The Usage of the Surface Distress Index (SDI) and Pavement Condition Index (PCI) to Evaluate the Condition of Jamin Ginting National Road (BTS. Medan City - BTS. Karo Regency)

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ABSTRACT

Considering the importance of national roads, it is necessary to conduct a review of maintenance strategies based on Minister of Public Works Regulation No. 13/PRT/M/2011 where road maintenance is a road handling activity, in the form of prevention, maintenance and repairs needed to maintain the condition of the road so that it continues to function optimally and serve the road so that the specified life plan can be achieved. The results of research carried out using the Pavement Condition Index (PCI) method for the Bts direction. Medan City – Bts. Regency. Karo is in "Good" condition and the strategy for maintenance is Routine Maintenance along 5.8 Km, Preventive Maintenance along 1.6 Km, Rehabilitation along 0.9 Km, Major Rehabilitation along 1.7 Km for IDR 5,278,395,170.

Keywords: Pavement Condition Index (PCI); maintenance strategy; maintenance cost; national road.

INTRODUCTION

It is commonly found that road conditions are damaged, which may hinder or slow down people in carrying out their activities. The impact of damaged roads is also contributes to the acceleration of damage to transportation such as motorcycles or cars due to passing through these roads. The damaged roads are frequently found on the Jamin Ginting National Road (Bts. Medan City – Bts. Karo Regency) which becomes the subject of the study.

Generally, the causes of road damage include the age of the designed lifespan of the road, puddles of water on the road surface that fail to drain due to poor drainage, excess vehicle tonnage that causes the lifespan of the road to be shorter than the specified design life, inappropriate planning, poor supervision, and implementation that does not with the existing standards. Hence, to deal with the above problems, road maintenance is necessary. Therefore, the strategy that could be applied to the above problems is road maintenance. According to *Permen PU* No. 13/PRT/M/2011 road maintenance is a road handling activity, According to *Permen PU* No. 13/PRT/M/2011 road maintenance is a road handling activity, consisting of precaution, maintenance, and repair needed to maintain the condition of the road so that it continues to function optimally to serve traffic so that the designated lifespan can be achieved.

The initial step in evaluating a road surface condition is to study the existing condition of the road. The approach method that can be applied in assessing the road condition is the Pavement Condition Index (PCI) method. According to Ratnasari (2014), the Pavement Condition Index (PCI) considers the type of damage, the severity of damage, and the total measures of damage which identified during the condition survey. PCI was developed to provide an index of the structural integrity of the pavement and the operational condition of the surface. PCI method was developed in United States by the U.S. Army Corp of Engineers for airport pavement, highways, and parking areas, because this method provides accurate data and forecasts of conditions based on actual conditions on site. This problem underlies the idea of conducting a condition assessment analysis of the Jamin Ginting National Road (Bts. Medan City – Bts. Karo Regency) using PCI (Pavement Condition Index).

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Pavement Condition Index (PCI) is the level of pavement surface condition and its size based on the usability function that refers to the condition and damage on the pavement surface (Hardiyatmo, 2007). In the PCI method, the level of damage is divided into 3 level which is L (Low severity level), M (medium severity level), and H (high severity level) using a numbered index between 0 and 100. The number 0 is used to indicate failed pavement conditions and the number 100 is used to indicate excellent pavement conditions. PCI calculations are based on the results of a visual road condition survey that are identified by the type of damage, severity and quantity.

Table 1. PCI Value Rating, Road Condition Assessment and Type of Road Treatment

PCI Value	Remarks	Type of Handling
100 – 86	Good	Regular Maintenance
71 – 85	Satisfactory	Preventive Maintenance
56 – 70	Fair	Rehabilitation
41 – 55	Poor	Major Rehabilitation
26 – 40	Very Poor	
11 – 25	Serious	Regular Maintenance
0 – 10	Failed	

RESEARCH METHODS

The location of this research is on the Jamin Ginting National Road (Bts. Medan City – Bts. Karo Regency) along 10 km. Figure 1 shows the map of the research location:

Figure 1. Research Location of Jamin Ginting National Road (Bts. Medan City – Bts. Karo Regency)

Preparation Stages

The preparation stage begins with preparing the research framework which consists of background study, problem formulation, research objectives, problem limitations, and research scope. At the literature study stage, there was a study and collection of data and references sourced from scientific writings, books, and the internet that are relevant to the problems of this research which is discussing about which is literature about the Pavement Condition Index (PCI).

