

Road Serviceability of Soekarno Hatta Road in Malang City Based on Star Rating

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ABSTRACT

The high traffic density on Jalan Soekarno Hatta has become a major issue that needs to be addressed immediately. The increase in the number of motor vehicles, both private and public, has created significant pressure on the capacity and functionality of these roads. In addition, the growth of settlements and business sectors around the road creates complexity in land use planning which can have an impact on the feasibility of road functions. Star rating is an evaluative approach used to assess the performance of a road section by considering various aspects, such as physical conditions, safety levels, and user comfort. The purpose of this study is to determine the feasibility of the function of Jalan Soekarno Hatta Malang City based on the star rating. Some of the data that was collected include: Road Geometry, separators, sidewalk medians, pedestrian facilities, land use and access properties. The feasibility of the function of the star rating road refers to the Regulation of the Minister of Public Works No. 06/P/BM/2024. Results of the Feasibility Analysis of the Star rating function of the Soekarno Hatta road section including 4 Stars with an SRS Score of 3.25 including the Yellow category means that the road is considered safer (saferroad)

KEYWORDS;-road serviceability, , Soekarno Hatta Road, Star Ratings

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I. INTRODUCTION

The increase in the number of vehicles and traffic complexity poses a significant challenge for developing cities, including Malang. Parts of Soekarno Hatta Road may face high traffic pressure and changes in technical conditions over time. Therefore, this study attempts to explore a deeper understanding of the factors that affect the technical functionality of the road based on the Star rating.

Roads that are up to technical standards can make travel more efficient, reduce traffic jams, and ultimately help improve the quality of life for people in Malang. On the other side, roads that aren't up to par can have a negative impact on people's daily lives and the development of the area. Road serviceability refers to Minister of Public Works Regulation No. 06/P/BM/2024. The assessment of serviceability aims to ensure that road infrastructure can guarantee safety for users and provide legal certainty for road operators and users. The high traffic density on Jalan Soekarno Hatta has become a major issue that needs to be addressed immediately. The increase in the number of motor vehicles, both private and public, has created significant pressure on the capacity and functionality of this road. In addition, the growth of residential and business sectors around the road has created complexities in land use planning that can impact the road serviceability. Star rating is an evaluative approach used to assess the performance of a road section by considering various aspects, such as physical condition, safety level, and user comfort. Testing the functionality of roads through a star rating system is a form of road quality assessment based on a variety of indicators. This approach not only provides a comprehensive picture of the actual condition of the road but also plays an important role in supporting more targeted decision-making processes in the planning and implementation of infrastructure improvements.

According to Indonesian Law No. 22 of 2022, a road is a land transportation facility that includes all parts of the road, including connecting structures, complementary structures, and equipment intended for traffic, located on the ground, above the ground, below ground level, and/or water, as well as above water level, except for railway tracks, tramways, and cableways. Regarding roads, public roads (Article 9) are classified according to the following categories:

1. National Roads
2. Provincial Roads
3. Regency Roads
4. City Roads
5. Village Roads

Based on function and status

1. National Roads include: JAP, JKP-1, toll roads, and national strategic roads designated by the Minister of Public Works.
2. Provincial Roads include: JPK-2, JKP-3, and provincial strategic roads designated by the governor.
3. District Roads include: JPK-4, JLP, JLPing-P, and district strategic roads designated by the regent.
4. City roads include: JAS, JKS, JLS, and JLPing-S designated by the mayor.
5. Village roads include: JLPing-P and JLP that are not included in district roads in rural areas designated by the regent.

Road Serviceability

According to Regulation No. 06/P/BM/2024 issued by the Minister of Public Works and Public Housing, road serviceability refers to the condition of a road section that has met technical and administrative requirements, thereby ensuring the safety of users and providing legal certainty for operators and the public as road users. Road serviceability reflects the level of infrastructure compliance with established standards, both technically and administratively. In other words, a road that is fit for purpose must not only be safe to use, but must also provide a clear legal basis for those involved in its management and utilization.

