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RISK-BASED ROAD RESOURCE ALLOCATION USING SDI AND ADT DATA

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Abstract: Safety is the most important aspect of a road to consider. Road safety means the road is in good condition for vehicles to travel on. Maintenance and reconstruction are the two means to be undertaken to preserve road performance and safety. Bina Marga Semarang, as the road administrator, uses Surface Distress Index (SDI) data to determine the appropriate maintenance/reconstruction (M/R) work for a road within Semarang's road network. The SDI method assigns a score to each road segment; the lower the score, the better the road condition, indicating less road damage. This research aimed to allocate resources based on the inherent risk of each road section. SDI in 2024 and Average Daily Traffic (ADT) in 2023 were used to quantify the magnitude of risk for each road section in the Kecamatan Tugu, Semarang, road network. The maintenance/reconstruction cost of each segment was also calculated to determine the road M/R cost. Road segments were then ranked based on the risk magnitude and M/R cost. The result showed that JL. Stasiun Jrakah was the riskiest road but ranked 7th in M/R cost.

Keywords: resource, road; risk, cost, maintenance

Abstrak: Keselamatan adalah aspek terpenting yang perlu dipertimbangkan dalam sebuah jalan. Keselamatan jalan berarti jalan dalam kondisi baik untuk dilalui kendaraan. Pemeliharaan dan rekonstruksi adalah dua cara yang harus dilakukan untuk menjaga kinerja dan keselamatan jalan. Bina Marga Semarang, sebagai pengelola jalan, menggunakan data Indeks Kerusakan Permukaan (SDI) untuk menentukan pekerjaan pemeliharaan/rekonstruksi (M/R) yang tepat untuk jalan di jaringan jalan Semarang. Metode SDI memberikan skor pada setiap ruas jalan; semakin rendah skornya, semakin baik kondisi jalan, menunjukkan kerusakan jalan yang lebih sedikit. Penelitian ini bertujuan untuk mengalokasikan sumber daya berdasarkan risiko inheren dari setiap ruas jalan. SDI tahun 2024 dan rata-rata lalu lintas harian (ADT) tahun 2023 digunakan untuk mengukur besarnya risiko untuk setiap ruas jalan di jaringan jalan Kecamatan Tugu, Semarang. Biaya pemeliharaan/rekonstruksi setiap ruas juga dihitung untuk menentukan biaya M/R jalan. Ruas jalan kemudian diurutkan berdasarkan besarnya risiko dan biaya M/R. Hasil penelitian menunjukkan bahwa JL. Stasiun Jrakah adalah jalan paling berisiko tetapi menempati peringkat ke-7 dalam biaya M/R.

Kata kunci: sumber daya; jalan; risiko; biaya; pemeliharaan

1. INTRODUCTION

User safety is the most important consideration in road construction. To maintain road serviceability, several measures are required, including routine maintenance and periodic reconstruction. Due to limited resources for maintaining road serviceability, this study aimed to prioritize road section maintenance/reconstruction (M/R) based on the inherent risk of each road section. The Kecamatan Tugu road network in Semarang was the object of this study. Kecamatan Tugu is one of the sub-districts in Semarang. There are 16 road segments in Kecamatan Tugu. Table 1 illustrates the segment with its dimensions. This study used secondary data on the Surface Distress Index (SDI) from 2024 and Average Daily Traffic from 2023, both obtained from Bina Marga Semarang. The SDI data represent the surface condition of each road segment, such as the percentage of longitudinal cracks, transverse cracks, and the number of potholes, which affect user safety (Priambodo et al., 2023). The higher the SDI value, the greater the risk on the road. The SDI method also determines the appropriate damage handling for each section, i.e., do-nothing, minor patching, grouting, or reconstruction with a 6 cm overlay. Average

Daily Traffic (ADT) was considered the exposure for road users; ADT itself may not cause an accident, but when combined with poor road surface conditions, it could trigger on

Table 1. Road Network in Kecamatan Tugu, Semarang (Dinas Bina Marga Kota Semarang)

No.	Road Segment	Width	Length	ADT
1	Jl. Cisadane	3	500	470.94
2	Jl. Gerbang Pintu Semarang	4	462	363.78
3	Jl. Irigasi	5	1850	496.32
4	Jl. Irigasi Utara (Mangkang Kulon)	5	2271	685.26
5	Jl. Karanganyar	4	751	1532.26
6	Jl. Kauman Mangkang Wetan	3	1562	685.26
7	Jl. Kauman Randugarut	3	671	2374.44
8	Jl. Kyai Gilang	3	962	1756.86
9	Jl, Mangunharjo (Mangkang Wetan)	3	2623	2464.68
10	Jl. Mekar	3	781	1395.9
11	Jl. Panggung	3	877	600.66
12	Jl. Pulau Tirang Tapak	3	2029	1192.86
13	Jl. Stasiun Jrakah	3.5	706	2382.9
14	Jl. Stasiun Mangkang	3.5	253	1818.9
15	Jl. Tapak	4	865	2377.26
16	Jl. Tugurejo	6.5	822	1367.7

