

## ANALYSIS OF CONDITION AND TYPE HANDLING OF NATIONAL ROAD IN CENTRAL SULAWESI PROVINCE (CASE STUDY: TOMPE - PANTOLOAN)

*Syamsul Arifin*

*Department of Civil Engineering, Faculty of Engineering, Tadulako University, Indonesia*

### **ABSTRACT**

*Tompe-Pantoloan Road is a National Roads in Central Sulawesi Province traversed by all types of vehicles. High traffic volumes combined with ineffective handling of road maintenance can lead to decrease performance in road conditions. Therefore, road handling must be adjusted to road conditions in order to achieve the target of road stability. The purpose of this research is to analyze the condition and type of handling of National Road in Central Sulawesi Province (Case Study: Tompe–Pantoloan). The method used in this research is the Integrated Road Management System (IRMS) application. In this software required input data are road surface roughness data (IRI), traffic data, road condition data, road inventory data, and reference point data. Based on the result of IRMS application output, IRI prediction condition for Tompe-Pantoloan Road is good condition, medium, and light damaged during 5 years of analysis. Handling of road maintenance for Tompe-Pantoloan Road covers routine, routine condition and Minor rehabilitation. The total cost in accordance with the recommendations of maintenance handling from 2018 to 2022 on the Tompe-Pantoloan Road section of Rp. 63.066.000.000,00,*

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### **INTRODUCTION**

Roads are infrastructures that play an important role in accommodating the movement of traffic flow so that during the service period the road is expected to not experience road damage that can affect safety and comfort for road users [4].

[19] National Road is an arterial and collector road in the primary road network system that connects provincial capitals and national and toll road strategic roads. The length of the National Road in Central Sulawesi Province is 2,373.4 Km (Kepmen PUPR No. 248 / KPTS / M / 2015).

The Tompe-Pantoloan section is the national road sections in Donggaladistrict which are the Primary Arterial Road within the City of Palu.

Based on the results of the road condition survey conducted by the Central Sulawesi National Road Planning and Monitoring Unit in 2013-2014, the condition of road stability increased by 0.76% from stability of 92.50% to 93.26%. And in 2014-2015 the condition of road stability increased by 0.57% from stability of 93.26% to 93.83%. While in 2015-2016 the condition of road stability decreased by 0.08% from the stability of 93.83% to 93.75%.

The Directorate General of Highways' Strategic Target presented in the 2017 Budget Year Work Program Arrangement in Jakarta targets 98% National Road stability at the end of 2019. The road stability condition of Central Sulawesi Province in the first semester of 2017 reached 92.95%. To achieve 98% stability, it is expected that the handling program for the following year will be adjusted to road conditions. [24][25]

At the moment the IRMS (Integrated Road Management Systems) program is used to determine the road conditions which will later result in the value of the International Roughness Index (IRI) that will be used to assist in the programming process to determine road handling. [5][33][34].

IRMS application is used to predict conditions in the following year so that it can determine more effective and efficient handling according to the needs and conditions of the field.

## LITERATURE REVIEW

### International Roughness Index (IRI)

IRI is a roughness parameter that is calculated from the cumulative number of ups and downs of the surface of the direction of the elongated profile at the measured surface distance and is used to evaluate the performance of pavement which can be assessed from the quality of driving above the road surface[5][34]. IRI is expressed in meters per kilometer (m/km) can be seen in figure-1. In general, if the road age and traffic load increase, road damage will increase so that the IRI value also increases. In road planning, traffic loads and subgrade types are the main factors that determine the value of the structural number, which is the number used to determine the thickness of the pavement layer. Roads built according to traffic requirements have optimal service performance during the service life.

