ISSN (*Online*) 2620-7222
ISSN (*Print*) 2503-2399

Available online at
https://jurnalteknik.unisla.ac.id/index.php/CVL

https://doi.org/10.30736/cvl.v2i2

Road Damage Evaluation Using the Provincial/District Roads Management System (PKRMS): A Case Study of Lamongan District, East Java

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A R T I C L E I N F O

Article History :
Article entry : 09-01-2026
Article revised : 10-02-2026
Article received : 27-07-2026

Keywords :
Evaluation, Road damage, PKRMS, DD1, Lamongan

IEEE Style in citing this article :
Andi patriadi, Johan Sanjoko, Anggatha Misykat Alamsyah, Ervinda Riduan, and Pepiet Elyswisnoto, "Road Damage Evaluation Using the Provincial / District Roads Management System (PKRMS) : A Case Study of Lamongan District, East Java", CVL, vol. 11, no. 1, pp. 134–141, Mar. 2026.

A B S T R A C T

The development of road conditions in Lamongan District still faces various challenges, thus requiring routine handling and maintenance on an annual basis. In the evaluation and planning of regional road infrastructure, baseline road condition data using the PKRMS method are employed. This method supports the maintenance and improvement of regional road asset management, particularly in terms of planning, programming, and budgeting. The analysis results indicate that the total length of District roads is 667.22 km, of which roads in serviceable condition (good and fair) account for approximately 55.14%, while unserviceable roads (lightly damaged and severely damaged) comprise about 44.86%. Road damage is predominantly classified as severely damaged, representing 34.87% of the total road length, followed by roads in good condition, which account for 36.27%.

1. Introduction

The evaluation of road conditions in Lamongan District was conducted using the Road Infrastructure Base Data (DD1) for 2025 as the primary data set[1][2]. The DD1 data set includes comprehensive road inventory information, such as segment length, pavement type, surface condition, and other relevant attributes necessary for detailed asset evaluation[3][4]. By integrating DD1 data within the PKRMS framework, the study systematically classified the road network into condition categories (*Good*, *Moderate*, *Light Damage*, *Severe Damage*). The analysis revealed a disproportionately high proportion of roads classified as *Severely Damaged* (34.87% of the total network), indicating significant deterioration and underscoring the urgent need for maintenance interventions [5][6].

Using this PKRMS-supported evaluation, priority rankings were established based on the level of damage and expected service impact. This prioritization approach enables regional planners to allocate resources more effectively across the network, align maintenance planning

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ISSN (*Online*) 2620-7222
ISSN (*Print*) 2503-2399

with budgetary constraints, and ensure that high-priority segments receive timely intervention[7][8][9].

The outcomes from the Lamongan condition assessment provide empirical evidence that systematic evaluation using PKRMS and DD1 yields actionable insights for infrastructure planning and enhances the ability of local authorities to prepare realistic, data-driven maintenance programs [10][11]. These results also position Lamongan's infrastructure performance relative to provincial averages, highlighting areas that require focused improvement for sustainable regional connectivity and economic resilience.

2. Research Method

This study applies the Provincial/District Road Management System (PKRMS) to evaluate the condition of District roads in Lamongan using the Basic Infrastructure Data (DD1) for 2025. The DD1 dataset serves as the primary input and includes road inventory information such as road identification, segment length, pavement type, functional classification, and surface condition [12]. Prior to analysis, the data were verified to ensure completeness and consistency. Each road section was then divided into homogeneous segments based on pavement type and surface condition in accordance with PKRMS guidelines, allowing for a more accurate assessment of pavement performance at the segment level.

Subsequently, road conditions for each segment were classified into good, fair, lightly damaged, and severely damaged categories. Based on this classification, the level of road serviceability was determined, where good and fair conditions were categorized as serviceable, while lightly and severely damaged conditions were categorized as unserviceable [13][14][15]. The analysis quantified the total length and percentage of each condition category across the District road network [16][17]. Priority levels for road handling were then established based on damage severity and functional importance, followed by recommendations for appropriate treatments, including routine maintenance, periodic maintenance, rehabilitation, or reconstruction [18]. The final results were integrated into the planning, programming, and budgeting framework to support performance-based road asset management and decision-making at the District level [19][20].

