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Assessment of Safety and Operational Standards of Suramadu–Bangkalan Road Using Star Rating

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ABSTRACT: The Suramadu National Road is a strategic corridor connecting Madura Island with the Surabaya metropolitan area, playing a crucial role in supporting public mobility and logistics distribution. The high traffic intensity and vital function of this road section require compliance with safety and roadworthiness standards. However, initial observations indicated several issues, such as malfunctioning street lighting, unauthorized U-turns, and the presence of hazardous objects on the roadside, which could potentially increase the risk of accidents. This highlighted the need for a Roadworthiness Test (ULFJ) evaluation to ensure that this road section met technical and operational requirements. This study aimed to analyze the roadworthiness level of the Suramadu–Bangkalan National Road (Sta 0+100 to Sta 3+400), a 3,392-meter section. The star rating approach, as stipulated in Minister of Public Works and Public Housing Regulation No. 4 of 2023 and Circular Letter 11/SE/Db/2024, was used. Data were obtained through field surveys at 100-meter intervals across 68 assessment segments. The assessment resulted in a Star Rating Score of 10.71, corresponding to a 3-star rating. According to PUPR Ministerial Regulation No. 4 of 2023, the road still met operational requirements and was classified as a safe road based on Circular Letter 11/SE/Db/2024. However, the 3-star rating indicated that several safety aspects only met minimum standards. Therefore, the prepared technical recommendations need to be implemented immediately to upgrade this road section to a safer category with a target rating of 4 or 5 stars.

KEYWORDS: Roadworthiness test; star rating; suramadu national road; transportation infrastructure.

1. Introduction

The role of roads as transportation infrastructure requires optimal conditions to support comfort, traffic flow efficiency, and safety for all users. Road transportation safety is no longer viewed solely as a technical transportation issue but has evolved into a global social concern, as evidenced by the high number of traffic accidents [1]. Numerous studies on traffic accidents and preventive strategies continue to emerge, accompanied by ongoing efforts to reduce accident rates on roads [2]. Previous research by Hartatik et al. (2025) highlighted that certain national road sections exhibited low levels of road safety, as reflected by star rating evaluations. In these cases, the ratings suggested that the roads had not yet met established safety standards.

Contributing factors included limited road safety facilities, inadequate street lighting, and poorly organized road markings and pedestrian pathways [3]. These findings underscore the need for active involvement from relevant authorities, such as the National Road Implementation Agency (BPJN) and the Transportation Agency, to improve road infrastructure through enhancements in markings, lighting, and pedestrian facilities, thereby increasing overall safety, particularly for vulnerable road users [4].

According to the Regulation of the Minister of Public Works of the Republic of Indonesia Number 4/PRT/M/2023 concerning Requirements for Road Function Feasibility Tests, a road may only be operated after being declared functionally feasible in both technical and administrative aspects. These technical requirements are intended to ensure safety, security, and smooth traffic flow for road users, confirming that the road is suitable for public operation [5]. To achieve roads that meet standards of safety, security, and efficient transportation of goods and passengers, it is necessary to conduct Road Function Feasibility Tests (Uji Laik Fungsi Jalan/ULFJ) on both newly constructed roads and existing operational roads. Based on Law Number 2 of 2022, concerning the Second Amendment to Law Number 38 of 2004 on Roads, and Government Regulation Number 34 of 2006 on Roads, the implementation of ULFJ ensures that roads can be operated after fulfilling technical and administrative requirements. Technical requirements guarantee that roads are fit, safe, and secure for users, while administrative requirements provide legal certainty for both road authorities and users [6].

Field surveys conducted in early August 2025 revealed that several segments of the Suramadu National Road in Bangkalan Regency did not meet applicable standards. Fatal accidents have been reported on this access road. At night, road conditions were extremely dark due to non-functioning public street lighting (PJU) along approximately 10 kilometers, which had been inoperative for an extended period. This condition, combined with adverse weather, contributed to an accident on July 1, 2025, when a motorcycle lost control and collided with a stalled tractor [7]. These findings underscore the necessity of conducting road function feasibility inspections (ULFJ) to ensure that every operating national road section complies with prevailing technical and safety standards. Inadequacies in geometric design, pavement surface conditions, and supporting road facilities such as lighting, traffic signs, and road markings can directly affect road user safety and traffic efficiency. Furthermore, ULFJ provides a basis for road authorities to implement targeted improvements and maintenance, thereby minimizing accident potential. Thus, the Road Function Feasibility Test serves not only as an administrative requirement but also as a preventive measure to ensure road user safety and comfort [8].

