Evaluation of Road Preservation Priorities Based on Road Condition and Traffic Load on the Jambi Province Border-Maur Corridor

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Abstract. This study aims to evaluate road preservation priorities based on road surface condition and traffic load along the Jambi Province Border–Maur project corridor. The dataset comprises maintenance cost data for ten road sections. The analysis was conducted by calculating the maintenance cost per kilometer, applying min–max normalization to the International Roughness Index (IRI) and Average Daily Traffic (ADT), and developing a Service Pressure Index (SPI). The results indicate that the Betung–Bts. Kota Palembang section has the highest preservation priority, with an SPI value of 0.953, followed by the Bts. Prov. Jambi–Peninggalan section with an SPI value of 0.623 and the Sei Lilin–Betung section with an SPI value of 0.431. These findings suggest that the SPI can serve as an initial decision-support tool for establishing road preservation priorities in a more proportional manner by considering both infrastructure condition and service pressure.

Keywords Average Daily Traffic, International Roughness Index, road maintenance cost, road preservation, Service Pressure Index

1. Introduction

Road infrastructure is a strategic element of the transportation system because it directly supports mobility, the distribution of goods and services, interregional connectivity, and regional economic growth. A road network in good condition can improve travel efficiency, reduce travel costs, expand access to public services, and strengthen regional development equity. In Indonesia, Law Number 2 of 2022 emphasizes that roads are public service infrastructure and economic resource facilities that support connectivity among activity centers and equitable regional development [1]. However, traffic growth and repeated road use can accelerate pavement deterioration, particularly on sections with high traffic loads. Therefore, road preservation must be planned systematically to maintain safe, comfortable, and sustainable road service performance.

Road preservation is not only oriented toward repairing visible damage, but also includes efforts to maintain pavement performance so that it does not deteriorate further. Minister of Public Works

Regulation Number 13/PRT/M/2011 explains that road maintenance includes care, rehabilitation, support, and improvement activities to keep roads functioning according to service standards [2]. In road network management practice, field treatment needs often exceed the available budget. This condition requires an objective, measurable, and technically justified priority system. Chen [3] states that maintenance and rehabilitation are needed to keep pavement networks in acceptable condition, yet funding limitations remain a major challenge in pavement management.

Pavement management decisions need to be supported by road condition data and performance indicators that can represent actual treatment needs. Tamagusko et al. [4] state that pavement management systems play an important role in pavement condition assessment, performance prediction, resource allocation, and the selection of maintenance and rehabilitation strategies. Similarly, Huang et al. [5] show that one of the main challenges in road maintenance is determining optimal treatment timing and budget allocation to avoid repeated investment and improve resource utilization. Thus, road preservation priorities should not be determined solely based on administrative considerations or total maintenance cost, but should be supported by technical indicators that show service pressure on each road section.

One indicator commonly used to evaluate functional road condition is the International Roughness Index (IRI). IRI describes longitudinal pavement roughness related to ride comfort, service quality, and maintenance intervention needs. A higher IRI value indicates a rougher road surface, lower ride comfort, and a greater tendency for treatment needs. Sayers et al. [6] introduced IRI as an international standard for measuring road roughness through the International Road Roughness Experiment. Recent research by Ceriani et al. [7] used changes in IRI values to evaluate the effectiveness of road maintenance interventions and showed that IRI can be an important indicator for assessing pavement performance before and after treatment.

The relevance of IRI in road evaluation is also supported by St. Maryam et al. [8], who compared the IRI, Pavement Condition Index (PCI), and Bina Marga methods on flexible pavement roads. Their results show that IRI provides an overview of road surface roughness, PCI describes the physical condition of pavement distress, while the Bina Marga method can support the selection of maintenance type. These findings indicate that IRI can be used as an initial indicator to read the functional condition of the road surface, especially when the study focuses on surface comfort and treatment priority needs.

