Novelty Journals

ISSN 2394-7357

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 11, Issue 2, pp: (7-21), Month: May - August 2024, Available at: www.noveltyjournals.com

Road Management Program Priority Determination at Area I of Malang Road and Bridge Management Technical Implementation Unit, Public Works and Highways Department of East Java Province, Indonesia

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DOI: https://doi.org/10.5281/zenodo.12804847

Published Date: 24-July-2024

Abstract: **A firm and stable road surface will ensure the smoothness implementation land transportation in the effort to support economic activities. To have stable road condition, it requires an efficient road management program through agencies which appointed by government as the road organizer with efforts to maintain the road quality that also require significant fund. Process of budgeting fund for road implementation are carried out through several stages, starting from the proposal process, discussion process and budget determination process. The process of determining priority for the proposal requires ample time for long discussion. The East Java Provincial Government through its Public Works and Highways Department (*Dinas Pekerjaan Umum Bina Marga*) has an important role in the process of road management system for provincial road sections which under its authority. Budget limitation as seen from the regular local government budget (APBD) and from other source of fund create challenges for road operators in selecting the most effective and optimal road management program.**

According to previous research, determination of priority in road management program can be done by employing criteria analysis and hierarchy process analysis, with priority determination criteria for this research were composed from technical criteria's (existing traffic condition, road stability condition, volume capacity ratio, vehicle travel speed and vehicle travel time), financial and economic criteria's (benefit cost ratio, NPV, IRR, BOK, Time Value).

This research will determine of how policy for determining the priority of road management program can be chosen optimally to get the priority order of the road management program. The priority order of the road management program which has been selected and determined are able to be used as input for the East Java Provincial Government through its Public Works and Highways Department to maximize the existing funds to obtain an optimal result of their road management program.

Keywords: **Malang, East Java, Bridge Management, Road Management, Selection or Determination of Road Management.**

I. INTRODUCTION

Transportation is one support system in regional development. In terms of transportation, road play's important role in creating a smooth transportation in land. In general, road has function to support smooth movement of people and goods. A firm and steady road condition will decide the level of smoothness implementation of land transportation for supporting the economic activities. To achieve the state of stable road condition, a good road management program is needed, and

there is a road handling activity known as the Pavement Management System (PMS) which generally consist of data collection; data analysis; evaluation and selection of treatment alternatives; as well as road management budgeting that available to be employed. The result from PMS activity will be used by decision makers to determine steps needed to maintain the road in a good or stable condition.

East Java Provincial Government has the authority in provincial roads maintenance which include authority in the regulation, guidance, construction and supervision of provincial roads as in accordance with the circular letter from Ministry of Public Works and Public Housing Number 12/SE/Db/2017 about Technical Instruction for Preparing Priority Programs for Road Development and Ministry of Public Works and Public Housing (2023). Also from circular letter Number 21/SE/Db/2023 about Guidelines for Indonesian Road Capacity, the Directorate General of Highways, Public Works and Highways Department, East Java Province which has the authority to administer the provincial roads along East Java that stretches for 1,671.57 km, in accordance with the East Java Governor Decree Number 188/210/KPTS/031/2023 issued on 11 May 2023 about Road Sections Determination according to Their Status as Provincial Roads that located in 28 regencies and 6 cities in East Java. Total length of the provincial road is divided into 196 road sections in East Java Regencies and 35 road sections in East Java cities which then be managed by 11 Technical Implementation Units for Road and Bridge Management.

Due to fund limits, the Public Works and Highways Department of East Java Province as the road organizer must have an optimal road management plan to achieve target of road stability. From several proposals, the writer will examine which programs should be the priority for treatment under limited funding condition.

The GAP research of this study. In several previous studies, researches have been carried out regarding road management priorities, such as from research conducted by Wignyajaya, 2005 that identifies the road network criteria that considered into decision making, as well as optimizing priorities and programs for managing the road network system in East Java province. In support, Londo (2008) also conducted research that analyzed the priority determination model using the Bayes method with criteria consisting of: PCI; road function classification; LHR; and the number of people served. Furthermore, research conducted by Ignasius *et al.* (2024) analyzed the criteria for determining alternative district road development using cut-off method and continued with AHP method to obtain criteria of weight values. Irawan *et al.* (2016) also held an analysis by AHP method to obtain criteria for determining the criteria for determination of priority scale determination to regency roads management. However, from several previous studies, these researches did not include a thorough and detail discussion regarding the data processing. Therefore, this research was conducted as a continuation and intensifies the existing researches, so that, this research is positioning to raise a title of "Road Management Priority Determination at Area I of Malang Road and Bridge Management Technical Implementation Unit, Public Works and Highways of East Java Province".