Star rating assessment is essential because it objectively reflects the level of risk and road safety performance. Roads with higher star ratings indicate safer and more reliable conditions, while lower ratings signal the need for immediate intervention. This approach assists the government and relevant agencies in formulating strategies to improve road quality and sustainably reduce traffic accident rates [6]. In line with international practices, the implementation of the Road Function Feasibility Test (ULFJ) has adopted a star rating system to assess various elements related to road user safety. Using this method, road feasibility levels are classified into five categories, ranging from one star to five stars. A road is considered functionally feasible if it meets technical and administrative criteria, with minimum standards set at four stars for toll roads, three stars for new non-toll roads, two stars for new non-toll roads without pavement or surface layers, and one star for long-operating non-toll roads [6].

Based on the context above, it is essential to conduct a study addressing these issues. This research evaluates the Road Function Feasibility Test (ULFJ) of the Suramadu National Road using a star rating score approach and proposes alternative solutions as recommendations, in accordance with the guidelines of the Regulation of the Minister of Public Works Number 4 of 2023 concerning Road Function Feasibility [9].

2. Materials and Methods

This research methodology was designed to obtain an accurate picture of the existing condition of the Suramadu National Road section (STA 0+100 to STA 3+400), its technical characteristics, and its safety level, based on PUPR Ministerial Regulation Number 4 of 2023 and Circular Letter Number 11/SE/Db/2024 concerning Technical Guidelines for Road Functionality Testing with Star Rating. The method employed a quantitative-descriptive approach through field surveys and technical analysis according to the standards of the Directorate General of Highways.

2.1. Research location.

This roadworthiness test case study was conducted on the 3.4-kilometer Madura side of the Suramadu Bridge Access Road, divided into several segments in both the normal and opposite directions. The survey locations are shown in Figures 1 and 2.

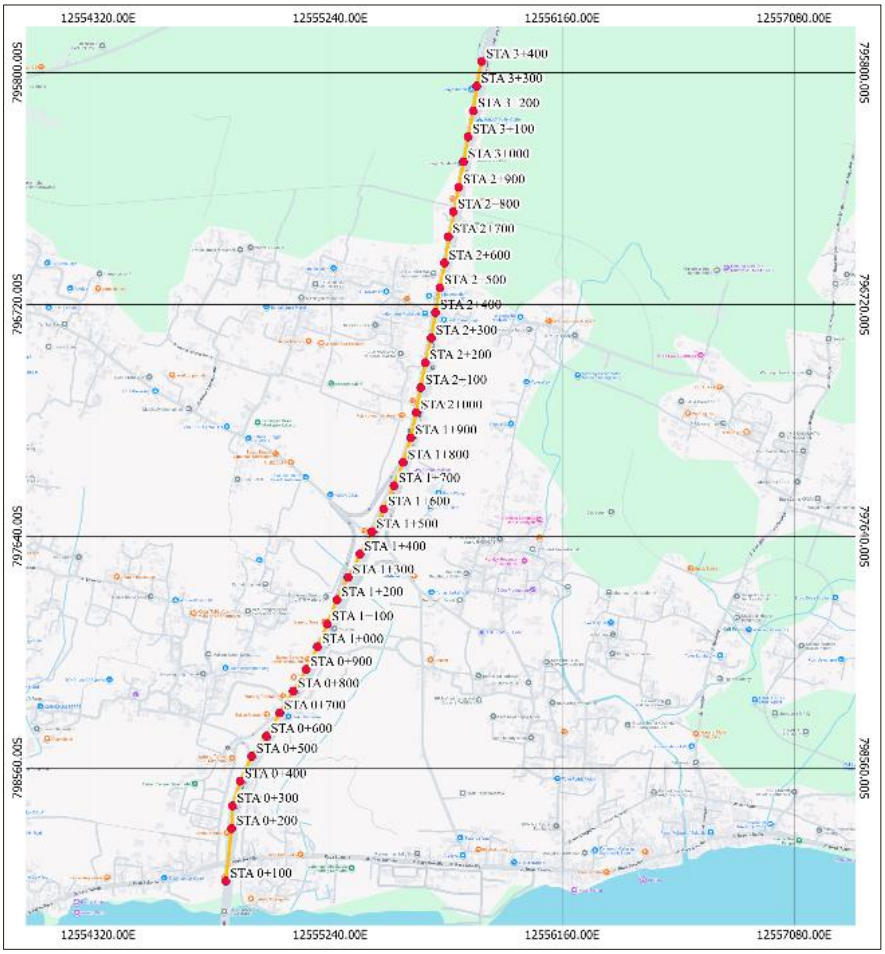

Figure 1. Location Map of STA Segments 0+100 - 3+400.