In addition to road surface condition, traffic load is an important factor in preservation evaluation. Average Daily Traffic (ADT) represents the intensity of vehicles passing through a road section on an average day. Sections with high ADT receive larger repeated vehicle loads, which may accelerate pavement fatigue, deformation, cracking, and surface distress. The Indonesian Highway Capacity Guideline places traffic flow as an important basis for evaluating road capacity and operational performance [9]. Therefore, ADT needs to be considered together with road condition so that preservation priorities reflect not only existing condition, but also the usage pressure received by each section.

Several previous studies show that road maintenance priorities should not depend on a single indicator. Hasan and Jaber [10] proposed a road maintenance prioritization framework by integrating the Fuzzy Best-Worst Method and VIKOR in a multi-criteria decision-making approach. Their study shows that maintenance priorities need to consider several criteria, such as road condition, traffic volume, economic aspects, land use, urban development, institutional aspects, safety, cost, and environmental impact. Huang et al. [5] also included indicators such as IRI, PCI, pothole count, traffic volume, heavy vehicle ratio, and maintenance cost in determining pavement maintenance strategies. This strengthens the need for a multi-indicator approach so that preservation decisions are more objective and not biased toward a single variable.

From the cost perspective, preservation evaluation needs to distinguish between total maintenance cost and cost intensity per unit length. A large total cost does not always indicate a higher technical priority because it can be influenced by section length, work volume, treatment type, and other field conditions. Chen [3] emphasizes that network-level maintenance and rehabilitation decision-making needs to consider budget constraints and cost allocation to maximize maintenance benefits. Bo et al.

[11] also developed a pavement maintenance decision optimization model by considering maintenance cost, affected traffic volume, carbon emissions, and maintenance effectiveness. Therefore, cost is important in decision-making, but it needs to be interpreted together with technical indicators.

A previous study on the Jambi Province Border-Maur corridor showed that IRI and ADT could explain only 42.4% of the variation in road maintenance cost, while the remaining 57.6% was influenced by factors outside the model, such as pavement type, road age, environmental condition, maintenance frequency, Volume to Capacity Ratio (VCR), and Surface Distress Index (SDI) [16]. This finding provides a basis that cost cannot be interpreted as a single indicator without considering technical variables and other field contexts. Therefore, in this study, regression is not used as the main tool for determining priorities; instead, preservation priorities are evaluated through a weighted index that combines road condition and traffic load.

In this study, road preservation priority is evaluated by combining two main indicators: IRI as a representation of road surface condition and ADT as a representation of traffic load. Both indicators are normalized using the min-max method and then combined into the Service Pressure Index (SPI). This index is used to describe the level of service pressure on each road section. A higher SPI value indicates greater service pressure, so the section is more appropriate to be considered as a preservation priority.

The Jambi Province Border-Maur project corridor was selected because it has an important role in interregional connectivity and shows variations in road condition, section length, traffic colume, and maintenance cost. The evaluated data consist of ten road section with different IRI and ADT values, so each section has a different level of service pressure and preservations needs. Therefore, an evaluation approach that considers cost per kilometer, road surface condition, and traffic load is needed to make treatment priorities more proportional.

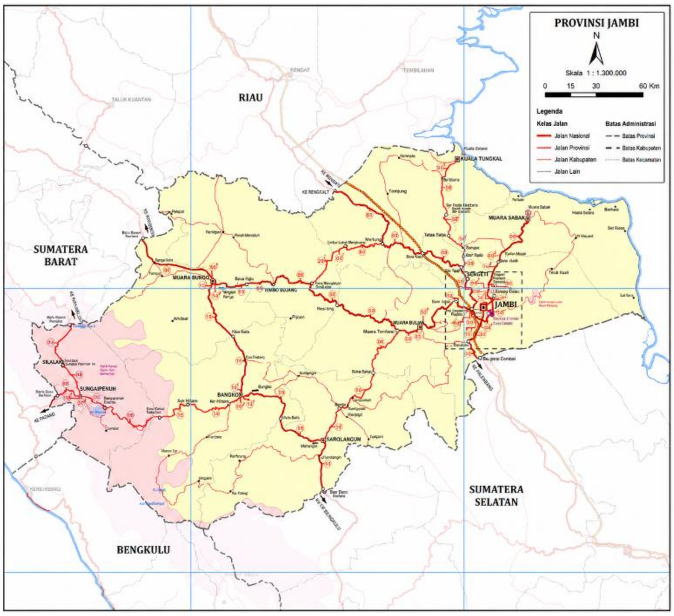

Figure 1. Road network map of Jambi Province

Source: Directorate General of Highways, Ministry of Public Works and Housing, 2021.

