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Original Article

Road Damage Analysis Using the AHP (Analytical Hierarchy Process) Method as the Basis for Road Handling Programs on Provincial Roads in Pacitan Regency

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Abstract

Land transportation infrastructure, such as roads and bridges, plays a crucial role as a link between regions that supports the economic, social, and cultural growth of a region. With limited budget in road management in Pacitan Regency, priority determination is needed to ensure that road management is carried out more efficiently and on target. This study aims to calculate the weight of the criteria using the Analytical Hierarchy Process (AHP) method based on expert opinions and to determine the priority order of road management in Pacitan Regency by utilizing the Provincial/Regency Road Management System (PKRMS) application, the AHP method, and a combination of the two methods. The method used in this study involves AHP with six criteria, namely road conditions, traffic volume, road connectivity, regional development, connecting economic and agricultural areas, and connecting public service facilities. This study focuses on five road sections in Pacitan Regency. The results of the study show that based on the AHP method, the road connectivity criterion gets the highest weight of (35%), followed by connecting public service facilities (22%), road conditions (14%), connecting economic and agricultural areas (13%), regional development (12%), and traffic volume (4%).

Keywords: Priority Analysis, Road Handling, Analytical Hierarchy Process.

1. Introduction

Road infrastructure plays a very strategic role in supporting development at various levels, from national, regional, to local. This infrastructure functions not only as the main mode of transportation that serves the mobility of people, goods, and services, but also plays a key role in the distribution of commodities, trade, and industrial activities (Todaro & Smith, 2014). As an integral part of development, roads support economic, social, cultural, political, and security growth, while also functioning as a supporter, driver, and driver of regional development and regional development (Masagung, 2023). In the context of East Java Province, the development of an integrated road network that is able to reach all corners of the region is a top priority in supporting public service functions (Haryanto, 2019).

Roads as part of land transportation facilities and infrastructure have a dominant role compared to other modes of transportation (Anjani & Mahendra, 2023; Fadillah Akbar, 2024). Data shows that land transportation is still the backbone of the movement of people and goods in Indonesia, including in Pacitan Regency. This regency has a fairly challenging topography, which makes land transportation the only main alternative to support the economic and social activities of the local community. The road sections in Pacitan Regency managed by the East

Java Provincial Government have a total length of 102.73 kilometers (SK Gubernur Jawa Timur, 2023), which is divided into five main road sections. These road sections are vital routes connecting various areas in Pacitan with other areas in East Java.

However, the constraint faced is the limited availability of budget each year, which forces the East Java Provincial Government, especially the PU Bina Marga Agency, to prioritize road handling (Aan, 2023). This prioritization aims to ensure that road sections with the most need for repair or maintenance receive attention first. In this context, road handling priority analysis is very important to support effective and efficient data-based decision making. There are several scientific methods that can be used in the analysis of road handling priorities, including the Analytical Hierarchy Process (AHP) (Asalam et al., 2021; Farhan et al., 2022). AHP is a method that is often used to determine priorities through a systematic decision-making approach, based on pairwise comparisons between various criteria (Austroads, 2006; Saaty, 2008).

In Pacitan Regency, the application of a combination of AHP and PKRMS methods has high relevance. This combination allows decision-making that is not only based on technical data, but also considers non-technical factors, such as surveys of the community as road users (Aan, 2023; Ramadan et al., 2023; Sutandi, 2021). Thus, this process can produce more comprehensive decisions and reflect the needs and aspirations of the community. One of the advantages of this approach is the ability to balance technical needs with input from road users, which ultimately increases the effectiveness of budget allocation and implementation of road maintenance programs (Firdaus, 2018; Putra et al., 2022).

This study aims to analyze road damage using the AHP method as the basis for road maintenance programs on provincial roads in Pacitan Regency. The main focus of this study is to identify road maintenance priorities based on a combination of technical and non-technical data, so that it can support better and more targeted planning. In this context, technical data includes road conditions, connectivity, traffic volume, and road functions as a connecting public service facility. Meanwhile, non-technical data is obtained through a survey of the community to understand their perceptions and needs regarding road conditions.