Figure 2. Location map of normal segment (FA) and opposite segment (FB).

2.2. Data collection.

Data collection was conducted using two types of sources: primary and secondary. Primary data were obtained directly from field surveys, while secondary data were obtained indirectly from information provided by relevant agencies.

2.2.1 Primary data collection.

The primary data in this study included road condition survey results and visual documentation obtained using a digital camera. This data collection method referred to Circular Letter Number 11/SE/Db/2024 concerning Technical Guidelines for Roadworthiness Tests Using the Star Rating System. Observations were conducted at 100-meter intervals; however, if physical inconsistencies were identified along the road section, the evaluation segment length was shortened to less than 100 meters. Such inconsistencies included changes in road type, significant differences in lane or track widths, differences in pavement materials, drastic changes in road geometry, or the presence of special structures such as bridges, tunnels, flyovers, and underpasses [10]. The tools used for the research process included a survey form to record and identify field conditions, a roll meter to measure road dimensions such as shoulder width, lane width, median width, and object distance, a walking distance meter to determine the length of road sections every 100 meters, a timestamp camera to mark the start and end coordinates of segments and document road conditions, a digital camera to record videos along

the research section, and a vehicle used by the author for transportation during data collection [11].

The stages of primary data collection were conducted as follows. First, segment determination was performed by measuring the road length every 100 meters using a walking distance meter. Second, segment coordinate points were determined using a timestamp camera at the beginning and end of each segment. Third, roadway attributes were identified, including the type of road, the number and width of existing lanes, curve conditions, medians, surface roughness, pavement condition, slope or gradient, visibility, delineation systems, road lighting, slow vehicle lanes, and textured center markings. These details ensured an accurate and comprehensive analysis. Fourth, roadside attributes were recorded, including object distance, object type, hardened shoulder width, and textured edge markings. Fifth, facilities for vulnerable road users and land use were identified, including area type, pedestrian crossing facilities, sidewalks, and the presence of School Safety Zones (ZoSS). Finally, intersections were examined, recording the type and condition of intersections, the presence of drainage channels, accessibility to surrounding land, and the number of vehicles passing through minor lanes, which provided important information for understanding the local traffic situation.

2.2.2 Secondary data collection.

This study utilized secondary data, including research location maps, speed data, and Average Daily Traffic (ADT) data. The ADT data specifically provided information on the volume of passing vehicles, while all secondary data were obtained from the East Java–Bali National Road Traffic Management Agency (BBPJN), the relevant authority for road traffic data.

2.3 Segmen Cutting.

According to Minister of Public Works and Public Housing Regulation Number 4 of 2023 and Circular Letter Number 11/SE/Db/2024, which provide Technical Guidelines for Roadworthiness Testing with Star Ratings, road assessment segments could be set at lengths of less than 100 meters if uneven physical conditions were observed in the field. This unevenness was considered in cases of changes in road type, significant differences in lane widths, changes in pavement type, drastic changes in road geometry, or the presence of complementary structures such as bridges, tunnels, flyovers, and underpasses [12]. Based on field survey results dividing the road into 100-meter segments, a total of 40 segments were obtained, consisting of FA and FB directions.

2.4 Completing the survey form.

The survey form was completed during the roadworthiness test in accordance with the guidelines outlined in Circular Letter Number 11/SE/Db/2024, which provided Technical Instructions for Roadworthiness Tests using the Star Rating System [13]. Serving as the primary tool for collecting field data, the form included a variety of critical information elements to ensure a comprehensive assessment. General information was recorded, such as the name of the surveyor, visual documentation of the road segment, the name and total length of the road section, the identification number and specific length of the assessment segment, the coordinates at the start and end points of each segment, and any additional notes deemed relevant to the context [14]. Traffic flow data, including Average Daily Traffic (ADT or LHR),

was collected to provide a realistic representation of vehicle volumes along the assessed segment, offering direct insight into daily traffic patterns [15]. Operational speed data were also recorded, covering speed limits, speed differentiation based on vehicle type, and any speed adjustments or engineering interventions implemented in the field [16].