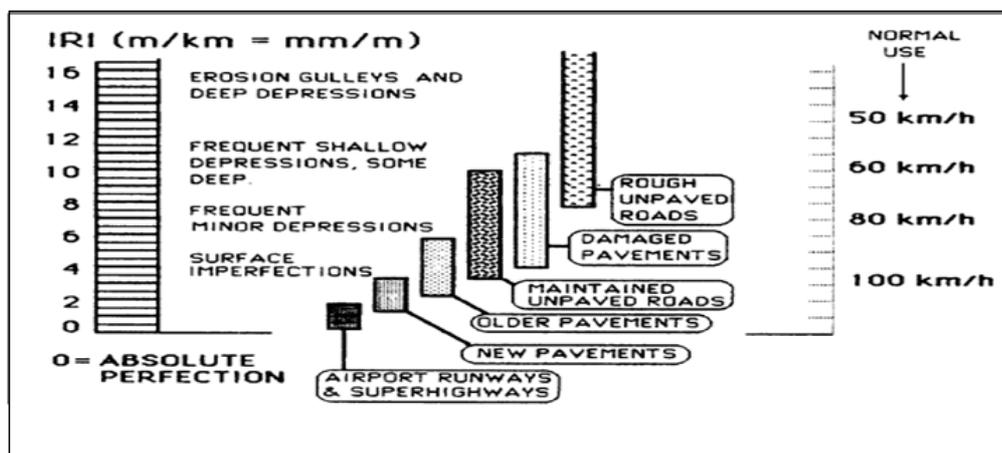


Figure 1: Value of IRI for Various Pavement Conditions and Normal Speeds [26]

### Road Maintenance

According to Minister of Public Works Regulation Number: 13 / PRT / M / 2011, road maintenance is a road handling activity, in the form of prevention, maintenance, and repairs needed to maintain road conditions in order to function optimally to serve traffic so that the planned age is achieved. [17][18]

Generally, maintenance work is an activity to maintain the condition of a decent road service capability, so that it can provide comfort and safety for drivers [15].

So that it can be concluded that the purpose of road maintenance is to maintain a steady road condition in accordance with the level of service and capabilities when the road is completed and operated until the planned age is reached. Handling road maintenance can be done regularly or periodically. Road maintenance is routinely carried out continuously throughout the year and is carried out as soon as possible when the damage has not been widespread. Care and repairs carried out at the stage of damage are still mild and local. This is done in connection with the relatively low repair costs and how to fix it is relatively easy/light. The relationship between condition, age, and type of road handling can be seen in Figure-2.

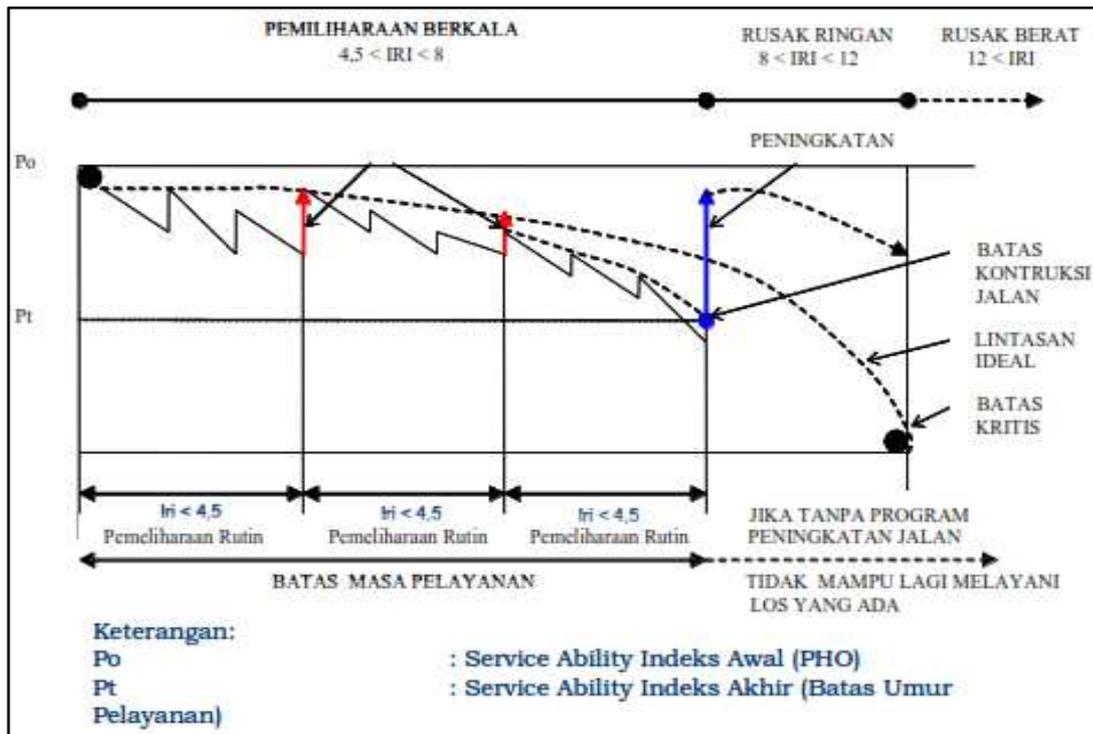


Figure 2: Relationship Between Condition, Age and Types of Road Handling [21]

### Types of Road Maintenance Handling

Based on Minister of Public Works Regulation Number: 13 / PRT / M / 2011 concerning Procedures for Road Maintenance and Surveillance, there are 4 types of road maintenance handling, namely:

#### Routine Maintenance

Routine maintenance is the activity of caring for and repairing damages that occur on road segments with steady service condition.