From the background explanation above, the purpose of this study is to determine the order of the weight of the criteria that affect the priority of road handling in Pacitan Regency using the AHP method, so that it can provide a clear picture of the most influential factors in determining the priority of roads that need to be repaired. And determine the order of priority of road handling in Pacitan Regency using the AHP method, to find out the results of the priority analysis based on qualitative considerations obtained through assessments by experts or stakeholders.

2. Methods

2.1. Research Subjects

The subject of this study is the Analysis of Road Handling on Provincial Road Sections in Pacitan Regency using the PKRMS application combined with the AHP method, and projecting the budget requirements for road handling for the next 5 years.

2.2. Research Instruments

This research uses instruments including:

a) GPS
b) Distance Measuring Tool
c) Car

d) Tablet/Laptop

2.3. Data Collection Procedure

Data collection in this study was carried out by:

a) Primary data includes literature studies collected in the form of administrative data, lists of road sections and unit prices for road maintenance.
b) Secondary data includes the results of direct surveys in the field in the form of road inventories, road conditions and traffic data.

2.4. Data Analysis Techniques

Data analysis is a process that changes data into information that is easy to understand, and can be used to find a solution to a problem formulation. In this study, the data analysis technique used is descriptive qualitative, namely by analyzing the data obtained and then describing the process, and the results of the data analysis. In this analysis, AHP analysis was carried out.

3. Results and Discussion

3.1. Geography and Demographic Aspects

Pacitan Regency is an area located at the southwest tip of East Java Province, directly bordering Central Java Province to the west and the Indian Ocean to the south. Its strategic location makes Pacitan a link between East Java and Central Java. With an area of approximately 1,389.87 km², Pacitan's topography is dominated by hills and mountains, mostly in the form of karst areas. This provides a distinctive feature in the form of unique caves and underground rivers that are a geological attraction as well as a natural tourist destination.

Geographically, Pacitan Regency has a tropical climate with two main seasons, namely the rainy season and the dry season. Rainfall in this area varies depending on its altitude and geographical conditions. In addition, this area has extraordinary natural beauty, such as exotic beaches (Klayar Beach, Soge Beach, Teleng Ria Beach) and famous caves (Gong Cave, Tabuhan Cave). This geographical uniqueness makes Pacitan one of the areas that has great potential in tourism development. From a demographic aspect, the population of Pacitan Regency is estimated at around 550,000 people, with an average density of 396 people/km². Most of the population lives in rural areas with their main livelihood in the agricultural sector, such as rice, corn, and cassava. In coastal areas, the fisheries sector is also a major source of livelihood, both through capture fisheries and marine cultivation.

The majority of Pacitan's population is Javanese, who use Javanese, especially the Mataraman dialect, as their daily language. In terms of religion, the majority of the population is Muslim, with small communities of Christians and Hindus. The general level of public education is still in the developing category, although the local government continues to strive to improve the quality and access to education through the construction of facilities and scholarship programs. With a combination of rich geographical potential and unique demographic dynamics, Pacitan Regency has great opportunities for further development, especially in the agriculture, fisheries and tourism sectors.

3.2. Road Condition Data

Based on the information contained in the Basic Infrastructure Data (DD1), which is attached as part of this document, a summary of the road conditions on the five road sections that are the object of the study has been prepared. The data is summarized in detail in Table

1, which presents a comprehensive picture of the physical condition and status of each road section studied in this study.

Table 1. List of Handling Sections in Pacitan Regency

Section Number	Road Section Name	Section Length (Km)	Survey Section Length (Km)	Section Width (M)
001	BTS. KAB. PONOROGO - BTS. KOTA PACITAN	44.96	44.73	7.00
001.11K	JLN. TENTARA PELAJAR	2.53	2.52	8.70
001.12K	JLN. BASUKI RACMAD	0.59	0.58	9.00
002	ARJOSARI - PURWANTORO (BTS. PROV. JATENG)	46.39	46.00	4.66
003	WARENG - MUKUS (BTS. PROV. JATENG)	8.26	8.21	7.09
Total		102.73	102.04	