Source: https://kectugu.semarangkota.go.id

This study used risk and (M/R) cost analysis of each road to allocate resources. Risk analysis was used to assign a risk rank to each road based on the magnitude of its risk. The higher the risk magnitude, the riskier the road. Bina Marga Semarang divided roads into 80-100-meter segments to assign SDI values. The SDI value was assigned to each segment based on its surface condition. This study used the highest SDI value for each road segment to quantify the magnitude of risk. The road M/R cost determined the resources needed to maintain road serviceability. The SDI value of each segment was used to analyze the M/R budget, and each segment's SDI value determined the appropriate action to maintain its serviceability. The Risk and budget analyses for each road were then ranked and can be used to prioritize M/R resource allocation.

Many studies have been done to allocate resources due to their limitations. Prayoga et al. (2023) studied road maintenance prioritization based on budget availability. The research aimed to determine the criteria used in road maintenance prioritization and to arrange the road maintenance priorities in the Banyuresmi District, Garut Regency. The research employed the Analytic Hierarchy Process (AHP) as its methodology. Using the AHP, Prabawati et al. (2024) Did a study on road handling priority in Malang. Utomo and Oetomo (2021*)* identified the level of road damage in Lamongan Regency to determine road handling priority using AHP. Achmad et al. (n.d.) used the AHP to prioritize road maintenance in Jalan Kabupaten Kapuas Hulu and Kabupaten Landak, in the Province of West Kalimantan.

Pembuain et al. (2018) did a review study about the effect of road infrastructure on traffic accidents. According to Pembuain et al. (2018), road infrastructure elements significantly affect accident risk. Road features include: (a) geometric features (lane width, horizontal and vertical curves); (b) surface conditions; (c) side hazards; (d) complementary road construction (bus bays and sidewalks); and (e) road equipment (lights, signs, and markings). Roads must be constructed using safety and security principles to provide a secure road system. Road engineering requirements are linked to road security, while pavement and geometric characteristics are the focus of safety. He said that the frequency of traffic accidents and the state of the road surface are closely related. The frequency of traffic accidents can be decreased with proper pavement surface upkeep.

In prioritizing pavement maintenance, Yalew et al. (2023) examined the effects of potholes on road users' comfort and driving safety. Artificial potholes with varying depths of 25 mm, 50 mm, 75 mm, and 100 mm and sizes of 200 mm, 500 mm, and 750 mm were utilized in the study. They were positioned at intervals of 10 m, 20 m, and 40 m and replicated using a driving simulator on two layers of asphalt. There were twenty-five participants in the study. The findings indicated that, although the road's roughness, as measured by the International Roughness Index (IRI), is in good condition, potholes 500 mm wide and deeper than 50 mm, and 750 mm wide and deeper than 25 mm, should receive maintenance priority to ensure the safety and comfort of road users.

Al-Nuaimi & Jameel (2023) Conducted a study of the impact of traffic characteristics on crash frequency. The impact of heavy trucks and average daily traffic on crash frequency was the main focus of this study. For this study, the two-lane, two-way historic Baghdad–Baquba rural route was selected. Two datasets were used in this study: crash data and traffic characteristics data. To model the impact of average daily traffic and the fraction of heavy vehicles on crash frequency, generalized linear regression models were employed. The average daily traffic and crash frequency, as well as the frequency of heavy trucks, were found to be positively correlated.

Cadar et al., (2017) studied how traffic volumes affected accidents. The research was conducted in Romania. The traffic information was supplied by the National Road Infrastructure Management Company (CNAIR). The traffic department of the General Inspectorate of Romanian Police (GIRPTD) supplied the data on traffic accidents. The data was gathered on Romania's major national routes in 2015. The purpose of the paper was to simplify the database by containing only pertinent information on the participants, the vehicles, and the accident. Software from the Geographic Information System (GIS) was used to conduct the initial studies. Using power regression, the results were further utilized in the study to emphasize the relationship between traffic volumes and accidents. On the seven national roads taken into consideration in this study, a total of 2188 incidents were reported in 2015. Of these, 583 occurred on DN1, 467 on DN2, 151 on DN3, 52 on DN4, 56 on DN5, 436 on DN6, and 443 on DN7. Sections of the road were labeled DN1 and DN2. According to the power regression model, as AADT increased, the overall number of accidents per kilometer across the routes under analysis increased throughout the year.