So far, discussions related to road management priority determination at Area I of Malang Road and Bridge Management Technical Implementation Unit, Public Works and Highways of East Java Province have not been carried out by many researchers, therefore, the writer raise the research problems of: (1) is there any change in the road work performance within the regional area of Malang Road and Bridge Management Technical Implementation Unit of Public Works and Highways Department of East Java Province, in before and after the implementation of 2021 road management program package after the analysis?, and (2) What is the order of priority level for road management on the road sections as proposed in the road management program package in the Malang Road and Bridge Management Technical Implementation Unit as included in 2024 road management activity program package?

II. LITERATURE REVIEW

This section presents theories which will support the problem solving where these theories are cited from results of previous researches, opinions of several experts as well as other references related to this study.

2.1 Previous Researches on Priority of Road Management

From Wignyajaya's (2005) research entitled "Determination of Priority for Handling Road Network System" has research focus on identifying road network criteria which need to be considered in decision making, also optimizing priorities and program for handling the road network system in East Java Province. Criteria that put into consideration are: a) weight condition criteria (35.07%), b) weight traffic criteria (22.03%), c) weight hierarchy criteria (19.64%), d) weight regional

criteria (12.09%), and e) weight mode criteria (11.17%). Whereas for optimizing program priority based on weighting is the road management through improvement activity (38, 87%), road management through maintenance activity (35.48%) and road management through construction/development activity (26.26%).

Meanwhile, Londo's (2008) research entitled "Pavement Condition Index as an Approach to Determine Road Maintenance Priority" has research focus in analyzing priority determination model using the Bayes method with criteria consisting of: PCI; classification of road function; LHR; and the amount of people that must be served. Research result showed 7.56% of regency/district roads in Sangihe Island must be handled by rehabilitation, 46.71 % must be handled by periodic maintenance and 45.73% must be handled by routine maintenance.

Research by Ignasius *et al.* (2014) entitled "A Study on Determining Road Network Development Priority" has research focus in analysis of criteria for alternative determination of regency/district road development using the cut-off method and continued with AHP method to obtain criteria weight values This research resulted in usable criteria's and weights include road surface condition (18%), road surface type (12%), accessibility (12 %), mobility (12 %), regional disparity (16%), poverty rate (6 %), and finance (24 %).

Research by Irawan *et al.* (2016) entitled "Priority Scale Determination for Road Management" has research focus on analysis using AHP method to obtain criteria for determining the priority scale in handling the regency/district roads. The result of this research is priority determination criteria consisted of: road damage (45.06%), mobility (20.62%), traffic volume (14.53%), accessibility level (12.78%), and regional development (7.01 %). In line with this research, Ahmed *et al.* (2017) comparing two methods (AHP and RCI) for obtaining priority orders for road management, where priority was determined by type of road damage such as patches, potholes, raveling, cracking and rutting, also from the type of roads consisting of major road and expressway.

Research by Sushera *et al.* (2018) entitled "Analysis of Road Maintenance Priority in Karanganyar Regency by Analytical Hierarchy Process (AHP) Method" has research focus on AHP method as a determinant of the priority order for road maintenance in Karanganyar Regency with employed criteria's in this research were road condition, daily traffic (*Lalu Lintas Harian*/LHR), road width, handling costs and land use function.

Based on result of previous studies, there are so many criteria variables used by researchers in determining road treatment priority, and from these various criteria's, it can be concluded that the appropriate criteria for determining road treatment priority can be categorized into two general criteria: (a) road work performance and (b) economic feasibility in that road treatment project. In complementing the previous researches, criteria of road work performance and economic feasibility used in determining the road management priority in this research are: (1) road work performance includes: LHR, road stability condition, volume capacity ratio, travel speed, travel time, (2) economic feasibility in the Road management program package consisted of benefit cost ratio, NPV, IRR, BOK, and time value. Next, from the mentioned criteria, the weight will be decided to determine the priority of road management by employing the Analysis Hierarchy Process (AHP) method.

III. RESEARCH METHOD

3.1 Data Collection

Method of data collection in this research was carried out by using two types of method; primary and secondary methods. The primary method according to Sugiyono in Herawati (2022) was the collected and processed data were tabulated by the researchers themselves directly from research subject or object, while the secondary method according to Murizal *et al.* (2022), data was collected through an intermediary (indirect party) which obtained these data from the existing source. In this research, the primary data was obtained from a survey method with topic of condition from the existing roads on all sections which proposed inside the road management program package of Malang Road and Bridge Management Technical Implementation Unit, Department of Public Works and Highways, East Java Province for 2023 fiscal year. Whereas the secondary data was using several sources of: (1) data of the proposed price on road management program package that stated on the Road management Program Package belongs to Malang Road and Bridge Management Technical Implementation Unit, Department of Public Works and Highways, East Java Province in 2023; (2) data on proposed price for Road management program package which included the LHR data from 2020 to 2022 period; and (3) data on

surrounding population related to road management program package from Malang Road and Bridge Management Technical Implementation Unit in 2023.

3.2 Assessment of Road Work performance

The assessment of road work performance was carried out on road sections which include within area under the authority of Malang Road and Bridge Management Technical Implementation Unit. This assessment has a purpose to measure technical criteria which later be quantified into scores for determining road management priority. The technical criteria which will be measured are all matters in technical aspects included in the design of road management activities such as:

3.2.1 Average of daily traffic (*Lalu Lintas Rarian*/LHR)

The average daily traffic (LHR) is one of secondary data obtained from the Public Works and Highways Department, East Java Province, and from the proposed four sections included in the road management program package, all of the LHR data were taken from 2020 to 2022. Next, LHR data will be analyzed for its trend by using simple regression calculation so that prediction or estimation of the addition or any change in vehicle volume per day in a certain year can be determined, or time when the project plan will finish in each section is able to be found.

3.2.2 Road stability condition

In this method, road stability condition assessed by combining values obtained from visual survey to observe the type of damage also from LHR data which later will gain road condition value and LHR class value. The priority order is obtained by the following equation:

$$Priority\ Order: = 17 - (LHR\ class + Road\ Condition\ Value) \quad (1)$$

3.2.3 Volume capacity ratio

Volume Capacity Ratio or VCR is a comparison between the passing volume (SMP) to the capacity on a particular road section (SMP). Amount of traffic volume is obtained based on collected LHR data whereas the capacity value is obtained from the road environment and geometric survey consisted of cross sections, intersections, horizontal alignment and vertical alignment. Next, calculation for volume capacity ratio is made based on the model developed into an equation below:

$$VCR = V / C \quad (2)$$

Descriptions:

VCR : Volume Capacity Ratio (value of service level)

V : Volume of Traffic (smp/hour)

C : Road capacity (smp/hour)

3.3 Assessment of Economic Feasibility

Assessment of economic feasibility of the road management program is taken from existing condition and *do something* condition. While Benefit Cost Ratio or BCR assessment is calculated for each package of road management program that has been proposed in 2023 by Malang Road and Bridge Management Technical Implementation Unit of Public Works and Highways Department, East Java Province. The economic feasibility criteria mentioned in this research is the Benefit and Cost Ratio (BCR) calculated for each work package by considering time value, NPV, IRR and BOK values.

3.4 The Priority Determination in the Road Management Program

To determine the priority order of the road management program, it requires an analysis of criteria which will be used as assessment parameters. The criteria analysis referred in here is analyzing technical criteria and economic criteria. The technical criteria cover an assessment of road work performance in existing condition on each road section (before the road management program package) and road condition after the road management program was implemented. Whereas the economic criteria are an assessment of economic feasibility of the road management program package (Benefit Cost Ratio Analysis). These criteria were put into analysis for each road section that being proposed in the road management program package for area under the authority of Malang Road and Bridge Management Technical Implementation Unit for 2023.

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Furthermore, when the analysis for all criteria have been completed, then each road management program package and its criteria will be put into next analysis by using Hierarchical Analysis Process (AHP) method to obtain the priority order for road management according to the score obtained for each road section.

IV. RESULT AND DISCUSSION

4.1 The Priority Determination of the Road Management Program

Selecting the priority for road management program in this research was using a multi-criteria analysis method to determine the priority for road management program in area of UPT PJJ Malang stated in the maintenance development plan. The analysis was carried out using a simple matrix with predetermined criteria and a certain assessment system that will produce values or weights which later be used as the basis for selecting priorities for handling the road maintenance.

To determine priority choice for handling the maintenance of road widening in Malang PJJ UPT area, there are several considerations that must be taken into account. Then, these considerations will be used as criteria and sub-criteria for each link assessment until the selected treatment priority for the road widening maintenance construction is obtained. The assessment criteria and sub-criteria are presented in table 1.

Table 1. Criteria and Sub-Criteria of The Assessment of Road Widening Maintenance Construction

No	Criteria	Sub-Criteria
1	Technical Factors	LHR Data
		Road Condition
		Degree of Saturation
		Travel Time
		Travel Speed
2	Economic Factors	Vehicle Operational Cost or *Biaya Operasional Kendaraan* (BOK)
		Time Value
		Benefit Cost Ratio (BCR)
		Net Present Value (NPV)

The following section is explanation about each criterion and sub-criteria listed in the table 1.

1. Technical Factor

- LHR Data. The Average Daily Traffic (LHR) data is very important data when assessing the road condition. If the traffic is large or exceeding the existing road capacity, it will result in unfavorable road condition where easy or prone to damage faster than the initial planning condition.
- Road Condition. In the UPT PJJ Malang area, unfavorable road condition is caused by several factors which one of the causes is the construction project of Malang airport that requires large vehicles to transport the ground fill material along with other materials for the Malang airport construction, so road condition that initially designed for not heavy vehicles usage then are passed by heavy vehicles resulting the road underwent quite severe damage.
- Degree of Saturation. Degree of Saturation is obtained from road capacity volume divided by the vehicles volume. In the UPT PKK Malang area, the average degree of saturation has value of more than 1, so it can be concluded that this road section experiences vehicle buildup resulted in traffic jams.
- Travel Time. Travel time is obtained from the road length multiplied by travel speed with result in the form of travel time of a vehicle, so it will be obtained travel time for a light vehicle.
- Travel Speed. Travel speed is obtained from several types of vehicles such as motorbike, light vehicle, bus and truck. Travel speed also depends on the degree of saturation, in which the higher the degree of saturation the longer the travel speed can be obtained.

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ISSN 2394-7357

International Journal of Novel Research in Civil Structural and Earth Sciences
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2. Economic Factor

- Vehicle Operational Cost or *Biaya Operasional Kendaraan* (BOK). When the road is in bad condition, this situation able to increase the vehicle operational cost because BOK also listing the necessity of tires that can be damaged when the vehicle drive on damage roads. So, when the road is in good condition, the BOK cost will be smaller or decrease.

- Time Value. Time value is the wasted time when transporting, plays as part of transportation economic analysis. This value increases along with the increasing or longer travel time.

- Benefit Cost Ratio. Benefit Cost Ratio (BCR) is an analysis of project selection which mostly conducted since the steps are so simple to do, by making a comparison between the benefit and the cost. If the value < 1 then the project has no economic value, and if > 1 then the project is feasible to be accepted.

- Net Present Value. Net Present Value is said as the difference found between current value of the cash inflow and cash outflow over a certain period of time. The capital budgeting and investment planning are using NPV as a method for determining profit or predicting the profitability of a project.

4.2 Analysis of Each Condition from Each Alternative

From the explanation about several criteria for assessment of road widening maintenance construction, an analysis is necessary to conduct to observe the condition of each alternative to be able to held an assessment with predetermined criteria for the alternative number 1,2, 3 and 4. The following table will explain the condition for each alternative which presented in table 2 until table 5.

Table 2. Data of Alternative Number 1

No	Criteria	Code	Description
1	**Technical Factors**		
	LHR Data	A	3.189
	Road Condition	B	20,82%
	Degree of Saturation	C	0,363
	Travel Time	D	1,731
	Travel Speed	E	3,890
2	**Economic Factors**		
	BOK	F	Rp5.218.901.000
	Time Value	G	Rp6.866.775.638
	BCR	H	0,74
	NPV	I	-Rp3.991.273.970

Table 3. Data of Alternative Number 2

No	Criteria	Code	Description
1	**Technical Factors**		
	LHR Data	A	3.190
	Road Condition	B	27,12%
	Degree of Saturation	C	0,346
	Travel Time	D	3,661
	Travel Speed	E	3,409
2	**Economic Factors**		
	BOK	F	Rp8.662.656.168
	Time Value	G	Rp4.403.916.943
	BCR	H	0,60
	NPV	I	-Rp8.382.143.904

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Table 4. Data of Alternative Number 3

No	Criteria	Code	Description
1	**Technical Factors**		
	LHR Data	A	1.967
	Road Condition	B	19,61%
	Degree of Saturation	C	0,213
	Travel Time	D	5,127
	Travel Speed	E	3,274
2	**Economic Factors**		
	BOK	F	Rp8.773.702.311
	Time Value	G	Rp10.499.363.483
	BCR	H	1,48
	NPV	I	Rp5.953.000.881

Table 5. Data of Alternative Number 4

No	Criteria	Code	Description
1	**Technical Factors**		
	LHR Data	A	2.388
	Road Condition	B	12,57%
	Degree of Saturation	C	0,259
	Travel Time	D	5,734
	Travel Speed	E	4,009
2	**Economic Factors**		
	BOK	F	Rp9.937.254.098
	Time Value	G	Rp18.552.319.747
	BCR	H	4,11
	NPV	I	Rp20.529.527.782

4.3 Determination of Numerical Scale

A numerical scale in this research was employed to compare each assessment parameter for producing a certain parameter that considered more important than the other parameters. In this study, a numerical scale ranging from 1 – 9 was used with explanation stated in the previous sub-chapter and in determining the comparative numerical scale to select which criteria is more important than others, a survey was conducted on 28 respondents within the Department of Public Works and Highways Department of East Java Province. Whereas the question items in the survey are listed as follow:

1. To what extent does the average daily traffic or LHR condition factor will affect the priority determination in provincial road management (in a scale from 1 – 5)?

2. To what extent does the road damage condition factor will affect the priority determination in the provincial road management (in a scale from 1 – 5)?

3. To what extent does the Volume per Capacity Ratio (VCR) factor or the Degree of Saturation (DS) factor will affect the priority determination in the provincial road management (in a scale from 1 – 5)?

4. To what extent does Vehicle Travel Time on One Road Section will affect the priority determination in the Provincial Road Management (in a scale from 1 – 5)?

5. To what extent does Vehicle Travel Speed on a road section will affect the priority determination in the Provincial Road management (in a scale from 1 – 5)?

