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ANALYSIS OF ROAD DAMAGE BASED ON THE BINA MARGA METHOD, SURFACE DISTRESS INDEX (SDI), AND PKRMS V.1.4.5 ON TLOGOWUNGU ROAD, PATI

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ABSTRACT

This study aims to identify the types of road damage on Tlogowungu Road, Pati, within the section from Sta 0+000 to Sta 1+500. The study evaluates the road conditions and determines appropriate maintenance solutions using the Bina Marga 1990 method, which suggests that for segments 1, 2, 3, 5, 6, 9, 10, 11, 12, 13, and 14, routine maintenance is required, while periodic maintenance applies to segments 4, 7, 8, and 15. The priority ranking obtained after calculating the Average Daily Traffic (LHR) places the road in traffic class number 4, with a total average LHR of 500–2000 vehicles/hour, resulting in a UP value of 8. The SDI method indicates that routine maintenance should be performed on segments 1, 2, 3, 8, and 13, while periodic maintenance is required on segments 4, 5, 6, 7, 9, 10, 11, 12, 14, and 15. The results from the PKRMS software show that Tlogowungu Road has suffered significant damage, ranging from 50% to 100%. However, when rehabilitation is carried out, the road condition improves, with the percentage of the road in good condition increasing to up to 95%.

Keywords: *Road Damage, Surface Distress Index (SDI), PKRMS Software*

1. Introduction

The case study discussed in this research is the road damage on flexible pavement on Tlogowungu Road, equipped with the primary local road network function system of Class III C, which is a type of flexible pavement. The total length of Tlogowungu Road is 4689 km, but only the section of Tlogowungu Road in Pati (STA 0000 – STA 1500) is analyzed in this study due to the damage [1]. This road has two lanes in each direction, with a 2/2 UD road type and a width of 6 meters. The section considered in this research is 1.5 kilometers long, as it is the only part with the most severe damage. The types of road damage include potholes, alligator cracks, hairline cracks, and others.

Several methods are used in assessing road conditions, including the Bina Marga 1990 method, PCI (Pavement Condition Index), IRI (International Roughness Index), and SDI (Surface Distress Index). The Bina Marga 1990 method has the advantage of observing traffic volume and the damage it causes on the road's performance scale, which is obtained from surveys or visual observation of road conditions [2]. The PCI method estimates road conditions using a rating system to indicate pavement conditions. The IRI method is used to assess road conditions based on the IRI value, which reflects surface roughness and is obtained through surveys using a Roughness Meter. The SDI method is a visual assessment of road conditions through a survey, resulting in an SDI value.

According to a study by Elvina Maharani in 2023, road damage refers to a condition where the structural and functional aspects of a road fail to provide optimal service for daily road users. In her study, road damage was analyzed along a 1.5 km section divided into 15 segments. Based on primary data, the types of road damage identified include potholes, patches, longitudinal cracks, transverse cracks, alligator cracks, and grooves. Road damage was identified using the Bina Marga 1990 method, Surface Distress Index (SDI), and PKRMS software. The results showed that the Bina Marga 1990 method, based on LHR volume data for Baturono Road, places it in traffic class No. 4, with the LHR value of 1076.34 falling within the range of 500–2000, yielding a priority ranking of 9 (>7).

Vol. 5, No. 2, pp. 127-136, 2024
Submit: 14-10-2024 |
Accepted: 23-12-2024 |
Publish: 24-12-2024 |

The SDI method resulted in an SDI value of <50, indicating the need for routine maintenance. The PKRMS software showed an output of "good" and also recommended routine maintenance [3]. Therefore, this study proposes three damage analysis methods that can be applied to all road damage conditions on flexible pavement.

The damage analysis used in this study includes three methods: the Bina Marga 1990 method, the SDI method, and the PKRMS software. These three methods assess damage based on factors such as crack width, crack area, the number of potholes, and wheel tracks or grooves. The purpose of these methods is to determine the level of road damage and the appropriate handling of the damage. Based on this background, the title of this paper is "Road Damage Analysis Based on the Bina Marga Method, Surface Distress Index (SDI), and PKRMS V.1.4.5 for Tlogowungu Road, Pati."

