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Road maintenance management system in Kendari City, Southeast Sulawesi, Indonesia

Mahmud Buburanda[1], Usman Rianse[2], La Ode Alwi[2], Adris Ade Putra[3].

[1]Doctoral Program in Engineering Management, Halu Oleo University, Kendari, Indonesia. [2]Department of Agricultural, Halu Oleo University, Kendari, Indonesia. [3]Department of Civil Engineering, Halu Oleo University, Kendari, Indonesia

Email. mahmud.raffa@yahoo.com

Abstract. This study aims to determine road conditions and determine the sustainability of road maintenance management in Kendari City in terms of social, economic and environmental aspects. This research was conducted through observation and data collection from the community regarding the management of highway maintenance by using the attributes of social, economic and environmental parameters. Data analysis used in determining the sustainable highway maintenance management index uses the RAT-HMM (Rapid Assessment Techniques for Highway Maintenance Management) Program. The results showed that the road conditions in Kendari City were in the Light to Moderate Damage Category with maintenance road status, namely Periodic Maintenance to Rehabilitation. In addition, this study also shows that the results of the assessment of all aspects of the social, economic and environmental dimensions are in the Sufficiently Sustainable category (> 64 – 72%) in the construction and maintenance of roads in Kendari City. Therefore, road maintenance management governance policies are still needed in Kendari City.

Keywords. Road maintenenance, management system, sustainability, Kendari City

Introduction

Recently, the issue of transportation and logistics has become a hot issue discussed by civil engineering (Pache, 2023), including road infrastructure. Roads are basic and main infrastructure (Medjitna, 2023) in moving the economy of a region because they play a role in distributing goods and services as well as population mobility (Siswanto et al. 2016). in addition, providing access to public services in the fields of education, health and employment (Masengi et al. 2023). