4th INTERNATIONAL CONFERENCE ON REHABILITATION AND MAINTENANCE IN CIVIL ENGINEERING

ASSESSMENT OF MAGETAN REGENCY'S ROAD PERFORMANCE BASED ON PAVEMENT AND OFF PAVEMENT COMPONENTS

By :

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1. INTRODUCTION

- **Road plays a fundamental role in a nation's economic and social well-being**.
- **A common problem, however, is that roads deteriorate in quality after extended periods of use**.
- **Thus, routine and sustainable road maintenance activities are always needed to keep roads motorable and safe for users.**
- **The purpose of this research is to determine road performance status after analysis using KRMS software and also to present necessary recommendations for road handling based on road performance results**

2. LITERATURE REVIEW

2.1 Functional conditions of roads

Suwardo and Sugiharto [1] argue that Roughness Index (RI) is one of many factors with great influence on comfort of drivers when on the road. Additionally, Suherman [2] posits that road roughness directly affects diver comfort. Hence the need to conduct periodical road inspection for better road performance

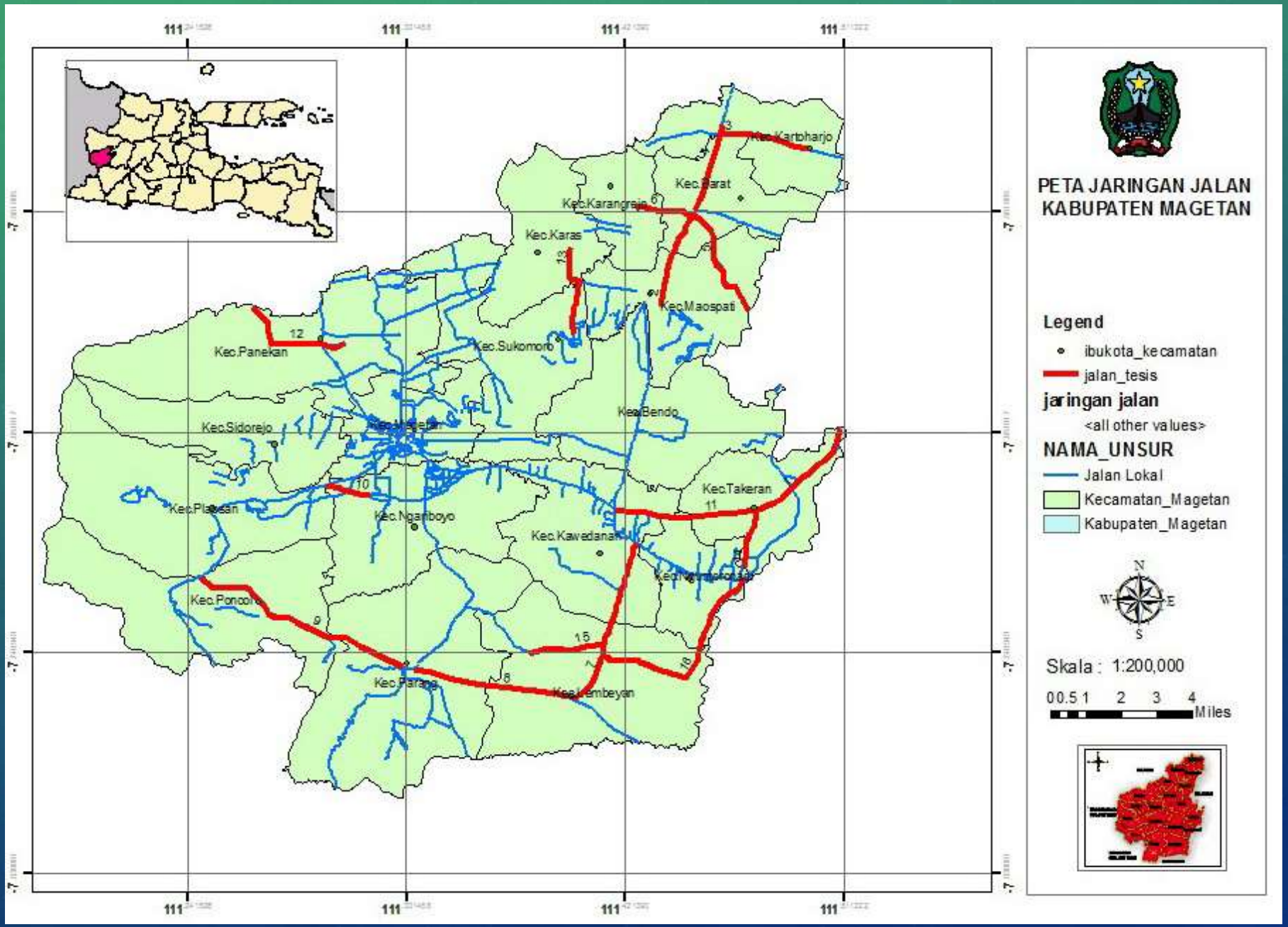
Assessment of functional conditions of roads can be done by physical evaluation through field evaluation and observation. Results are then documented for visual assessment.

2.2 Road performance

- Road performance is the relative function and ability of road pavements to optimally meet traffic demands within a certain period. To determine the state of road conditions, the International Roughness Index (IRI), the Pavement Condition Index (PCI)
- Thus, road performance can be determined using the values of IRI, PCI and SDI [6] as well as the combination of the three methods [7].
- To investigate road performance based on the functional and structural conditions of roads, the method used by Bina Marga and AASHTO 1993 can be adopted
- A new method using a special software - Kabupaten Road Management System (KRMS)