6. To what extent does Vehicle Operational Cost or *Biaya Operasional Kendaraan* (BOK) will affect the priority determination in provincial road management (in a scale from 1 – 5)?

7. To what extent does the Benefit Cost Ratio (BCR) factor will affect the priority determination of provincial road management (in a scale from 1 – 5)?

8. To what extent does the Net Present Value (NPV) condition will affect the priority determination of provincial road management (in a scale from 1 – 5)?

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From the procedure above, the result assessment of which criteria that has a greater influence on the priority on the provincial road management will be found, and the total points as survey result were obtained and presented in the following table.

Table 6. Total Points of Each Criteria as Survey Result on Level of Importance in Priority Determination for Provincial Road Management Program

Criteria	Total Points
A	120
B	132
C	114
D	100
E	102
F	93
G	78
H	71

Total points of each criterion then will be compared with the difference found between one criterion to another. This difference will determine how many points belongs to the Importance Intensity value that will be put into the pairwise comparison matrix in an assessment as shown in the following table.

Table 7. Determination of Interest Intensity Value

Difference Value	Importance Intensity Value
0	1
0-8	2
8 - 16	3
16 - 24	4
24-32	5
32 - 40	6
40 - 48	7
48 - 56	8
56 - 64	9

4.4 Determination of Criterias

Determining criteria to be put into the pairwise comparison matrix is done by assessing the level of importance from a criterion that compared to other criteria. The pairwise comparison matrix is presented in the following table.

Table 8. Matriks Pairwise Comparison

Criteria	A	B	C	D	E	F	G	H	I
A	1,00	0,33	2,00	4,00	4,00	5,00	5,00	7,00	8,00
B	3,00	1,00	4,00	5,00	5,00	6,00	6,00	8,00	9,00
C	0,50	0,25	1,00	3,00	3,00	4,00	4,00	6,00	7,00
D	0,25	0,20	0,33	1,00	0,50	2,00	2,00	4,00	5,00
E	0,25	0,20	0,33	2,00	1,00	3,00	3,00	4,00	5,00
F	0,20	0,17	0,25	0,50	0,33	1,00	2,00	3,00	4,00
G	0,20	0,17	0,25	0,50	0,33	0,50	1,00	3,00	4,00
H	0,14	0,13	0,17	0,25	0,25	0,33	0,33	1,00	2,00
I	0,13	0,11	0,14	0,20	0,20	0,25	0,25	0,50	1,00

Description:

A = LHR Data

B = Road Condition

C = Degree of Saturation

D = Travel Time

E = Travel Speed

F = Vehicle Operational Cost or *Biaya Operasional Kendaraan* (BOK)

G = Time Value (VOT)

H = Benefit Cost Ratio (BCR)

I = Net Present Value (NPV)

Data interpretation of Table 8 is stated as below:

- (A, A) has value of 1: The row A parameter (LHR data) is considered to have an "*equally important value*" when compared to column A parameter (LHR data).
- (A, B) has value of 0,33: The row A parameter (LHR data) is considered to have a "*relatively more important value*" when compared to column B parameter (road condition).
- (A, C) has value of 2: The row A parameter (LHR data) is considered to have a "*relatively more important value*" when compared to column C parameter (Degree of Saturation).
- (A, D) has value of 4: The row A parameter (LHR data) is considered to have a "*relatively more important value*" when compared to column D parameter (Travel Time).
- (A, E) has value of 4: The row A parameter (LHR data) is considered to have a "*more important value*" when compared to column E parameter (Travel Speed).
- (A, F) has value of 5: The row A parameter (LHR data) is considered to have a "*relatively not more important value*" when compared to column F parameter (Vehicle Operational Cost/BOK).
- (A, G) has value of 5: The row A parameter (LHR data) is considered to have a "*relatively not more important value*" when compared to column G parameter (Time Value).
- (A, H) has value of 7: The row A parameter (LHR data) is considered to have a "*relatively not more important value*" when compared to column H parameter (Benefit Cost Ratio).
- (A, I) has value of 8: The row A parameter (LHR data) is considered to have a "*relatively not more important value*" when compared to column I parameter (Net Present Value).

For other column and row parameters can be interpreted with the same way as explained above.

4.5 The Weighting Calculation

Based on the Pairwise Comparison Matrix in Table 8, next step of this research was calculated the eigenvector value for each criterion which conducted by equation which has been explained in previous sub chapter with result from weighting and importance ranking for each criterion are presented in the following table.

