations.

Tabel 1. Damage Data

Cracking Area	Length (m)	Width (m)	Area (m²)
Area 1	5	0.02	0.10
Area 2	7	0.02	0.14
Area 3	7	0.02	0.14
Area 4	10	0.02	0.20
Total Longitudinal Cracking Area			**0.58 m²**

Therefore, the total longitudinal cracking area in the STA 0+000 to STA 0+200 segment was 0.58 m². The percentage of longitudinal cracking was calculated using the ratio between the damaged area and the total pavement area, as follows:

$$\text{Percentage of Longitudinal Cracking} = \frac{0.58}{620} \times 100\% = 0.09\%$$

Tabel 2. Pavement Distress Data

No	Segment (STA)	Type of Distress	Damage Area (%)
1	0+000 – 0+200	Longitudinal Cracking	0.09
2	0+200 – 0+400	Longitudinal Cracking	19.17
3	0+400 – 0+600	Longitudinal Cracking	4.42
4	0+600 – 0+800	Longitudinal Cracking	1.58
5	0+800 – 1+000	Longitudinal Cracking	0.05
6	1+000 – 1+200	Potholes	50.00
		Longitudinal Cracking	0.13
7	1+200 – 1+400	Potholes	100.00
8	1+400 – 1+600	Potholes	100.00
9	1+600 – 1+800	Potholes	5.50
		Cracking	1.07
		Patching	0.57
10	1+800 – 2+000	Potholes	0.82
		Bleeding	8.33
		Cracking	25.00
11	2+000 – 2+200	Potholes	23.00
		Cracking	0.91
12	2+200 – 2+400	Potholes	100.00
13	2+400 – 2+600	Potholes	100.00
14	2+600 – 2+800	Potholes	100.00
15	2+800 – 3+000	Potholes	51.90
16	3+000 – 3+200	Potholes	98.11
17	3+200 – 3+400	Potholes	100.00
18	3+400 – 3+600	Potholes	94.74

No	Segment (STA)	Type of Distress	Damage Area (%)
19	3+600 – 3+800	Potholes	90.00
20	3+800 – 4+000	Potholes	100.00
21	4+000 – 4+200	Potholes	100.00
22	4+200 – 4+400	Potholes	50.00
23	4+400 – 4+600	No Distress	0.00
24	4+600 – 4+800	No Distress	0.00
25	4+800 – 5+000	No Distress	0.00
26	5+000 – 5+182	No Distress	0.00

The systematically identified and measured technical data were then integrated into the *Provincial and Kabupaten Road Management System* (PKRMS). The input process was carried out by entering the damage area parameters into the digital form based on the predetermined road segment division. This stage aimed to process raw field data through the system database in order to generate objective road condition outputs.

Data Processing Using PKRMS

Input of Road Administrative Data

The collected road administrative information was integrated into the PKRMS system through the road network management module. This stage was an important initial step to ensure that the road identity database was accurately synchronized within the application before further analysis was conducted.

The administrative data included detailed regional information for the Parengan–Lakardowo Road Section. These data consisted of the road location in Mojokerto Regency, East Java Province, and the official road section identity registered in the database of the relevant agency.

Information regarding the location, road section name, and survey area code was obtained from the authorized agency. Before being used in the analysis, the data were validated and confirmed by the Bina Marga Division of the Public Works Office of Mojokerto Regency as the road authority.