3. RESEARCH METHOD AND DATA COLLECTION TECHNIQUE

Map of research location

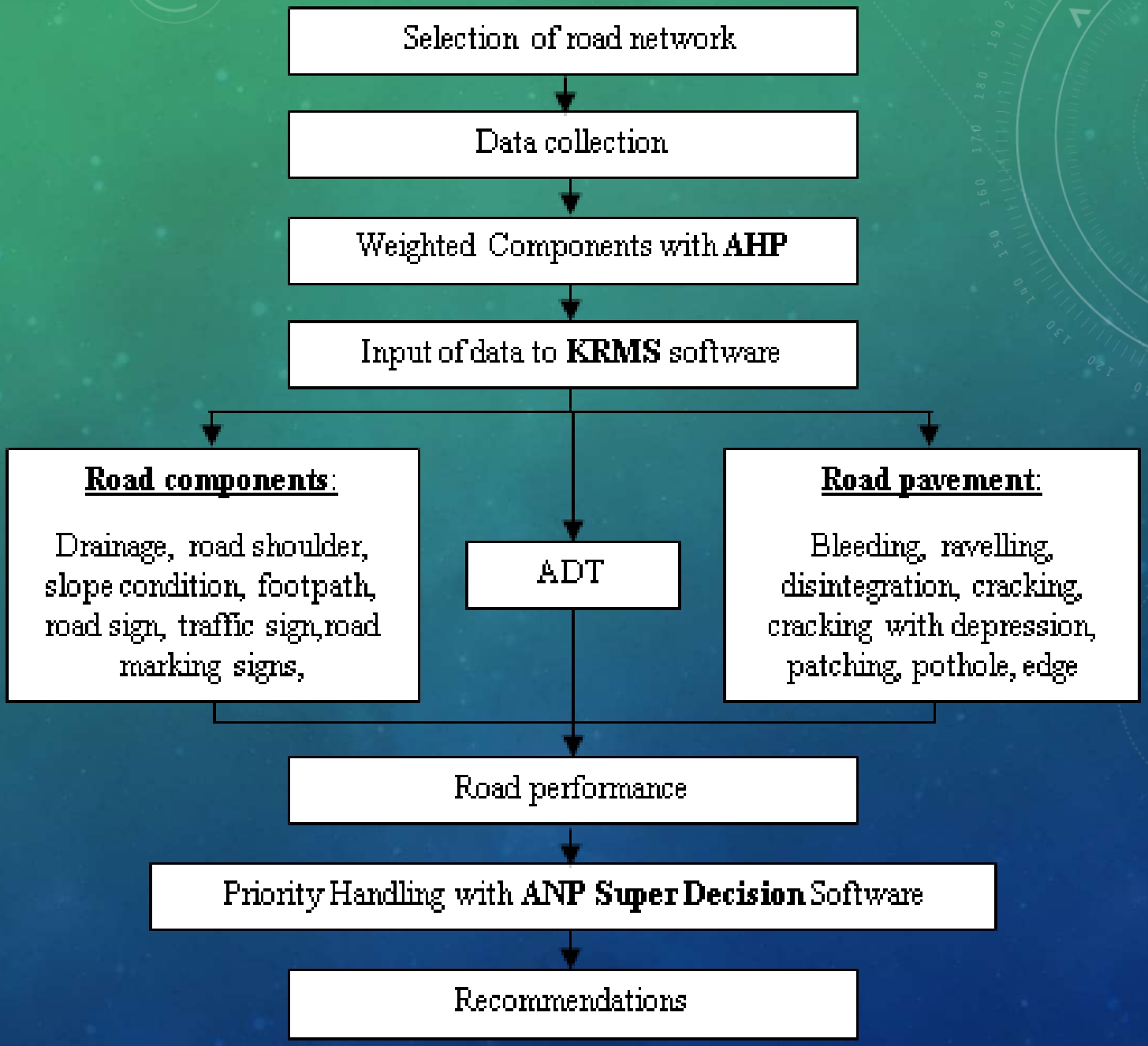


Name of road section location

No.	Name of Road Section	Sub-district Traversed	Length (km)	Type of pavement
1.	Takeran-Mardigondo	Takeran	5,50	Asphalt
2.	Maospati-Karangsono	Maospati-Barat	4,50	Asphalt
3.	Tebon-Karangmojo	Barat-Kartoharjo	3,60	Asphalt
4.	Tebon-Batur	Barat	4,00	Asphalt
5.	Karangsono-Teguhan	Barat-Maospati	5,50	Asphalt
6.	Purwodadi-Grabahan	Barat-Karangrejo	2,30	Asphalt
7.	Genengan-Lembeyan	Kawedanan-Lembeyan	10,30	Asphalt
8.	Tamanarum-Lembeyan	Parang-Lembeyan	7,40	Asphalt
9.	Parang-Turus	Parang-Poncol	11,60	Asphalt
10.	Ringinagung-Bangsri	Ngariboyo	1,10	Asphalt
11.	Tulung-Kenongomulya	Kawedanan-Takeran	5,50	Asphalt
12.	Panekan-Jabung	Panekan	4,40	Asphalt
13.	Tinap-Jongke	Sukomoro-Karas	5,70	Asphalt
14.	Takeran-Kenongomulya	Takeran	3,40	Asphalt
15.	Pupus-Tapen	Lembeyan	3,70	Asphalt
16.	Pupus-Semen	Lembeyan-Takeran	7,10	Asphalt
		TOTAL	85,60	

Data on road and road component damages collected in the survey were in a video format. The visual assessment of the video was afterwards done to determine the damages of the road and its complementary facilities. For more extensive results, secondary data were obtained from the Office of Public Works and Development Planning Agency at Sub-National Level of Magetan Regency. These data included Magetan Regency administrative map, road section map, and Average Daily Traffic (ADT) data.

The full methodology and steps employed in this research are shown in Figure 2.

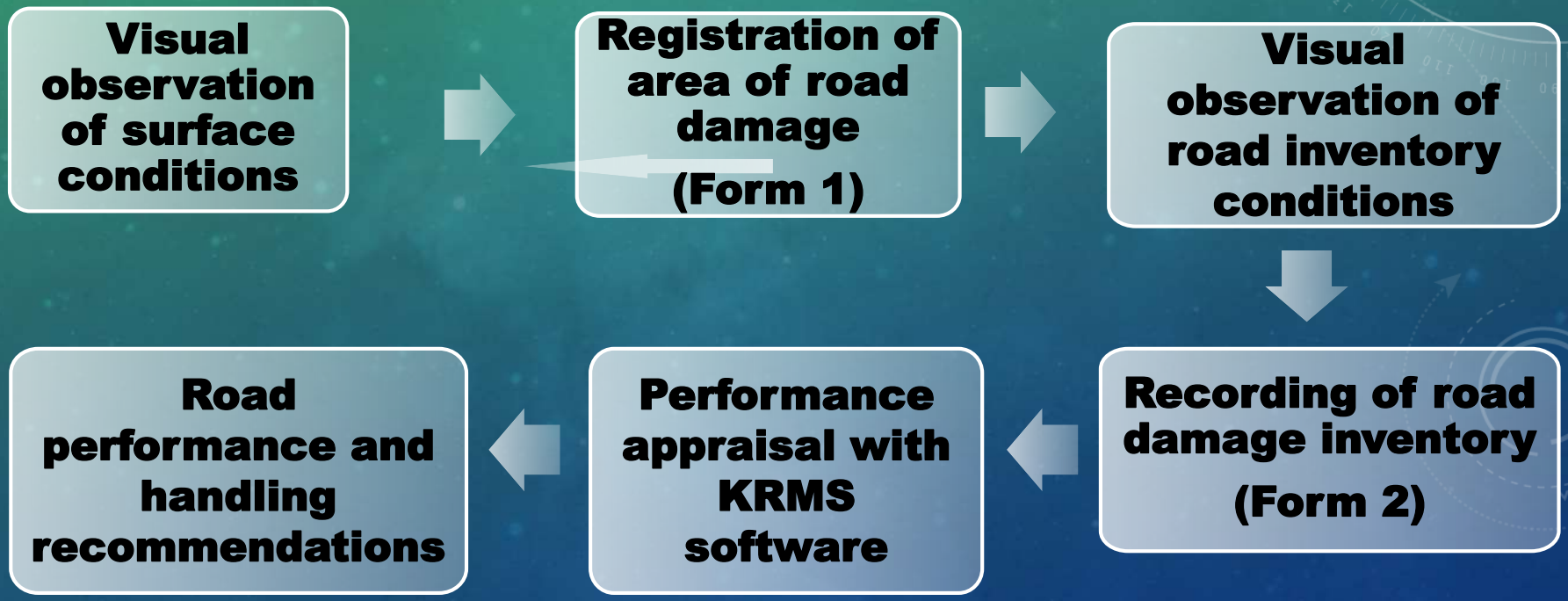

Selection of road network
Data collection
Weighted Components with AHP
Input of data to KRMS software
Road components:
Drainage, road shoulder, slope condition, footpath, road sign, traffic sign,road marking signs,
ADT
Road pavement:
Bleeding, ravelling, disintegration, cracking, cracking with depression, patching, pothole, edge
Road performance
Priority Handling with ANP Super Decision Software
Recommendations

- In this research, KRMS method was used to determine road performance without using the IRI value. Using this method, damage assessment of pavement and road components was done with the user-friendly KRMS software which provided in-depth results on SLD Reports (Straight Line Diagram) and Map Report Diagram (Strip Map Diagram).