The form further documented roadway attributes, including road types, the number and width of lanes, the conditions of horizontal curves, median types, road surface roughness, pavement condition, slope, sight distance, delineation systems, and roadway lighting. Additional features such as slow lanes, frontage roads, and textured centerline markings were also noted [17]. Roadside attributes were recorded, including object distances and types, the width of paved shoulders, and the presence of textured edge markings [18]. Facilities for vulnerable road users and surrounding land use were documented, encompassing pedestrian crossings, sidewalks or dedicated pedestrian paths, and School Safety Zones (ZoSS), providing a comprehensive view of the infrastructure and safety conditions adjacent to the road [19]. Intersection data were also collected, detailing intersection type and quality, canalization, access to surrounding properties, and vehicle volumes at minor intersections [20]. Collectively, these data elements ensured that the roadworthiness assessment was conducted in a standardized, systematic, and technically accountable manner [21].

3. Results and Discussion

After conducting a 100-meter field survey, each segment produced FA and FB. Segment cutting on the Madura side of the Suramadu Bridge Access Road covered a total length of 3.4 kilometers (STA 0+100 – STA 3+400). Subsequently, the roadworthiness conditions of each segment were identified by completing a survey form in accordance with Circular Letter Number 11/SE/Db/2024 concerning Technical Guidelines for Road Functionality Tests with Star Ratings.

3.1. Coordinate points of road assessment segments.

The coordinate points for each assessment segment were collected to determine the start and end positions, facilitating location identification during the road function feasibility analysis. The summary of coordinate points for all segments is presented in Table 1. These data allowed for precise mapping of the FA and FB directions for the 34 segments along the 3.4-kilometer section of the Suramadu Bridge Access Road (STA 0+100 to STA 3+400).

Table 1. Road assessment segment coordinate points.

No.	STA	FA	FB	Coordinate Point
1	0+100	FA 1	FB 34	-7.15891233 112.7819244
2	0+200	FA 2	FB 33	-7.1570533 112.782133
3	0+300	FA 3	FB 32	-7.56041649,112.36613531
4	0+400	FA 4	FB 31	-7.1553866 112.78243833
5	0+500	FA 5	FB 30	-7.1545018 112.78284904
6	0+600	FA 6	FB 29	-7.15379166 112.7833700
7	0+700	FA 7	FB 28	-7.1529633 112.78384499
8	0+800	FA 8	FB 27	-7.1521959 112.78432857
9	0+900	FA 9	FB 26	-7.1514241 112.78478545
10	1+000	FA 10	FB 25	-7.1506243 112.7851919
11	1+100	FA 11	FB 24	-7.1498196 112.7855396
12	1+200	FA 12	FB 23	-7.1489625 112.7858883
13	1+300	FA 13	FB 22	-7.1481672 112.7862836
14	1+400	FA 14	FB 21	-7.55802614,112.35649421
15	1+500	FA 15	FB 20	-7.1465535 112.7871366
16	1+600	FA 16	FB 19	-7.1457529 112.7875528

No.	STA	FA	FB	Coordinate Point
17	1+700	FA 17	FB 18	-7.1449288 112.7879198
18	1+800	FA 18	FB 17	-7.1440977 112.7882426
19	1+900	FA 19	FB 16	-7.1432306 112.7885207
20	2+000	FA 20	FB 15	-7.55466529,112.35286324
21	2+100	FA 21	FB 14	-7.1414539 112.7888743
22	2+200	FA 22	FB 13	-7.1405692 112.7890373
23	2+300	FA 23	FB 12	-7.1397009 112.7892466
24	2+400	FA 24	FB 11	-7.1387950 112.7893969
25	2+500	FA 25	FB 10	-7.1379194 112.7895542
26	2+600	FA 26	FB 9	-7.1370415 112.7897154
27	2+700	FA 27	FB 8	-7.1361165 112.7898564
28	2+800	FA 28	FB 7	-7.1352333 112.7900346
29	2+900	FA 29	FB 6	-7.1343608 112.7902266
30	3+000	FA 30	FB 5	-7.1334619 112.7903933
31	3+100	FA 31	FB 4	-7.1325808 112.7905597
32	3+200	FA 32	FB 3	-7.1316620 112.7907435
33	3+300	FA 33	FB 2	-7.1307882 112.7908672
34	3+400	FA 34	FB 1	-7.1307882 112.7908672

3.2. Road characteristics identification.

After collecting primary and secondary data, the roadworthiness conditions of each segment were evaluated using the survey form as outlined in Circular Letter Number 11/SE/Db/2024. For illustrative purposes, the FA 28 and FB 7 segments of STA 2+800 were selected as examples. General information for FA 28 included the officer's name, Alfian Febriansyah Muttaqin, documentation of the road segment, the road section name and total length (Suramadu Bridge Access Road on the Madura side, Jl. H. Moh. Noer, 3.4 km), segment number (FA 28), segment length (100 meters), and the starting and ending coordinates (-7.1352333, 112.7900346 to -7.1343608, 112.7902266) (Table 2). Similarly, FB 7 contained comparable general information, with the segment starting and ending coordinates reversed (-7.1343608, 112.7902266 to -7.1352333, 112.7900346) (Table 3).