3. Description and Technical

The PKRMS approach applies DD1 road data (2025) to evaluate District road performance through segmentation of homogeneous road sections and condition classification into four damage levels. These condition classes are aggregated to determine overall road serviceability and quantified by total length and proportion. The results are then used to define maintenance priorities and select appropriate treatment strategies within a planning and budgeting framework.

1. Data Collection and Preparation

The analysis begins with the collection of Basic Infrastructure Data (DD1) 2025 for District roads, which include road inventory information such as road identification, segment length, pavement type, functional classification, and surface condition. Prior to analysis, the data are verified and organized to ensure completeness, consistency, and reliability as inputs for the PKRMS framework.

2. Road Segmentation

Each road section is divided into homogeneous segments based on similar pavement type and surface condition, following PKRMS guidelines. This segmentation process allows variations in road condition along a single road to be identified more accurately and ensures that condition assessments reflect actual pavement performance at the segment level.

3. Road Condition Evaluation

Road conditions for each segment are evaluated using DD1 data by identifying the type and severity of surface distress. The segments are then classified into four condition categories,

ISSN (*Online*) 2620-7222
ISSN (*Print*) 2503-2399

namely good, fair, lightly damaged, and severely damaged, which represent different levels of pavement deterioration and maintenance needs.

4. Serviceability and Quantitative Analysis

Based on the condition classification, road segments are grouped into serviceable (good and fair) and unserviceable (lightly and severely damaged) categories. The total length and percentage of each condition class are calculated to describe the overall serviceability and performance of the District road network.

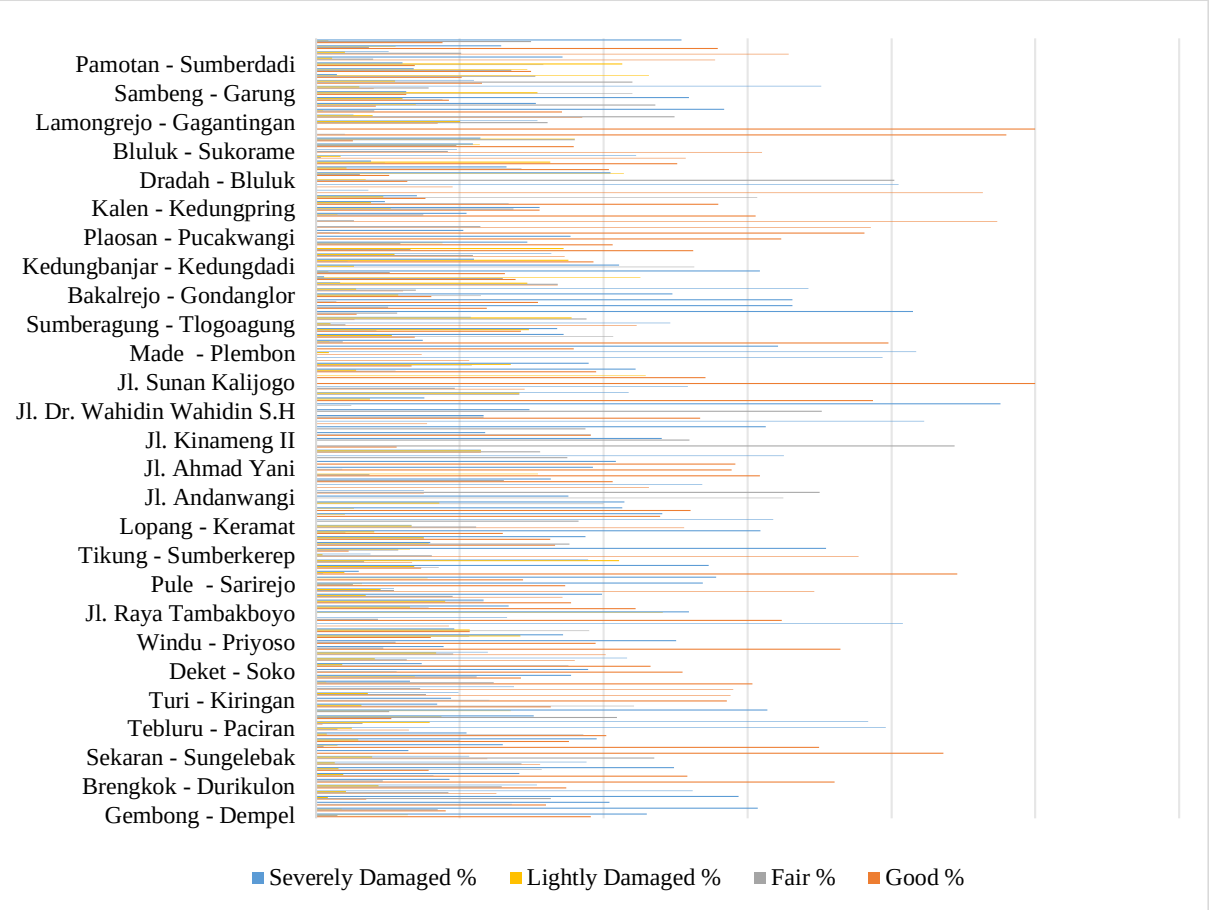
5. Priority Setting and Treatment Recommendation