Data Collection Stages

The data was obtained from the site survey by identifying various types of damage which then were included in the PCI condition assessment form of each road segment by dividing out every 100 m per segment.

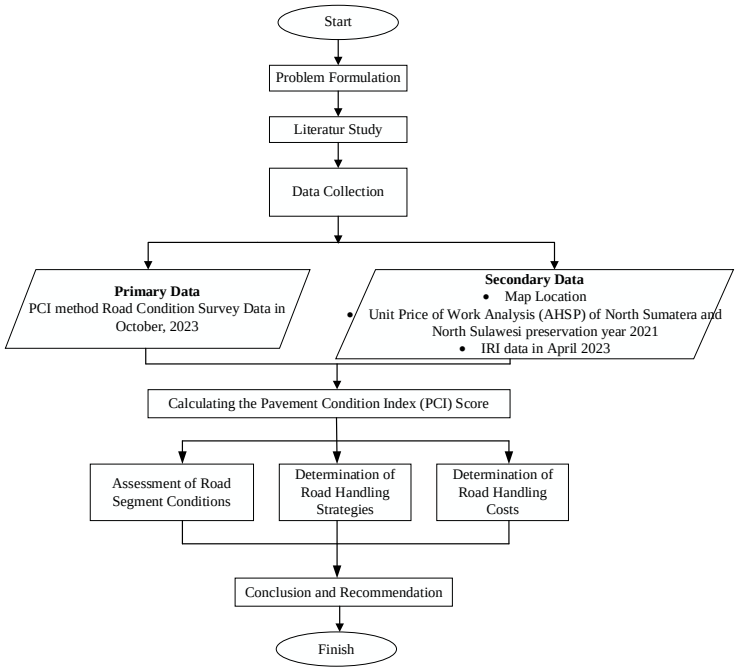

Figure 2. Research Stages Diagram

RESULTS AND DISCUSSION

The analysis of road conditions using the Pavement Condition Index (PCI) method was conducted on flexible pavement on Jl. Jamin Ginting (Bts. Medan City-Bts. Karo Regency) and in the reverse direction. The data was obtained from the results of a survey from October 3rd, 2023 – October 20th, 2023 in which 10 to 15 segments were surveyed in one day.

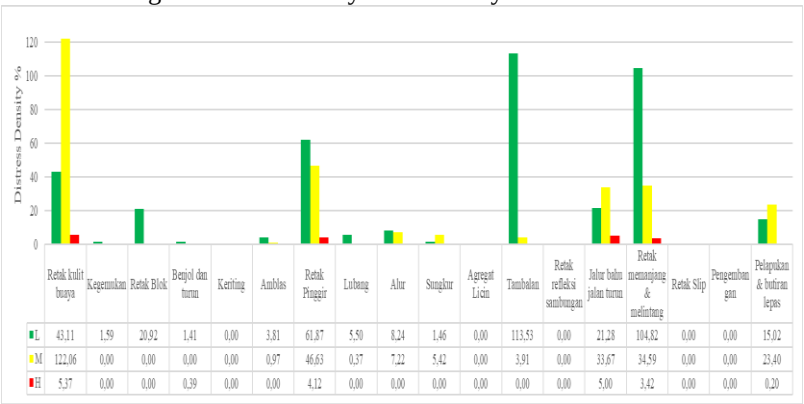

Figure 3. Road Condition Data on Flexible Pavement based on Damage Quantity Percentage for each Damage Type (Bts. Medan Ciy – Bts. Karo Regency)

1. Conduct a damage survey
   Damage identification is carried out in conducting a damage survey.

2. Determine the Deduct Value (*Deduct Value*)

The deduct value is intended to show the effect of every identified damage with a score of 0 – 100. The deduct value is determined by the damage type, severity, total damage and damage density of the reviewed segment.
The stages for acquiring the deduct value are as follows:

1) Calculate the total damage types and determine the severity.
2) Calculate the density of each types of damage.

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3) Determine the deduct value by plotting a line on the applicable deduct value chart based on the type of damage. For instance, consider the Alligator Cracking damage type with a severity level of M and a distress density of 0.6%. Hence, the deduct value is 18.

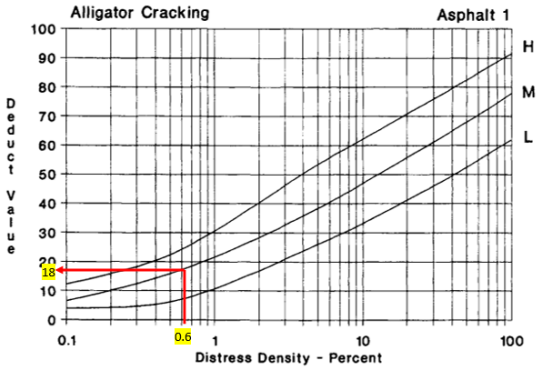

Figure 4. Deduct value plotting for the Alligator Cracking damage type

3. Determination of Maximum Allowable Deduct Amount
   1) If there is no or only a single damage (one individual deduct value), then the total deduct value is taken as the maximum CDV.
   2) If there is more than one individual deduct value. Therefore, the individual deduct values are sorted from the largest to the smallest.
   3) Determine the allowable amount of deduct value (m).
   4) Total of the individual deduct value is reduced to a value of m. If it is smaller than m, then all individual values are taken into account.
      For instance, the value of m on STA 7+200 - 7+300 is
      m = 1+(9/98) (100-HDV)
      = 1+(9/98) (100-18)
      = 8,53 > 2 (2 is the sum of subtraction data, DV)
      Since the value of m is greater than the deduct value, therefore the entire deduct value is taken for the iteration of the PCI calculation.
4. Determination of Maximum Corrected Deduct Value (Maximum CDV)
   1) Set the value of q, which means the number of deductions>2. In the previous example, the number of deducts>2 is 2, so q = 2.
   2) Calculate the total deduct value (TDV) by summing up all the individual values of each iteration.
   3) Determine the smallest corrected deduct value, and reduce it to 2 for values greater than 2. Continue the iteration process until the value is q = 1.
   4) Determine the maximum CDV which is the largest CDV value from the iteration results. For example, at STA 7+200 - 7+300, the maximum CDV will be determined, as shown in Table 4.2 and the CDV value in Figure 4.4.

Table 2. Iteration Calculation to get the Max CDV Value

Stationing		**Individual Deduct Value**							**Total**	**q**	**CDV**
Initial	Final	1	2	3	4	5	6	7	**DV**		
7 + 200	7 + 300	18	5						23	2	16
		18	2						20	1	20