Table 2. General Information (A.0) FA 28.

No.	Attribute	Description
A.0.1	Officer's name	Alfian Febriansyah Muttaqin
A.0.2	Road assessment documentation	-
A.0.3	Road segment name and length	Suramadu Bridge Access Road Section on the Madura Side, (Jl.H.Moh.Noer) / 3,4 km
A.0.4	Road assessment segment number	FA 28
A.0.5	Road assessment segment length (meters)	100m
A.0.6	Starting coordinates of the road assessment segment	-7.1352333 112.7900346
A.0.7	End coordinates of the road assessment segment	-7.1343608 112.7902266
A.0.8	Notes	-

Table 3. General Information (A.0) FB 7.

No.	Attribute	Description
A.0.1	Officer's name	Alfian Febriansyah Muttaqin
A.0.2	Road assessment documentation	-
A.0.3	Road segment name and length	Suramadu Bridge Access Road Section on the Madura Side, (Jl.H.Moh.Noer) / 3,4 km
A.0.4	Road assessment segment number	FA 28
A.0.5	Road assessment segment length (meters)	100m
A.0.6	Starting coordinates of the road assessment segment	-7.1352333 112.7900346
A.0.7	End coordinates of the road assessment segment	-7.1343608 112.7902266
A.0.8	Notes	-

Traffic flow data recorded the average daily traffic (LHR) as 40,000 vehicles per day for both FA 28 and FB 7 (Table 4). Speed assessment indicated an operational speed of 60 km/h, a maximum speed limit of 80 km/h, no speed differentiation by vehicle type, and no speed regulation engineering applied in the field (Table 5). Roadway attributes showed that the segments were divided roads (Type A) with two lanes separated by a physical median 5–10 meters wide, lane widths ≥3.25 m, straight or gently curving alignment, paved surface in good condition, a low slope of 0–7.5%, adequate sight distance, poor delineation, no street lighting, and no slow lanes or textured center markings (Table 6).

Table 4. Traffic flow (A.1) FA 28 dan FB 7.

No.	Attributes	Description
A.1.1	LHR (average daily traffic)	40000

Table 5. Speed (A.2) FA 28 and FB 7.

No.	Attribute	Code	Condition
A.2.1	Operational speed	4	60 km/h
A.2.2	Speed limit	6	80 km/h
A.2.3	Speed limit differential	1	None
A.2.4	Speed regulation engineering	1	None

Table 6. Road body attributes (A.3) FA 28 and FB 7.

No.	Attribute	Code	Condition
A.3.1	Road Type	1	Divided road (A)
A.3.2	Number of Lanes	1	Two lanes (median)
A.3.3	Lane Width	1	Width (≥ 3.25m)
A.3.4	Horizontal Curve/Bend	1	Straight or tending to be straight
A.3.5	Bend Quality	3	Not applicable
A.3.6	Median Type	5	Physical barrier/median with a width of 5m to 10m
A.3.7	Road Roughness	2	Paved - moderate
A.3.8	Pavement Condition	1	Good
A.3.9	Grade	1	0% to <7.5%
A.3.10	Sight Distance	1	Adequate
A.3.11	Delineation	2	Poor
A.3.12	Street Lighting	1	Not available
A.3.13	Frontage Road	1	Not available
A.3.14	Textured Center Markings	1	Not available

Roadside attributes indicated several substandard conditions. Objects along both sides of the road were located 0–1 meter from the roadway, consisting of trees with diameters ≥10 cm. Paved shoulder widths were also narrow (0–1 m), and textured edge markings were absent (Table 7). Assessment of vulnerable road user facilities and land use showed undeveloped areas on the right, commercial/office areas on the left, intercity area type, absence of pedestrian crossings, no sidewalks or dedicated paths on either side, and no School Safety Zones (ZoSS) present (Table 8). These findings highlighted potential safety risks and emphasized the need for improvements to enhance the safety and operational standards of the road.

Table 7. Roadside attributes (A.4) FA 28 and FB 7.