Maintenance and rehabilitation priorities are determined by considering the severity of road damage and the functional importance of each road segment. Appropriate treatment strategies—ranging from routine maintenance and periodic maintenance to rehabilitation and reconstruction—are then recommended and integrated into the planning, programming, and budgeting processes to support effective road asset management.

4. Results and Discussions

4.1 Analysis of Basic Infrastructure Data (DD1) 2025

The Basic Infrastructure Data (DD1) 2025 provides a comprehensive overview of the District road network conditions in Lamongan District. Based on the DD1 dataset, the total length of District roads analysed reaches 667.22 km, covering all officially registered road sections under District authority. The dataset is used for evaluating road network performance using the PKRMS framework.



Source: Data Analysis, 2025

Figure 1. Basic Infrastructure Data (DD1) 2025

ISSN (*Online*) 2620-7222
ISSN (*Print*) 2503-2399

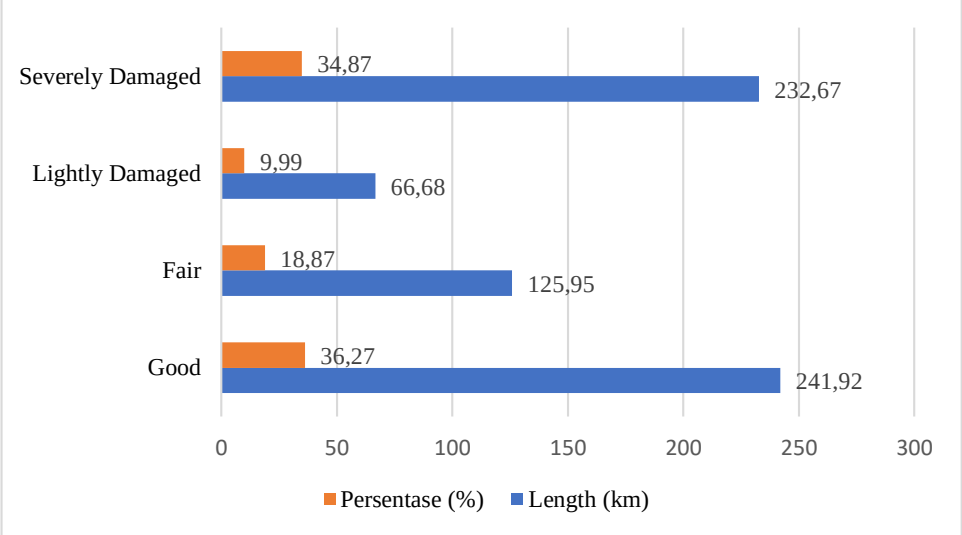
Referring to Figure 1, which presents the percentage distribution of pavement condition categories for each road section, the District road network in Lamongan can be clearly grouped into three priority levels based on the dominance of condition classes within each section.