Road Serviceability Categories

The categories for meeting technical road serviceability requirements are grouped into:

1. 1 Star :
 - a. Description: The lowest category, indicating that the road is not safe for use.
 - b. Condition: Requires urgent repair and is unfit for traffic.
2. 2 Stars :
 - a. Description: Roads with some issues, but still usable with caution.
 - b. Condition: Requires repairs in the near future to improve safety.
3. 3 Stars :
 - a. Description: This category indicates that the road is in good condition, but there are some aspects that need attention.
 - b. Condition: Suitable for use, but regular maintenance is needed to maintain quality.
4. 4 Stars:
 - a. Description: Roads that meet most safety and performance standards.
 - b. Condition: Suitable for use with minor repairs needed for optimization.
5. 5 Stars:
 - a. Description: The highest category, indicating that the road is in excellent condition and safe for use.
 - b. Condition: Meets all technical and administrative requirements and does not require repairs

Road Serviceability Assessment Parameters

- a. Physical Condition of Roads: Includes road surface, pavement structure, and the presence of damage.
- b. Road Equipment: Signs, road markings, lighting, and crossing facilities.
- c. Traffic Management: Speed regulation, traffic engineering, and vehicle flow management.
- d. Environmental Conditions: Impact of the surrounding environment and its effect on road user safety.
- e. Compliance with Regulations: Ensuring that the road meets all applicable regulations and standards.

A road can be declared fit for purpose as referred to in Article 4 paragraph (1) if it meets the administrative requirements and technical requirements with the following minimum categories:

- a. 4 stars for toll roads;
- b. 3 stars for new non-toll roads;
- c. 2 stars for new non-toll roads without pavement/surfacing; and
- d. 1 star for non-toll roads that are already in operation.

This is based on Indonesian Law No. 38 of 2004 concerning roads and Indonesian Law No. 22 of 2009 concerning Road Traffic and Transportation, Minister of Public Works Regulation No. 06/P/BM/2024 concerning Road Serviceability Requirements.

The star rating system covers 7 (seven) attributes:

1. A0 General
2. A1 Traffic Flow
3. A2 Speed
4. A3 Roadway
5. A4 Roadside
6. A5 Facilities for Vulnerable Road Users and Land Use
7. A6 Intersections

Star rating attributes include:

a. General information (A.0)

Information about the name of the officer, road assessment segment documentation, road section name and length, road assessment segment number, road assessment segment length, road assessment segment start coordinates, road assessment segment end coordinates, and notes.

b. Traffic flow (A.1)

Information about average daily traffic that represents or describes the conditions of the road section to be tested.

c. Speed (A.2)

Information about operational speed, speed limits, speed limit differentiation, and speed control engineering.

d. Roadway attributes (A.3)

Information regarding road type, number of lanes, lane width, horizontal curves or bends, bend quality, median type, road roughness, pavement condition, slope, sight distance, delineation, road lighting, slow lanes (frontage roads), and textured center lines.

e. Roadside attributes (A.4)

Information regarding the distance of roadside objects, type of roadside objects, width of paved shoulders, and textured edge markings.

f. Facilities for vulnerable road users and land use (A.5)

Information regarding land use, area type, pedestrian crossing facilities, availability of pedestrian paths or sidewalks, and School Safety Zones (ZoSS).

g. Intersections (A.6)

Information regarding intersection type, intersection quality, intersection channelization, property access, and vehicle volume on minor intersection arms

Risk Factor Value

The risk factor value or Crash Modification Factors (CMF) is a multiplier used to calculate the estimated number of accidents after treatment has been carried out at the location. CMF is used in star ratings to link road attributes with accident rates.

Star Rating Score The star rating score (SRS) is influenced by five types of accidents, namely: accidents caused by driving off the road, head-on collisions due to loss of control, head-on collisions due to overtaking, accidents at intersections, and accidents at property access points. The SRS calculation formula is as follows:

$$\text{SRS} = \text{SRSSRun-off} + \text{SRSHo-Loc} + \text{SRSHo-ot} + \text{SRSInt} + \text{SRSPa}$$

Explanation:

SRS : Star Rating Score (SRS);

SRSSRun-off : Run-off accident score;

SRSHo-Loc: Head-on collision score due to loss of control;

SRSHo-ot : Head-on collision score due to overtaking;

SRSInt : Intersection accident score; and

SRSPa : Property access accident score.

