Evaluation of Road surface damage levels by PCI and SDI method-Review Comprehensive

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Abstract -Roads that have been functioned are in good condition, slightly damaged, moderately damaged, and heavily damaged, therefore road maintenance is needed. Road maintenance uses costs, and the available costs are often insufficient to carry out road repairs as a whole, so it is necessary to determine the priority scale of road repairs. The condition of road surfaces plays a crucial role in the overall performance and safety of road networks. Two widely adopted methods for evaluating road surface damage levels are the Pavement Condition Index (PCI) and the Surface Distress Index (SDI). This study aims to conduct a comparative analysis between these two methods, highlighting their efficiency, reliability, and suitability for various types of road networks. The Pavement Condition Index (PCI) is a comprehensive method that assesses pavement condition based on detailed surveys of visible surface distress, including cracks, potholes, and raveling. In contrast, the Surface Distress Index (SDI) is more focused on quantifying surface distress types that are directly observable, with fewer parameters involved in its calculation compared to PCI.

Keywords-damage levels, PCI method, SDI method,

I. INTRODUCTION

Road networks are vital for economic growth, social interaction, and the movement of goods and services. However, they are subjected to continuous wear and

tear due to traffic load, environmental conditions, and aging materials. Assessing road damage levels is crucial for timely maintenance, ensuring safety, and optimizing costs. A comprehensive assessment enables decision-makers to prioritize repair actions,

prevent accidents, and extend the lifespan of the infrastructure. The quality of road infrastructure is critical for efficient transportation, economic development, and public safety. As road networks age, proper evaluation and maintenance of pavement conditions become essential to ensure their functionality and longevity. Pavements are subjected to various stresses such as traffic loads, environmental conditions, and material degradation, which lead to surface damage over time. Accurately assessing the

condition of pavements is vital for planning maintenance and rehabilitation activities, ensuring that resources are allocated efficiently.

Various methods have been developed to quantify road surface damage, among which the Pavement Condition Index (PCI) and the Surface Distress Index (SDI) are two widely recognized and utilized approaches. Both methods aim to provide objective assessments of pavement conditions, but they differ in scope, data collection processes, and the types of surface distress they emphasize.

The Pavement Condition Index (PCI), developed by the United States Army Corps of Engineers, is a comprehensive evaluation system that assesses the overall condition of pavement based on a detailed survey of surface distresses such as cracks, potholes, rutting, and raveling. It provides a score between 0 (failed pavement) and 100 (perfect pavement), making it an effective tool for long-term pavement management. However, the PCI method requires extensive data collection, which can be resource-intensive and time-consuming.

The Surface Distress Index (SDI), on the other hand, is a simpler method that focuses more narrowly on the visible surface distress types, using fewer parameters to evaluate road conditions. While the SDI method is faster and less costly, it may not capture all the complexities of pavement degradation, making it more suitable for quick assessments rather than detailed management planning.

This study seeks to compare the PCI and SDI methods in terms of their effectiveness, reliability, cost, and practicality in different road environments. By analyzing specific road sections with varying traffic loads and environmental conditions, this comparative analysis aims to provide a clear understanding of the strengths and limitations of each method. The findings from this research will offer guidance to road

management authorities in selecting the most appropriate evaluation method for their specific needs, contributing to more informed decision-making in pavement maintenance and rehabilitation strategies.

2.PROBLEM STATEMENT

The failure to employ contemporary methods for managing and maintaining road networks and pavement has prevented the desired outcomes. Prioritizing paving projects according to a road's significance within a network and its current state is necessary for efficient pavement maintenance. Experience and analysis have led to the conclusion that pavement management operates on the tenet of "Pay now, or pay much more lately." As the pavement network has developed, maintenance and rehabilitation (M&R) requirements and their significance are now determined using a systematic manner in cost-effective environments. It is now necessary to manage highway networks rather than just repair them.

3.LITERATURE SURVEY

1.[Muhammad Isradi, AD Hedianto, AI Rifai, A Mufhidin] This study aims to determine the level of damage that occurs, as well as determine the appropriate type of road damage handling. The method used in assessing the condition of road pavement damage is the PCI (Pavement Condition Index) and SDI (Surface Distress Index) method, which conducts a visual survey by viewing and analyzing the damage based on the type, level of damage and quantity of damage to be used as a basis for carrying out maintenance and repair activities.

2.[Heidy Amelia Setiaputri, Muhammad Isradi, Andri Irfan Rifai, Amar Mufhidin, Joewono Prasetijo]
This study aims to determine the level of damage that occurs, as well as determine the appropriate type of road damage handling. The method used in assessing the condition of road pavement damage is the PCI (Pavement Condition Index) and SDI (Surface Distress Index) method, which conducts a visual survey by viewing and analyzing the damage based on the type, level of damage and quantity of damage to be used as a basis for carrying out maintenance and repair activities.