No.	Attribute	Code	Condition
A.4.1	Roadside Object Distance (Right Side)	1	0m to <1m
A.4.2	Roadside Object Type (Right Side)	11	Trees with a diameter of ≥ 10cm
A.4.3	Paved Shoulder Width (Right Side)	3	0m to <1m
A.4.4	Roadside Object Distance (Left Side)	1	0m to <1m
A.4.5	Roadside Object Type (Left Side)	11	Trees with a diameter of ≥ 10cm
A.4.6	Paved Shoulder Width (Left Side)	3	0m to <1m
A.4.7	Textured Edge Markings	1	Not Available

Table 8. Vulnerable road user facilities and land use (A.5) FA 28 and FB 7.

No.	Attribute	Code	Condition
A.5.1	Land use on the right side	1	Undeveloped area
A.5.2	Land use on the left side	4	Commercial or office area
A.5.3	Area type	2	Intercity
A.5.4	Pedestrian crossing facilities	7	No facilities
A.5.5	Availability of pedestrian paths/sidewalks on the right side	5	Not available
A.5.6	Availability of pedestrian paths/sidewalks on the left side	5	Not available
A.5.7	School Safety Zone (ZoSS)	4	Not applicable

The assessment of facilities for vulnerable road users and land use indicated that the right side of the road remained undeveloped, while the left side had been developed into a commercial or office area. Although this road section served an intercity function, it did not support pedestrian safety, as there were no crossing facilities and no sidewalks on either side. Additionally, the concept of a School Safety Zone (ZoSS) could not be implemented in this location (Table 8).

Intersection evaluation for the FA 28 and FB 7 segments revealed the presence of an unofficial U-turn. Consequently, the intersection quality was deemed not applicable. There was no canalization, no property access, and vehicle volumes at minor intersection arms were not applicable in this context (Table 9). These findings highlighted the need for targeted improvements to ensure road user safety and better infrastructure planning along this segment.

Table 9. Junction (A.6) FA 28 and FB 7.

No.	Attribute	Code	Condition
A.6.1	Intersection type	14	Unofficial U-turn
A.6.2	Intersection quality	3	No intersection
A.6.3	Intersection canalization	1	No canalization
A.6.4	Property access	4	No access
A.6.5	Vehicle volume at minor intersection arms	7	Not applicable

3.3. Star rating score analysis.

The star rating analysis was conducted on 68 segments of the Suramadu Bridge Access Road on the Madura side, comprising 34 normal (FA) segments and 34 opposite (FB) segments. Segment lengths varied slightly around 100 meters, resulting in a total road assessment length of 3,392 meters. The analysis generated a total Star Rating Score (SRS) of 10.71, corresponding to a 3-star road rating (☆☆☆) according to the methodology described in Circular Letter 11/SE/Db/2024 (Table 10). Table 10 summarizes the Star Rating Scores and corresponding star ratings for each segment. Most segments achieved 3- or 4-star ratings, while a small number of segments showed extreme SRS values resulting in 1-star ratings. The distribution of star ratings is further summarized in Table 11 and illustrated in Figure 3. Of the 68 segments, 4 segments received a 1-star rating, 18 segments a 3-star rating, 42 segments a 4-star rating, and 4 segments a 5-star rating. No segments were rated 2 stars.

Table 10. Star rating results.

no.	road assessment segment number (*)	road assessment segment length (meters)(**)	star rating score (***)	star rating (****)
1	FA 1	92	5.51	☆☆☆
2	FA 2	100	9.25	☆☆☆
3	FA 3	100	2.74	☆☆☆☆
4	FA 4	100	3.29	☆☆☆☆
5	FA 5	100	3.29	☆☆☆☆
6	FA 6	100	3.29	☆☆☆☆
7	FA 7	100	2.74	☆☆☆☆
8	FA 8	100	3.29	☆☆☆☆
9	FA 9	100	5.27	☆☆☆
10	FA 10	100	4.39	☆☆☆☆
11	FA 11	100	0.88	☆☆☆☆☆
12	FA 12	100	6.58	☆☆☆
13	FA 13	100	2.63	☆☆☆☆
14	FA 14	100	2.63	☆☆☆☆
15	FA 15	100	6.58	☆☆☆
16	FA 16	100	5.48	☆☆☆
17	FA 17	100	2.52	☆☆☆☆
18	FA 18	100	1.32	☆☆☆☆☆
19	FA 19	100	5.27	☆☆☆
20	FA 20	100	5.27	☆☆☆
21	FA 21	100	7.90	☆☆☆
22	FA 22	100	3.09	☆☆☆☆
23	FA 23	100	2.82	☆☆☆☆
24	FA 24	100	4.19	☆☆☆☆
25	FA 25	100	4.22	☆☆☆☆
26	FA 26	100	4.22	☆☆☆☆
27	FA 27	100	4.19	☆☆☆☆
28	FA 28	100	24.16	☆
29	FA 29	100	4.19	☆☆☆☆
30	FA 30	100	4.19	☆☆☆☆
31	FA 31	100	24.17	☆
32	FA 32	100	4.19	☆☆☆☆
33	FA 33	100	4.19	☆☆☆☆
34	FA 34	100	4.19	☆☆☆☆
35	FB 1	100	4.19	☆☆☆☆
36	FB 2	100	4.19	☆☆☆☆
37	FB 3	100	4.19	☆☆☆☆
38	FB 4	100	24.17	☆
39	FB 5	100	4.19	☆☆☆☆
40	FB 6	100	4.19	☆☆☆☆
41	FB 7	100	24.16	☆
42	FB 8	100	4.19	☆☆☆☆
43	FB 9	100	4.22	☆☆☆☆
44	FB 10	100	4.22	☆☆☆☆
45	FB 11	100	4.19	☆☆☆☆
46	FB 12	100	2.82	☆☆☆☆
47	FB 13	100	3.09	☆☆☆☆
48	FB 14	100	7.90	☆☆☆
49	FB 15	100	5.27	☆☆☆
50	FB 16	100	5.27	☆☆☆
51	FB 17	100	1.32	☆☆☆☆☆
52	FB 18	100	2.52	☆☆☆☆
53	FB 19	100	5.48	☆☆☆
54	FB 20	100	6.58	☆☆☆