2. RESEARCH METHOD

The study took place in the road network in Kecamatan Tugu, Semarang. As shown in Table 1, sixteen roads were investigated. The reason behind the road network selection was that Kecamatan Tugu is a busy area with a high traffic volume and connects residential areas.

The data used were the roads' 2024 SDI values, road dimensions, 2023 ADT, and the maintenance unit price for Semarang. The data and the source are as follows.

Table 2. Data used in this study

Data Type	Source	Year
SDI Value	Dinas Bina Marga Kota Semarang	2024
Average Daily Traffic Volume	Dinas Bina Marga Kota Semarang	2023
Road Segment Inventory	Dinas Bina Marga Kota Semarang	2023
Maintenance Unit Price	Semarang City Govenrment Regulations	2024

Source: Research Team, 2025

Surface Distress Index (SDI) is an assessment method used by Dinas Bina Marga of Semarang to maintain road serviceability. The assessment is based on road surface condition. A road is divided into segments, usually every 80-100 meters, when performing an assessment. The assessor brings forms listing road names and segments, and records the road's damage properties for each segment. The damage categories are potholes, ruts, and cracks. SDI score was assessed based on:

1. The cracked area category:

Table 3. Cracked Area-Based SDI Value

No	Category	SDI1
1	None	-
2	<10%	5
3	10%-30%	20
4	>30%	40

Source: (Daffarial Prasodjo et al., 2024)

2. The crack width category:

Table 4. Cracked Width-Based SDI Value

No	Category	SDI2
1	None	-
2	Fine <1 mm	-
3	Medium 1-3 mm	-
4	Wide>3 mm	SD11 * 2

Source: Daffarial Prasodjo et al., (2024)

3. The number of hole categories:

Table 5. Number of Hole-Based SDI Value

No	**Category**	**SDI3**
1	None	-
2	<10/km	SDI2 + 15
3	10-50/km	SDI2 + 75
4	50/km	SDI2 + 225

Source: (Daffarial Prasodjo et al., 2024)

4. Ruts depth category:

Table 6. Ruts Depth-Based SDI Value

No	Category	X	SDI4
1	None	-	-
2	<10/km	0.5	SDI3 +5*X
3	10-50/km	2	SDI3 +5*X
4	>50/km	5	SDI3 +4*X

Source: (Daffarial Prasodjo et al., 2024)

5. Road condition assessment according to the SDI method:

Table 7. Road Condition Based on SDI Value

Road Condition	SDI
Good	<50
Medium	50-100
Light damage	100-150
Heavy damage	>150

Source: (Daffarial Prasodjo et al., 2024)

Handling type for each road depends on the SDI category above, as follows:

Table 8. Handing type for each SDI value

Handling Type	SDI
Do-nothing/routine maintenance	<50
Minor patching	50-100
Grouting/patching	100-150
6 cm overlay	>150

Source: (Manual-Konstruksi-Dan-Bangunan-No-001-01m2011-Tentang-Survei-Kondisi-Jalan-Untuk-Pemeliharaan-Rutin, 2011)

In 2022, Wong et al., (2022) investigated the implementation of the HIRARC (Hazard Identification, Risk Assessment and Risk Control) Risk Management Plan and Risk Registered Matrix for the construction project of the Mengkuang Dam in Malaysia, which involved the scopes of raising and extension of the existing dam. According to Wong et al., (2022)Risk is the combination of the likelihood and severity of a specified hazardous event with a specific circumstance that may have caused the hazard to occur. The risk can be calculated using the following equation:

Risk (R) = Likelihood(L) x Severity (S) (1)

Risk (R) is the "combination of likelihood and severity," Likelihood (L) is "an event likely to occur within the specific period or in specified circumstances," and Severity (S) is "an outcome from an event such as severity of injury or health of people, or property damage, or insult to environment, or any combination of those caused by the event," according to the Department of Occupational Safety and Health's (Guidelines for Hazard Identification, Risk Assessment and Risk Control (HIRARC), 2008). This study used Average Daily Traffic (ADT) to estimate Likelihood (L), as higher ADT increases the likelihood of accidents. It used the Surface Distress Index (SDI) to estimate Consequences (C), as a higher SDI indicates greater surface damage, which increases accident severity or discomfort. so that in this study, risk was defined as:

$$\text{Risk (R)} = \text{SDI} \times \text{ADT} \quad (2)$$

SDI value depicts road surface condition, which in turn affects safe riding. Pembuain, (n.d.) The 11th Asia Pacific Transportation and the Environment Conference (APTE 2018) stated that road surface condition is a major contributor to road accidents, alongside road geometry, signs, and accessory buildings. Yalew et al., (2023) Did a study about the effect of potholes on driver response. His study revealed that potholes distract drivers ' concentration, which can lead to an accident. Accidents are also affected by traffic volume. Al-Nuaimi & Jameel, (2023)Using two datasets, i.e., traffic characteristics and accidents, the study examined the effect of large vehicle volume on accidents on the Baghdad-Baquba Road. Using generalized linear regression, the model revealed a positive relationship between the number of large vehicles and the number of accidents. Cadar et al., (2017) researched to find out the most influential factor in accidents on the seven main roads in Romania in 2015. He collected traffic volume and the number of accidents. The data was then plotted into a chart. The chart showed a linear relationship between the two datasets: the number of accidents increased with traffic volume.

After calculating the risk magnitude of each road within the network using equation (2), the results were ranked, and risk categories were assigned to each road. The risk classifications are as follows:

Table 9. Risk Category

Risk Category	Percentile Range	Description
High Risk	≥ 75 percentiles	Top 25% of roads with the highest risk score
Medium Risk	25th to <75th percentile	Middle 50% of roads
Low Risk	< 25th percentile	Bottom 25% of roads with the lowest risk

Source: Yalew et al. (2023)

The M/R cost for each road was calculated using its SDI value. The SDI value determined the appropriate M/R action for each road segment. The Semarang Mayor's Regulation No. 3, 2024 (*WALI KOTA SEMARANG PROVINSI JAWA TENGAH*, n.d.) was used as the reference for the action required unit price. Here are some of the SDI value-based cost analyses:

Table 10. The Unit Price of Gravel Reconstruction (SDI Value 175)

No	Job description	Unit	Unit Price (Rp)	Description
1	Cleaning and stripping of damaged layers	m²	2000	Peeling off damaged surface parts & mud
2		m²	6800	

	Addition of aggregate layer (C class gravel)			Thickness ±15–20 cm, according to road conditions
3	Leveling and compaction with heavy equipment	m²	4500	Grader + vibratory roller
4	Procurement and spreading of coal dust (if necessary)	m²	1200	Its function is as a binding material and surface covering.
5	Side drainage repair (simple earth ditch)	m²	1500	Average cost if there is a need for water pipes (divided proportionally)
6	Mobilization and demobilization of equipments	m²	1600	Heavy equipment, dump trucks, and other auxiliary equipment
7	Field technical supervision	m²	700	Technical supervision costs in the field
	Total per m²	m²	**18300**	Estimated total price (without VAT & incidentals)

Source: Peraturan Wali Kota Semarang, 2024

Table 11. The Unit Price of Flexible Pavement Reconstruction (The SDI Value 80-98)

No	Job description	Unit	Unit Price (Rp)	Description
1	Surface cleaning	m²	1500	Clean the surface before repair
2	Crack sealing	m²	3800	For longitudinal cracks and local alligator cracks
3	Local patching (repairing small holes & damage)	m²	6500	Using hot-mix asphalt or a local AC–WC mixture
4	Slurry seal / thin surface layer (if necessary)	m²	2800	Thin layer to restore texture and waterproof
5	Repainting markings (optional)	m²	700	If the repair causes disturbance to the old markings
6	Mobilization and demobilization of light equipment	m²	1300	Divided proportionally to the total volume of work
7	Technical supervision	m²	600	Experts and field supervisors
	Total HSPK per m²	m²	**17200**	Estimated total price (without VAT & incidentals)

Source: Peraturan Wali Kota Semarang, 2024

Table 12. The Unit Price of Rigid Pavement Reconstruction (The SDI Value 98-105)

No	Job description	Unit	Unit Price (Rp)	Description
1	Cleaning concrete surfaces from dust & dirt	m²	1800	Initial work for the repair of cracks and joints
2	Crack sealing < 5 mm	m²	3600	

				Estimated crack ±0.6 m/m², price equivalent to Rp. 6,000/m² crack
3	Concrete joint filling	m²	3000	Estimated connection ±0.3 m/m², price equivalent to Rp. 10,000/m
4	Minor repairs to concrete slabs (spot repair < 1 m²)	m²	4500	Estimate 1 point per 8–10 m², averaged
5	Epoxy bonding agent	m²	1200	Used for adhesion to patch slabs
6	Mobilization & demobilization of light equipment	m²	1500	Allocated from the total project cost per m²
7	Field technical supervision	m²	500	An estimated 2 working days is allocated per m² of a small project
	Total HSPK per m²	m²	16100	Estimated total price (without VAT & incidentals)