- Determination of weight of road components like its physical and functional conditions was done using a questionnaire which was afterwards analysed using the Analytical Hierarchy Process (AHP) method.

- Determination of priority scale in handling Magetan district road was subsequently done using ANP (Analysis Network Process) with the help of Super Decision software. The data input method and criteria were then used to inform key priorities of the road.

Analysis


Visual observation of surface conditions
Registration of area of road damage (Form 1)
Visual observation of road inventory conditions
Recording of road damage inventory (Form 2)
Performance appraisal with KRMS software
Road performance and handling recommendations

FORMULIR SURVEI UNTUK KONDISI JALAN ASPAL

RUAS	No. :	Nama Daerah :
	Nama :	Kabupaten :
	Dari Km :	Disurvei oleh :
	Ke Km :	Tanggal :
	Status :	Paraf :

	Kerusakan Perlengkapan Jalan (Kiri)				Lereng (Kiri)	Drainase Tepi (Kiri)	Bahu Jalan (Kiri)		Perkerasan										Bahu Jalan (Kanan)		Drainase Tepi (Kanan)	Lereng (Kanan)	Kerusakan Perlengkapan Jalan (Kanan)			
	VI/1	VI/2	VI/3	VI/4	IV	III	II	V	I/1	I/2	I/3	I/4	I/5	I/6	I/7	I/8	I/9	I/10	II	V	III	IV	VI/1	VI/2	VI/3	VI/4
0,1 KM																										
0,2 KM																										
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KM																										

LEGENDA

I. PERKERASAN
1. IRI
2. Kepermukaan (m^2)
3. Butir Lepas (m^2)
4. Disintegrasi (m^2)
5. Retak & Penurunan (m^2)
6. Tambalan (m^2)
7. Retak (m^2)
8. Lubang (m^2)
9. Jejak Roda (m^2)
10. Rusak Tepi (m^2)

II. BAHU JALAN
1. Jejak Roda/Erosi Ringan
2. Jejak Roda/Erosi Berat
3. Di atas Permukaan Jalan
4. Sama dengan Permukaan Jalan
5. Di bawah Permukaan Jalan
6. Dibutuhkan Rabat

III. DRAINASE TEPI
1. Tersumbat
2. Tergerus
3. Runtuh
4. Dibutuhkan Drainase Pasangan Batu

IV.LERENG TEPI
1. Runtuh

V. TROTOAR
1. Berbahaya

VI.KERUSAKAN PERLENGKAPAN JALAN
1. Rambu Jalan (No.)
2. Pagar Pengaman (m)
3. Patok Pengarah (No.)
4. Marka Jalan

FORMULIR SURVEI UNTUK INVENTARISASI ASPAL

No.	:	Nama Daerah	:
Nama	:	Kabupaten	:
Dari Km	:	Disurvei oleh	:
Ke Km	:	Tanggal	:
Status	:	Paraf	:

DARI		KE		PERKERASAN		BAHU JALAN KIRI		BAHU JALAN KANAN		TIPE DRAINASE		TATA GUNA LAHAN		MEDIAN JALAN
KM	OFSET	KM	OFSET	LEBAR (m)	TIPE	LEBAR (m)	TIPE	LEBAR (m)	TIPE	KIRI	KANAN	KIRI	KANAN	

FORM 2

LEGENDA

TIPE PERKERASAN
1. Beton
2. Blok Beton
3. Aspal
4. Perkerasan Makadam
5. Batu Kali
6. Kerikil
7. Tanah

TIPE BAHU JALAN
1. Beton
2. Blok Beton
3. Aspal
4. Perkerasan Makadan
5. Batu Kali
6. Kerikil
7. Tanah

DRAINASE
1. Tidak Ada Drainase
2. Tidak Ditemukan Drainase
3. Drainase Tanah
4. Drainase Pasangan Batu Terbuka
5. Drainase Pasangan Batu Tertutup

TATA GUNA LAHAN
1. Tidak Ada
2. Pertanian
3. Desa
4. Kota

BAHU JALAN
1. Datar
2. Bukit
3. Gunung

4. THE OUTCOME OF ANALYSIS AND REVIEWS

Figure 3. Takeran-Mardigondo Road Section Documentation

4.1 EVALUATION OF THE PHYSICAL STATE OF THE ROAD

Table 2. SUMMARY OF ROAD DAMAGES RECORDED FOR EVERY SEGMENT OF THE ROAD (M^2).

Name of Road Section	Bleed-ing (m^2)	Ravell-ing (m^2)	Dis-integra-tion (m^2)	Crack with Depres-sion (m^2)	Patching (m^2)	Crack-ing (m^2)	Pothole (m^2)	Rutting (m^2)	Edge Damage (m^2)
Takeran-Madigondo	-	137,5	30,0	57,0	80,4	39,0	60,3	-	-
Maospati-Karangsono	-	-	-	3,7	146,4	19,2	6,9	-	6,6
Tebon-Karangmojo	-	-	-	-	-	9,0	11,3	-	8,0
Tebon-Batur	0,4	0,3	-	0,7	377,2	106,9	2,1	-	5,2
Tamanarum-Lembeyan	50,0	350,8	65,4	-	1.123,2	108,6	10,9	-	6,6
Genengan-Lembeyan	35,3	364,9	445,0	11,8	1.091,9	126,2	13,7	134,1	22,1
Purwodadi-Grabahan	-	70,5	-	-	86,2	-	9,1	-	-
Karangsono-Teguhan	36,0	2,1	162,8	-	177,7	71,9	41,1	-	36,7
Parang-Turus	-	10,0	28,5	-	1.471,6	32,6	35,5	-	4,9
Pupus-Tapen	-	7,1	41,1	11,1	126,9	79,3	32,5	-	4,6
Takeran-Kenongomulyo	-	-	-	-	6,0	-	-	-	-
Tinap-Jongke	73,1	-	1,6	1,6	167,7	8,8	25,8	-	0,9
Panekan-Jabung	-	-	-	-	376,1	62,0	2,5	-	-
Tulung-Kenongomulyo	-	-	-	-	28,1	92,4	3,1	-	0,6
Ringinagung-Bangsri	-	0,5	-	-	2,0	-	6,2	-	-
Pupus-Semen	-	4,0	92,2	4,5	-	163,10	141,8	-	8,0

Grafik Jenis Kerusakan

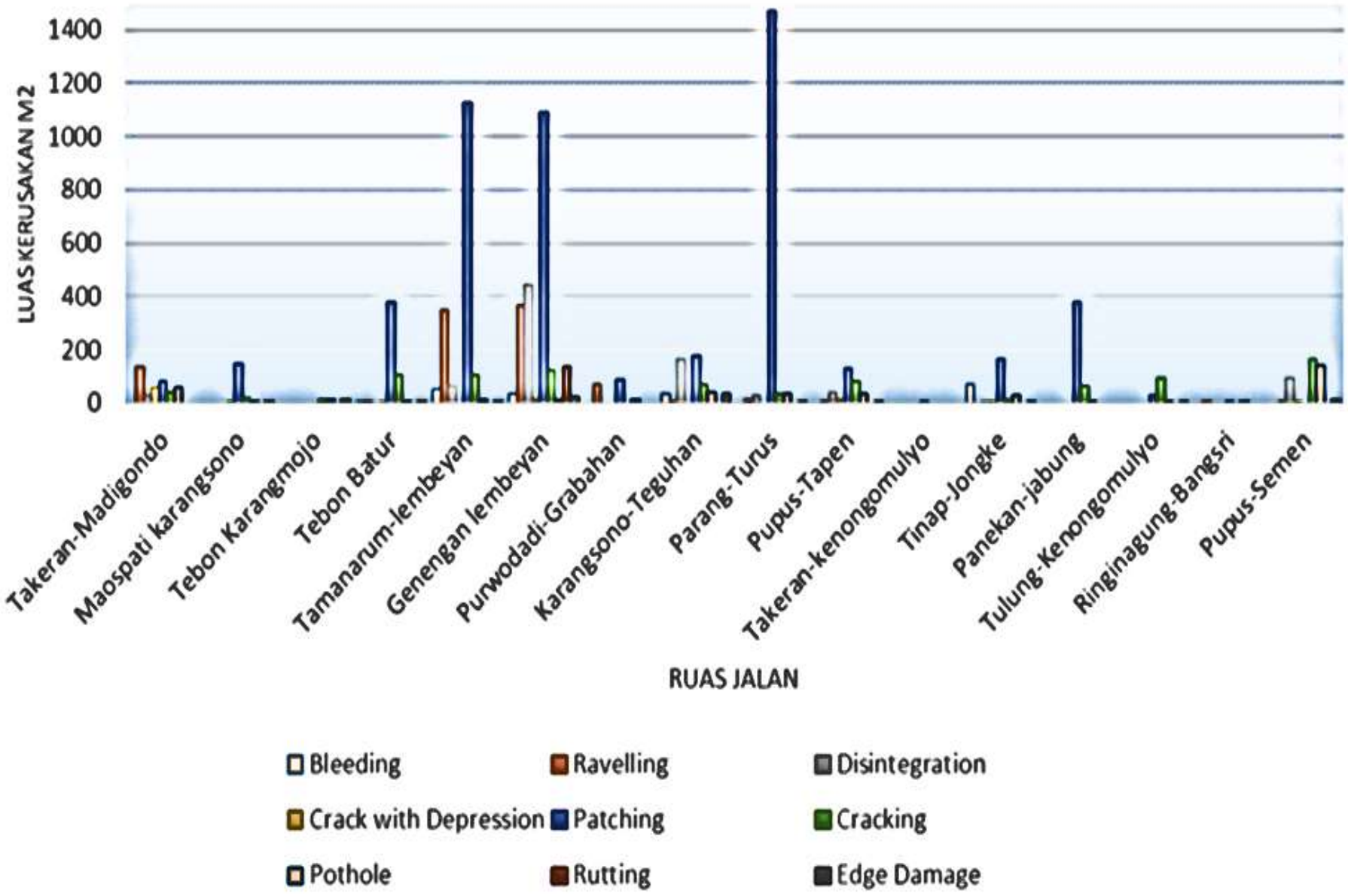


TABLE 2 INDICATES THE MAGNITUDE OF DISFIGUREMENT PER 100 METERS FOR EACH PART OF THE ROAD. TABLE 2 IS ACCOMPANIED BY A VISUAL EXAMINATION OF THE DETERIORATION OF THE ROAD AS WELL.

AN ANALYSIS OF TABLE 2 SHOWS THAT PATCHES, LOOSE AND CRACKED GRAINS (IN THAT ORDER) REMAIN THE HIGHEST FORM OF ROAD DEGENERATION. 5261.4M2 IS THE SUM OF ROAD DAMAGE DUE TO PATCHES WHILE THAT CAUSED BY GRAIN LOOSENING IS 947.17 M2. HOWEVER, 919 M2 IS RECORDED FOR CRACK DEGENERATIONS.

4.2 ASCERTAINMENT OF WEIGHT REQUIREMENTS OF ROAD COMPONENTS

USING THE ANALYTICAL HIERARCHY PROCESS (AHP) TECHNIQUE VIA A QUESTIONNAIRE, AN ANALYSIS OF THE ASCERTAINMENT OF THE WEIGHT REQUIREMENT OF ROAD COMPONENTS WHICH COVERS THE UTILITY AND PHYSICAL STATE OF ROADS CAN BE CARRIED OUT

POST ANALYSIS VIA THE AHP TECHNIQUE RESULTED IN THE DETERMINATION OF THE MASS OF EACH ROAD COMPONENT THESE ARE –

- ROAD ON PAVEMENT COMPONENTS 80%
- COMPONENTS OFF PAVEMENT ROAD 20%
- PHYSICAL CONDITION ON PAVEMENT 73%
- CONDITION ON PAVEMENT FUNCTION 27%
- AND CONDITION OFF PAVEMENT FUNCTION 81%

OTHERS ARE:

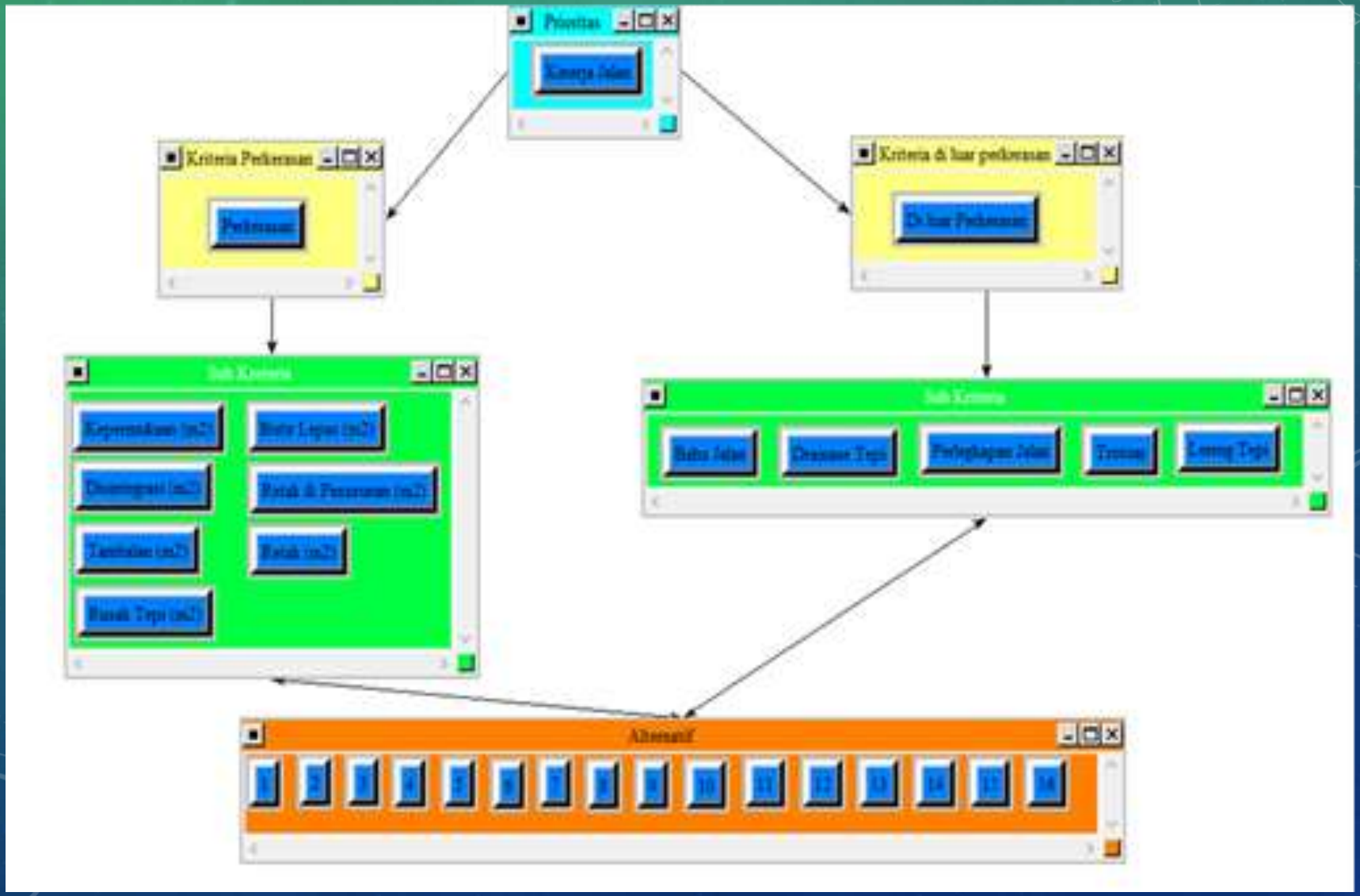
- PHYSICAL CONDITIONS OFF PAVEMENT 19%,
- ROAD SHOULDER 36%,
- DRAINAGE EDGE 24%,
- EDGE SLOPE 19%,
- SIDEWALK 12%,
- STREET FIXTURES 8%,
- RUT DEPTH/MILD EROSION 25%,
- AND RUT DEPTH/SEVERE EROSION 30%.