3.[M Melyar, M Isya, SM Saleh]
This research took place on the road Geumpang Road-West Aceh boundary. The results of the calculation obtained the type and level of damage to the road surface on the Guempang road-the boundary of West Aceh which became the object of research, there were several types of damage such as holes, 8.70%, cracks 4.10%, subsidence 3.16%, patches 0.83%, edge damage 3.33%, and 0.51% peeling off. Overall, the average IRI value obtained from the PUPR Office in 2019 is 3.45% in very good conditions, for the average SDI value is 15.02% in good conditions, while the average PCI value is 79, 63% were in very good condition

4.["Joewono Prasetijo"]
"This study aims to determine the level of damage that occurs, as well as determine the appropriate type of road damage handling. The method used in assessing the condition of road pavement damage is the PCI (Pavement Condition Index) and SDI (Suface Distress Index) method, which conducts a visual survey by viewing and analyzing the damage based on the type, level of damage and quantity of damage to be used as a basis for carrying out maintenance and repair activities. "

5.["Putu Hermawati, NPAS Putri"
It is collecting field data regarding the condition of the road pavement, including the type and extent of existing damage. This data is then analyzed using the formula that has been determined in the SDI and PCI methods. In the research that has been done, the average SDI value for flexible pavement for Jalan Gunung Agung is 18 (Good) and the average PCI value is 63.8 (Good)."

6.["Dendy Paramaartha Siswoyo, Ary Setyawan"]
"This study aims to determine the functional condition of the road by three methods and to assess the closeness of the relationship between these three methods. The descriptive study is carried out to conduct the comparability of the road condition assessment data resulted from three methods for analyzing the results of the assessment of road conditions between the years of 2011-2013. "

7.["Wachid Nur Ihsan, Widarto Sutrisno, Dimas Langga"]
"this case, with the facilities that have been developed by researchers and experts, the stages in the planning, manufacture, and maintenance process. Researchers developed a variety of different methods, including; method that is often used and until now has become a reference in research. There are SDI, RCI, PCI, IRI and so on. Such as the research conducted on the road

section on the Campurejo-Wates road section. This study uses the SDI method from the District Office of Highways for analyzing, researching, and interpreting.

8.["Bagus Hario Setiadji"]
"In this study, an effort to increase the effectiveness of SDI parameters especially for crack damage was carried out. The improvement of SDI parameter was conducted by developing a non-linear equation for each type of crack damage based on the deduct value curve of the PCI method, with a coefficient of determination R 2 of at least 0.99. The proposed SDI equations have been calibrated and produced an error less than 6.2%. A comparison between the value of the proposed and the existing SDI also was presented and the results showed that the similarities between the two SDI values were only 19.86%"

9.["Sebastianus Priambodo, Judiono Judiono, Ikhwanuddin Ikhwanuddin"]
" The purpose of the research on the Gresik-Surabaya road section, km. 4+ 900 to km. 7+ 700, is to find the value of the Surface Distrees Index (SDI) on a 2.8 km long study. The SDI method is carried out by sampling data with visual surveys using a road damage survey form (SKJ) or what is commonly called a Road Condition Survey (RCS), which is divided every 100 meters. So that the results obtained on the Gresik Surabaya road section, East Java, from segments 11 to 18 and continued on segments 26 to 28, the damage that is enough to get a large SDI value is the ruts. While in segments 2, 3, 5, and 6, the damage that gets the largest SDI value with moderate damage classification is cracking for carrying out maintenance and repair activities. repair.

10.[Jati Utomo Dwi Hatmoko, Bagus Hario Setiadji, Mohammad Agung Wibowo"]
"This research intends to develop methods for assessing the damage and failure of pavement as a tool of rapid and accurate decision-making system to determine the factors of pavement failure. To obtain accurate results, a case study was taken on Kendal Timur road to enable a deep evaluation of the factors that causing failure on the road. The results showed that many factors involved in causing the failure of the road, such as un-functional drainage channel, uncontrolled overload due to the closing of weigh stations around the road, and also low quality of road maintenance work so that repeating similar road damages occurred in the not-too-distant future.

11.["Akbar Bayu Kresno Suharso"]
The method involves several stages, including a survey of road conditions, determination of severity levels, assessment of damage, and determination of pavement condition. The survey was conducted in 100-meter segments from KM 10 to KM 14, revealing various types of damage on the toll road, including alligator cracking, bleeding, corrugation, shoving, potholes, and more. Thereafter, an analysis of the severity level and damage assessment was carried out, resulting in an average PCI value of 68, categorized as a" Good" condition. Based on these findings, it is recommended to address this issue through routine maintenance, including repairing minor damage, patching potholes, sweeping, repairing pavement edge damage, sidewalk maintenance, side channel and complementary building drainage, road equipment, and roadside maintenance."

12.[Yohanes Nahak, Krisantus Satrio Wibowo Pedo"]
This study aims to identify damage to road infrastructure that occurred in East Penfui Village. The research method used is to identify road damage using the SDI (Surface Distress Index) method. "

4.OBJECTIVE

1.To identify Causes of road damage.
2. To determine road damage level using Pavement Condition Index (PCI) and surface Distress Index (SDI) method.
3.To identify types of damage.
4.To compare data obtained from PCI and SDI method and determine most suitable and accurate method.