Table 2. Road Condition Results Report

Road Section		Pavement Type / Condition								Regency
Number	Name	Concrete (km)	Concrete Block (km)	Asphalt (km)	Distance (km)	Good (km)	Medium (km)	Minor Damage (km)	Serious Damage (km)	
001	BTS. KAB. PONOROGO - BTS. KOTA PACITAN	0,00	0,00	44,73	0,00	1,23	43,10	0,40	0,00	Pacitan Regency
001.11K	JLN. TENTARA PELAJAR	0,00	0,00	2,52	0,00	0,10	2,42	0,00	0,00	Pacitan Regency
001.12K	JLN. BASUKI RACMAD	0,00	0,00	0,58	0,00	0,50	0,08	0,00	0,00	Pacitan Regency
002	ARJOSARI - PURWANTORO (BTS. PROV. JATENG)	0,00	0,00	46,00	0,00	4,20	21,40	20,40	0,00	Pacitan Regency
003	WARENG - MUKUS (BTS. PROV. JATENG)	0,00	0,00	8,21	0,00	1,30	6,91	0,00	0,00	Pacitan Regency
Total		0,00	0,00	102,04	0,00	7,33	73,91	20,80	0,00	
Percentage		0,00%	0,00%	100,00%	0,00%	7,18%	72,43%	20,38%	0,00%	

Based on the data displayed in the table above, it is known that the road section with the highest level of damage is the Arjosari - Purwantoro road section (Bts. Prov. Jateng). On this road section, the road conditions categorized as Moderate have a length of 21.40 km or 46.52% of the total length of the section, and Light Damage has a length of 20.40 km or 44.35% of the total length of the section. This shows that most of this road section requires special attention for repair and maintenance, considering the significant damage conditions on almost its entire length.

3.3. Traffic Volume Data

Table 3. Traffic Volume Data

No	Section Name	Road Type	Road Length (km)	LHR Direction 1 (veh. / day)	LHR Direction 2 (veh. / day)	Average
1	Bts. Ponorogo Regency - Bts. Pacitan City	2/2TT	44.81	5.178	10,033	7,605
2	Student Army Street (Pacitan)	2/2TT	2.50	11,719	11,928	11,823
3	Jl. Basuki Rachmad (Pacitan)	2/2TT	0.66	6,843	6,977	6,910
4	Arjosari - Purwantoro (Bts. Central Java Province)	2/2TT	46.14	5.178	11,818	8,498
5	Wareng - Mukus	2/2TT	8.23	9,357	7,979	8,668
Total Length		102.34				
Total Length of Provincial Roads in UPT Pacitan		102.34				

3.4. Road Connectivity Data

Table 4. Road Connectivity Data

No	Section Name	Connectivity with National Roads	Connectivity with Provincial Roads
1	BTS. KAB. PONOROGO - BTS. KOTA PACITAN	None	Yes (The object is a Provincial Road)
2	JLN. TENTARA PELAJAR	None	Yes (The object is a Provincial Road)

No	Section Name	Connectivity with National Roads	Connectivity with Provincial Roads
3	JLN. BASUKI RACMAD	Yes	Yes (The object is a Provincial Road)
4	ARJOSARI - PURWANTORO (BTS. PROV. JATENG)	None	Yes (The object is a Provincial Road)
5	WARENG - MUKUS (BTS. PROV. JATENG)	Yes	Yes (The object is a Provincial Road; if referring to connectivity with other provincial roads, then none)

3.5. Area Development Data

Through a literature review conducted with reference to the Pacitan Regency Administrative Map, information was obtained related to the Regional Development Plan which is the main focus in this research object. The development plan was formulated based on an analysis of administrative data and the potential of the region in Pacitan Regency. The details of the regional development plan relevant to the object of this research can be explained in more detail as follows.