THE FOLLOWING WAS ALSO OBSERVED:

- HIGHER THAN ON PAVEMENT 24%,
- LOWER THAN ON PAVEMENT 11%,
- CONCRETE REBATE REQUIRED 9%,
- CLOGGED DRAIN 43%, ERODED DRAIN 23%,
- COLLAPSED DRAIN 24%,
- NEEDING TO ATTACH STONES 10%,
- ROAD SIGN 41%,
- ROAD SAFETY BARRIER 26%,
- ROAD MARKING SIGNS 18%, AND
- ROAD MARKING 14%.

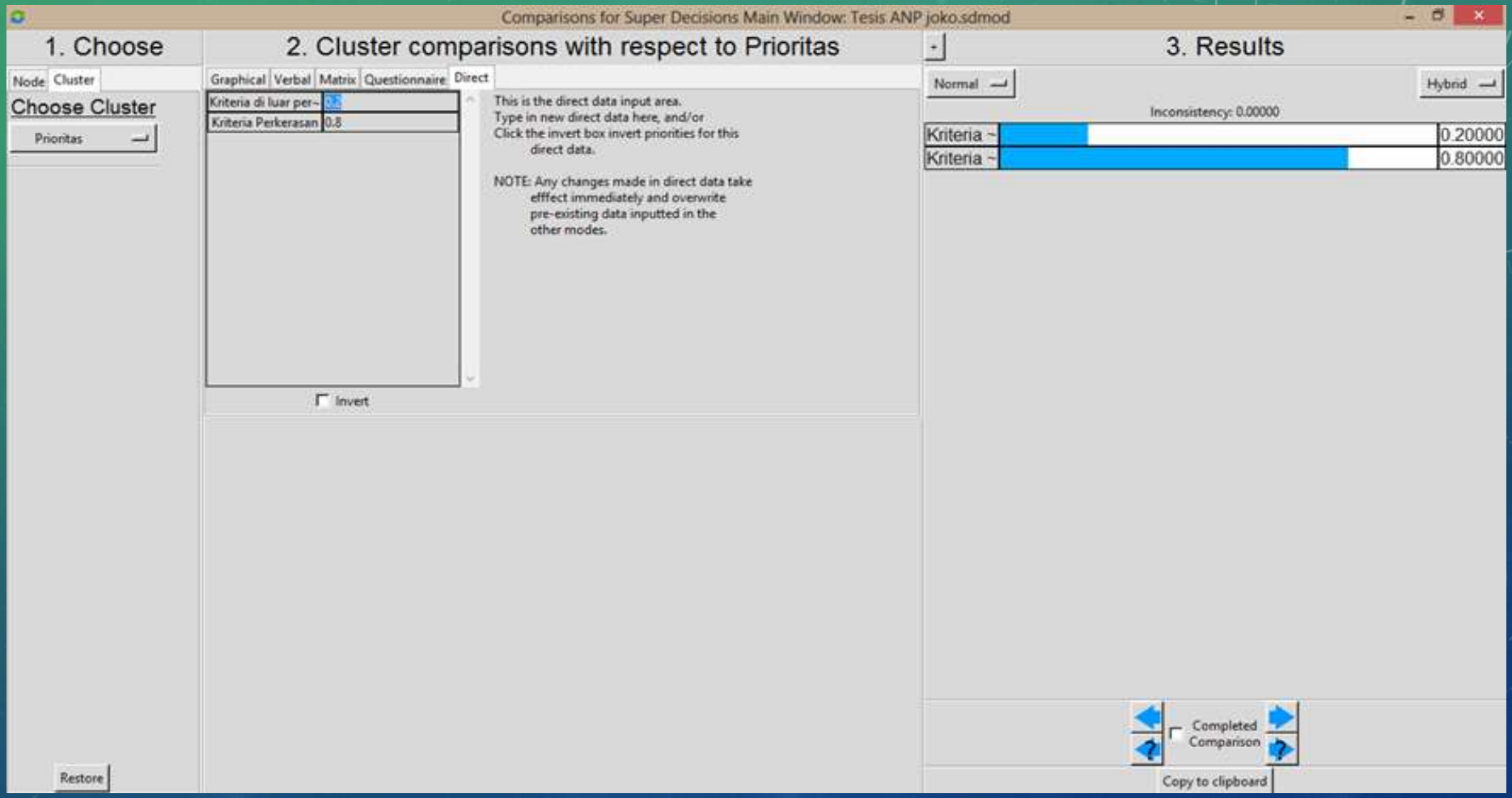
4.3 MODEL MAKING OF PRIORITY FOR ROAD HANDLING

FIGURE 4 IS THE REPRESENTATION OF THE PRIORITY SCALE MODEL ADOPTED IN THIS STUDY. NEVERTHELESS, THE NEXUS BETWEEN CRITERIA ON PRIORITY AND ALTERNATIVES IS DERIVED FROM THE PRIORITY SCALE DETERMINATION APPROACH.