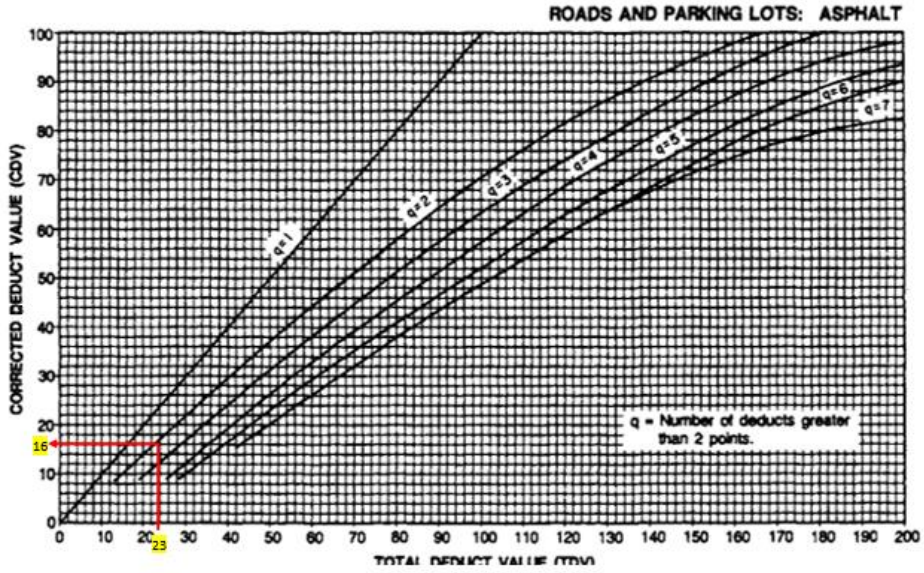

Figure 5. CDV Value Plotting

5. PCI Value Calculation
   The PCI value is derived by subtracting the value of 100 from the Maximum CDV value that has been calculated at the previous point (the equation has been discussed in Chapter III). Based on the result of the subtraction, the PCI can then be categorized based on the rating, which are Perfect, Very Good, Good, Medium, Bad, Very Bad, and Fail.

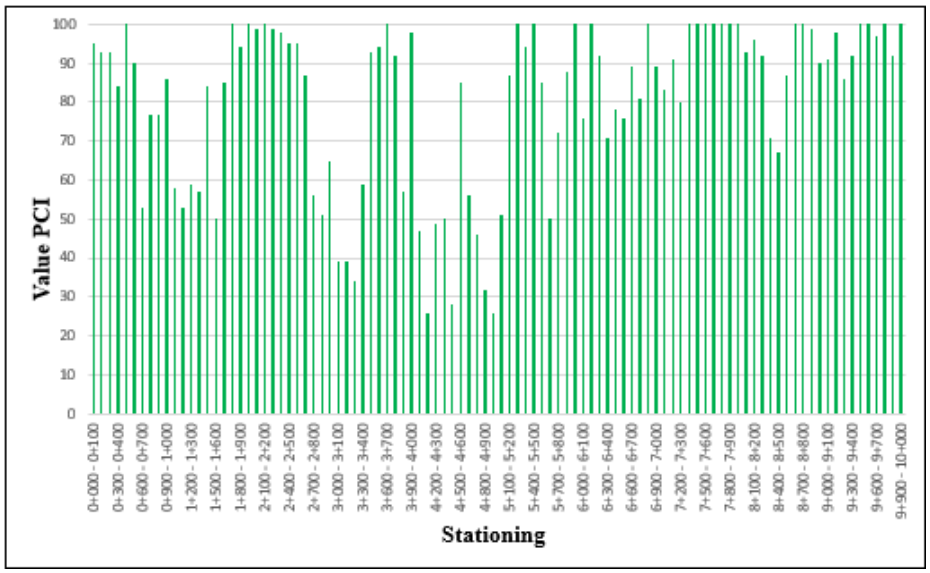

Figure 6. Recapitulation of Flexible Pavement Condition Analysis Results with PCI Method in the route of Bts. Medan City - Bts. Karo Regency

Based on the PCI values obtained from the aforementioned calculations, the objective is to determine the functional condition and type of handling strategy of each reviewed segment figure 7 below.

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No.	Initial STA.	Final STA.	PCI Method			No.	Initial STA.	Final STA.	PCI Method		
			PCI Value	Road Condition	Handling Strategy				PCI Value	Road Condition	Handling Strategy
1	0+000	0+100	95	Perfect	Regular Maintenance	51	5+000	5+100	51	Medium	Major Rehabilitation
2	0+100	0+200	93	Perfect	Regular Maintenance	52	5+100	5+200	87	Perfect	Regular Maintenance
3	0+200	0+300	93	Perfect	Regular Maintenance	53	5+200	5+300	100	Perfect	Regular Maintenance
4	0+300	0+400	84	Very Good	Preventive Maintenance	54	5+300	5+400	94	Perfect	Regular Maintenance
5	0+400	0+500	100	Perfect	Regular Maintenance	55	5+400	5+500	100	Perfect	Regular Maintenance
6	0+500	0+600	90	Perfect	Regular Maintenance	56	5+500	5+600	85	Very Good	Prevention Maintenance
7	0+600	0+700	53	Medium	Major Rehabilitation	57	5+600	5+700	50	Medium	Major Rehabilitation
8	0+700	0+800	77	Very Good	Preventive Maintenance	58	5+700	5+800	72	Very Good	Prevention Maintenance
9	0+800	0+900	77	Very Good	Preventive Maintenance	59	5+800	5+900	88	Perfect	Regular Maintenance
10	0+900	1+000	86	Perfect	Regular Maintenance	60	5+900	6+000	100	Perfect	Regular Maintenance
11	1+000	1+100	58	Good	Rehabilitation	61	6+000	6+100	76	Very Good	Prevention Maintenance
12	1+100	1+200	53	Medium	Major Rehabilitation	62	6+100	6+200	100	Perfect	Regular Maintenance
13	1+200	1+300	59	Good	Rehabilitation	63	6+200	6+300	92	Perfect	Regular Maintenance
14	1+300	1+400	57	Good	Rehabilitation	64	6+300	6+400	71	Very Good	Prevention Maintenance
15	1+400	1+500	84	Very Good	Preventive Maintenance	65	6+400	6+500	78	Very Good	Prevention Maintenance
16	1+500	1+600	50	Medium	Major Rehabilitation	66	6+500	6+600	76	Very Good	Prevention Maintenance
17	1+600	1+700	85	Very Good	Preventive Maintenance	67	6+600	6+700	89	Perfect	Regular Maintenance
18	1+700	1+800	100	Perfect	Regular Maintenance	68	6+700	6+800	81	Very Good	Prevention Maintenance
19	1+800	1+900	94	Perfect	Regular Maintenance	69	6+800	6+900	100	Perfect	Regular Maintenance
20	1+900	2+000	100	Perfect	Regular Maintenance	70	6+900	7+000	89	Perfect	Regular Maintenance
21	2+000	2+100	99	Perfect	Regular Maintenance	71	7+000	7+100	83	Very Good	Prevention Maintenance
22	2+100	2+200	100	Perfect	Regular Maintenance	72	7+100	7+200	91	Perfect	Regular Maintenance
23	2+200	2+300	99	Perfect	Regular Maintenance	73	7+200	7+300	80	Very Good	Prevention Maintenance
24	2+300	2+400	98	Perfect	Regular Maintenance	74	7+300	7+400	100	Perfect	Regular Maintenance
25	2+400	2+500	95	Perfect	Regular Maintenance	75	7+400	7+500	100	Perfect	Regular Maintenance
26	2+500	2+600	95	Perfect	Regular Maintenance	76	7+500	7+600	100	Perfect	Regular Maintenance
27	2+600	2+700	87	Perfect	Regular Maintenance	77	7+600	7+700	100	Perfect	Regular Maintenance
28	2+700	2+800	56	Good	Rehabilitation	78	7+700	7+800	100	Perfect	Regular Maintenance
29	2+800	2+900	51	Medium	Major Rehabilitation	79	7+800	7+900	100	Perfect	Regular Maintenance
30	2+900	3+000	65	Good	Rehabilitation	80	7+900	8+000	100	Perfect	Regular Maintenance
31	3+000	3+100	39	Bad	Major Rehabilitation	81	8+000	8+100	93	Perfect	Regular Maintenance
32	3+100	3+200	39	Bad	Major Rehabilitation	82	8+100	8+200	96	Perfect	Regular Maintenance
33	3+200	3+300	34	Bad	Major Rehabilitation	83	8+200	8+300	92	Perfect	Regular Maintenance
34	3+300	3+400	59	Good	Rehabilitation	84	8+300	8+400	71	Very Good	Prevention Maintenance
35	3+400	3+500	93	Perfect	Regular Maintenance	85	8+400	8+500	67	Good	Rehabilitation
36	3+500	3+600	94	Perfect	Regular Maintenance	86	8+500	8+600	87	Perfect	Regular Maintenance
37	3+600	3+700	100	Perfect	Regular Maintenance	87	8+600	8+700	100	Perfect	Regular Maintenance
38	3+700	3+800	92	Perfect	Regular Maintenance	88	8+700	8+800	100	Perfect	Regular Maintenance
39	3+800	3+900	57	Good	Rehabilitation	89	8+800	8+900	99	Perfect	Regular Maintenance
40	3+900	4+000	98	Perfect	Regular Maintenance	90	8+900	9+000	90	Perfect	Regular Maintenance
41	4+000	4+100	47	Medium	Major Rehabilitation	91	9+000	9+100	91	Perfect	Regular Maintenance
42	4+100	4+200	26	Bad	Major Rehabilitation	92	9+100	9+200	98	Perfect	Regular Maintenance
43	4+200	4+300	49	Medium	Major Rehabilitation	93	9+200	9+300	86	Perfect	Regular Maintenance
44	4+300	4+400	50	Medium	Major Rehabilitation	94	9+300	9+400	92	Perfect	Regular Maintenance
45	4+400	4+500	28	Bad	Major Rehabilitation	95	9+400	9+500	100	Perfect	Regular Maintenance
46	4+500	4+600	85	Very Good	Preventive Maintenance	96	9+500	9+600	100	Perfect	Regular Maintenance
47	4+600	4+700	56	Good	Rehabilitation	97	9+600	9+700	97	Perfect	Regular Maintenance
48	4+700	4+800	46	Medium	Major Rehabilitation	98	9+700	9+800	100	Perfect	Regular Maintenance
49	4+800	4+900	32	Bad	Major Rehabilitation	99	9+800	9+900	92	Perfect	Regular Maintenance