High-priority road sections are identified in Figure 1 by the predominance of severely damaged segments, indicated by long blue bars relative to other condition categories. These road sections show limited proportions of good or fair conditions, suggesting advanced structural deterioration along substantial portions of the alignment. The concentration of severe damage across these sections indicates reduced serviceability and highlights the need for immediate rehabilitation or reconstruction measures. Such road sections contribute significantly to the overall proportion of unserviceable roads at the network level.

Medium-priority road sections are characterized in the figure by a more balanced distribution between fair and lightly damaged conditions, with neither category overwhelmingly dominant. In these sections, the presence of moderate damage indicates ongoing deterioration that has not yet reached critical levels. As illustrated in Figure 1, these transitional patterns suggest that timely preventive or periodic maintenance could effectively slow deterioration and prevent progression into severe damage, thereby preserving network performance at a lower intervention cost.

Low-priority road sections, as shown in Figure 1, are dominated by good condition pavement, represented by prominent orange bars. These sections exhibit minimal proportions of damaged pavement, indicating satisfactory structural and functional performance. Although these road sections do not require immediate major intervention, routine maintenance remains essential to sustain current condition levels and to prevent premature deterioration.

Overall, the graphical distribution in Figure 1 confirms that road condition performance in Lamongan District is highly heterogeneous across road sections. The coexistence of multiple condition categories within individual road sections further emphasizes the importance of segment-based analysis under the PKRMS framework. This grouping provides a clear technical basis for priority-based road asset management, ensuring that high-priority sections receive urgent attention while medium- and low-priority sections are managed through appropriate preventive and routine maintenance strategies.



Source: Data Analysis, 2025

Figure 2. Recapitulation of Basic Infrastructure Data (DD1) 2025

The results indicate that roads in good condition account for the largest proportion of the network in terms of length, reaching 241.92 km or 36.27% of the total District road network. This suggests that a substantial portion of the network remains in satisfactory condition and requires primarily routine maintenance to preserve its current performance. Roads classified as

ISSN (*Online*) 2620-7222
ISSN (*Print*) 2503-2399

fair condition extend over 125.95 km, representing 18.87% of the total network, indicating moderate deterioration that may require periodic maintenance to prevent further degradation.

In contrast, roads categorized as unserviceable constitute a significant share of the network. Lightly damaged roads cover 66.68 km or 9.99%, while severely damaged roads account for 232.67 km, equivalent to 34.87% of the total road length. The dominance of severely damaged roads among unserviceable categories highlights the presence of extensive structural deterioration within the network. This condition implies that a large proportion of the road system requires major intervention, such as rehabilitation or reconstruction, rather than routine maintenance.

Overall, the figure reveals that the combined proportion of serviceable roads (good and fair) reaches 55.14%, whereas unserviceable roads (lightly and severely damaged) account for 44.86% of the network. This distribution reflects a critical imbalance in road condition performance and underscores the urgency of implementing priority-based maintenance and rehabilitation strategies within the PKRMS framework to improve overall road serviceability in Lamongan District.

4.2 Road Handling Priority Analysis

Based on the existing road conditions as described above and referring to the technical maintenance guidelines issued by Bina Marga and the Ministry of Public Works and Housing (PUPR), the road handling priorities for Lamongan District in 2025 were established, as presented in Table 3. The prioritization is determined using the principle of damage progression control, meaning that road sections with the most severe damage are given the highest priority for improvement, followed by those with lighter damage, while roads in good condition are maintained through routine maintenance activities to preserve their performance.

Table 1. Priority Road Management for Lamongan District in 2025

Road Condition	Length (km)	Types of Road Damage Management	Priority
Good	241,92	Routine maintenance	Prioritas 3
Fair	125,95	Periodic maintenance	Prioritas 2
Lightly Damaged	66,68	Structural periodic maintenance	Prioritas 2
Severely Damaged	232,67	Reconstruction	Prioritas 1

Source: Data Analysis, 2025

The handling criteria presented in Table 1 are based on the level of damage severity and the required technical interventions. Roads in good condition (with no or very minimal damage) are directed toward routine maintenance (such as drainage cleaning, minor patching, and early crack sealing) and assigned Priority 3. The main objective is to keep these roads in good condition for a longer period through preventive maintenance.