Province Name: East Java

Province Code: 35

Regency Code: 16

Road Section Name: Parengan–Lakardowo

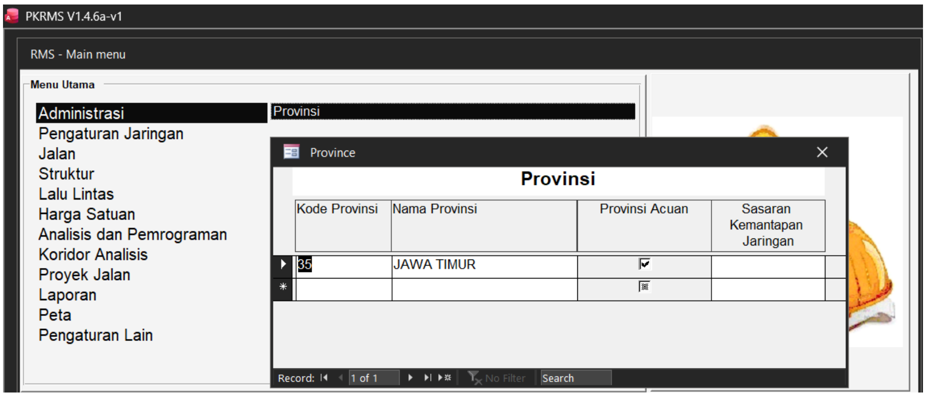

Figure 1. Province Code Input in the PKRMS Application

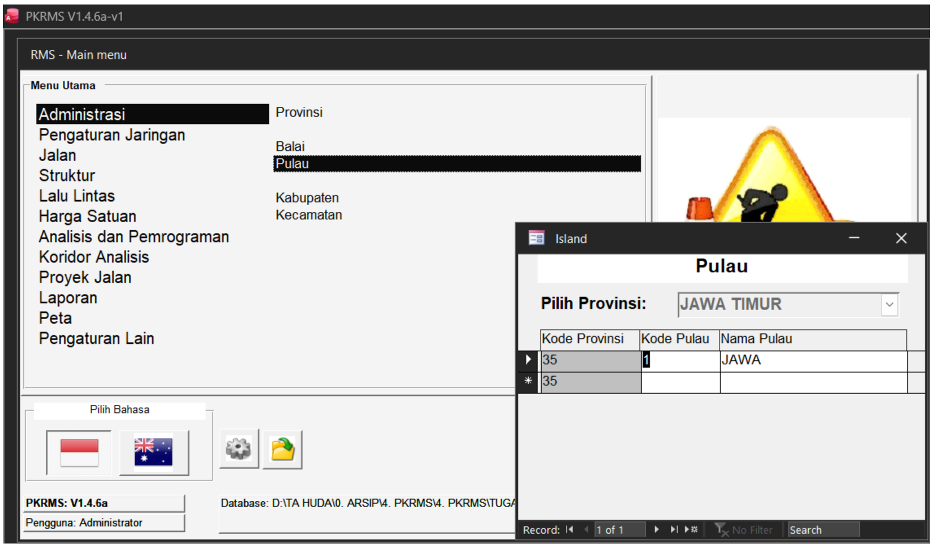

Figure 2. Island Code Input in the PKRMS Application

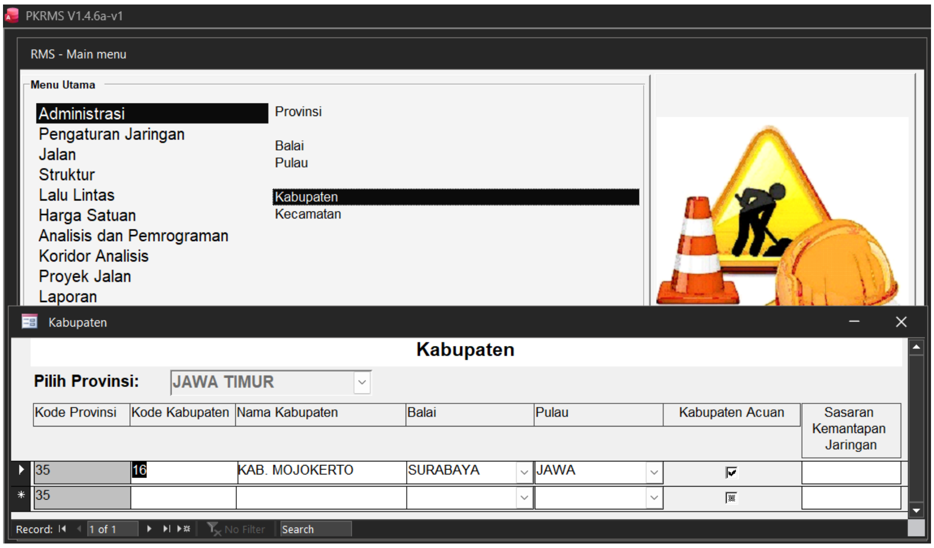

Figure 3. Regency Code Input in the PKRMS Application

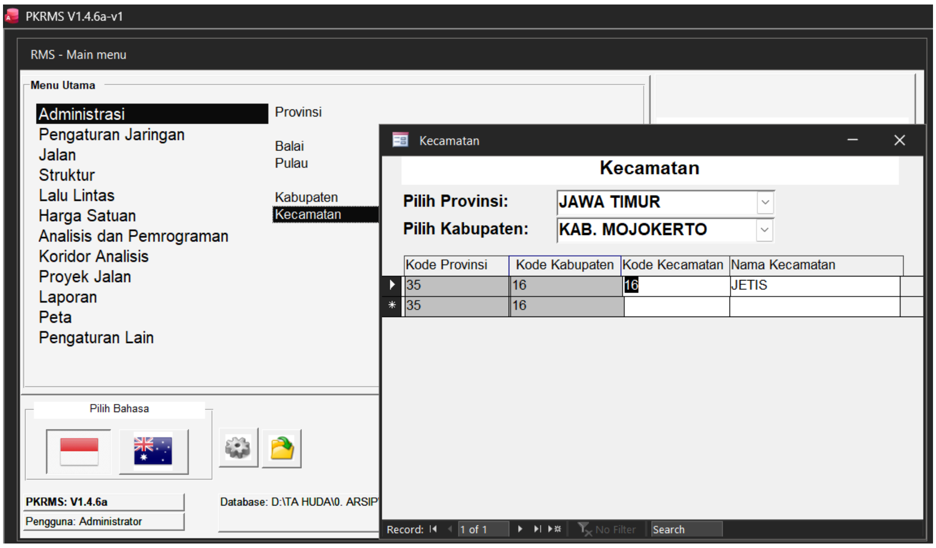

Figure 4. District Code Input in the PKRMS Application)

Road Network Data Input

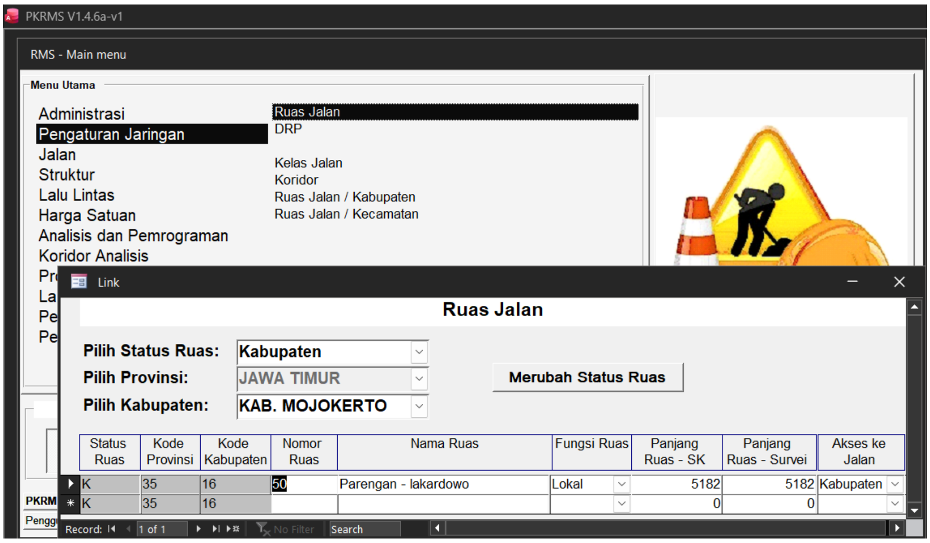

Figure 5. Road Section Data Input in the PKRMS Application

Road Inventory Data Input

Road inventory data should ideally be updated within a five-year cycle because the data generally have a relatively low rate of change. However, the update period may be adjusted if significant changes occur in the function or structure of the road right-of-way (Ruang Milik Jalan/Rumija). In such cases, a new inventory survey should be conducted immediately to ensure that the technical information remains accurate and relevant to existing field conditions.