2. Methods

The selection of the Bina Marga, SDI, and PKRMS methods in this study is based on the strengths and relevance of each in analyzing road damage on flexible pavement. The Bina Marga 1990 method is used to analyze damage based on traffic volume, which is effective in Indonesia and helps determine maintenance priorities based on traffic frequency. The SDI (Surface Distress Index) method is a simple approach that visually assesses road surface conditions, such as cracks and potholes, providing a quick and effective evaluation to determine the necessary maintenance. Meanwhile, the PKRMS software offers more detailed, data-driven analysis to assess road conditions and repair strategies, integrating road damage and traffic volume data for more accurate maintenance planning.

By combining these three methods, the study provides a comprehensive analysis and appropriate maintenance solutions. The combination of Bina Marga, SDI, and PKRMS allows for a more thorough assessment of road damage and tailored maintenance recommendations based on the actual road conditions in the field. Research requires data that is used as support to solve research problems. Both from primary and secondary data. The following is a detailed explanation regarding evaluating road damage using the Bina Marga method, the Surface Distress Index (SDI), and the PKRMS V.1.4.5 software.

a. In this study, the first step conducted was a 24-hour traffic volume survey. The survey results, initially recorded in vehicles/hour, were converted to passenger car units/hour (pcu/hour) according to the vehicle load and appropriate road type.
b. A road damage survey was then conducted according to the predetermined segment division of 100 meters.
c. Priority analysis was carried out to obtain appropriate road maintenance outcomes.
d. The type of road maintenance was determined based on the priority order established previously.

2.1. Bina Marga Method

The Bina Marga 1990 method is used to analyze road damage by considering traffic volume and road conditions. The steps include collecting average daily traffic (ADT) data and assessing the physical condition of the road, such as potholes and cracks. The road is then classified based on ADT into several categories, reflecting the level of damage influenced by traffic volume. Next, maintenance priorities are determined, with routine maintenance applied for mild to moderate damage, and periodic maintenance for severe damage. The road condition is evaluated to assess the severity of the damage, and the Pavement Condition Index (PCI) is calculated to establish maintenance priorities [2].

Based on the 1990 Guidelines for Urban Road Maintenance Procedures, the Road Layout Method is used to determine the type of damage to guide the selection of repair methods based on visual data analysis. The assessment of road damage levels is based on data regarding the width, length, and diameter of the road damage.

After obtaining the road damage analysis results, the next step is to determine the priority order for repairs. To set the priority order, daily traffic volume data (LHR) is used. The following reference is used to establish priority order:

Vol. 5, No. 2, pp. 127-136, 2024
Submit: 14-10-2024 |
Accepted: 23-12-2024 |
Publish: 24-12-2024 |

Priority Order = 17 - (Traffic Volume Class + Road Condition Score)

Based on these calculations, the results range from Priority Scale A to Priority Scale C.

Priority A (score > 7): considered to be a road in good condition.
Priority B (score 4 - 6): classified as requiring periodic maintenance.
Priority C (score 0 - 3): classified as a road type that should be included in the road condition improvement program.

Table 1. Traffic Class

Traffic Class	LHR (smp/hour)
0	<20
I	20 – 50
II	50 – 200
III	200 – 500
IV	500 – 2000
V	2000 – 5000
VI	5000 – 20000
VII	20000 – 50000
VIII	>50000

Source: Data Analysis, 2024

2.2. The Surface Distress Index Method

The Surface Distress Index (SDI) method involves several steps to assess road conditions. First, gather tools such as a measuring tape, camera, and distress index chart, and select the road segments to survey. Conduct a visual inspection to identify common distresses like potholes, cracks, rutting, and surface wear, then classify and measure the severity and extent of each distress. Next, calculate the SDI by assigning numerical values based on severity and extent. Analyze the SDI values to determine each segment's condition and the required maintenance level, whether routine, periodic, or rehabilitation. Finally, prepare a report with recommendations for maintenance based on SDI findings, prioritizing areas with higher distress levels.