Figure 7. The objective is to determine the functional condition

Due to the limited data acquired, the unit price of work for each kilometer is taken from the average price of road preservation project financing for each kilometer in 2021 in North Sulawesi Province which was obtained from the Core Team of P2JN North Sulawesi Province for the estimated cost of regular maintenance, preventive maintenance and rehabilitation were based on the unit price of work for each kilometer of road preservation work in North Sumatra Province in 2021 while the estimation of the major cost of rehabilitation and reconstruction were taken from road preservation work in North Sumatra Province in 2021. The unit price for each kilometer of each road maintenance work can be seen in Table 3 below.

Table 3. The Unit Price of Work per Kilometer of Each Road Maintenance Work

No.	Maintenance Type	Units	The Unit Price
1	Regular Maintenance	Rp/Km	Rp 42.545.000
2	Preventive Maintenance	Rp/Km	Rp 408.931.000
3	Minor Rehabilitation/ Periodic Maintenance	Rp/Km	Rp 678.418.000
4	Major Rehabilitation	Rp/Km	Rp 2.215.746.100
5	Improvement/ Reconstruction	Rp/Km	Rp 5.968.440.428

By using the unit price of work for each kilometer, the cost requirements for handling roads with a PCI rating can be seen in Table 4.

Table 4. Cost Requirement based on Bina Marga Method Rating

No.	Route	Maintenance Type	Number of segments	Distance (km)	The Unit Prince	Total
1	Bts. Medan City - Bts. Karo Regency	Regular Maintenance	58	5,8	Rp 42.545.000	Rp 246.761.000
		Preventive Maintenance	16	1,6	Rp 408.931.000	Rp 654.289.600
		Rehabilitation	9	0,9	Rp 678.418.000	Rp 610.576.200
		Major Rehabilitation	17	1,7	Rp 2.215.746.100	Rp 3.766.768.370
Total Cost						**Rp 5278.395.170**

CONCLUSION

By the Pavement Condition Index (PCI) method, the section of Jamin Ginting Road towards Bts. Medan City - Bts. Karo Regency resulted in 1.7 km of road in a damaged condition. Furthermore, according to the PCI method, the Jamin Ginting Road Section towards Bts. Medan City - Bts. Karo Regency resulted in 58% in an Excellent condition, 16% in a Very Good condition, 9% in a Good condition, 10% in a Moderate condition, and 7% in a Poor condition. Types of maintenance and costs that can be recommended according to the PCI Method are Regular Maintenance along 5.8 Km, Preventive Maintenance along 1.6 Km, Rehabilitation along 0.9 Km, Major Rehabilitation along 1.7 Km, Reconstruction along 0.3 Km at a cost of Rp5,278,395,170.

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