Roads in fair condition generally experience damage below the structural threshold; therefore, the appropriate treatment is periodic maintenance (e.g., asphalt resurfacing or overlay), categorized as Priority 2. This action is necessary to prevent roads in fair condition from deteriorating into severely damaged roads.

Roads classified as lightly damaged, although the damage is still limited (approximately 16–23% of the surface area affected), should already begin to be treated through structural periodic maintenance (such as large-area patching, replacement of the wearing course, or partial pavement strengthening) and are also assigned Priority 2, equivalent to roads in fair condition. This is because lightly damaged roads, if left untreated, tend to deteriorate further and more extensively; therefore, early intervention is more cost-effective in the long term.

Finally, roads in severely damaged condition require the most serious interventions in the form of full reconstruction or comprehensive rehabilitation of the pavement structure and are

ISSN (*Online*) 2620-7222
ISSN (*Print*) 2503-2399

assigned Priority 1 (highest priority). The severely damaged category is characterized by extensive damage affecting more than 23% of the pavement surface, the presence of large potholes, wide cracking, deformation, and a loss of structural bearing capacity. Reconstruction measures include improvements from the base layers up to the surface layer. Giving top priority to severely damaged roads is consistent with Ministry of PUPR guidelines, which state that severely damaged roads must be structurally repaired immediately to restore safe traffic service.

Based on the above approach, it can be practically concluded that the allocation of resources and rehabilitation budgets for 2025 in Lamongan District should primarily focus on road sections classified as severely damaged (Priority 1). Once these urgent needs are addressed, treatment can proceed to lightly damaged and fair-condition roads (Priority 2) through periodic maintenance programs. Meanwhile, routine maintenance programs (Priority 3) must continue for all roads in good condition, as well as other road sections, to prevent deterioration of roads that are already in good condition.

This tiered strategy reflects the principles of pavement management adopted by the Directorate General of Bina Marga in the Road Management System, namely maintaining good roads, preventing light damage from progressing into severe damage, and rehabilitating severely damaged roads in a timely manner. Consistent implementation of these priorities is expected to improve the overall road serviceability level of Lamongan District in the coming years.

5. Conclusion and Suggestion

5.1 Conclusion

Based on the analysis of existing road conditions in Lamongan Regency using the PKRMS approach, it can be concluded that the overall condition of the road network varies significantly across road sections. Although a substantial portion of the network remains in good condition, a considerable length of roads is classified as severely damaged, indicating structural failure that requires immediate intervention. The distribution of road conditions confirms that without timely treatment, lightly and moderately damaged roads have a high risk of deteriorating into severe damage, which would increase future rehabilitation costs.

The classification and prioritization of road handling based on damage severity provide a clear and rational framework for decision-making. Roads in severely damaged condition have been appropriately identified as Priority 1 due to their high level of distress and loss of structural capacity, while roads in fair and lightly damaged condition are assigned Priority 2 to prevent further deterioration. Roads in good condition are maintained through routine maintenance under Priority 3 to preserve their serviceability. This prioritization strategy is consistent with the technical guidelines of Bina Marga and the Ministry of Public Works and Housing (PUPR), as well as the fundamental principles of pavement management systems.

5.1 Suggestion

To improve the effectiveness and sustainability of road infrastructure management in Lamongan Regency, several recommendations are proposed. First, the implementation of Priority 1 treatments for severely damaged roads should be carried out promptly through full reconstruction or comprehensive rehabilitation to restore structural performance and traffic safety. Second, greater emphasis should be placed on periodic maintenance for fair and lightly damaged roads, as early intervention is proven to be more cost-effective than delayed rehabilitation.

Third, routine maintenance activities should be consistently implemented across all road sections in good condition to prevent premature deterioration and to protect past infrastructure investments. Fourth, the PKRMS database should be updated regularly using systematic field surveys to ensure that road condition data remain accurate and reliable for planning purposes. Finally, future studies are encouraged to integrate traffic volume data, economic analysis, and

ISSN (*Online*) 2620-7222
ISSN (*Print*) 2503-2399

budget optimization scenarios to further enhance the prioritization of road maintenance and rehabilitation programs.

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