Table 9. Eigenvector and Criteria Weighing

Criteria	*Eigenvector*	Weight	Rank of The Most Influential Criteria
A	2,909	0,215	2
B	4,514	0,334	1
C	2,089	0,154	3
D	0,956	0,071	5
E	1,220	0,090	4
F	0,685	0,051	6
G	0,587	0,043	7
H	0,326	0,024	8
I	0,238	0,018	9
∑	**11,987**	**1,000**	

Novelty Journals

ISSN 2394-7357

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 11, Issue 2, pp: (7-21), Month: May - August 2024, Available at: www.noveltyjournals.com

The following explanation will give an example of eigenvector and weighting calculation for A criteria (Treatment for road damage)

$$Eigenvector\ A = \sqrt[n]{a_{AA}\ x\ a_{AB} x\ a_{AC}\ x\ a_{AD}\ x\ a_{AE}\ x\ a_{AF}\ x\ a_{AG}\ x\ a_{AH}\ x\ a_{AI}}$$

$$= \sqrt[n]{1\ x\ 0{,}3\ x\ 2\ x\ 4\ x\ 4\ x\ 5\ x\ 5\ x\ 7\ x\ 8}$$

$$= 2{,}909$$

$$\text{Weight of Criteria A} = \frac{Eigenvector\ A}{\Sigma}$$

$$= \frac{2{,}909}{11{,}987}$$

$$= 0{,}215$$

$$= 21{,}5\%$$

According to result presented in Table 9, the first ranking is the B criteria as listed to be Road Damage Condition which becomes the most influential criteria in selecting the priority of road management.

4.6 Assessment Limit for Each Criteria

In determining the relative weight for each criterion, there is limitation applied to obtain limit values into low, medium and high category which are adjusted to conditions belong to each alternative. The assessment limits are explained in the following table.

Table 10. The Assessment Limitation to Relative Weight

No	Criteria	Limitation		
		Low	***Medium***	***High***
1	**Technical Factors**			
	LHR Data	<2000	2000-3000	>3000
	Road Condition	< 15%	15% - 20%	> 20%
	Degree of Saturation	< 0,260	0,260 - 0,314	> 0,314
	Travel Time	< 2,25	2,25 - 3,99	> 3,99
	Travel Speed	< 3,60	3,61 - 3,94	> 3,94
2	**Economic Factor**			
	BOK	< Rp. 4.350.000.000	Rp. 4.350.000.000 - Rp. 7.550.000.000	> Rp.7.550.000.000
	Time Value	< Rp. 10.350.000.000	Rp. 10.350.000.000 - Rp. 16.300.000.000	> Rp.16.300.000.000
	BCR	0 - 1,37	1,32 - 2,74	> 2,74
	NPV	0 - Rp. 15.800.000.000	Rp. 15.800.000.000 - Rp. 31.750.000.000	> Rp. 31.750.000.000

The following discussion is about description of the assessment limit for each criterion to get relative weight value as presented in Table 10.

4.6.1 Criteria of LHR data

Low = When LHR data has value < 2.000.

Medium = When LHR data has value between 2.000 - 3.000.

High = When LHR data has value > 3.000.

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From the assessment limit, it can be concluded if LHR data is categorized into low assessment, then it will be given smallest value of 1 because the less vehicle passing on road, the less road damage will occur and the budget spent on maintenance cost will be smaller.

Meanwhile, if the LHR data is categorized into high assessment, it will be given the smallest value of 3 because the more vehicles passing on roads, the greater possibility of road damage and the bigger budget spent for maintenance cost. For medium limit, in-between value (from 1 to 3) namely 2 will be taken.

4.6.2 Road condition criteria

Low = when road condition has value < 15%.

Medium = when road condition has value between 15% - 20%.

High = when road condition has value > 20%

From the assessment limit, it can be concluded if the road condition is categorized into low assessment, then it will be given smallest value of 1 because the less vehicle passing on the road, the less damage to the road.

Meanwhile, if the road condition is categorized into high assessment, it will be given the lowest score of 3 because the more damage that occurred, the greater the possibility of road damage. For the medium limit, in-between value (from 1 to 3) namely 2 will be taken.

4.6.3 Degree of saturation criteria

Low = when degree of saturation has value < 0,260.

Medium = when degree of saturation has value between 0,260 - 0,314.

High = when degree of saturation has value > 0,314.

From the assessment limit, it can be concluded if the degree of saturation is categorized into low assessment, then it will be given the smallest value of 1 because the less the degree of saturation, the less the probability of road congestion will occur.

Meanwhile, if the degree of saturation is categorized into high assessment, it will be given the smallest value of 3, because the greater the degree of saturation, the greater the possibility of traffic jams or road congestion. For the medium limit, in-between value (from 1 to 3) namely 2 will be taken.

4.6.4 Travel speed criteria

Low = when travel speed has value < 2,00.

Medium = when travel speed has value between 2,00 – 3,60.

High = when travel speed has value > 3,60.

From the assessment limit, it can be concluded if the travel speed is categorized into low assessment, then it will be given the smallest value of 1, because the less travel speed value, the faster the road will experience congestion.

Meanwhile, if the travel speed is categorized into high assessment, it will be given the smallest value of 3, because the greater the travel speed value, the less congested the road will be. For the medium limit, in-between value (from 1 to 3) namely 2 will be taken.