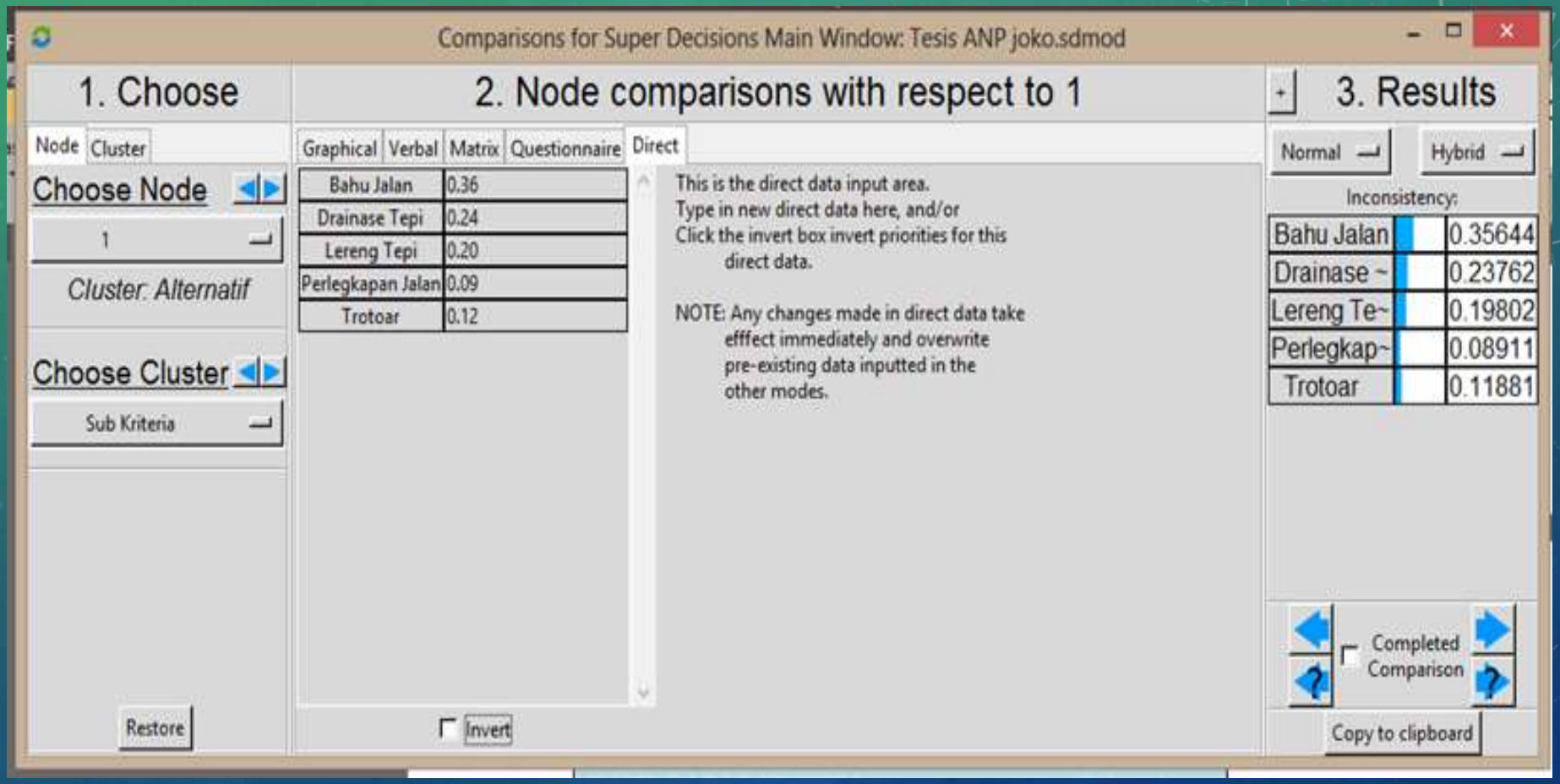


Perform Input the mass value

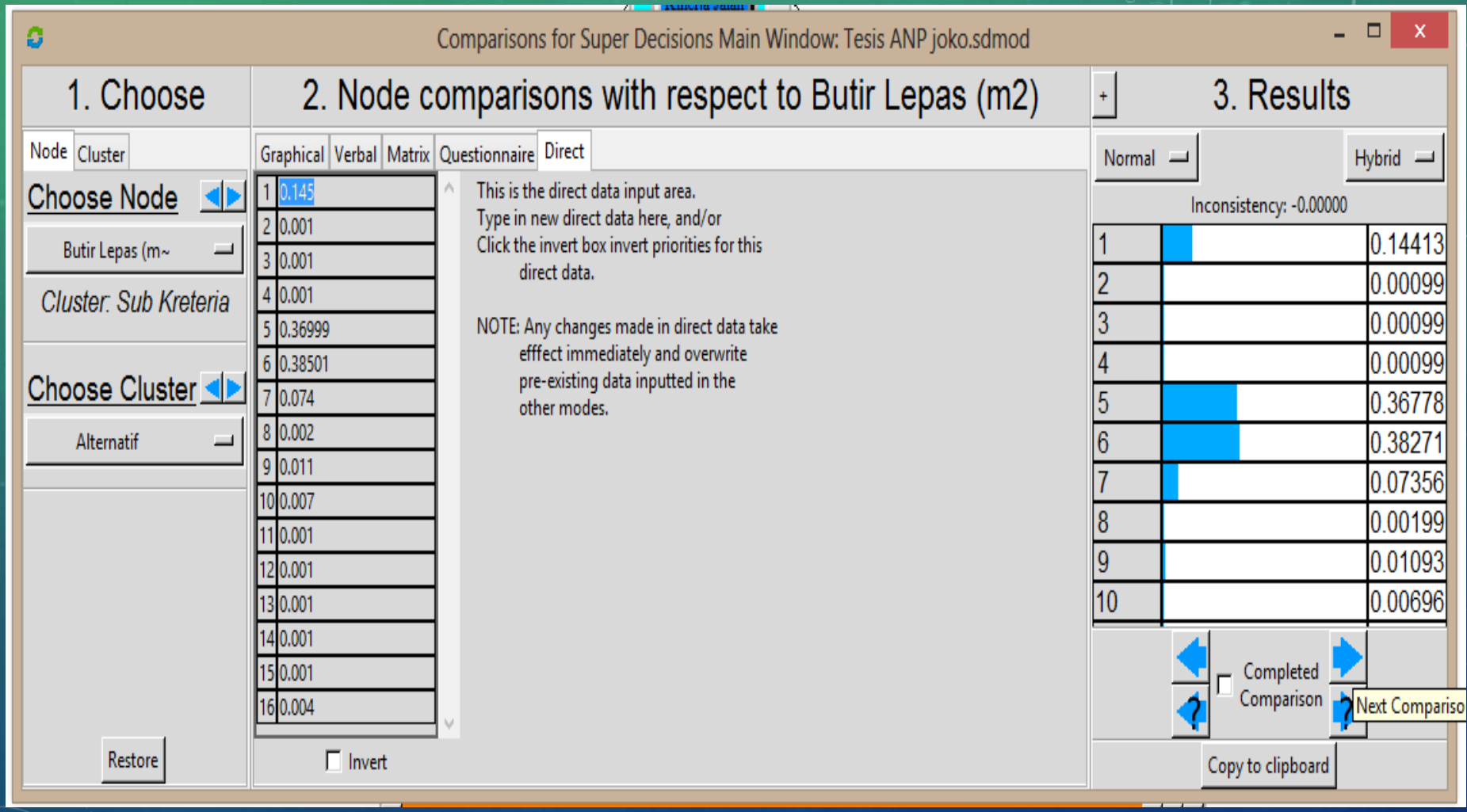
1. The mass Value of Criteria



2. The mass Value of Sub Criteria



3. The mass Value Condition



The priority scale of Road Section

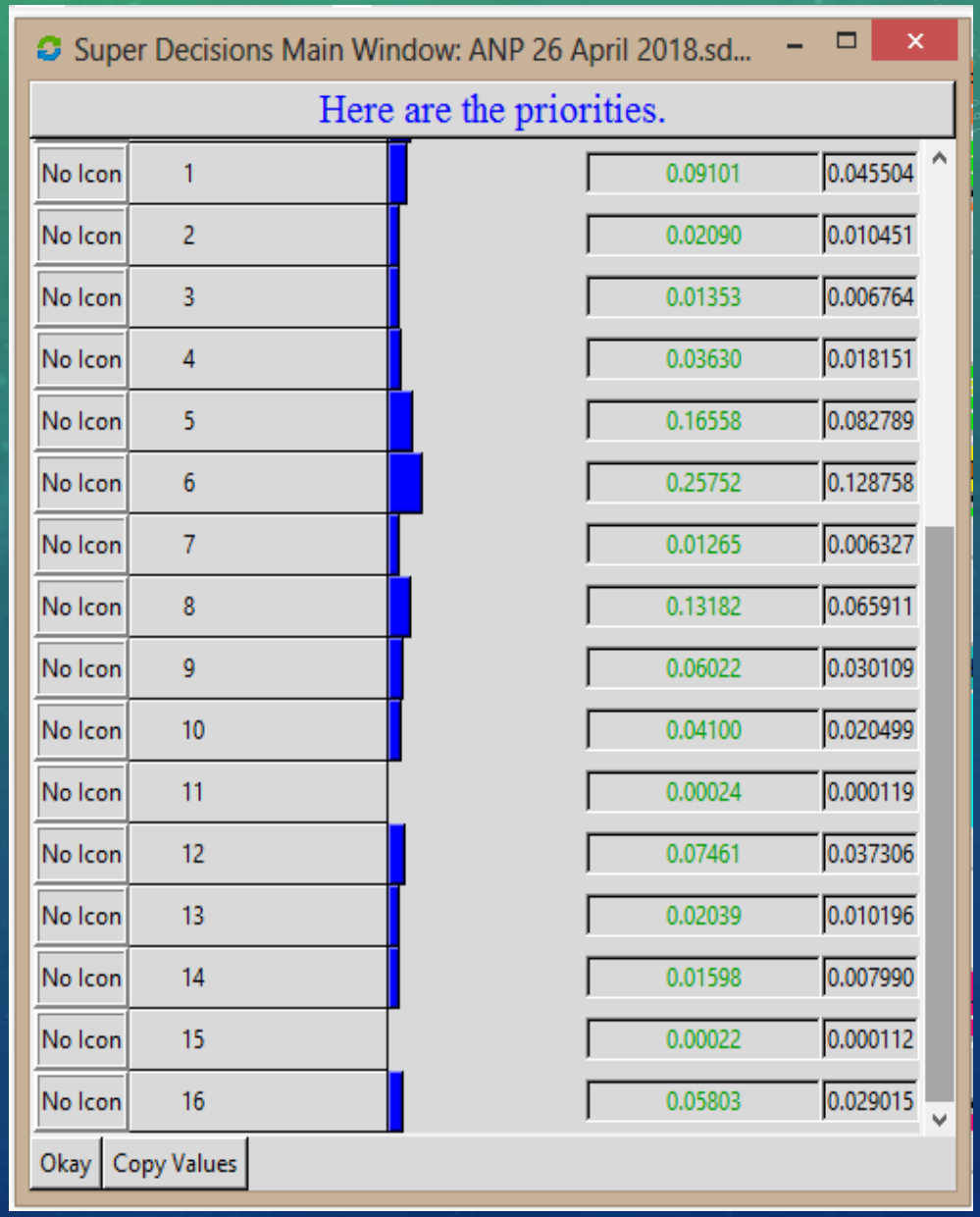


Table 4. The priority scale of Road Section

No Road Section	Alternatif	Ideal	The priority scale
027	Genengan lembeyan	0.25750	1
029	Tamanarum-lembeyan	0.16559	2
020	Karangsono-Teguhan	0.13182	3
008	Takeran-Mardigondo	0.09101	4
055	Tinap-Jongke	0.07461	5
030	Parang-Turus	0.06022	6
082	Pupus-Semen	0.05803	7
077	Pupus-Tapen	0.04100	8
019	Tebon Batur	0.03630	9
011	Maospati karangsono	0.02090	10
048	Panekan-jabung	0.02039	11
