The comparison between the method of Bina Marga and the pavement condition index (PCI) in road damage condition evaluation (case study: Prof. Ali Hasyimi Street, Banda Aceh)

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Abstract. Monitoring in-service road surface conditions is a part of road pavement maintenance. The most effective maintenance type will save costs and time. Road damage usually occurs on roads that have reached the design age, but some roads have been damaged before reaching the design age. To assess road damage, several methods can be used. The most widely used method in Indonesia is the Bina Marga method and the PCI (Pavement Condition Index) method. This study aims to compare both methods, in terms of accuracy and workability, in monitoring the surface condition of Prof. Ali Hasyimi street, which is located in the city of Banda Aceh. The data required for these two methods is the primary data, which are geometric, visual road damage, and traffic volume. Based on this study's results, the Bina Marga method is easier and faster to use, while the PCI method is more detailed to utilize. In terms of accuracy, both methods relatively have the same accuracy.

1. Introduction
Rocks are one of the most important transportation infrastructures to support the economic growth of a region. However, the newly constructed roads will experience damage either due to natural factors or vehicle loads. Road damage causes enormous losses, especially for road users, such as long travel times, congestion, accidents.

The concept of the pavement management system is used to address the road damage problem. There are several steps in the pavement management system, including in-service monitoring and evaluation. The in-service monitoring and evaluation data are used to define the most appropriate interruption and schedule in maintaining the road structure [1]. Also, the data is used as the decision support system in infrastructure investment [2]. There are three most frequently used methods to monitor and evaluate the road surface in Indonesia: Bina Marga, PCI, and the Asphalt Institute method [3]. While PCI is also used in other countries [4, 5].

PCI method has been compared with other road-surface monitoring methods, such as the international roughness index (IRI) method and pavement structural strength index (PSSI) [6, 7]. However, only a few studies compare the Bina Marga method with the PCI method. This study aims to compare both methods in evaluating the surface condition of a secondary arterial road, a road that lies in built-up areas and serves much traffic.
2. Study area
This research was conducted on a segment of Prof. Ali Hasyimi street, which is between the BPKP intersection and the Pango Bridge. This road is located in the city of Banda Aceh, and it serves much traffic. Banda Aceh is the capital of Aceh Province with a population in 2019 of around 270,321 people. Since the 2004 tsunami, the city of Banda Aceh has experienced very rapid development. One aspect to support this development is the policy of the Aceh Regional Spatial Plan, which establishes the city of Banda Aceh City as the national activity center. According to the city’s land-use planning, Prof. Ali Hasyimi street is planned as an office and trading area. This street has transportation facilities, such as the off-street parking facilities made to prevent on-street parking activities.

Based on the historical data, Prof. Ali Hasyimi street was completed in 2011. The street planned age is 10 years. As a result, it is estimated that by 2021 the road has reached the design age. Because of the short remaining service life—one year—the researcher wants to examine the condition of Prof. Ali Hasyimi's road by using two different methods: Bina Marga Method and the PCI method.

Prof. Ali Hasyimi street has a length of about 1.65 km, a width of 18 meters, and 3 meters median. The type of road is 6/2 D. It is classified as a class II road. The road functional status is secondary arterial. For more details, the location of the road position can be seen in Figure 1.

![Figure 1. Map of the study area](image)

3. Methodology
This research began with the formulation of the problem, background, and the research objective. Then, the literature study was conducted. After that, the primary and secondary data was collected. The primary data in this research is the road geometry obtained by measuring the dimensions of the road using a length measuring instrument. The Secondary data in this study are administrative maps, road status based on current regulations, and a sketch of the research location obtained from google maps. Then, data processing and data analysis were carried out using two types of methods, namely the Bina Marga method and the PCI method.

Prof. Ali Hasyimi street has a total width of 21 meters, a pavement width of 18 meters, and a median of 3 meters. The cross-section of the road can be seen in Figure 2. The length of the road is 1,650 meters.
Furthermore, it is divided into five segments, each of which is 330 m long. The image containing the segment divisions can be seen in Figure 3.

![Cross section](image1)

**Figure 2. Cross section**

![Segment division](image2)

**Figure 3. Segment division**

The road damage survey was conducted from March 10 to March 11, 2020. Road damage data can be seen in Figure 3. The traffic survey was carried out in three days, namely Tuesday, Wednesday, and Saturday, which are 16, 17, and 20 June 2020, respectively. The data collected through the traffic survey can be seen in Figure 4.

![Types of road damage](image3)

**Figure 4. Photos and types of road damage**

Regarding the step for the Bina Marga method, first, the road segments were determined [8]. Next, the areas of road damage and the level of damage were calculated. Road damage data can be seen in the figure. Then, the value of the annual average daily traffic was collected. Furthermore, the value of the...
road classes was determined. Then, the results of the survey were determined, and the data was classified according to the type of damage. After that, the parameters for each type of damage was calculated, and an assessment of each type of damage was conducted. Then, each number for all types of damage was added up, and a road condition value to the total damage figure was assigned. The value of road conditions based on the total number of damage was obtained from each segment.

The Bina Marga method decides the priority order of the maintenance types. For the priority sequence of 0 to 3, it indicates that the road should be included in the road improvement program. For the order priority of 4 to 6, it indicates that the roads need to be included in a regular maintenance program. While for the order of priority of more than 7, the road is sufficiently included in the routine maintenance program.