The Surface Distress Index method, or SDI, is used to assess field road damage. The purpose of using this method is to determine the type of maintenance required based on the available damage data. Road Condition Survey (SKJ) or Road Condition Survey (RCS) is used to collect baseline data. The information received is evaluated based on survey results using SKJ samples by examining four factors:

1. Percentage of crack area

Table 2. Percentage of crack area

Type of Crack Area	SDIA Value
None	-
<10%	5
10%-30%	20
>30%	40

Source: Data Analysis, 2024

Vol. 5, No. 2, pp. 127-136, 2024
Submit: 14-10-2024 |
Accepted: 23-12-2024 |
Publish: 24-12-2024 |

2. Average crack width

Table 3. Average crack width

Type of Crack Area	SDIb Value
None	-
Fine < 1 mm	-
Medium 1 -3 mm	-
Wide > 3 mm	Hasil SDIa x 2

Source: Data Analysis, 2024

3. Number of potholes

Table 4. Number of potholes

Type of Crack Area	SDIC Value
None	-
<10 / 100 m	Hasil SDIb + 15
10 - 50 m	Hasil SDIb + 75
>50 / 100 m	Hasil SDIb + 225

Source: Data Analysis, 2024

4. Average depth of potholes.

Table 5. Average depth of potholes

Type of Wheel Mark	SDI Value
None	-
<1 cm dalam	Hasil SDIc + 5 x 0,5
1 - 3 cm	Hasil SDIc + 5 x 2
>3 cm	Hasil SDIc + 20

Source: Data Analysis, 2024

Next, the value obtained from SDId is used to determine the road condition. Once the road condition value is known, the appropriate type of maintenance can be identified based on the road's condition.

2.3. PKRMS Software

The Provincial/District Road Management System (PKRMS) is a tool specifically designed for Planning, Programming, and Budgeting (PPP) purposes that can be used at the Provincial or District level [4]. The PKRMS software is user-friendly and supports road asset management, planning, scheduling, and maintenance of regional road assets, particularly provincial or regional roads. Regional roads are typically narrower roads with two lanes. PKRMS is designed to bridge the gap between the more complex IRMS (usually centrally managed and primarily focused on National Highways) and other manual or electronic applications used to manage provincial/territorial roads. PKRMS requires standardized road data, particularly road segments, inventories, conditions, and traffic data.

PKRMS (Provincial/Kabupaten Road Management System) is a software-based method used to evaluate road conditions and determine appropriate maintenance actions. It is designed for Planning, Programming, and Budgeting (PPP) purposes at the provincial or district level [4]. To analyze road damage using PKRMS, open the "PKRMS Vn.r.accdb" document, enter the user ID and password, and choose whether to create a new database or open an existing one. Input provincial data, including the province code and name, then save. Next, input road segment details like road code, name, function, and length based on gubernatorial regulations and surveys. After entering all data, select

Vol. 5, No. 2, pp. 127-136, 2024
Submit: 14-10-2024 |
Accepted: 23-12-2024 |
Publish: 24-12-2024 |

analysis parameters, validate the data, and check for errors to ensure completeness before proceeding with the analysis.

3. Results and Discussion

3.1. Bina Marga Method Analysis

Road damage analysis using the Bina Marga Method requires an average daily traffic survey conducted directly in the area under review. The author conducted the LHR survey over three days: Friday (February 16, 2024), Sunday (February 18, 2024), and Monday (February 19, 2024), with each survey lasting 24 hours. The peak hour data from each day was determined by the highest average value recorded within that day. On Friday, the peak hour was at 5:00–5:15 PM, with 377.6 smp/hour; on Monday, it was at 7:45–8:00 PM, with 357.4 smp/hour; and on Sunday, it was at 8:30–8:45 PM, with 570.6 smp/hour. This places the road within Category III traffic class according to Table 2.14, with a total LHR range of 200–500.

1. Road Damage

Road damage in the Bina Marga method is categorized based on its types, including surface roughness, potholes, patches, cracks, and subsidence. An example of road damage is shown in Segment 1.

Table 6. Type of Damage

No. Segment	Type of Damage	Length (m)	Width(m)	Depth	Area (m^2)	% Crack Area
1	Longitudinal Crack	8.5	1.2		10.20	2.5
	Longitudinal Crack	3.3	1.4		4.62	
	Pothole	3.3	1.2	0.3	3.96	1.9
	Pothole	1.2	1	0.4	1.20	
	Pothole	3.7	0.9	0.4	3.33	
	Pothole	2.27	1.19	0.012	2.70	

Source: Data Analysis, 2024

Calculation of Crack Area in Segment 1 Representing the Calculation Method for All Segments. To calculate the area of cracks in Segment 1, you can follow these steps, which will also apply to the other segments. The area of cracks is determined by measuring the length and width of each crack type and applying the relevant formulas.

Ar = Pr x Lr

= 8.5 x 1.2

= 10.2 m^2

Ar = Pr x Lr

= 3.3 x 1.2

= 3.96 m^2

Ar = Pr x Lr

= 3.7 x 0.9

= 3.33 m^2

The next step is to calculate the priority order, which is useful for determining the type of handling required for road damage. The priority order for example Segment 1 is as follows:
UP = 17 − (Traffic Class + Damage Value)

Vol. 5, No. 2, pp. 127-136, 2024
Submit: 14-10-2024 |
Accepted: 23-12-2024 |
Publish: 24-12-2024 |

Calculating this gives:
UP = 17 − (3 + 6)
UP = 17 − (3 + 6)
UP = 17 − (3 + 6)
Thus,
UP = 8
Below is a recap of the priority order for each segment and the type of maintenance required. In the Bina Marga Method, the results showed routine maintenance for segments 1, 2, 3, 5, 6, 9, 10, 11, 12, 13, and 14, with the average road damage in these segments being potholes, aggregate loss, longitudinal cracks, and alligator cracks. Meanwhile, periodic maintenance was required for segments 4, 7, 8, and 15. The priority value obtained after calculating the Average Daily Traffic (LHR) indicated that Tlogowungu Road belongs to traffic class number 4, with an average LHR of 500 – 2000 vehicles per hour, resulting in a UP value of 8, which suggests that Tlogowungu Road falls under priority class A and is in good condition. Therefore, it can be concluded that the damage occurring on Tlogowungu Road, based on the Bina Marga Method, is relatively severe, as segments 1 to 15 show a significant need for routine maintenance.

3.2. Surface Distress Index Method Analysis

In road damage assessment using the Surface Distress Index (SDI) method, data collection is carried out through observation and recording of the types and sizes of damages that occur. The data obtained from the field survey is presented in the following table, which represents all segments:

Table 7. SDI Table

No. Segment	Type of Damage	Area (m²)	% Crack Area	Area (m²)	Area (m²)	% Crack Area
1	Longitudinal Crack	8.5	1.2		10.20	2.5
	Longitudinal Crack	3.3	1.4		4.62	
	Pothole	3.3	1.2	0.3	3.96	1.9
	Pothole	1.2	1	0.4	1.20	
	Pothole	3.7	0.9	0.4	3.33	
	Pothole	2.27	1.19	0.012	2.70	

Source: Data Analysis, 2024

Each segment has a length of 100 m and a width of 6 m, so the area of the segment is:
Area of Segment: 6 x 100 = 600 m²
After that, the percentage of the cracked area is calculated as follows; this calculation represents all segments.
Longitudinal Cracks : 11.34/600 x 100 = 1.9%
Holes : 4.89/600 x 100 = 0.8%
The SDI value is obtained by summing all the values from SDI I + SDI II + SDI III + SDI IV.
In segment 1, a value of 100 was obtained from the following calculation:
SDI for segment 1 = 5 + 10 + 85 + 0
= 100 (light damage)
Thus, it can be concluded that in Segment 1, the condition of the Tlogowungu highway experiences light damage based on the Surface Distress Index (SDI) method. The calculation results from this method show that road conditions in segments 1, 2, 3, and 8 are classified as lightly damaged, resulting in routine maintenance. Segments 4, 5, 6, 7, 9, 10, 11, 12, 14, and 15 are in good condition, so they fall under periodic maintenance. Segment 13 has severe damage and requires immediate routine maintenance and repair. It can be concluded that the analysis results using this method show that the overall road condition on Tlogowungu Highway is fairly good, with data from segments 1 to