047	Tulung-Kenongomulyo	0.01598	12
013	Tebon Karangmojo	0.01353	13
021	Purwodadi-Grabahan	0.01266	14
058	Takeran-kenongomulyo	0.00024	15
034	Ringinagung-Bangsri	0.00022	16

USING THE ANALYSIS NETWORK PROCESS (ANP) ALONGSIDE THE SUPER DECISION SOFTWARE, THE PRIORITY OF DAMAGE HANDLING LED TO THE DETERMINATION OF THE FIRST PRIORITY ROAD SECTION OF GENENGAN-LEMBEYAN ROAD. THAT OF TAMANARUM-LEMBEYAN ROAD CAME SECOND WHILE KARANGSONO-TEGUHAN CAME THIRD IN THE HANDLING PRIORITY.

4.4 ROAD PERFORMANCE EVALUATION

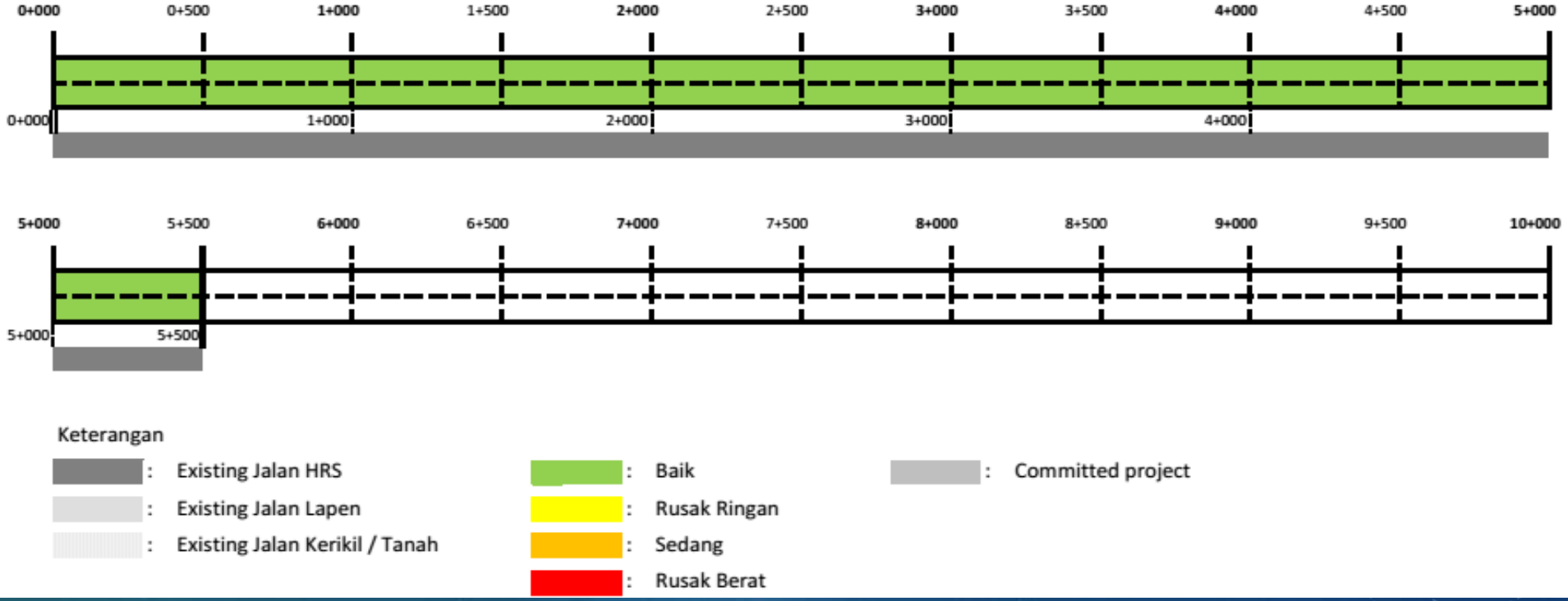


Fig. 5: Straight Line Diagram of Takeran-Mardigondo Road Segment

The all-green color in the diagram above shows that the present HRS on the Takeran-Mardigondo road is in an excellent state.