Source: Peraturan Wali Kota Semarang, 2024

The analysis was performed for each appropriate action based on the SDI value of each road segment. The total M/R cost of a road was the sum of the M/R costs of its segments. The total M/R cost for each road in Kecamatan Tugu, based on the SDI value, is as follows:

Table 13. Total M/R Cost

Road Segment	M/R. Cost (Rp.)
Jl. Cisadane	17,339,250
Jl. Gerbang Pintu Semarang	45,191,280
Jl. Irigasi	23,822,000
Jl. Irigasi Utara (Mangkang Kulon)	0
Jl. Karanganyar	24,372,400
Jl. Kauman Mangkang Wetan	97,640,460
Jl. Kauman Randugarut	37,769,480
Jl. Kyai Gilang	21,248,680
Jl, Mangunharjo (Mangkang Wetan)	6,683,000
Jl. Mekar	21,077,530
Jl. Panggung	8,600,000
Jl. Pulau Tirang Tapak	74,647,300
Jl. Stasiun Jrakah	33,012,800
Jl. Stasiun Mangkang	27,677,660
Jl. Tapak	58,987,400
Jl. Tugurejo	54,795,200

Source: Research Team, 2025

The tables below summarise the SDI values, the appropriate action for each SDI value, the unit, and the total price of each road within the Kecamatan Tugu road network. Some calculations are as follows:

Table 14. Jl. Irigasi

STA		LENGTH (M)	SDI Value Calculation Every 200 meter											
FROM	TO		CRACK AREA	CRACK WIDTH	No. of pothole	Rutting	SDI Value	Condition	Pavement Type	Pavement Width	Pavement Wide (m^2)	Type of Handling	Cost per m2	Total Cost
	0+000													
0+000	0+100	100	5	0	5	5	5	B	Concrete	4	400	Do-nothing	0	0
0+100	0+200	100	5	0	5	5	5	B	Concrete	4.1	410	Do-nothing	0	0
0+200	0+215	15	5	0	5	5	5	B	Concrete	4.1	61.5	Do-nothing	0	0
0+215	0+300	85	40	80	155	175	175	RB	Gravel	3.5	297.5	6 cm overlay	18300	5444250
0+300	0+400	100	40	80	155	175	175	RB	Gravel	3.5	350	6 cm overlay	18300	6405000
0+400	0+500	100	40	80	155	175	175	RB	Gravel	3	300	6 cm overlay	18300	5490000
													Total	17,339,250.00

Table 15. Jl. Gerbang Pintu

STA		LENGTH (M)	SDI Value Calculation Every 200 meter											
FROM	TO		CRACK AREA	CRACK WIDTH	No. of pothole	Rutting	SDI Value	Condition	Pavement Type	Pavement Width	Pavement Wide (m^2)	Type of Handling	Cost per m2	Total Cost
	0+000													
0+000	0+100	100	40	80	80	80	80	S	Asphalt	6	600	Minor patching	17200	10320000
0+100	0+200	100	40	80	80	80	80	S	Asphalt	6.2	620	Minor patching	17200	10664000
0+200	0+300	100	40	80	80	80	80	S	Asphalt	6	600	Minor patching	17200	10320000
0+300	0+400	100	40	80	80	80	80	S	Asphalt	6.4	640	Minor patching	17200	11008000
0+400	0+462	62	40	80	80	80	80	S	Asphalt	2.7	167.4	Minor patching	17200	2879280
													Total	45,191,280.00

Source: Dinas Bina Marga Kota Semarang (2023) and Peraturan Wali Kota Semarang (2024)

Table 16. Jl. Kauman Mangkang Wetan

STA		LENGTH (M)	SDI Value Calculation Every 200 meter				SDI Value	Condition	Pavement Type	Pavement Width	Pavement Wide (m^2)	Type of Handling	Cost/m2	Total Cost
FROM	TO		CRACK AREA	CRACK WIDTH	No. of pothole	Rutting								
	0+000													
0+000	0+100	100	40	80	80	80	**80**	**S**	Asphalt	3.80	380	Patching minor	17200	6536000
0+100	0+200	100	20	0	20	20	**20**	**B**	Asphalt	3.40	340	Tidak perlu perbaikan	0	0
0+200	0+300	100	5	0	5	5	**5**	**B**	Asphalt	4.50	450	Tidak perlu perbaikan	0	0
0+300	0+400	100	40	80	95	98	**98**	**S**	Asphalt	3.10	310	Patching minor	17200	5332000
0+400	0+500	100	40	80	80	80	**80**	**S**	Asphalt	3.40	340	Patching minor	17200	5848000
0+500	0+600	100	40	80	80	80	**80**	**S**	Asphalt	3.10	310	Patching minor	17200	5332000
0+600	0+700	100	40	80	80	80	**80**	**S**	Asphalt	3.00	300	Patching minor	17200	5160000
0+700	0+800	100	40	80	80	80	**80**	**S**	Asphalt	3.20	320	Patching minor	17200	5504000
0+800	0+900	100	40	80	80	80	**80**	**S**	Asphalt	3.00	300	Patching minor	17200	5160000
0+900	0+990	90	40	80	80	80	**80**	**S**	Asphalt	3.00	270	Patching minor	17200	4644000
0+990	1+000	10	40	80	95	98	**98**	**S**	Concrete	3.10	31	Perbaikan sambungan / grouting / patching	16100	499100
1+000	1+100	100	40	80	95	98	**98**	**S**	Concrete	3.20	320	Perbaikan sambungan / grouting / patching	16100	5152000
1+100	1+200	100	40	80	95	105	**105**	**RR**	Concrete	3.80	380	Perbaikan sambungan / grouting / patching	16300	6194000
1+200	1+300	100	40	80	95	105	**105**	**RR**	Asphalt	2.80	280	Patching minor	15000	4200000
1+300	1+400	100	40	80	155	165	**165**	**RB**	Asphalt	3.60	360	Overlay aspal 5–6 cm (AC–WC)	55500	19980000
1+400	1+500	100	40	80	155	165	**165**	**RB**	Asphalt	2.80	280	Overlay aspal 5–6 cm (AC–WC)	55500	15540000
1+500	1+562	62	40	80	95	98	**98**	**S**	Asphalt	2.40	148.8	Patching minor	17200	2559360
													Total	97,640,460.00

Source: Dinas Bina Marga Kota Semarang (2023) and Peraturan Wali Kota Semarang (2024)

The same calculation was performed for every road within the Kecamatan Tugu road network. The total M/R cost for each road was then ranked from the highest to the lowest in the table below:

Table 17. M/R Cost for Each Road

Road Segment	M/R. Cost (Rp.)	Rank
Jl. Cisadane	17,339,250	13
Jl. Gerbang Pintu Semarang	45,191,280	5
Jl. Irigasi	23,822,000	10
Jl. Irigasi Utara (Mangkang Kulon)	0	16
Jl. Karanganyar	24,372,400	9
Jl. Kauman Mangkang Wetan	97,640,460	1
Jl. Kauman Randugarut	37,769,480	6
Jl. Kyai Gilang	21,248,680	11
Jl, Mangunharjo (Mangkang Wetan)	6,683,000	15
Jl. Mekar	21,077,530	12
Jl. Panggung	8,600,000	14
Jl. Pulau Tirang Tapak	74,647,300	2
Jl. Stasiun Jrakah	33,012,800	7
Jl. Stasiun Mangkang	27,677,660	8
Jl. Tapak	58,987,400	3
Jl. Tugurejo	54,795,200	4

Source: Research Team, 2025

Using equation (2), the risk of each road within the network was calculated and ranked; the table is as follows:

Table 18. Risk Magnitude of Each Road Within the Network

Road Segment	Risk Score	Rank
Jl. Cisadane	82414.5	12
Jl. Gerbang Pintu Semarang	29102.4	15
Jl. Irigasi	48639.36	13
Jl. Irigasi Utara (Mangkang Kulon)	27410.4	16
Jl. Karanganyar	150063.48	8
Jl. Kauman Mangkang Wetan	113067.9	10
Jl. Kauman Randugarut	232695.12	4
Jl. Kyai Gilang	140548.8	9
Jl, Mangunharjo (Mangkang Wetan)	241538.64	2
Jl. Mekar	111672	11
Jl. Panggung	48052.8	14
Jl. Pulau Tirang Tapak	196821.9	7
Jl. Stasiun Jrakah	281182.2	1
Jl. Stasiun Mangkang	214630.2	5
Jl. Tapak	213953.4	6
Jl. Tugurejo	239347.5	3

Source: Research Team, 2025

3. RESULT AND DISCUSSION

Tables 17 and 18 were combined to determine which road should be prioritized for safety riding and M/R cost.