The inventory data include detailed physical road elements, such as geometric characteristics, road width, pavement type, and other supporting road components. The field data were collected using manual survey forms or the PKRMS tablet-based system to improve the efficiency of data recording and digitalization.

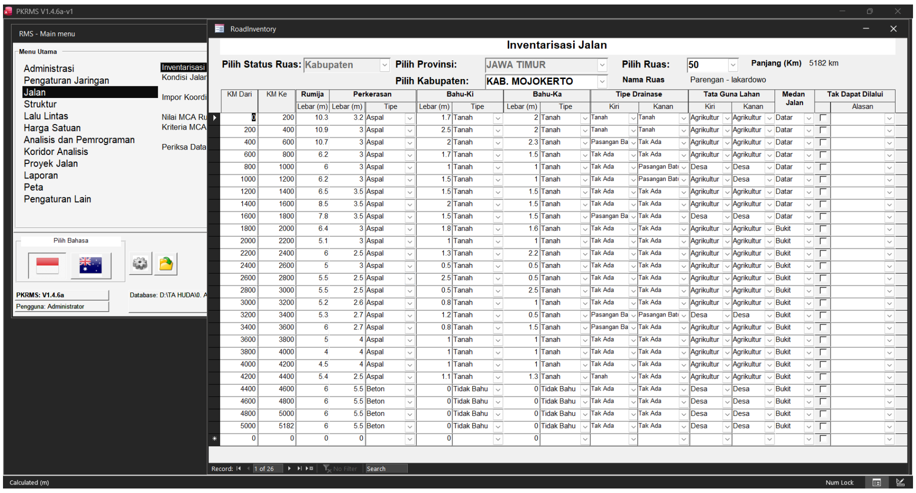

Figure 6. Road Inventory Analysis in the PKRMS Application

Road Condition Data Input

Technically, road condition data indicate the level of physical deterioration that may reduce traffic safety, driving comfort, and road serviceability. Field assessment parameters focused on two main components: evaluation of the pavement layer and identification of damage to supporting road elements, such as shoulders, drainage channels, slopes, and road facilities.

Since road deterioration can worsen rapidly within a short period, road condition monitoring should be conducted more frequently than road inventory surveys. To support accurate maintenance planning, road condition data are generally updated at least once a year.

In practice, functional condition data collection must represent the entire length of the road section, except for segments that cannot be accessed due to technical constraints. All raw data collected from the field survey were then digitized and integrated into the input module of the PKRMS application as the basis for road maintenance planning.