JICE Journal Innovation of Civil Engineering
Vol. 5, No. 2, pp. 127-136, 2024
Submit: 14-10-2024 |
Accepted: 23-12-2024 |
Publish: 24-12-2024 |

15 indicating that 4 segments require light maintenance, 10 segments need periodic maintenance, and 1 segment requires routine maintenance and urgent repair due to severe damage.

3.3. PKRMS Software

The PKRMS application serves as an auxiliary tool in planning activities, encompassing programming and handling processes that heavily depend on the accuracy of the data being input. The steps for applying the PKRMS application are as follows:

1. Data Input Method
   The administrative location data is the most fundamental information in the PKRMS application that must be input based on the standards generally applicable in this country, starting with the name and code obtained from the Central Bureau of Statistics.
2. Inputting Road Segment Data
   As a reference, access the main menu and select Network Settings → DRP → Define Road Segments.

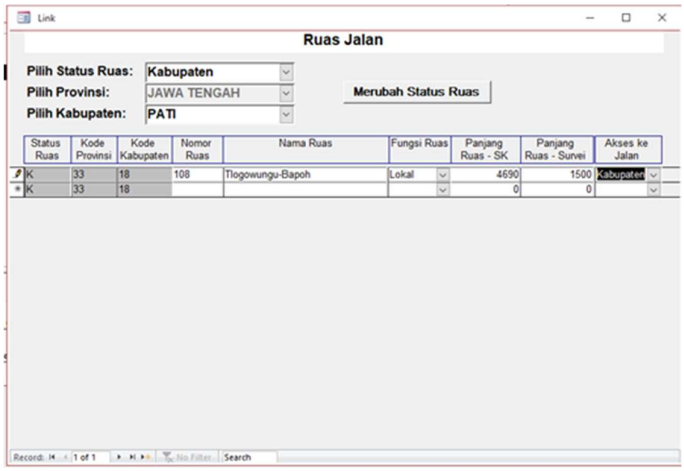

Figure 1. Inputting Road Segment Data
Source: Data Analysis, 2024

3. Inputting Road Inventory Data
   To enter road class data, access the main menu and select Network Settings → Choose Road Class → Select Define Segment. Repeat the same steps for each segment.

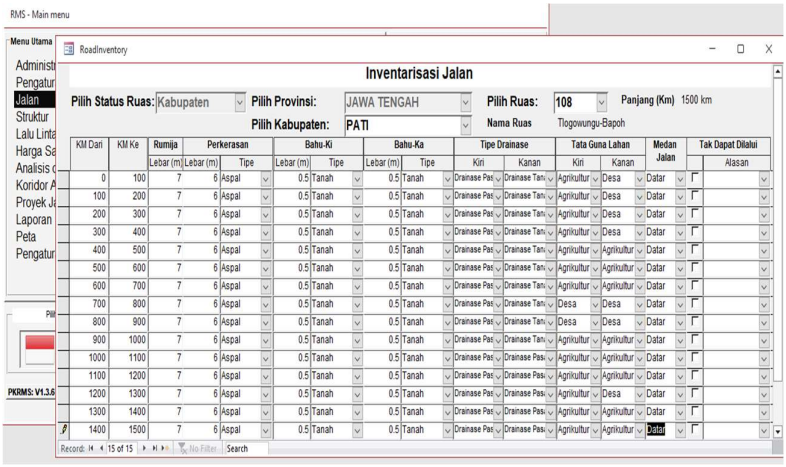

Figure 2. Inputting Road Inventory Data
Source: Data Analysis, 2024

JICE Journal Innovation of Civil Engineering
Vol. 5, No. 2, pp. 127-136, 2024
Submit: 14-10-2024 |
Accepted: 23-12-2024 |
Publish: 24-12-2024 |

4. Entering Road Condition Data
Based on the visual survey results of field conditions, this data is entered into the PKRMS tablet by first creating the PKRMS tablet. The steps are: select Other Settings → Tablet Application → Export Tablet → Fill in Road Condition Description → Enter Survey Year → Select All Road Segments → Click Road Condition in survey type → Click 'Left' → Specify the output directory location. After that, repeat the same steps for 'Pavement' and 'Right', then fill in the road condition data from the survey.