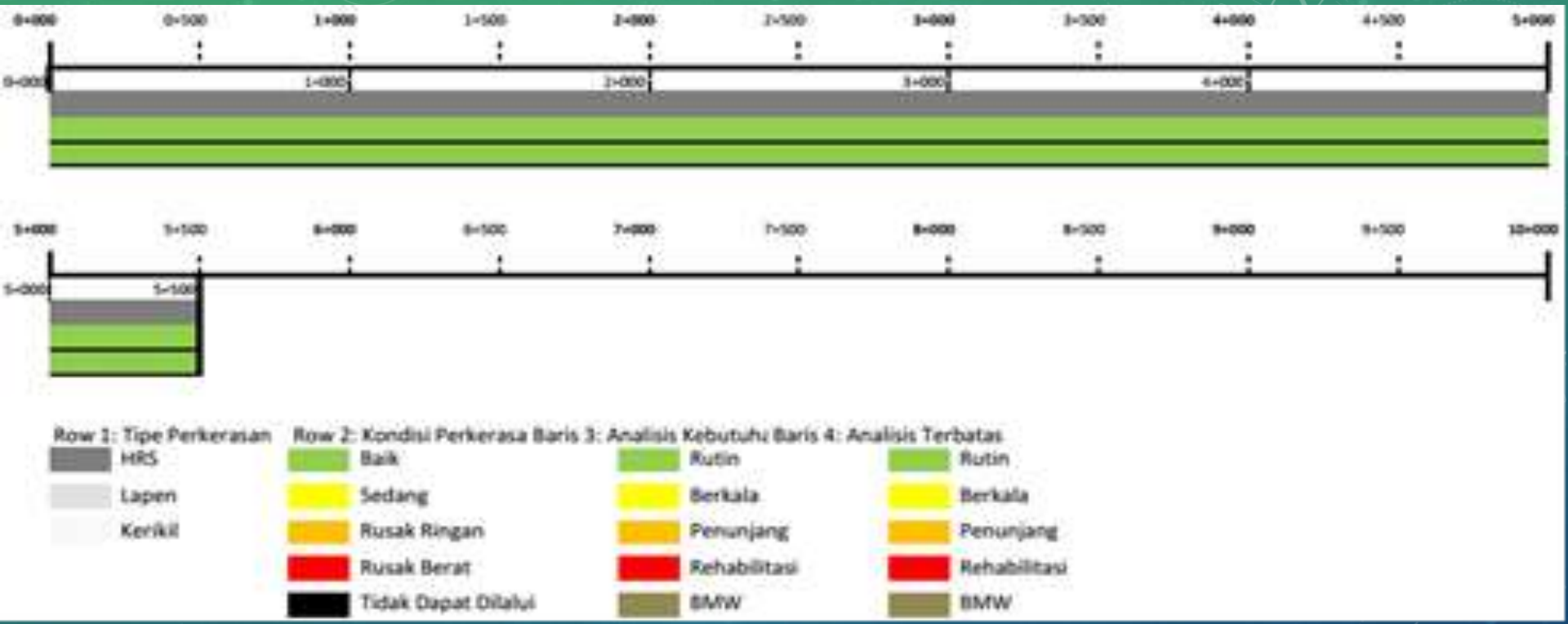


Fig. 6: Strip Map Diagram on Takeran-Mardigondo Road Segment

The Takeran-Mardigondo road demands periodic maintenance because the state of its present HRS is positive. The diagram above is self-explanatory.

4.5 ROAD MAINTENANCE HANDLING: SUGGESTIONS

Table 3. Performance-based District Road Maintenance Handling Recommendations

No.	Name of Road Section	Performance	Maintenance Recommendations
1.	Takeran-Mardigondo	Good	Routine maintenance
2.	Maospati-Karangsono	Good	Routine maintenance
3.	Tebon-Karangmojo	Good	Routine maintenance
4.	Tebon-Batur	Good	Routine maintenance
5.	Karangsono-Teguhan	Good	Routine maintenance
6.	Purwodadi-Grabahan	Good	Routine maintenance
7.	Genengan-Lembeyan	Good	Routine maintenance
8.	Tamanarum-Lembeyan	Good	Routine maintenance
9.	Parang-Turus	Good	Routine maintenance
10.	Ringinagung-Bangsri	Good	Routine maintenance
11.	Tulung-Kenongomulya	Good	Routine maintenance
12.	Panekan-Jabung	Good	Routine maintenance
13.	Tinap-Jongke	Good	Routine maintenance
14.	Takeran-Kenongomulya	Good	Routine maintenance
15.	Pupus-Tapen	Good	Routine maintenance
16.	Pupus-Semen	Good	Routine maintenance

5. CONCLUSION

AS DETERMINED BY THE OUTCOME OF THE ANALYSIS, WE ARRIVE AT THE FOLLOWING CONCLUSIONS:

1. THE PHYSICAL EVALUATION OF ROADS USING THE KRMS SOFTWARE IS SUPPORTED BY THE FINDINGS IN 16 STRAIGHT LINE DIAGRAM. IT INDICATES THAT THE STATE OF 16 DISTRICT ROAD OF MAGETAN REGENCY IS IN EXCELLENT SHAPE.
2. THE BASIS OF THE ANALYSIS EMBRACED THE ENTIRE RANGE OF DISTRICT ROAD DETERIORATIONS DETERMINED BY VISUAL INSPECTION OF THE ROAD. WE RECOMMEND THAT ROUTINE MAINTENANCE OF ALL ROAD SEGMENTS COVERED IN THE MAGETAN DISTRICT SHOULD BE CARRIED OUT. OUR SUGGESTION FLOWS FROM AN EVALUATION OF THE ROAD USING KRMS SOFTWARE AND THE OUTCOME OF 16 STRIP MAP DIAGRAMS. ALSO, THE FIRST PRIORITY ROAD SEGMENT HANDLING IS GENENGAN-LEMBEYAN ROAD FOLLOWED BY THAT OF TAMANARUM-LEMBEYAN ROAD AND KARANGSONO-TEGUHAN. THIS WOULD NOT HAVE BEEN POSSIBLE WITHOUT THE PRIORITY OF DAMAGE HANDLING ANALYSIS OF THE ANALYSIS NETWORK PROCESS (ANP) TECHNIQUE AND THE SUPER DECISION SOFTWARE.

Thank You