Table 19. Risk Score and M/R Cost of the Roads Within the Network

Road Segment	SDI	ADT	Risk Score	Risk Rank	Risk Category	M/R Cost (Rp.)	Budget Rank
Jl. Cisadane	175	470.94	82414.5	12	Medium Risk	17,339,250	13
Jl. Gerbang Pintu Semarang	80	363.78	29102.4	15	Low Risk	45,191,280	5
Jl. Irigasi	98	496.32	48639.36	13	Low Risk	23,822,000	10
Jl. Irigasi Utara (Mangkang Kulon)	40	685.26	27410.4	16	Low Risk	0	16
Jl. Karanganyar	98	1531.26	150063.48	8	Medium Risk	24,372,400	9
Jl. Kauman Mangkang Wetan	165	685.26	113067.9	10	Medium Risk	97,640,460	1
Jl. Kauman Randugarut	98	2374.44	232695.12	4	High Risk	37,769,480	6
Jl. Kyai Gilang	80	1756.86	140548.8	9	Medium Risk	21,248,680	11
Jl, Mangunharjo (Mangkang Wetan)	98	2464.68	241538.64	2	High Risk	6,683,000	15
Jl. Mekar	80	1395.9	111672	11	Medium Risk	21,077,530	12
Jl. Panggung	80	600.66	48052.8	14	Low Risk	8,600,000	14
Jl. Pulau Tirang Tapak	165	1192.86	196821.9	7	Medium Risk	74,647,300	2
Jl. Stasiun Jrakah	118	2382.9	281182.2	1	High Risk	33,012,800	7
Jl. Stasiun Mangkang	118	1818.9	214630.2	5	High Risk	27,677,660	8
Jl. Tapak	90	2377.26	213953.4	6	Medium Risk	58,987,400	3
Jl. Tugurejo	175	1367.7	239347.5	3	High Risk	54,795,200	4

Source: Research Team, 2025

As a bar chart:

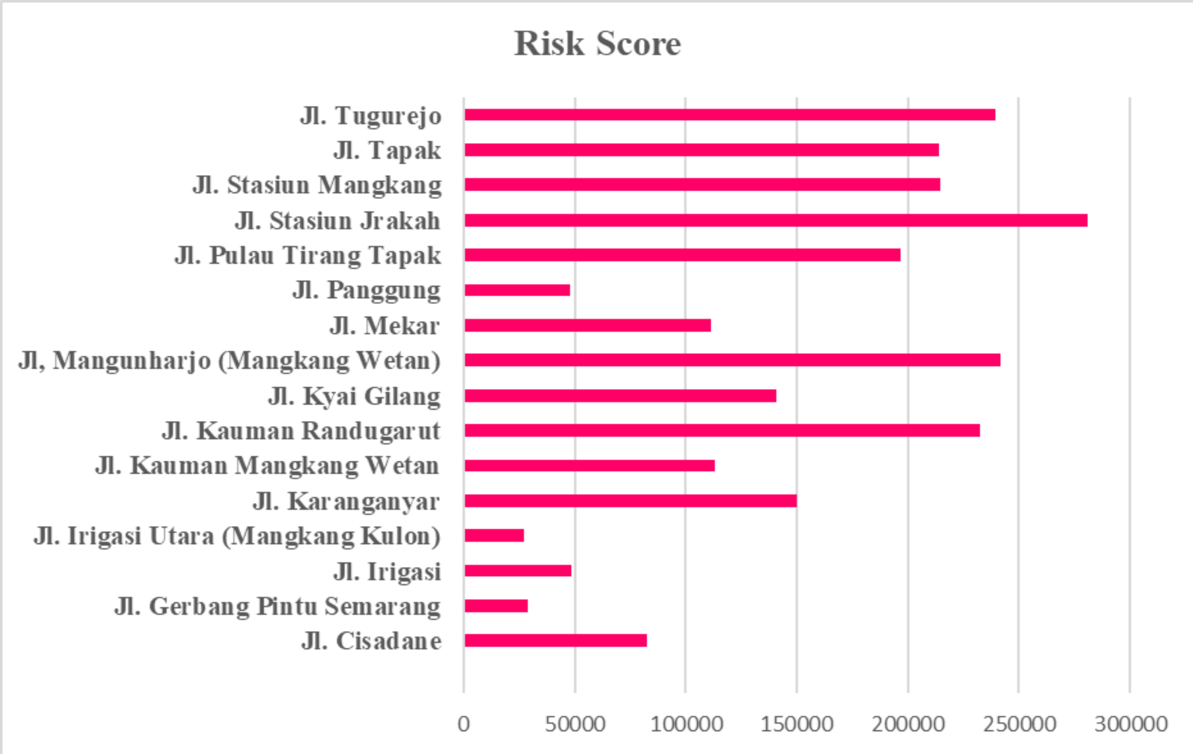

Diagram 1. Risk Score for Each Road.