Based on the star rating calculation formula, each type of accident is influenced by the following factors: likelihood, severity, operational speed, external flow influence, and median traversability. The following is an explanation of the factors for each type of accident:

- Likelihood: A road attribute risk factor that influences the occurrence of accidents by taking into account the probability of an accident occurring;
- Severity: A road attribute risk factor that describes the severity of an accident;
- Operating speed: A factor that considers the extent to which risk changes due to speed influence;
- External flow influence: A factor that takes into account the risk of a person being involved in an accident influenced by other road users; and
- Median traversability: A factor that takes into account the potential for a vehicle traveling in the wrong direction to cross the median.

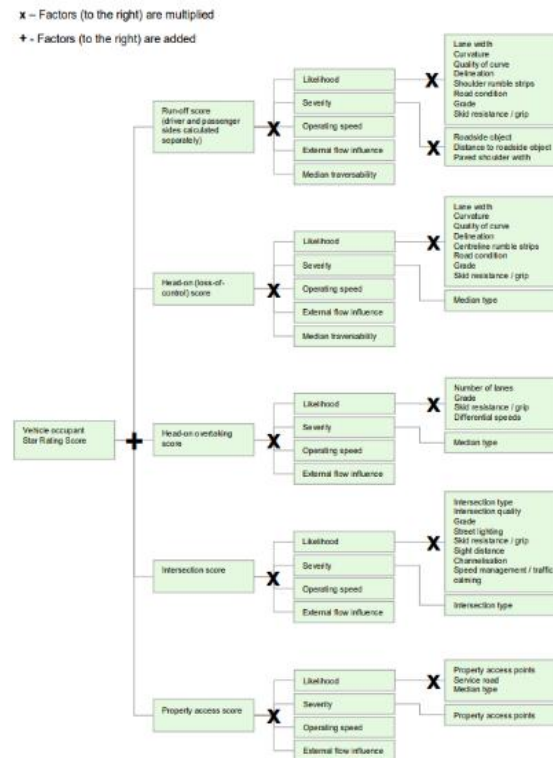


Figure 1 - Illustration of Star Rating Score (SRS) calculation

Accident Type Score

The accident type score is calculated based on the relationship between the accident type, risk factors, and road attributes, as described below:

a. The off-road accident score (SRSRun-off) is the product of the following factors:

- 1) Likelihood, which consists of the following attributes:
 - a. Lane width;
 - b. Horizontal curvature/curves;
 - c. Curve quality;
 - d. Delineation;
 - e. Textured edge markings;
 - f. Road pavement condition;
 - g. Slope; and
 - h. Road roughness.
- 2) Severity, which consists of the following attributes:
 - a. Distance of roadside objects (right and left);
 - b. Type of roadside objects (right and left); and
 - c. Width of paved shoulders (right and left).
- 3) Vehicle operating speed;
- 4) External flow influence, which is affected by the attributes of Average Daily Traffic (ADT) and number of lanes; and
- 5) Median traversability, which is affected by the attribute of median type.

b. The head-on collision score due to loss of control (SRSHo-Loc) is the product of the following factors:

- 1) Likelihood, which consists of the following attributes:
 - a. Lane width;
 - b. Horizontal curvature/bends;
 - c. Bend quality;
 - d. Delineation;
 - e. Textured centerline markings;
 - f. Road surface condition;
 - g. Slope; and
 - h. Road roughness.

- 2) Severity, influenced by median type attributes;
 - 3) Operating speed of vehicles;
 - 4) External flow influence, influenced by Average Daily Traffic (ADT) and number of lanes; and
 - 5) Median traversability, influenced by median type attributes.
- c. The head-on collision score due to overtaking (SRSHo-ot) is the product of the following factors:
1. Likelihood, which consists of the following attributes:
 - a. Number of lanes;
 - b. Slope;
 - c. Road roughness; and
 - d. Speed limit differentiation.
 2. Severity, which is influenced by the median type attribute;
 3. Vehicle operating speed;
 4. External flow influence, which is influenced by the Average Daily Traffic (ADT) and number of lanes attributes.