Based on this background, this study aims to evaluate road preservation priorities based on condition and traffic load on the Jambi Province Border-Maur project corridor . Specifically, this study analyzes IRI, ADT, maintenance cost per kilomeyer, and SPI to determine the order of preservation priorities. The results are expected to support more objective, measurable, and technically relevant road preservation decision-making.

2. Methods

2.1. Project Location and Data

This study uses a descriptive quantitative approach to evaluate ten road sections on the Jambi Province Border-Maur project corridor. The data used are secondary data consisting of road section length, IRI value, motorcycle ADT, non-motorcycle ADT, total ADT, and road maintenance cost. The quantitative approach was selected because the main research variables are numerical and can be compared among sections through a consistent evaluation procedure [12].

The Jambi Province Border-Maur project corridor is part of the road network that supports connectivity from Jambi toward South Sumatra. The road network map of Jambi Province that serves as the basis for the project location is shown in Figure 1.

Table 1. Basic data of the analyzed road sections

Road Section	Length (km)	IRI	Total ADT	Maintenance cost (IDR billion)
Bts. Prov. Jambi - Peninggalan	8.878	4.86	10,671	18,815.35
Peninggalan - Sei Lilin	3.379	3.41	12,464	3.46
Sei Lilin - Betung	4.365	4.16	14,305	597.28
Betung - Bts. Kota Palembang	5.570	4.71	62,211	9,780.75
Terawas - Bts. Prov. Bengkulu	1.607	3.43	30,802	2.02
Bts. Kota Palembang - Bts. Kab. Prabumulih	1.231	3.14	26,215	1.57
Bts. Kab. Prabumulih - Muara Enim	1.994	3.63	19,658	1.75
Bts. Kota Kayu Agung - Sp. Penyandingan	1.063	4.12	15,935	0.39
Prabumulih - Baturaja	9.231	3.33	7,502	6.15
Baturaja - Maur	1.200	2.94	14,491	1.00

Source: PT. Bumi Persada Engineering Consultant and PT. Cakra Graha, 2025; Data analysis (2025).

2.2. Variables and Analytical Formulation

The main variables in this study include the International Roughness Index (IRI), Average Daily Traffic (ADT), road section length, and maintenance cost. IRI is used to represent the functional condition of the road surface, while ADT is used to represent traffic load intensity. Maintenance cost is also calculated per kilometer so that road sections with different lengths can be compared more proportionally. Total ADT is obtained by adding motorcycle traffic and non-motorcycle traffic, as shown in Equation (1).

$$ADT_{total} = ADT_{MC} + ADT_{non-MC} \quad (1)$$

Furthermore, maintenance cost is not only evaluated based on the total value, but is also divided by road section length. This calculation is used to obtain maintenance cost intensity per kilometer, as shown in Equation (2).

$$C_{km} = \frac{C_{total}}{L} \tag{2}$$

Because IRI and ADT have different units and measurement scales, both variables are normalized using the min-max normalization method. This process places each variable on a comparable scale between 0 and 1, as shown in Equation (3).

$$X_{norm} = \frac{(X_i - X_{min})}{(X_{max} - X_{min})} \tag{3}$$

After normalization, the IRI and ADT variables were integrated into the Service Pressure Index (SPI). In this study, a weight of 0.60 was assigned to IRI because road surface condition serves as a direct indicator of preservation needs. Meanwhile, ADT was assigned a weight of 0.40, as traffic volume reflects the level of road usage pressure that may accelerate pavement deterioration. Accordingly, the SPI was formulated as shown in Equation (4).

$$SPI = 0.60 IRI_{norm} + 0.40 ADT_{norm} \tag{4}$$

where:
ADT_{total} = total average daily traffic;
ADT_{Mc} = average daily motorcycle traffic;
ADT_{non-MC} = average daily non-motorcycle traffic;
C_{km} = maintenance cost per kilometer;
C_{total} = total maintenance cost;
L = road section length;
X_{norm} = normalized value;
X_i = variable value of road section i;
X_{min} = minimum value of the variable;
X_{max} = maximum value of the variable;
SPI = Service Pressure Index.