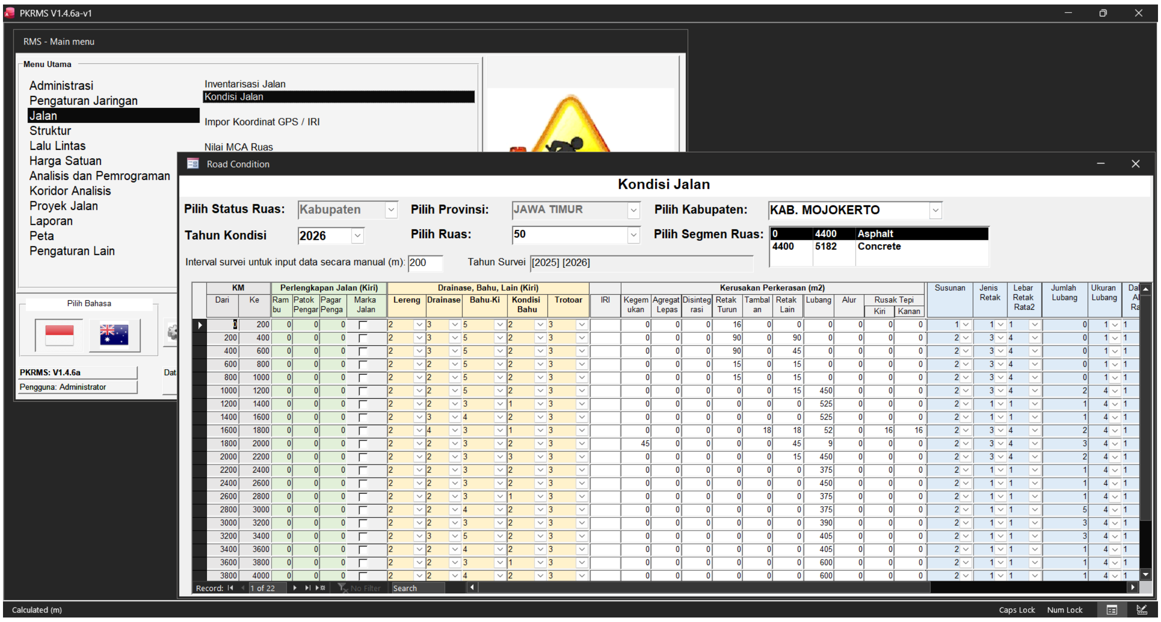

Figure 7. Road Condition Analysis in the PKRMS Application

Strip Maps Hasil Analisis

The stripmap visualization generated from the TTI analysis comprehensively represents the actual condition profile of the surveyed road section while simultaneously identifying segments that require technical maintenance treatment. Specifically, the stripmap summarizes various spatial and technical information, including road stationing (STA), functional road condition, shoulder and drainage system conditions, pavement surface quality, and the final TTI values calculated from field observation data processing.

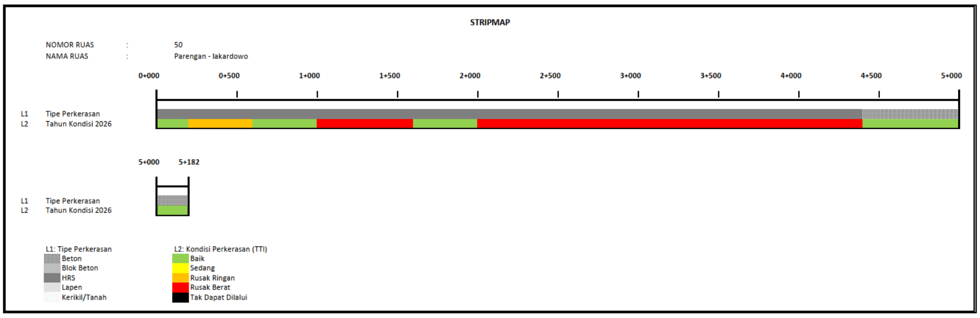

Figure 8. Strip Maps

DISCUSSION

The results of the stripmap analysis indicate that the functional condition of the Parengan–Lakardowo Road Section varies significantly along the observed segments. Based on the PKRMS analysis, the road condition was classified into three categories: good condition, lightly damaged condition, and severely damaged condition. The good condition segments were identified at STA 0+000 – 0+200, STA 0+600 – 1+000, STA 1+600 –

2+000, and STA 4+400 – 5+182. Meanwhile, lightly damaged pavement was identified at STA 0+200 – 0+600, while severe pavement deterioration dominated the segments from STA 1+000 – 1+600 and STA 2+000 – 4+400. These findings indicate that pavement deterioration on the road section is not uniformly distributed and tends to concentrate in segments subjected to heavier structural stress.

The variation in pavement condition is closely related to several contributing factors, including traffic loading, pavement quality, drainage performance, and maintenance frequency. Segments categorized as severely damaged generally exhibited extensive potholes, cracking, and surface deformation, indicating structural fatigue due to repeated overloaded vehicle traffic. In addition, inadequate drainage systems contributed to water infiltration into the pavement structure, which accelerated pavement weakening and deterioration. Poor drainage conditions can reduce pavement bearing capacity and shorten pavement service life, particularly in road sections with insufficient maintenance. Therefore, the deterioration observed on the Parengan–Lakardowo Road Section is likely the result of the interaction between traffic overload, environmental conditions, and limited preventive maintenance practices.