As mentioned above, the Bina Marga method requires some data including traffic volume. The traffic volume is the number of motorized vehicles passing a certain point at a specific time. Traffic volume is expressed in vehicles per hour (pcu / hour) [9]. The formula for traffic volume can be seen in Formula 1 and 2. Formula 2 is for calculating traffic volume, from peak hours to average daily traffic flow. The K-factor for outer-city roads is 0.11 and the K-factor for inner-city roads is 0.09. The formula for determining the road priority value can be seen in formula 3.

\[ Q_{pcu} = PCE_{LV} \times LV + PCE_{HV} \times HV + PCE_{MC} \times MC \]  

Information:
\( Q_{pcu} \): Total traffic flow (pcu / hour)
\( LV \): Light vehicle, pce value = 1
\( HV \): Heavy vehicle, pce value = 1.3
\( MC \): Motorcycle, pce value = 0.5

\[ ADT = \frac{peak\ hour}{k} \]  

Priority Value = 17 - (ADT Class + Road Condition Value)  

Where:
\( ADT \): Average daily traffic

The results of the calculation of the Bina Marga method are shown in Table 1. The average priority value is 9, which is entered into the periodic maintenance handler.

| No. | Segment | Priority value |
|-----|---------|---------------|
| 1   | 1       | 10            |
| 2   | 2       | 8             |
| 3   | 3       | 9             |
| 4   | 4       | 8             |
| 5   | 5       | 10            |
|     | Average | 9             |

Regarding the steps in the PCI method, first, the visual-observation based data of damage was recorded. Then, the level of damage was decided according to the formula [3]. The recapitulation of the percentage value of road damage can be seen in Table 2. Next, the severity of the pavement damage

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according to the damage conditions was decided. The severity was divided into low (L), medium (M), and High (H). Then, the deduct value—the reduction value for each type of damage that is slotted into the curve—was decided. Next, the maximum allowable reduction amount was determined. After that, the maximum corrected reduction value was determined based on the graph of Figure 5. The qualification of pavement quality according to PCI can be seen in Figure 6.

\[(density) \, (\%) = \frac{A_d}{A_s} \times 100\% \quad (4)\]

Information:
\(A_d\) = the total area of damage types for each level of damage (m^2),
\(A_s\) = the total area of the segment unit (m^2).

| No. | Type of Damage   | L   | M   | H   | Total Damage Rate | Average PCI Value (\%) |
|-----|------------------|-----|-----|-----|--------------------|------------------------|
| 1   | Pothole          | 1.27| 0.44| 0.53| 2.23               | 3.01                   |
| 2   | Alligator        | 34.54| 35.76| 0.00| 70.30              | 94.88                  |
| 3   | Longitudinal cracks | 0.06| 1.45| 0.06| 1.56               | 0.15                   |
|     | Total            |     |     |     | 74.09              | 100.00                 |

Figure 5. Corrected Deduct Value (CDV) graph
The results of the calculation of the PCI method can be seen in Table 3. From the above values, it can be concluded that the pavement value in the segment of Prof. Ali Hasyimi street is categorized as perfect (excellent). The average PCI value is 94.4.

| No. | Segment     | Total PCI Value | Condition   |
|-----|-------------|-----------------|-------------|
| 1   | Segment I   | 100             | Excellent   |
| 2   | Segment II  | 100             | Excellent   |
| 3   | Segment III | 84              | Very good   |
| 4   | Segment IV  | 88              | Excellent   |
| 5   | Segment V   | 100             | Excellent   |
| Σ   |             | 475             |             |

4. Result and discussion

Based on the analysis using the Bina Marga Method, the obtained order of priority is 9, which means the road is included in the routine maintenance program. For the analysis based on the PCI method, the obtained PCI value is 9.46, which means the road is in perfect condition. From both methods, it can be concluded that the two methods have the same treatment recommendation results. However, the PCI and Bina Marga method have several differences in determining the assessment of road damage conditions. The differences can be seen in Table 4.

| Table 4. Comparison of the Bina Marga Method and the PCI Method |
|---------------------------------------------------------------|
| Bina Marga | PCI |
| 1. Conducting average daily traffic survey | 1. Not conducting the average daily traffic survey |
| 2. The analysis includes the number of damage condition and the average daily traffic class value | 2. The analysis uses a graph according to the type of damage |
| 3. The final result is in the form of the order of priority for road damage handling | 3. The final result is in the form of the level of road pavement damage |

There are several advantages and disadvantages of both Bina Marga and PCI methods. For the Bina Marga method, the advantage is that the method involves the volume of traffic passing through a road...
section. Also, the Bina Marga method process is faster because the calculation does not use many graphs with much data needed. However, the limitation of this method is that the method lacks detail in the assessment because it only includes the type of available damage to the road damage value. Furthermore, for potholes damage, this method compares with the percentage area of the road under review. This type of pothole damage calculation could underestimate small damages in the road divided into many segments.

In terms of the PCI method, the advantage is that the method has a more detailed damage analysis. This is because the graph for each type of damage, which is different one by one, is used in this method. The disadvantage of this method is that the process takes a longer time than those of the Bina Marga method because the method requires the input of each type of damage, which should be conducted one by one into the graph. Furthermore, the PCI method does not include the actual traffic volume while the actual traffic volume should have a high impact on road damage.

5. Conclusion
The conclusion that can be drawn from this research is that, in terms of workability, the Bina Marga method is easy to use compared to the PCI Method that involves many graphics and requires several repetitions to get the best value. Furthermore, in terms of accuracy, the Bina Marga method lacks detail in assessing road damage because it only includes the type of road damage without paying attention to the number in a segment. To address this issue, we encourage to use smaller segmentation in the Bina Marga method. On the other hand, the PCI method analyzes in more detail so that any type of road damage can be analyzed using this method. However, the PCI method does not include the traffic volume factor, which should have an impact on road damage. From the results of the assessment, these two methods have relatively the same final value.

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