The assessment procedure consists of five stages, namely:

1. Collection of data and information
2. Determination of road assessment segments
3. Completion of technical inspection forms
4. Processing of Star rating assessments
5. Completion of administrative inspection forms

Star Rating Categories

Star ratings for a road segment or road section are categorized based on the results of star rating score calculations as shown in Table 2

Table 1-Star rating categories

Star Category	Score	Colour category ^{*)}
5 Star	0,0s.d.< 2,5	Green
4 Star	2,5s.d.< 5,0	Yellow
3 Star	5,0s.d.< 12,5	Orange
2 Star	12,5s.d.<22,5	Red
1 Star	≥ 22,5	Black

^{*)}The color category is used to indicate the star rating of a road rating segment or road section within a road network map

The following is an explanation of each star rating category in Table 2:

- Star 1 and Star 2 are roads considered to be most at risk of accidents;
- Star 3 is a road considered to be safe; and
- Star 4 and Star 5 are roads considered to be more safe (safer roads)

Road Geometry

Road geometry design aims to ensure that roads can be used safely and efficiently by various types of vehicles and road users, as well as to accommodate the expected traffic volume. These geometric aspects must be designed in accordance with applicable standards and guidelines to ensure the functionality of the road.

Traffic Lanes

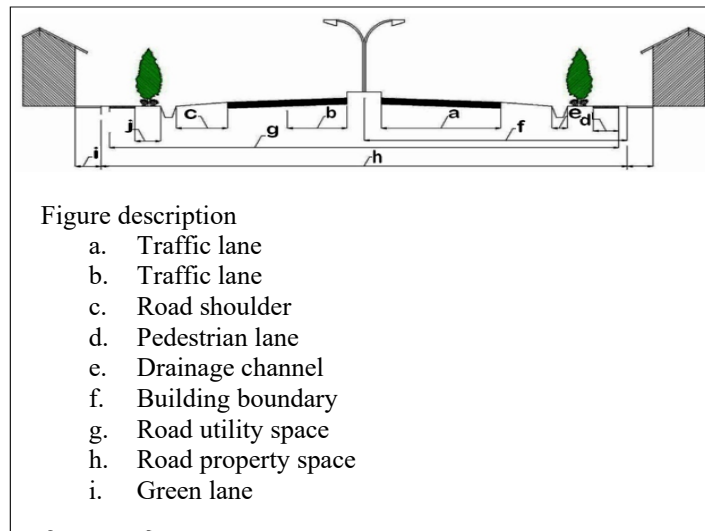