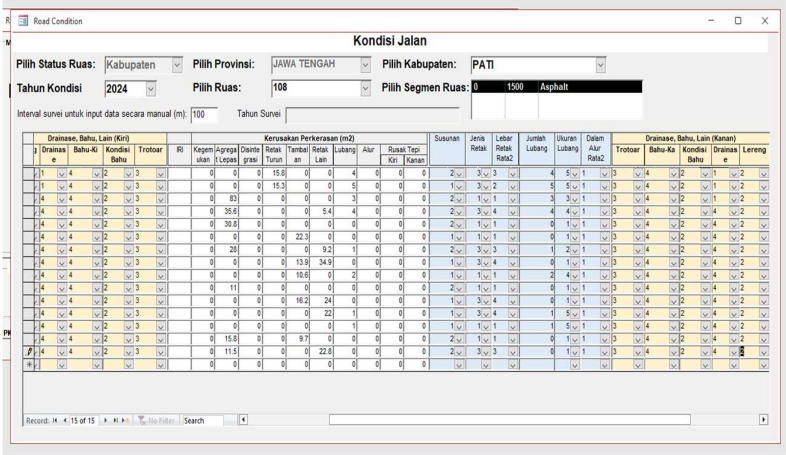

Figure 3. Entering Road Condition Data
Source: Data Analysis, 2024

5. Input Traffic Light Volume
From the traffic survey results, this data is entered into the PKRMS tablet by first creating the PKRMS tablet. The steps are: select Other Settings → Tablet Application → Export Tablet → Fill in MCO Traffic Description → Enter Survey Year → Select All Road Segments → Click Traffic: MCO in survey type → Specify the output directory location.

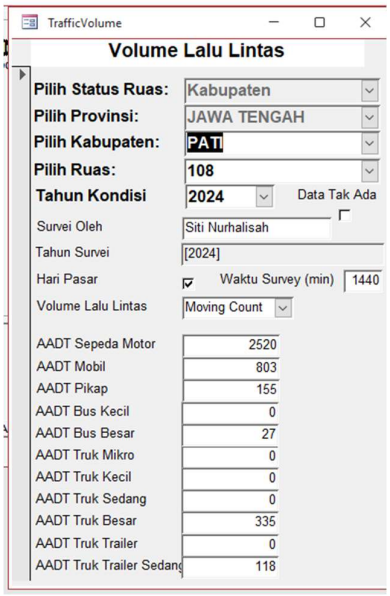

Figure 4. Input Traffic Light Volume
Source: Data Analysis, 2024

JICE Journal Innovation of Civil Engineering
Vol. 5, No. 2, pp. 127-136, 2024
Submit: 14-10-2024 |
Accepted: 23-12-2024 |
Publish: 24-12-2024 |

6. Results of Inputted Data

Figure 5. Results of Inputted Data
Source: Data Analysis, 2024

The two graphs above illustrate the road conditions without rehabilitation and with rehabilitation. The red color indicates that the damage occurring on the Tlogowungu Highway is quite severe, ranging from 50% to 100% damage. However, when rehabilitation is conducted, the condition of the Tlogowungu Highway shows an increase in the percentage of roads in good condition, reaching values up to 95%, as indicated by the green color on the graph.

4. Conclusions

This study analyzes road damage over 1.5 km, divided into 15 segments, identifying potholes, longitudinal cracks, transverse cracks, and alligator cracks. The Bina Marga method recommends routine maintenance for segments 1, 2, 3, 5, 6, 9, 10, 11, 12, 13, and 14, and periodic maintenance for segments 4, 7, 8, and 15. The traffic classification of Tlogowungu Highway is Class 4 with 500-2000 vehicles/day, indicating good road condition. The SDI method recommends routine maintenance for segments 1, 2, 3, 8, and 13, and periodic maintenance for others. The PKRMS software shows severe damage (50%-100%) but predicts a 95% improvement with rehabilitation.