#### Periodic Maintenance

Periodic maintenance is more extensive prevention of damage prevention activities and any damage calculated in the design so that a decrease in road conditions can be returned to the condition of conformity in accordance with the plan.

#### Road Rehabilitation

Road rehabilitation is the activity of handling prevention of extensive damage and any damage that is not taken into account in the design, which results in a decrease in the condition of stability in certain parts of a road with mild

damage so that the condition of stability can be restored to the condition according to plan.

### Reconstruction

Reconstruction is an increase in the structure which is a handling activity to be able to increase the ability of parts of the road that is in a state of severe damage so that the part of the road has a steady condition again according to the age of the plan set [17][18].

Based on Minister of Public Works Regulation Number: 13 / PRT / M / 2011 concerning Procedures for Road Maintenance and Surveillance, the determination of the program for handling the maintenance of asphalt/cement concrete roads can be seen in table-1 as follows:

**Table 1: Determination of Road Maintenance Program for Asphalt / Concrete Cement Concrete Covering**

Road Conditions	Damage Limitation Percentage (Percentage of Surface Surface Pavement Area)	Handling Program
Good	< 6 %	Routine Maintenance
Medium	6 - < 11 %	Regular / Periodic Maintenance
Lightly damaged	11 - < 15 %	Rehabilitation Maintenance
Severe damaged	15 > %	Structure Reconstruction / Improvement

Source:[17][18]

### Integrated Road Management System (IRMS)

The Integrated Road Management System (IRMS) is a computer application program used in Indonesia as a tool in monitoring road conditions for use in planning road maintenance programs. [5] [14][33][34]

In an effort to perfect the IRMS application, an IRMS application was created that provides applications to provide input to decision makers. Available applications include:

- Data Input System (SMD)
- Sectioning data
- Network Analysis Module (NAM)
- Strategic Expenditure Planning Module (SEPM)
- Programming Module
- Budgeting Module
- Construction Implementation Module (CIM)
- Monitoring and Review Module (MRM)
- Economic Review Module (ERM)
- Analysis Module Statistics (SAM)
- Enhanced Highway Information Module (EHIM)
- Bridge Management System (BMS)

## RESEARCH METHOD

### Research Locations

The location of this study was carried out on section (016) Tompe-Pantoloan along 64.44 Km from KM 24 + 560 to Km. 89 + 000.

**Table 2: Research Locations**

No. Street	Name of Street	Length	Wide	Surface Type	Road Type
		(KM)	(M)		
16	Tompe - Pantoloan (Bts. Kota Palu)	64,440	6.00	Flexible	2/2 UD

Source:[24][25]

### Type and Source of Data

In this study using primary data and secondary data obtained from the National Roads Planning and Supervision Planning Agency Central Sulawesi Province. The types of data used in this study can be seen in the table as follows:

**Table 3: Data Inputing IRMS**

Type of Data	Source of Data
Traffic Data	Field Survey
Reference Point Data (DRP)	Satker P2JN Prov. Sulteng
Road Inventory Data (RNI)	Satker P2JN Prov. Sulteng
Road Roughness Data (International Roughness Index, IRI)	Satker P2JN Prov. Sulteng
Road Condition Data (RCS)	Satker P2JN Prov. Sulteng
Unit Price Data	Direktorat Jenderal Bina Marga

### Data Analysis Technique

In this study the data analysis technique is carried out to produce predictions of IRI using an IRMS application, then the determination of road handling and allocation is needed.