4.6.5 Travel time criteria

Low = when travel time has value < 3,60.

Medium = when travel time has value between 3,60 – 3,90.

High = when travel time has value > 3,90.

From the assessment limit, it can be concluded if the travel time is categorized into low assessment, then it will be given the smallest value of 1, because the less the travel time value, the less road congestion will occur.

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Meanwhile, if the travel time is categorized into high assessment, it will be given the smallest value of 3, because the greater the travel time value, the faster the road will experience congestion/traffic jam. For the medium limit, in-between value (from 1 to 3) namely 2 will be taken.

4.6.6 Vehicle operational cost or *Biaya Operasional Kendaraan* (BOK) criteria

Low = when BOK has value < Rp. 4.350.000.000.

Medium = when BOK has value between Rp. 4.350.000.000 – Rp. 7.550.000.000.

High = when BOK has value > Rp. 7.550.000.000.

From the assessment limit, it can be concluded if the Vehicle Operational Cost (BOK) is categorized into low assessment then it will be given the smallest value of 1 because the smaller the BOK value, the smaller the operational cost on the road.

Meanwhile, it the vehicle operational cost (BOK) is categorized into high assessment, it will be given the smallest value of 3 because the greater BOK value, the greater the operational cost on the road. For the medium limit, in-between value (from 1 to 3) namely 2 will be taken.

4.6.7 Time value criteria

Low = when time value has value < Rp. 10.350.000.000.

Medium = when time value has value between Rp. 10.350.000.000 – Rp. 16.300.000.000.

High = when time value has value > Rp. 16.300.000.000.

From the assessment limit, it can be concluded if the time value is categorized into low assessment, then it will be given smallest value of 1, because the less the time value, the less operations on the road.

Meanwhile, if the time value is categorized into high assessment, it will be given the smallest value of 3, because the greater the time value, the higher operations on the road occur. For the medium limit, in-between value (from 1 to 3) namely 2 will be taken.

4.6.8 Benefit Cost Ratio (BCR) criteria

Low = When BCR has value < 0 – 1,37.

Medium = When BCR has value between 1,37 – 2,74.

High = When BCR has value > 2,64.

From the assessment limit, it can be concluded if the BCR is categorized into the low assessment, it will be given the smallest value of 1, because if BCR value is less than 1, then it is not feasible to do.

Meanwhile, if the BCR is categorized into the high assessment, it will be given the smallest value of 3, because if the BCR has value more than 1 then it is feasible to do. For the medium limit, in-between value (from 1 to 3) namely 2 will be taken.

4.6.9 Net Present Value (NPV) criteria

Low = When NPV has value < 0 - Rp. 15.800.000.000.

Medium = When NPV has value between Rp. 15.800.000.000 – Rp. 31.750.000.000.

High = When NPV has value > Rp. 31.750.000.000.

From the assessment limit, it can be concluded if the NPV is categorized into low assessment, it will be given the smallest value of 1 because the NPV value is less than 1 so it is not feasible to do.

Meanwhile, if the NPV is categorized into high assessment, it will be given the smallest value of 3 because the NPV value is more than 1, so it is feasible to do. For the medium limit, in-between value (from 1 to 3) namely 2 will be taken.

According to assessment limit explanation above, the values for each criterion then presented in the following table.

Novelty Journals

ISSN 2394-7357

International Journal of Novel Research in Civil Structural and Earth Sciences
Vol. 11, Issue 2, pp: (7-21), Month: May - August 2024, Available at: www.noveltyjournals.com

Table 11. Value from Multi Criteria Analysis

No	Criteria	Limitation		
		Low	Medium	High
1	**Technical Factors**			
	LHR Data	1	2	3
	Road Condition	1	2	3
	Degree of Saturation	1	2	3
	Travel Speed	1	2	3
	Travel Time	1	2	3
2	**Economic Factors**			
	BOK	1	2	3
	Time Value	1	2	3
	BCR	1	2	3
	NPV	1	2	3

4.7 Assessment of Each Alternative Limitation

After weights and ratings for each criterion were obtained, then an analysis to the ratings for each alternative according to the explanation in previous section was held. The weight for each criterion based on the analysis result is presented in Table 12.

Table 12. Weight of Criteria for The Assesment of Multi Criteria Analysis

Criteria		Weight
A	LHR Data	21,51%
B	Road Condition	33,37%
C	Degree of Saturation	15,44%
D	Travel Time	7,07%
E	Travel Speed	9,02%
F	BOK	5,07%
G	Time Value	4,34%
H	BCR	2,41%
I	NPV	1,76%
Total		**100%**

Then, an assessment calculation was carried out for each alternative, by multiplying value of each criterion that obtained by the analysis process above with the weight of each criterion. The assessment result of each alternative is presented in Table 13 to Table 16.