Table 5. Area Development Data

No	Section Name	Border Area	Industrial Designation Area
1	BTS. KAB. PONOROGO - BTS. KOTA PACITAN	Yes (District Boundary)	Yes (wood)
2	JLN. TENTARA PELAJAR	No	No
3	JLN. BASUKI RACMAD	No	No
4	ARJOSARI - PURWANTORO (BTS. PROV. JATENG)	Yes (Provincial Boundary)	Yes (wood)
5	WARENG - MUKUS (BTS. PROV. JATENG)	Yes (Provincial Boundary)	Yes (wood)

3.6. Connector Data for Economic and Agricultural Areas

Based on the literature review conducted by referring to the Pacitan Regency Economic and Agricultural Area Map, important information was obtained regarding the conditions and characteristics of the area that is the object of the study. This study provides a comprehensive picture of the economic potential and agricultural activities that dominate the area. Analysis of this map allows the identification of relevant regional development patterns and their relationship to the local economic and agricultural sectors. The findings related to this research object can be described in more detail as follows.

Table 6. Connector Data for Economic and Agricultural Areas

No	Section Name	Trading Area	Agricultural Area
1	BTS. KAB. PONOROGO - BTS. KOTA PACITAN	Yes (market)	Yes
2	JLN. TENTARA PELAJAR	Yes	No
3	JLN. BASUKI RACMAD	No	No
4	ARJOSARI - PURWANTORO (BTS. PROV. JATENG)	Yes (market)	Yes
5	WARENG - MUKUS (BTS. PROV. JATENG)	Yes (market)	No

3.7. Connector Data for Public Service Facilities

Through a literature review conducted with reference to the Pacitan Regency Public Service Facility Map, important data relating to the relationship between public service facilities in the area was obtained. This information includes the relationship between public service facilities in the research area, such as schools, health centers, government offices, and other public infrastructure. The study of this map allows for a deeper understanding of the distribution patterns and connectivity between these facilities, which play a significant role in supporting regional development and the needs of the local community. The detailed results of the public service facility connection data can be described as follows.

Table 7. Connector Data for Public Service Facilities

No	Section Name	Public Service Facilities					
		Hospital/Health Center	Education	Terminal	Harbor	Reservoir/Dam	Station
1	BTS. KAB. PONOROGO - BTS. KOTA PACITAN	Yes	Yes	No	No	No	No
2	JLN. TENTARA PELAJAR	Yes	Yes	No	No	No	No
3	JLN. BASUKI RACMAD	Yes	No	No	No	No	No
4	ARJOSARI - PURWANTORO (BTS. PROV. JATENG)	Yes	Yes	Yes (Market Terminal)	No	No	No
5	WARENG - MUKUS (BTS. PROV. JATENG)	Yes	Yes	No	No	No	No

3.8. Weighted Values Based on Data

Table 8. Weighted Values Based on Data

	K1	K2	K3	K4	K5	K6
Bts. Kab. Ponorogo - Bts. Kota Pacitan	0.20	0.19	0.14	0.33	0.33	0.20
Jln. Tentara Pelajar (Pacitan)	0.20	0.25	0.14	0.00	0.17	0.20
Jln. Basuki Racmad (Pacitan)	0.20	0.19	0.29	0.00	0.00	0.10
Arjosari - Purwantoro (Bts. Prov. Jateng)	0.20	0.19	0.14	0.33	0.33	0.30
Wareng - Mukus	0.20	0.19	0.29	0.33	0.17	0.20

Description:
K1: Road Condition
K2: Traffic Volume
K3: Connectivity
K4: Area Development
K5: Connector for Economic and Agricultural Areas
K6: Connector for Public Service Facilities

3.9. Analytical Hierarchy Process (AHP) Questionnaire Result Data

The results of the AHP (Analytic Hierarchy Process) questionnaire collected from respondents contain assessment data on various research criteria. This data is used to determine the weight of the criteria and to prioritize. The details of the results are presented as follows.