The findings of this study are consistent with previous studies that reported traffic loading and drainage problems as dominant factors causing pavement deterioration. Alfarizi found that increasing traffic volume significantly contributes to pavement damage, particularly potholes and cracking (Alfarizi et al., 2021). Similarly, previous PCI- and SDI-based studies showed that road sections with poor drainage systems tend to experience faster structural deterioration. However, this study provides a different contribution by applying the PKRMS method, which integrates road inventory data, pavement condition assessment, and stripmap visualization into a comprehensive road management system. Unlike conventional visual assessment methods, PKRMS enables the identification of maintenance priorities through spatial condition mapping and integrated database processing. This integration represents the novelty of the present study, particularly for district road evaluation in Mojokerto Regency.

The results of this study demonstrate the importance of integrating road condition analysis with maintenance management systems. The stripmap visualization not only describes pavement distress distribution but also provides practical information regarding the urgency of maintenance treatment for each segment. The identification of severely damaged segments highlights the need for immediate structural rehabilitation to restore pavement capacity and improve road serviceability. In a broader context, the implementation of PKRMS contributes to more objective and systematic road maintenance decision-making, which is essential for improving the efficiency of regional infrastructure management.

From a practical perspective, the study has both functional and dysfunctional implications. Functionally, the application of PKRMS can support local governments in determining maintenance priorities, optimizing maintenance budgets, and improving road serviceability. The system also enhances the accuracy of pavement condition evaluation by integrating technical and spatial information. However, the effectiveness of PKRMS depends heavily on the availability of updated field data, technical expertise, and periodic monitoring. Inadequate data updating and limited maintenance budgets may reduce the effectiveness of the system in supporting sustainable road management.

Based on these findings, several policy and technical actions are recommended. Severely damaged segments identified in the stripmap should receive priority structural treatment, including pavement reconstruction or rehabilitation, to restore pavement strength and accommodate traffic loading. In addition, drainage improvement should be integrated into pavement maintenance planning to prevent recurring pavement deterioration caused by water infiltration. Routine monitoring and periodic updating of road condition data through PKRMS are also necessary to maintain accurate road management databases. Furthermore, local governments are encouraged to strengthen overload vehicle control policies and increase preventive maintenance programs to reduce the rate of pavement deterioration and extend road service life sustainably.

CONCLUSION

This study demonstrates that the pavement performance of the Parengan–Lakardowo Road Section varies significantly across different segments based on the PKRMS analysis results. The dominant types of pavement distress identified in the study include potholes, longitudinal cracking, alligator cracking, ravelling, and rutting. These forms of deterioration indicate that pavement structural fatigue, overloaded traffic loads, inadequate drainage systems, and insufficient periodic maintenance are the primary factors contributing to road damage. The stripmap analysis further revealed that severely damaged pavement conditions were concentrated in the middle section of the road, particularly between STA 2+000 and STA 4+400, while the initial and final sections generally remained in good condition. These findings highlight the importance of systematic pavement condition evaluation to support more effective road maintenance planning.

The scientific contribution of this study lies in the application of the Provincial and Kabupaten Road Management System (PKRMS) for evaluating district road pavement performance in Mojokerto Regency. Unlike conventional visual assessment methods, PKRMS integrates road inventory data, pavement condition analysis, and stripmap visualization into a comprehensive road management framework. This integration enables more objective road condition classification and more accurate maintenance priority determination. Furthermore, this study provides practical contributions for local governments by demonstrating how PKRMS can support sustainable road maintenance decision-making through data-based pavement condition mapping and structural treatment recommendations.

However, this study has several limitations. The analysis was primarily based on visual pavement condition surveys and PKRMS data processing without incorporating detailed structural testing, traffic loading analysis, or geotechnical investigation of the subgrade conditions. In addition, the study was limited to one road section within Mojokerto Regency, which may limit the generalization of the findings to other road networks with different characteristics. Therefore, future studies are recommended to integrate PKRMS analysis with structural pavement testing, traffic performance analysis, and drainage modeling to produce more comprehensive and accurate pavement maintenance strategies.

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