Table 13. Result of Multi Criteria Analysis on Alternative 1

Criteria	Description	Value	Weight	∑
LHR Data	3.189	3	21,51	64,53
Road Condition	20,82%	3	33,37	100,12
Degree of Saturation	0,363	3	15,44	46,33
Travel Time	1,731	1	7,07	7,07
Travel Speed	3,89	2	9,02	18,05
BOK	Rp5.218.901.000	2	5,07	10,13
Time Value	Rp6.866.775.638	1	4,34	4,34
BCR	0,74	0	2,41	0,00
NPV	-Rp3.991.273.970	0	1,76	0,00
		Total Scores		**250,57**

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Table 14. Result of Multi Criteria Analysis on Alternative 2

Criteria	Description	Value	Weight	∑
LHR Data	3.190	3	21,51	64,53
Road Condition	27,12%	3	33,37	100,12
Degree of Saturation	0,346	3	15,44	46,33
Travel Time	3,661	2	7,07	14,14
Travel Speed	3,41	1	9,02	9,02
BOK	Rp8.662.656.168	3	5,07	15,20
Time Value	Rp4.403.916.943	1	4,34	4,34
BCR	0,60	0	2,41	0,00
NPV	-Rp8.382.143.904	0	1,76	0,00
		Total Scores		**253,69**

Table 15. Result of Multi Criteria Analysis on Alternative 3

Criteria	Description	Value	Weight	∑
LHR Data	1.967	1	21,51	21,51
Road Condition	19,61%	2	33,37	66,75
Degree of Saturation	0,213	1	15,44	15,44
Travel Time	5,127	3	7,07	21,20
Travel Speed	3,27	1	9,02	9,02
BOK	Rp8.773.702.311	3	5,07	15,20
Time Value	Rp10.499.363.483	2	4,34	8,69
BCR	1,48	2	2,41	4,82
NPV	Rp5.953.000.881	1	1,76	1,76
		Total Scores		**164,40**

Table 16. Result of Multi Criteria Analysis on Alternative 4

Criteria	Description	Value	Weight	∑
LHR Data	2.388	2	21,51	43,02
Road Condition	12,57%	1	33,37	33,37
Degree of Saturation	0,259	1	15,44	15,44
Travel Time	5,734	3	7,07	21,20
Travel Speed	4,01	3	9,02	27,07
BOK	Rp9.937.254.098	3	5,07	15,20
Time Value	Rp18.552.319.747	3	4,34	13,03
BCR	4,11	3	2,41	7,23
NPV	Rp20.529.527.782	2	1,76	3,52
		Total Scores		**175,57**

From results analysis and calculations performed in this research for selecting the road management priority using Multi Criteria Analysis (MCA), it was found that the largest value was alternative 2 with value of 253.69; therefore, alternative 2 will be used as a development priority for road widening maintenance program and selected in the next analysis stage. Recapitulation scores from each alternative is presented in Table 17.

Table 17. Recapitulation Result of Multi Criteria Analysis for Each Alternative

Alternative	Link	Score	Rank
1	018	250,57	2
2	135.11K	253,69	1
3	134.15K	164,40	4
4	135.16K	175,57	3

The recapitulation result from Multi Criteria Analysis (MCA) presented in table 17 found the ranking order for each alternative for road widening maintenance program. The priority order from the highest to the lowest rank are stated as follow: (a) first rank for construction of road widening maintenance is alternative 2 – Link 135.11 K with value of 253.69,

(b) second rank is the alternative 1 – Link 018 with value of 250.57; (c) third rank is alternative 4 – Link 134.15 K with value of 164.40; (d) fourth rank is alternative 3 – Link 135.16 K with value of 175.57.

V. CONCLUSION

From technical perspective after the research analysis completed, there is a change in road work performance within area of Malang Road and Bridge Management Technical Implementation Unit before and after implementation the 2021 road management package. Based on data from Link 135.11 K, there are significant differences found in several technical parameters. The differences are including an increase of 3,190 skr/hour in the level of traffic density (LHR) with an average road condition of 27.12 %. Next, the degree of saturation has increased by 0.346 while travel speed and travel time increased by 3.409 km/hour and 3.661 minutes respectively. Whereas from the economic perspective, there are significant changes found such as the benefit to cost ratio (BCR) also increased by 0.60 and the net present value (NPV) showed a negative change of - Rp. 8,382,143,904. Then, benefit to cost (BOK) also increased by Rp. 8,662,656,168 after the 2021 road management program was implemented.

Priority for road management within area of UPT PJJ Malang as included in the 2024 road management package program have been determined with priority order is arranged from the highest to the lowest ranks:

1. First rank for road widening maintenance construction is the alternative 2 – Link 135.11 K with value of 253.69,
2. Second rank is alternative 1 – Link 018 with value of 250.57,
3. Third rank is alternative 4 – Link 134.15 K with value of 164.40 and
4. Fourth rank is alternative 3 – Link 135.16 K with value of 175.57.

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