The steps in using the Integrated Road Management System (IRMS) application are as follows:

#### A Process of Inputing Data to IRMS

Data input system (data input) is the result of a survey that has been conducted which consists of:

- Link Description
- Data Reference Point (DRP)
- Road Network Inventory (RNI)
- International Roughness Index (IRI)
- Road Condition Survey (RCS)
- Traffic [33][34]

### **IRI Prediction Analysis**

After the process of inputting data into the IRMS software program, sectioning data is then performed. This data section aims to group road segments with similar characteristics according to the matrix criteria of road segment groups, namely:

- Wide pavement
- International Roughness Index (IRI)
- Surface Distress Index (SDI)
- Average Annual Daily Traffic (AADT)

After a NAM analysis, the prediction of IRI value data will be obtained which will be used to determine the handling of the road and the budget needed in accordance with the treatment of the road.

### **Determination of Types of Road Maintenance Handling**

Maintenance based on the assessment of IRI prediction conditions resulting from IRMS application output. The assessment of road pavement conditions according to the Directorate General of Highways (2016) is divided into the following:

- Good condition with IRI value <4;
- Moderate conditions with IRI values 4-8;
- Lightly damaged conditions with IRI values 8-12;
- Severe Damaged Conditions with IRI values > 12.

Based on these functional conditions, it can be determined the type of maintenance handling on the road sections which are the location of the study in accordance with Minister of Public Works Regulation Number: 13 / PRT / M / 2011 concerning Procedures for Road Maintenance and Surveillance, cement concrete. The maintenance program is as follows:

- Routine Maintenance for Good Conditions;
- Routine Maintenance of Conditions for Moderate Conditions;
- Maintenance of minor rehabilitation for mildly damaged conditions with IRI values 8-10;
- Maintenance of major rehabilitation for mildly damaged conditions with IRI values 10-12;
- Increased Reconstruction for Severely Damaged Conditions.

### **Calculation of Road Maintenance Handling Costs**

Unit price data is obtained from secondary data. After obtaining maintenance handling proposals and by referring to the 2017 Fiscal Year Road Preservation Program Instructions Letter (attachment 13) initial unit price instructions for road preservation cost estimates issued by Director of Road Preservation, the road maintenance handling costs will be obtained for the three locations that are locations research. The unit price to be used can be seen in the table-4 as follows:

**Table 4: Road Handling Unit Price Data**

Type of Handling	Small Road (Million)	Medium Road (Million)	Highways (one Direction) (Million)
EWP Routine Maintenance	25	35	35
Non -EWP Routine Maintenance	35	50	50
Condition Routine Maintenance	75	100	100
Preventive Maintenance	350	500	750
Minor rehabilitation	1500	2500	3000
Major rehabilitation	3000	4000	5000

Source : [4][5][6][7]

Determination of the classification of highways/medium/small roads based on the amount of traffic that refers to Permen PU No. 19 / PRT / M / 2011, the unit price used in this study is a medium road classification. [17][18]

## RESULT AND DISCUSSION

### RESULT

#### IRI Data Survey Results for Semester 1 of 2017

After the IRI Semester, 1 survey in 2017, data on road conditions per 100 meters were obtained. The recapitulation of road conditions for the road conditions at the research sites such as table-5 are as follows:

**Table 5: IRI Conditions for Semester 1 of 2017**

No. Street	Name of Street	Lenght(KM)	Road Conditions			
			Good (KM)	Moderate (KM)	Lightly Damaged (KM)	Severe Damaged (KM)
16	TOMPE - PANTOLOAN (BTS. KOTA PALU)	64,44	36,80	27,04	0,50	0,10

Source : [24][25]

#### Prediction of IRI Value

In the analysis of the prediction of IRI values in the study using the Integrated Road Management System (IRMS) program. The IRI value will be predicted for the next 5 years starting in 2018 until 2022, using IRI value data in 2017 semester 1.

The prediction of the IRI value is obtained from the IRMS Network Analysis Module (NAM) program. The output of NAM can be seen as table 5. After the IRI value prediction is obtained, a prediction of the IRI value will be carried out for the next 5 years for each of these road segments.