no.	road assessment segment number (*)	road assessment segment length (meters)(**)	star rating score (***)	star rating (****)
55	FB 21	100	2.63	☆☆☆☆
56	FB 22	100	2.63	☆☆☆☆
57	FB 23	100	6.58	☆☆☆
58	FB 24	100	0.88	☆☆☆☆☆
59	FB 25	100	4.39	☆☆☆☆
60	FB 26	100	5.27	☆☆☆
61	FB 27	100	3.29	☆☆☆☆
62	FB 28	100	2.74	☆☆☆☆
63	FB 29	100	3.29	☆☆☆☆
64	FB 30	100	3.29	☆☆☆☆
65	FB 31	100	3.29	☆☆☆☆
66	FB 32	100	2.74	☆☆☆☆
67	FB 33	100	9.25	☆☆☆
68	FB 34	92	5.51	☆☆☆

Table 11. Number of star ratings.

Stars	Number
1	4
2	0
3	18
4	42
5	4
Total	68

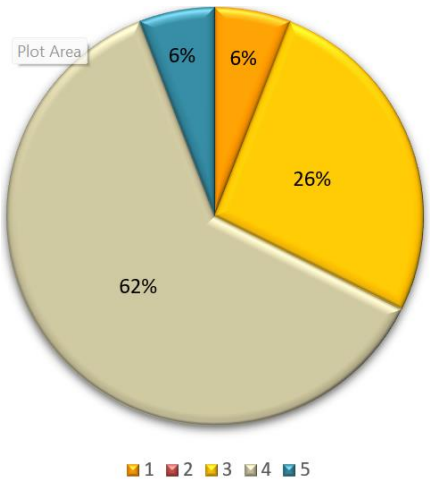

Figure 3. Star rating chart.

The analysis highlighted that certain segments exhibited the highest Star Rating Scores but corresponded to the lowest star ratings. These included FA 24, FA 28, FA 31, FB 4, and FB 11, indicating potential inconsistencies between the calculated risk scores and categorical ratings. To investigate these segments further, detailed SRS calculations were carried out for FA 28 and FB 7 as representative examples. The run-off road assessment for the passenger side of FA 28 and FB 7 segments considered multiple risk factors, including likelihood, severity, operating speed, external flow influence, and median traversability (Table 12). Likelihood was calculated based on road attributes such as lane width, horizontal alignment, pavement condition, delineation, textured edge markings, and road roughness. Severity evaluated the potential consequences of accidents, taking into account roadside objects and shoulder widths. Operating speed and external flow were included to quantify dynamic risks arising from vehicle

interactions. The combined evaluation yielded a Star Rating Score of 23.94 for the run-off road (passenger side), indicating a high-risk potential.

Table 12. Run-off road (passenger side) Segment FA 28 and FB 7.