Table 9. Analytical Hierarchy Process (AHP) Questionnaire Result Data

Respondents	Respondents' Perception														
	K1:K2	K1:K3	K1:K4	K1:K5	K1:K6	K2:K3	K2:K4	K2:K5	K2:K6	K3:K4	K3:K5	K3:K6	K4:K5	K4:K6	K5:K6
R1	7.00	0.14	0.20	0.20	0.20	0.14	0.14	0.14	0.14	9.00	9.00	9.00	1.00	1.00	1.00
R2	1.00	1.00	3.00	3.00	3.00	0.25	0.25	0.17	0.11	1.00	5.00	1.00	1.00	1.00	1.00
R3	3.00	1.00	3.00	1.00	1.00	1.00	1.00	2.00	2.00	1.00	1.00	1.00	0.50	0.50	1.00
R4	5.00	4.00	1.00	0.50	0.20	0.33	0.33	0.20	0.20	1.00	0.33	0.33	0.20	0.20	0.20
R5	1.00	0.20	3.00	3.00	3.00	0.20	0.50	0.20	0.20	1.00	1.00	1.00	5.00	5.00	1.00
R6	5.00	0.14	0.14	0.14	0.11	0.11	0.14	0.25	0.11	7.00	7.00	7.00	1.00	1.00	1.00
R7	7.00	0.50	0.20	7.00	0.20	0.20	0.20	0.14	0.01	7.00	7.00	7.00	0.20	0.20	0.14
R8	6.00	0.13	9.00	9.00	0.11	0.14	0.14	0.14	0.14	6.00	7.00	7.00	0.14	0.14	0.14
R9	7.00	7.00	8.00	8.00	0.14	0.13	0.20	0.20	0.20	7.00	7.00	7.00	0.14	0.14	0.14
R10	8.00	0.14	0.13	8.00	0.13	0.13	0.20	1.00	3.00	4.00	2.00	5.00	0.25	4.00	5.00
R11	6.00	0.20	0.25	6.00	0.13	0.14	0.14	0.14	0.17	6.00	6.00	6.00	0.14	0.14	0.14
R12	7.00	0.20	0.11	7.00	0.13	0.11	0.11	2.00	0.25	1.00	1.00	3.00	1.00	1.00	1.00
GEOMEAN	4.39	0.43	0.76	2.30	0.28	0.19	0.22	0.30	0.21	2.96	2.95	3.05	0.45	0.57	0.52

3.9.1. Criteria Comparison Matrix

Table 10. Calculation Results of Criteria Comparison Matrix

Criteria	K1	K2	K3	K4	K5	K6
K1	1.00	4.39	0.43	0.76	2.30	0.28
K2	0.23	1.00	0.19	0.22	0.30	0.21
K3	2.32	5.34	1.00	2.96	2.95	3.05
K4	1.31	4.48	0.34	1.00	0.45	0.57
K5	0.44	3.32	0.34	2.21	1.00	0.52
K6	3.55	4.81	0.33	1.76	1.91	1.00

Description:
K1: Road Condition
K2: Traffic Volume
K3: Connectivity
K4: Area Development
K5: Connector for Economic and Agricultural Areas
K6: Connector for Public Service Facilities

3.9.2. Criteria Value Matrix

Table 11. Calculation Results of Criteria Value Matrix

Criteria	K1	K2	K3	K4	K5	K6	Amount	Priority	Eigenvalue
K1	0.11	0.19	0.16	0.09	0.26	0.05	0.86	0.14	1.27
K2	0.03	0.04	0.07	0.03	0.03	0.04	0.24	0.04	0.92
K3	0.26	0.23	0.38	0.33	0.33	0.54	2.08	0.35	0.91
K4	0.15	0.19	0.13	0.11	0.05	0.10	0.73	0.12	1.09
K5	0.05	0.14	0.13	0.25	0.11	0.09	0.77	0.13	1.15
K6	0.40	0.21	0.12	0.20	0.21	0.18	1.32	0.22	1.24
Total	1.00	1.00	1.00	1.00	1.00	1.00	6.00	1.00	6.57

Table 12. CR Value Results

CI	0.11
RI	1.24
CR	0.092 (CR<0.10 = Consistent)

The results of the AHP (Analytic Hierarchy Process) analysis produce criteria weights that indicate the level of importance of each. The details of the weight values are as follows:

Table 13. Criteria Weight according to AHP

Criteria	Criteria Description	Weight	Priority
K1	Road Conditions	0.14	3
K2	Traffic Volume	0.04	6
K3	Connectivity	0.35	1
K4	Area Development	0.12	5
K5	Connecting Economic and Agricultural Areas	0.13	4
K6	Public Service Facility Connector	0.22	2