A higher SPI value indicates that a road section experiences greater service pressure. Therefore, road sections with higher SPI values can be considered higher priorities for road preservation. In this study, the priority classification is divided into three categories: high priority for SPI ≥ 0.67, medium priority for 0.34 ≤ SPI < 0.67, and low priority for SPI < 0.34.

3. Results and Discussion

3.1. Road Section Characteristics

The ten road sections on the Jambi Province Border-Maur project corridor have different characteristics in terms of section length, road surface condition, and traffic load. The analyzed sections range from 1.063 km to 9.231 km in length. The shortest section is Bts. Kota Kayu Agung-Sp. Penyandingan, while the longest section is Prabumulih-Baturaja. This difference in section length is important because it can affect the magnitude of maintenance cost needs.

Based on road surface condition, IRI values range from 2.94 to 4.86. The highest IRI value is found on the Bts. Prov. Jambi-Peninggalan section, at 4.86. This condition indicates that the section has the highest surface roughness compared with the other sections. Meanwhile, from the traffic load perspective, the highest ADT is found on the Betung-Bts. Kota Palembang section, at 62,211 vehicles per day. This indicates that the section receives the greatest usage pressure and has the potential to require greater attention in the preservation program.

3.2. Service Pressure Index Ranking

Table 2. Normalization results and Service Pressure Index ranking

Rank	Road Section	IRI norm	ADT norm	SPI	Category
1	Betung - Bts. Kota Palembang	0.922	1.000	0.953	High
2	Bts. Prov. Jambi - Peninggalan	1.000	0.058	0.623	Medium
3	Sei Lilin - Betung	0.635	0.124	0.431	Medium
4	Bts. Kota Kayu Agung - Sp. Penyandingan	0.615	0.154	0.430	Medium
5	Terawas - Bts. Prov. Bengkulu	0.255	0.426	0.323	Low
6	Bts. Kab. Prabumulih - Muara Enim	0.359	0.222	0.305	Low
7	Bts. Kota Palembang - Bts. Kab. Prabumulih	0.104	0.342	0.199	Low
8	Peninggalan - Sei Lilin	0.245	0.091	0.183	Low
9	Prabumulih - Baturaja	0.203	0.000	0.122	Low
10	Baturaja - Maur	0.000	0.128	0.051	Low

Source: PT. Bumi Persada Engineering Consultant and PT. Cakra Graha, 2025; Data analysis (2026).

The Service Pressure Index (SPI) calculation shows that preservation priorities are influenced not only by road surface condition, but also by the magnitude of traffic load received by each section. The Betung-Bts. Kota Palembang section ranks first with an SPI value of 0.953 and is classified as high priority. This value is influenced by the highest ADT and a relatively high IRI value, making this section the one with the most dominant service pressure compared with the other sections.

The Bts. Prov. Jambi-Peninggalan section ranks second with an SPI value of 0.623 and is classified as medium priority. Although the ADT of this section is not as high as Betung-Bts. Kota Palembang, its highest IRI value indicates that the surface condition needs attention. The Sei Lilin-Betung section ranks third with an SPI value of 0.431, while Bts. Kota Kayu Agung-Sp. Penyandingan ranks fourth with an SPI value of 0.430. Both sections are also classified as medium priority.

The other sections, namely Terawas-Bts. Prov. Bengkulu, Bts. Kab. Prabumulih-Muara Enim, Bts. Kota Palembang-Bts. Kab. Prabumulih, Peninggalan-Sei Lilin, Prabumulih-Baturaja, and Baturaja-Maur, are classified as low priority. These results show that the SPI approach can distinguish preservation priority levels among sections based on technical pressure derived from road surface condition and traffic load.