Types of risk factors	Category	Risk Factor	Score
Road attributes (likelihood)			
Lane width	Width (≥ 3.25m)	1.00	
Horizontal curve/bend	Straight or tending to be straight	1.00	
Bend quality	Not Applicable	1.00	
Delineation	Poor	1.20	
Textured edge markings	Not Available	1.25	
Pavement condition	Good	1.00	
Grade	0% to <7.5%	1.00	
Road roughness	Hardened - Medium	1.40	
Product of road attribute risk factor (likelihood)			**2.10**
Road attributes (severity level)			
Roadside Object Distance (Left Side)	0m to <1m	1.00	
Roadside Object Type (Left Side)	Tree diameter ≥ 10cm	60.00	
Hardened Shoulder Width (Left Side)	0m to <1m	0.95	
Risk factors of road attribute products (severity)			**57.00**
External flow influence	40000	1.11	0.500
Operating speed	60 km/h		0.40
Star Rating Score (SRS) run-off road (passenger side)			**23.94**

Intersection assessment was also performed for FA 28 and FB 7 segments (Table 13). The analysis incorporated the likelihood of accidents due to intersection type, quality, and road attributes, as well as severity of potential impacts, operating speed effects, and external flow influences. This resulted in an Intersection Star Rating Score of 0.23, reflecting a relatively low risk at this intersection.

Table 13. Intersection segments FA 28 and FB 7.

Types of risk factors	Category	Risk Factor	Score
Road attributes (likelihood)			
Intersection Type	Unofficial U-turns	0.50	
Intersection Quality	Poor	1.20	
Grade	0% to <7.5%	1.00	
Street Lighting	Available	1.00	
Road Surface Surface Surface Surface Sight Distance	Moderately hardened	1.40	
Intersection Channelization	Adequate	1.00	
Speed Control Engineering	No canalization	1.20	
Intersection Type	None	1.25	
Faktor risiko produk atribut jalan (*likelihood*)			**1.26**
Road attribute (severity)			
Intersection Type	Unofficial U-turn	45.00	
Risk factors of road attribute products (severity)			45
External flow influence	Not applicable		0.01
Operating speed	60 km/h		0.40
Star Rating Score (SRS) Intersection			**0.23**

Finally, the overall Star Rating Score for the FA 28 and FB 7 segments was calculated by combining all accident types, including run-off road (driver and passenger side), head-on collisions, intersections, and property access (Table 14). The total SRS was 24.17, corresponding to a 1-star rating. This result highlighted the discrepancy between individual segment scores and the cumulative star rating, emphasizing the need for targeted interventions on high-risk segments, particularly regarding road geometry, delineation, and roadside hazards.

Table 14. Star rating score segment FA 28 and FB 7.

Type of accident	Star Rating Score (SRS)	Star Rating
- Run-off road (driver's side)	0.00	
- Run-off road (passenger's side)	23.94	
- Head-on (loss of control)	0.00	
- Head-on (overtaking)	0	
- Intersection	0.23	
- Property access	0	
Total Score (*Star Rating)*	**24.17**	**1.00**

4. Conclusions

The Suramadu Bridge Access Road on the Madura side, from STA 0+100 to STA 3+400, extended 3,392 meters and was divided into 68 assessment segments, covering both normal (FA) and opposite (FB) directions. The road consisted of a 6/2D configuration from STA 0+200 to 2+100 and a 4/2D configuration from STA 2+200 to 3+400, located in an intercity area. Overall, the road feasibility conditions indicated a relatively high level of accident risk, as evidenced by numerous points lacking street lighting or having non-functioning lights at several STA locations, as well as poor delineation quality in multiple segments. Non-standard U-turn locations were also identified at STA 2+800 and 3+100. Based on the assessment, this section obtained a Star Rating Score of 10.71 and was classified as a 3-star road. Although this classification met the operational eligibility requirements under Ministerial Regulation PUPR No. 4/2023 and was considered a “safe road” according to Circular Letter 11/SE/Db/2024 and the Technical Guidelines for Road Function Feasibility Tests (06/P/BM/2024), a 3-star rating nonetheless indicated several safety aspects that required particular attention. Some safety elements appeared to be at the minimum threshold, necessitating regular monitoring to prevent further decline, especially regarding non-official U-turns and suboptimal street lighting. Based on the assessment results, recommended technical improvements should be implemented promptly as an initial step to enhance overall safety. Ideally, this road section should not only meet minimum requirements but also progress toward a safer standard, aiming to achieve a 4-star or even 5-star rating.

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Author Contribution

Alfian Febriansyah Muttaqin : Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing – Original Draf. Nurani Hartatik: Validation, Software, Visualization, Writing – Review & Editing, Supervision, Project Administration, Funding Acquisition, Writing – Review & Editing, Correspondence. I Gede Agus Punarta : Resource, Data Collection, Technical Support, Validation.

Competing Interest

The authors declare that they have no known financial, personal, or professional competing interests that could have appeared to influence the work reported in this paper.

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