Road Damage-
Damage to the Road Among the various forms of pavement deterioration are:
1) Deformation-Deformation, which includes wavy grooves, subsidence, shoveling, swelling, and falling, is a change in the road surface from its initial profile following construction.
2) Broken- The crack is caused by tensile strain on the asphalt surface, which can be longitudinal, transverse, diagonal, reflecting, block, crocodile skin, and crescent shaped, exceeding the maximum tensile strain.
3) Deterioration of the surface texture, which includes peeling, stripping, obesity, loose grains, and slick aggregates.
4) Damage to holes, which include crossings and road fixes.

5) Cracked or broken edges and sinking shoulders are examples of pavement damage.

Causes of Road Damage-
The following elements contribute to pavement damage:
1)excessive traffic volume, unstable subgrade conditions; 2) poor foundation soil condition; 3) Poor processing and materials from the pavement structure; 4) A reduction brought on by utilities being built beneath the pavement layer; 5) inadequate drainage; 6) an excessive amount of bitumen in the mixture; 7) Pavement fatigue, compaction, or shearing in every layer of the foundation
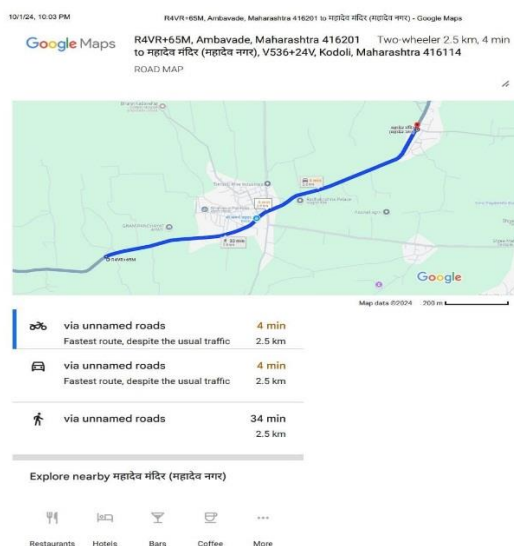
Types of Road Damage-
Among the various forms of road damage are: 1) cracks, which indicate that the pavement surface has been damaged or broken and allow water to seep into the deeper layer, which is one of the things that leads to serious damage; 2) Hole (Potholes), which is damage that resembles a water-holding bowl. This damage happens close to fissures or as a result of inadequate drainage. 3) Rutting, which occurs when vehicle weights cause damage to the tire tracks parallel to the axles and take the shape of grooves, resulting in the vehicle developing ruts.

5.REASEARCH LOCATION

The road segment with a length of 1.5Km and a width of 7.66 meters. The community benefits greatly from this land transportation route, which speeds up the business, tourism.

Figure 1 below provides a general illustration of the research loca

6. METHODOLOGY

(1)Data Collection:

The methodology began with the collection of road surface images from Shahapur village (ODR) captures using mobile devices. The dataset was carefully curated to include diverse road conditions and types of road damage, particularly focusing on potholes. We ensured the representativeness and relevance of the dataset to our research objectives.

(2)Data Preprocessing:

Preprocessing procedures were used to standardize the format and quality of the collected photos.
Primary data from the field is needed to evaluate the pavement condition using the Pavement Condition Index Method in the Shahapur road Section.
Primary data are information obtained directly from the field, such as measurements of the types of pavement damage, types of pavement used, and traffic composition data. These data are obtained by observing the case directly at the location of the study. The survey includes a survey on road surface conditions and the road segment of Shahapur along ±1.5 km divided into several segments. This is done to facilitate the identification of road damage. The surveys conducted include:
1.Road damage type-For every road segment examined, the types of current road damage are summarized. Damage of all types is visually inspected and painted. Next, a meter measures the depth, width, and length of all damage kinds.

2. Damage is evaluated according to its quantity and quality, such as whether it is heavy, moderate For every stretch that is being examined, every kind of road damage is summarized and totaled.

3. Information gathered indirectly or through middlemen is referred to as secondary data. Books, documents, pre-existing proof, or well-published archives that are open to the public are typically the formats in which these data are found. The site plan is the secondary data required for this study. To find the value of this approach, follow these steps:

1. Value Deducted (DV).
2. Density (D)
3. TDV, or total deduction value.
4. Value of Corrected Deduction (CDV)
5. Pavement Quality Classification.

COCLUSION

Using the PCI and SDI methodologies to evaluate road surface damage offers a systematic way to determine the types, extent, and severity of damage, which helps determine maintenance priorities and repair choices. Through the identification of crucial places that require repair, PCI and SDI provide precise condition ratings, maintenance planning, and thorough damage categorization (e.g., cracks, potholes, ruts). These techniques, which are adaptable to varied road environments, provide information about how various circumstances impact road deterioration. All things considered, PCI and SDI provide data-driven choices for effective budgetary allocation, maintenance, and enhanced long-term road performance and safety.

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