Figure 2 Road sections

Road Shoulder

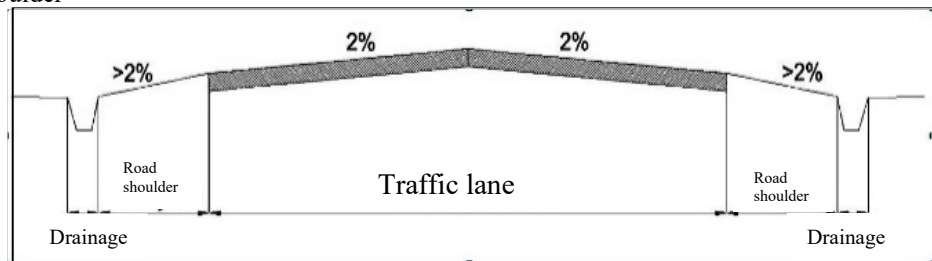


Figure 3 Cross section of standard road

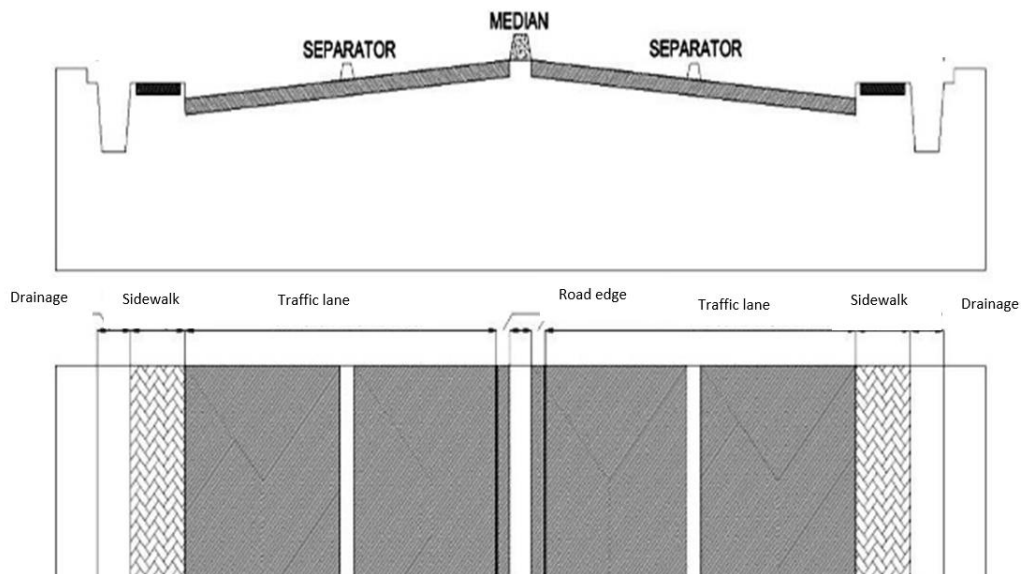


Figure 4 Road Cross Section

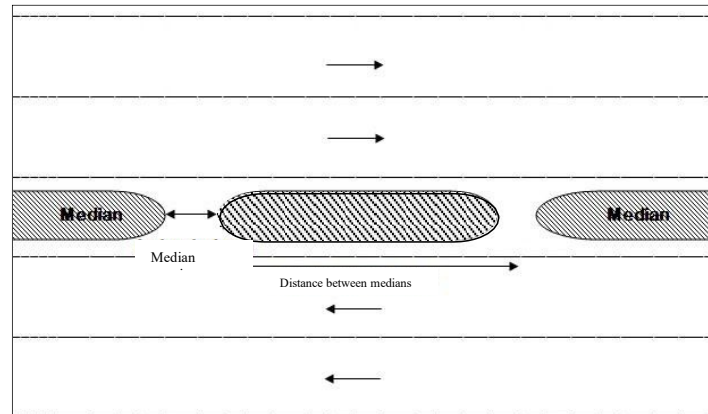


Figure 5 Opening on the Road Median

Curve Radius

a. Arterial Roads

Location	Primary (V = 60km/hours)	Secondary (V=30km/hours)
Intercity	110 m	50 m
Intracity	200 m	100 m

b. Collector Road

Location	Primary (V = 60km/hours)	Secondary (V=30km/hours)
Intercity	110 m	50 m
Intracity	200 m	100 m

UTILIZATION OF ROAD SECTIONS

Road Utilization Space

Width and Height of Road Utilization Space

a. Arterial Roads

Freeway:

1. 42.5m for Traffic Lane Width = 2x14m
2. 35.5m for Traffic Lane Width = 2x11m
3. 28.5m for Traffic Lane Width = 2x7m

Highway:

1. 38.5m for Traffic Lane Width = 2x14m
2. 31.0m for Traffic Lane Width = 2x11m
3. 24m for Traffic Lane Width = 2x7m

Medium road:

13m for Traffic Lane Width 7m

Small road:

1. 8.5m for Traffic Lane Width 5.5m
2. 5.5m for Traffic Lane Width 2.5m
3. Road Usable Space Height 5m

Road Usable Space Depth 1.5m

b. Collector

Freeway:

1. 42.5m for Traffic Lane Width = 2x14m
2. 35.5m for Traffic Lane Width = 2x11m
3. 28.5m for Traffic Lane Width = 2x7m

Highway:

1. 38.5m for Traffic Lane Width = 2x14m

2. 31.0m for Traffic Lane Width = 2x11m
3. 24m for Traffic Lane Width = 2x7m

Medium road:

1. 13m for Traffic Lane Width 7m small road:
2. 8.5m for Traffic Lane Width 5.5m
3. 5.5m for Traffic Lane Width 2.5m

Road Usable Space Height 5m

Road Usable Space Depth 1.5m

Road Surveillance Space

Width of road surveillance space

Arterial

1. Primary: minimum 15m
2. Secondary: minimum 15m b. Collector
3. Primary: minimum 10m
4. Secondary: minimum 5m

Use of Road Surveillance Space

Intended for unobstructed driver visibility and road construction safety and road function safety

II. METHODOLOGY

Research Location

This research was conducted on the Soekarno Hatta road in Malang City

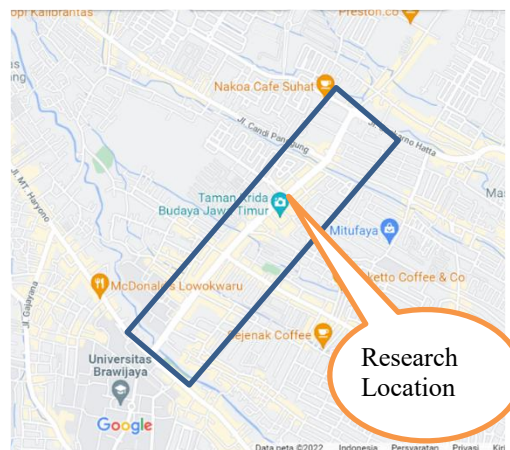


Figure 6 Research Location

Source: <https://www.google.com/maps/>

Surveyor placement

Primary data collection was carried out by several placement surveyors. Surveyor placement can be seen in Figure 7

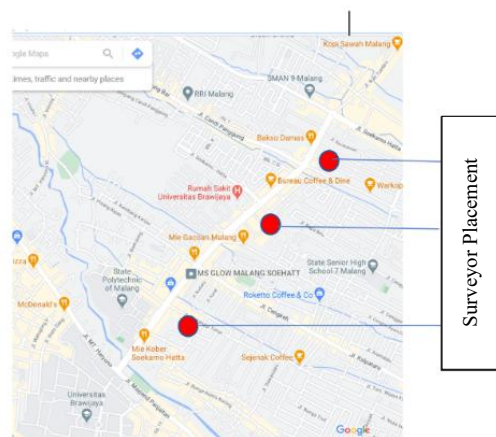


Figure 7 Surveyor placement location

Results and Analysis

Analysis of the Technical Condition of Soekarno Hatta Road

Soekarno-Hatta Road is located in the western part of Malang City and is a class III a collector road that serves as the main link between the city center, campuses, business districts, and residential areas.

Geometric conditions and road facilities

- a. Road type : 4/2 T
- b. Lane width : 3.75 m
- c. Sidewalk width : 2 m
- d. Median : 4.5 m
- e. Road markings : white longitudinal markings
- f. Speed limit : 50 km/h