3.3. Maintenance Cost Intensity and Priority Alignment

Table 3. Maintenance cost intensity per kilometer

Road Section	Cost/km (IDR million/km)	Cost rank	SPI rank
Bts. Prov. Jambi - Peninggalan	2,119.32	1	2
Betung - Bts. Kota Palembang	1,755.97	2	1
Sei Lilin - Betung	136.83	3	3
Bts. Kota Palembang - Bts. Kab. Prabumulih	1.28	4	7
Terawas - Bts. Prov. Bengkulu	1.26	5	5
Peninggalan - Sei Lilin	1.02	6	8
Bts. Kab. Prabumulih - Muara Enim	0.88	7	6
Baturaja - Maur	0.83	8	10
Prabumulih - Baturaja	0.67	9	9
Bts. Kota Kayu Agung - Sp. Penyandingan	0.37	10	4

Source: PT. Bumi Persada Engineering Consultant and PT. Cakra Graha, 2025; Data analysis (2026).

Cost per kilometer is used to obtain a more proportional comparison among sections because each section has a different length. The analysis results show that the highest maintenance cost intensity is found on the Bts. Prov. Jambi-Peninggalan section, followed by Betung-Bts. Kota Palembang. Both sections are also ranked high based on SPI values. This indicates that, in general, there is alignment between maintenance cost intensity and technical pressure on high-priority sections.

However, several sections show differences between cost ranking and SPI ranking. The Bts. Kota Kayu Agung-Sp. Penyandingan section ranks fourth in SPI but has a lower cost ranking. This condition indicates that the technical pressure on this section is relatively higher than the recorded maintenance cost intensity. Conversely, some sections have higher cost rankings than SPI rankings. This difference may occur because maintenance cost is not only influenced by IRI and ADT values, but also by work type, treatment volume, drainage condition, shoulder work, pavement age, and the type of distress occurring in the field. This interpretation is also consistent with classic pavement management references, which state that maintenance planning should consider pavement condition, structural characteristics, traffic load, and the benefits of alternative treatments [13], [14], [15].

This finding is consistent with the previous study by Pratiwi et al. [16] on the Jambi Province Border-Maur corridor, which showed that IRI and ADT could explain only 42.4% of the variation in maintenance cost, while the remaining 57.6% was influenced by other factors such as pavement type, road age, environmental condition, maintenance frequency, Volume to Capacity Ratio (VCR), and Surface Distress Index (SDI). Therefore, the results of this study reinforce that maintenance cost cannot be used as the only basis for determining preservation priorities. SPI is more appropriate as an initial tool for reading the technical pressure of road sections, while final decisions still need to consider more detailed field conditions.

Overall, the evaluation results show that SPI can help arrange preservation priorities more objectively and clearly. This approach does not replace technical field surveys, but it can serve as an initial basis for determining which sections should receive earlier attention in road preservation planning.

4. Conclusions

Based on the evaluation of road preservation priorities on the Jambi Province Border-Maur project corridor, the Service Pressure Index (SPI) can identify the order of treatment priorities by combining road surface condition and traffic load. The Betung-Bts. Kota Palembang section is the first priority with an SPI value of 0.953 and is classified as high priority. The next priorities are Bts. Prov. Jambi-Peninggalan with an SPI value of 0.623, Sei Lilin-Betung with 0.431, and Bts. Kota Kayu Agung-Sp. Penyandingan with 0.430, all classified as medium priority. The remaining sections are classified as low priority. These results indicate that preservation priorities become more proportional when road surface condition and traffic load are considered simultaneously.

As a follow-up, SPI can be used as an initial supporting tool in preparing road preservation priorities. However, final treatment decisions still need to be supported by field surveys, distress identification, drainage condition, pavement age, heavy vehicle ratio, structural capacity, and budget availability. Future studies may add variables such as PCI, SDI, and drainage condition so that the resulting priorities can better represent field needs.

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