In conclusion, routine and periodic maintenance are needed. Periodic maintenance should include resurfacing, crack sealing, and cleaning drains, while routine maintenance focuses on pothole patching and ensuring drainage functionality. Regular inspections and timely repairs are essential for maintaining road conditions.

This research is expected to serve as a reference for advanced students under my guidance in making more accurate decisions regarding road damage issues in the surrounding area. Furthermore, the findings of this study are anticipated to be practically implemented to improve the performance of roads in each section. The author acknowledges that this research has limitations, and further

Vol. 5, No. 2, pp. 127-136, 2024
Submit: 14-10-2024 |
Accepted: 23-12-2024 |
Publish: 24-12-2024 |

studies are needed to address questions that remain unanswered in this study. It is hoped that the results of this research will provide better insights and knowledge about road damage and how to address it, benefiting all stakeholders involved.

References

[1] [Online]. Available: https://sijakapati.patikab.go.id/jalan/jalankabupaten.

[2] P. L. ZALUKHU, ANALISA DAMPAK BEBAN KENDARAAN DAN, MEDAN, 2021.

[3] A. An Nissa, "Evaluasi Kerusakan Jalan Berdasarkan Metode Bina Marga Pada Jalan Raya Kepadangan-Keret Sidoarjo," *Evaluasi Kerusakan Jalan Berdasarkan Metode Bina Marga Pada Jalan Raya Kepadangan-Keret Sidoarjo,* vol. 4, 2022.

[4] B. M. C. K. P. J. Tengah, "LAPORAN HASIL P/KRMS Program Hibah Jalan Daerah.," 2023.

[5] "Direktur di Direktorat Jenderal Bina Marga, Kepala Balai Besar Pelaksanaan Jalan Nasional di Direktorat Jenderal Bina Marga," in *Direktorat Jenderal Bina Marga*, 1990.

[6] M. Farhan and S. M. Nuh, "Sistem Manajemen Jalan Untuk Menentukan Proritas Rehabilitasi Jalan Provinsi Dengan Menggunakan Program PKRMS," 2021.

[7] E. Maharani and K. H. Putra, *Evaluasi Kerusakan Jalan Berdasarkan Metode Surface Distress Index, Binamarga 1990, Serta Berbasis Software PKRMS Informasi Artikel.,* vol. 2, p. 8, 2023.

[8] "Manajemen Aset Jalan Pengantar Manajemen Aset Jalan," in *Pengantar Manajemen Aset Jalan PKRMS*, 2018.

[9] A. K. Putri and S. M. A , "Manajemen Konstruksi," *EVALUASI KERUSAKAN PERKERASAN JALAN BERDASARKAN METODE BINA MARGA RUAS JALAN TAWANGARGGO-NGIJO KARANGPLOSO,* Vols. 4, Nomor 2, 2023.

[10] A. Purba and P. A, *Prosiding Seminar Nasional Keinsinyuran (SNIP) IV Seminar Nasional Insinyuran Profesional (SNIP) Penilaian Kondisi Jalan Dengan Metode Surface Distress Index (SDI).,* 2020.

[11] S. Maryam, *Comparative Study of Performance between International Roughness Index (IRI), Pavement Condition Index (PCI), and Bina Marga Method on Roadways.,* vol. 8, 2023.

[12] M. A. Ridwam, *Analysis Of Road Damage Repair Using SDI (Surface Distress Index) Method: Case Study: KS. Tubun St.–Merpati St., Tegal City.,* vol. 4, 2024.

[13] Y. Armayadi and D. Dharmawansyah, *PENERAPAN APLIKASI PROVINCIAL/KABUPATEN ROAD MANAGEMENT SYSTEM (PKRMS) PADA KEGIATAN PRESERVASI JALAN DI KABUPATEN SUMBAWA BARAT.,* vol. 4, p. 17, 2023.