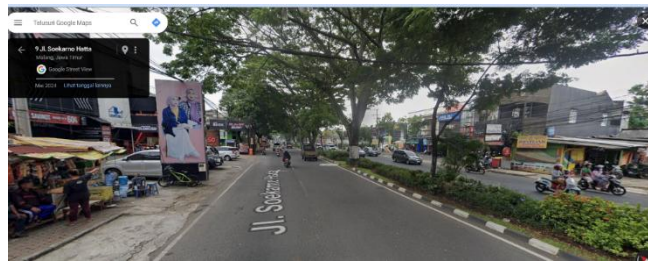


Figure 8 Soekarno Hatta Road, Malang City

Source: <https://www.google.co.id/maps>

III RESULT

Analysis results for the Speed attribute

Table .. Analysis for the Speed attribute

No.	Attribution	Code	Condition
A.2	Speed		
A.2.1	Operational speed	2	40 km/hour
A.2.2	Speed limits	3	50 km/hour
A.2.3	Speed limit differentiation	2	Present
A.2.4	Speed control engineering	2	Present
A.3	Roadway Attributes		
A.3.1	Road type	1	The road splits in the direction of A
A.3.2	Number of lane	1	Two lanes (there is median)
A.3.3	Lane width	1	Width ($\geq 3.25\text{m}$)
A.3.4	Horizontal curves/bends	1	Straight or relatively straight
A.3.5	Curve quality	3	No application
A.3.6	Median Type	6	Physical barriers/medians with a width of 1 m to 5 m
A.3.7	Road roughness	1	Hardened - adequately
A.3.8	Road pavement condition	1	Good
A.3.9	Slope	1	0% s/d <7.5%
A.3.10	Visibility	1	Adequate
A.3.11	Delineasi	1	Adequate
A.3.12	Street lighting	2	Available
A.3.13	Slow lane (<i>frontage road</i>)	1	Not Available
A.3.14	Textured center mark	1	Available

Based on survey results and analysis, Soekarno Hatta Road has a 4/2 T type, with a lane width > 3.25 m. The median serves as a road divider with a width of 1-5 m. The road pavement is in good condition and has adequate smoothness and adequacy. Road lighting is available. Soekarno Hatta Road does not have a low-speed lane

Results of analysis for roadboundary attribute

A.4	Roadside Attributes		
A.4.1	Distance of roadside object (right side)	1	0m s/d <1m
A.4.2	Roadside object type (right side)	12	Textured center mark
A.4.3	Hardened shoulder width (right side)	4	Not Available
A.4.4	Distance of roadside objects (left side)	1	0m s/d <1m
A.4.5	Roadside object type (left side)	12	Sign posts, lamp posts, or fixed markers
A.4.6	Hardened shoulder width (left side)	2	1m s/d <2.4m
A.4.7	Textured edge markings	1	Not Available

Roadboundary attributes distance to roadside objects 0-1 m, objects consist of signposts, lampposts and rigid posts, road shoulders are not paved

Analysis results for vulnerable road user facilities and land use

A.5	Vulnerable Road User Facilities and Land Use		
A.5.1	Land Use on the Right Side	5	Areas related to education
A.5.2	Land Use on the Left Side	4	Commercial or office areas
A.5.3	Area type	1	Urban
A.5.4	Pedestrian crossing facilities	5	Zebra cross only
A.5.5	Availability of right side pedestrian/sidewalk	4	Sidewalk 0m to < 1m from the curb
A.5.6	Left-hand side walkway/sidewalk availability	4	Sidewalk 0m to < 1m from the curb
A.5.7	School Safe Zone (ZoSS)	4	Cannot be applied

The land use around Soekarno Hatta Road is an educational area because it contains the Malang State Polytechnic campus and a commercial area because there are many shops on both sides of the road. For pedestrian facilities, Soekarno-Hatta Road has pedestrian facilities in the form of zebra crossings and sidewalks along the road

Results of analysis for intersections

A.6	Intersections		
A.6.1	Intersection type	5	3 arms with APILL lights and special turning lanes
A.6.2	Intersection quality	1	Adequate
A.6.3	Intersection channeling	1	No canalization
A.6.4	Property login	4	No access
A.6.5	Volume of vehicles on the arm of the minor	7	Not applicable

The type of intersection on Soekarno Hatta Road is a 3-arm intersection with traffic lights. There is no canalization at the intersection, and there is no property access at the intersection.

Results of star rating analysis

After analyzing a 1,900-meter section, the star rating for Soekarno-Hatta Road is 4 stars with an SRS score of 3.25, categorized as Yellow, meaning the road is considered safer (safer road).

Based on the results of the analysis, congestion on Soekarno Road occurs due to high traffic volume, especially during rush hour. The utilization of the Soekarno Hatta road section contributes to traffic congestion

IV. CONCLUSION

From the analysis results, it can be concluded that:

1. The Soekarno Hatta road section is a four-lane road divided into two directions. Each lane is 3.75 meters wide, bringing the total width of the road to 15 meters. In addition, there is a 4-meter-wide median. On the left and right sides of the road, there are sidewalks, each 2.0 meters wide.
2. The road serviceability rating of the Soekarno Hatta road section is 4 stars with an SRS score of 3.25, which is in the yellow category, meaning that the road is considered safer

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