Based on the results of the analysis that has been carried out using the Analytic Hierarchy Process (AHP) method, the order of the criteria weights that influence the priority of road handling is obtained. This weight reflects the relative importance of each criterion in

determining priorities. The Connectivity criterion has the highest weight, which is 35%, indicating that this aspect is considered the most important in road handling. Furthermore, the Public Service Facility Connector criterion has a weight of 22%, followed by Road Conditions with a weight of 14%, which also makes a significant contribution. The Economic and Agricultural Area Connector criterion is in the next order with a weight of 13%, followed by Area Development at 12%. Meanwhile, the Traffic Volume criterion has the lowest weight, which is 4%, indicating a relatively small level of influence on the priority of road handling. This order provides a comprehensive overview of the main factors considered in decision making related to the priority of road infrastructure handling.

3.10. Analysis of the Analytical Hierarchy Process Method

Based on the analysis of the weight of the road section criteria, both from technical data and the AHP (Analytic Hierarchy Process) questionnaire, the results obtained describe the level of importance of each criterion in determining the priority of road handling. These results combine objective data and respondent perceptions, providing a comprehensive basis for formulating handling priorities. The details of the analysis results are as follows:

Table 14. Priority Weight Based on AHP

Section Name	Road Section Data Weight					AHP Questionnaire Weight							Global Priority Weight	Priority
	K1	K2	K3	K4	K5	K6	K1	K2	K3	K4	K5	K6		
Bts. Kab. Ponorogo - Bts. Kota Pacitan	0.20	0.19	0.14	0.33	0.33	0.20	0.14	0.04	0.35	0.12	0.13	0.22	0.21	3
Jln. Tentara Pelajar (Pacitan)	0.20	0.25	0.14	0.00	0.17	0.20	0.14	0.04	0.35	0.12	0.13	0.22	0.15	5
Jln. Basuki Racmad (Pacitan)	0.20	0.19	0.29	0.00	0.00	0.10	0.14	0.04	0.35	0.12	0.13	0.22	0.16	4
Arjosari - Purwantoro (Bts. Prov. Jateng)	0.20	0.19	0.14	0.33	0.33	0.30	0.14	0.04	0.35	0.12	0.13	0.22	0.23	2
Wareng - Mukus	0.20	0.19	0.29	0.33	0.17	0.20	0.14	0.04	0.35	0.12	0.13	0.22	0.24	1

4. Conclusion

The results of the criteria weight analysis using the AHP method with expert respondents show different priority proportions. The Connectivity Criteria has the highest weight of 35%, followed by Public Service Facility Connectors 22% and Road Conditions 14%. The Economic and Agricultural Area Connector Criteria gets a weight of 13%, while Area Development 12%. Finally, Traffic Volume has the lowest weight of 4%. These criteria reflect important aspects in determining road handling priorities.

Based on the results of the analysis using the Triggered Priority Index (TPI) method, the priority order of road handling has been determined based on the TPI value from the highest to the lowest. The Wareng - Mukus road section (Bts. Prov. Central Java) has the highest TPI value of 82.6, making it the main priority for handling. Furthermore, the Basuki Racmad road section is in second place with a TPI value of 32.8, followed by the Arjosari - Purwantoro section (Bts. Prov. Central Java) in third place with a TPI value of 19.4. The Tentara Pelajar road section is in fourth place with a TPI value of 14.8, while the Ponorogo Regency - Pacitan City Bts. section is the fifth priority with a TPI value of 10.8.

Based on the analysis using the AHP method and the criteria weight value, the global weight shows the difference in the priority level of road handling. The Wareng - Mukus section has the highest weight of 0.24 and is the first priority, followed by Arjosari - Purwantoro with a weight of 0.23 as the second priority. The Bts. Kab. Ponorogo - Bts. Kota Pacitan section is

in third place with a weight of 0.21, while Jln. Basuki Racmad 0.16 and Jln. Tentara Pelajar 0.15 occupy the fourth and fifth priorities.

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