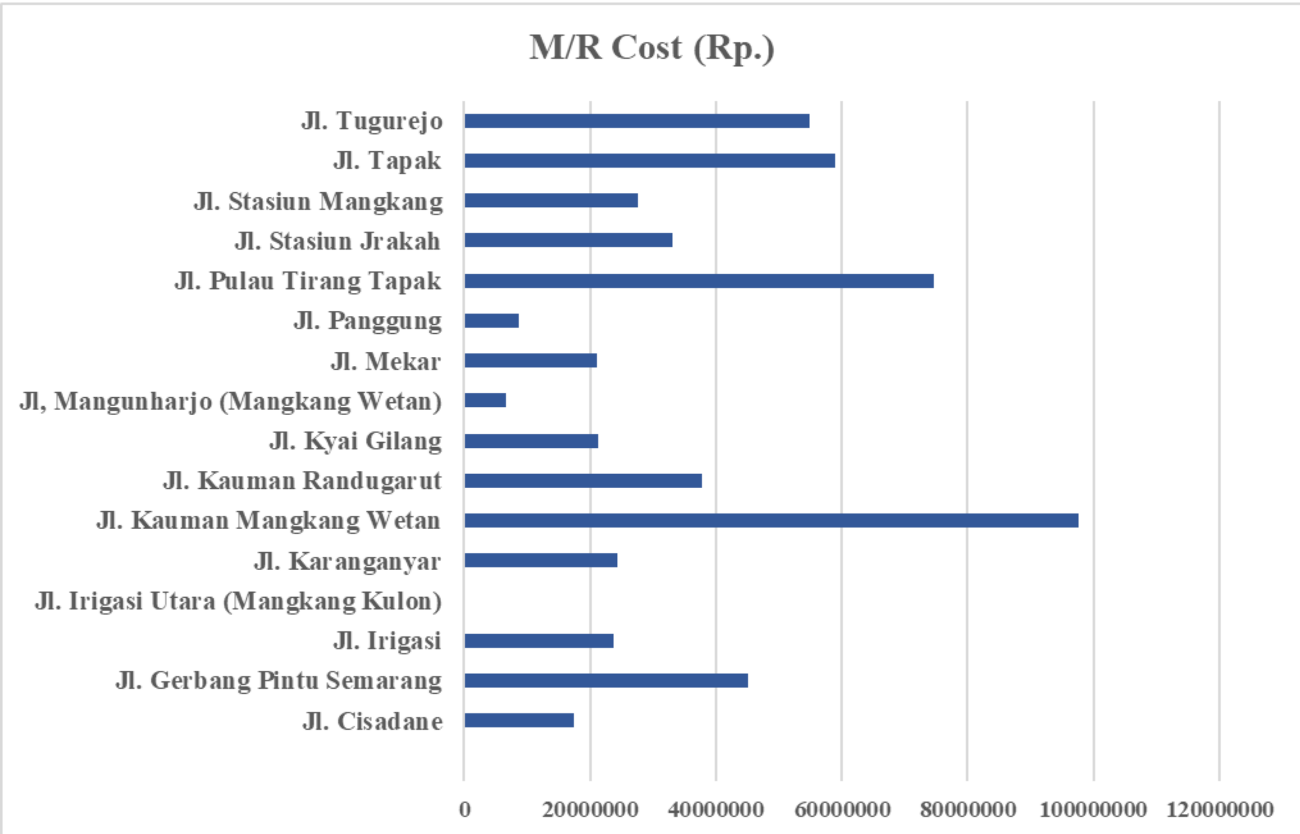

Diagram 2. M/R Cost for Each Road

From Table 19 and Diagram 1, we can conclude that the riskiest road was JL. Stasiun Jrakah, while the M/R cost was Rp. 33.012.800 was on the 7th position. The highest M/R cost was on JL. Kauman Mangkang Wetan with the M/R cost of Rp. 97.640.460, in fact, jl. Kauman Mangkang Wetan was in 10th position for safety riding.

4. CONCLUSION

In conclusion, risk-based resource allocation can guide which road to prioritize for road safety. A road with a high score risk does not necessarily have a high M/R cost, JL. Stasiun Jrakah road, for example. This analysis can be used in cases of resource limitations.

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