The value of IRI conditions increases every year, so the analysis is needed to determine the conditions in order to determine the type of treatment to be carried out. The results of predictions for the next 5 (five) years can be seen in the table as follows:

**Table 6: Prediction of IRI 2018 - 2022 Tompe – Pantoloan Section**

No Street	Name of Street	Segment	KM - M	Lenght	IRI					
					2017	2018	2019	2020	2021	2022
016	TOMPE - PANTOLOAN (BTS. KOTA PALU)			64.44						
		1	0 – 90	0.9	3.1	3.3	3.6	3.8	4.1	4.4
		2	90 - 210	1.2	3.7	4.0	4.2	4.5	4.8	5.2
		3	210 - 300	0.9	3.3	3.5	3.7	4.0	4.2	4.5
		4	300 - 430	1.3	4.3	4.6	4.8	5.2	5.5	5.9
		5	430 - 570	1.4	3.1	3.3	3.5	3.8	4.0	4.3

Based on Table-6, can be seen in the Tompe - Pantoloan Section the smallest IRI value in segment 1 along 0.9 Km, namely 2017 = 3.1, then increasing in 2018 = 3.3, Year 2019 = 3.6, 2020 = 3.8, Year 2021 = 4.1 and Year 2022 = 4.4. Whereas the biggest IRI occurs in segment 4 with a segment length of 1.3 Km with an IRI value of 2017 = 4.3, then increasing in 2018 = 4.6, Year 2019 = 4.8, Year 2020 = 5.2, Year 2021 = 5.5 and Year 2022 = 5.9.

### Analysis of Handling Maintenance and Calculation of Budgets

Analysis of Handling maintenance for the next 5 (five) years begins in 2018 to 2022 in the section that is the location of this study. In this handling analysis, based on the IRI value of each segment the output of the IRMS program. The condition assessment is divided into the following:

- Good condition with IRI value <4;
- Moderate conditions with IRI values 4-8;
- Conditions of minor damage with IRI values 8-12;
- Conditions of severe damage with IRI values > 12.

Based on these functional conditions [4][5][6][7], it can be determined the type of maintenance handling on the road segments that are the location of the study. The maintenance program according to the Directorate General of Highways (2016) is as follows:

- Routine maintenance for good conditions;
- Routine Condition maintenance conditions for moderate conditions;
- Maintenance of minor rehabilitation for mildly damaged conditions with an IRI value of 8-10;
- Maintenance of major rehabilitation for mildly damaged conditions with IRI values 10-12;
- Improved reconstruction for severely damaged conditions.

So that the proposed maintenance program for the next 5 (five) years based on the results of the analysis can be seen in the table-7, as follows:

**Table 7: Handling Road Maintenance**

No Street	Name of Street	Lenght (Km)	Type of Handling	Lenght (Km)				
				2018	2019	2020	2021	2022
016	TOMPE - PANTOLOAN (BTS. KOTA PALU)	64.44	Routine	32.10	26.10	23.60	13.30	7.50
			Routine Condition	32.34	38.34	39.14	47.94	51.04
			Minor Rehab	-	-	1.70	3.20	5.90
			Major Rehab	-	-	-	-	-
			Reconstruction	-	-	-	-	-

After obtaining unit prices for 2018 to 2022, as in table-10, handling costs can be calculated based on the type of handling as in the following table:

**Table 10: Cost of Handling Road Maintenance Costs**

No Street	Name of Street	Lenght (Km)	Type of Handling	Cost of Handling (Rp. )				
				2018	2019	2020	2021	2022
016	TOMPE - PANTOLOAN (BTS. KOTA PALU)	64,44	Routine	1.687.000	1.439.000	1.361.000	800.000	469.000
			Routine Condition	3.400.000	4.228.000	4.515.000	5.770.000	6.392.000
			Minor Rehab	-	-	4.903.000	9.629.000	18.473.000
			Major Rehab	-	-	-	-	-
			<b>TOTAL</b>	<b>5.087.000</b>	<b>5.667.000</b>	<b>10.779.000</b>	<b>16.199.000</b>	<b>25.334.000</b>
				<b>63.066.000</b>				

## DISCUSSIONS

Based on the results of the research and discussion that has been conducted, the following conclusions are obtained:

- The results of the analysis of prediction conditions for IRI application output for the Tompe-Pantoloan Section is good, moderate and lightly damaged during the 5 years of analysis.
- The maintenance handling is recommended for 5 years of analysis for Tompe - Pantoloan segment includes routine maintenance of conditions and minor rehabilitation.
- Total costs in accordance with the recommendation for handling maintenance starting from 2018 to 2022 on the Tompe-Pantoloan Road section of Rp. 63,066,000,000.

## SUGGESTION

The suggestions submitted for further research are:

- Further research is needed to analyze the conditions and types of road handling by adding Falling Weight Deflect (FWD) data/deflection data;
- The application used to predict IRI until 2022 will be more accurate if the traffic growth is adjusted to the conditions of reality from observations in the field.

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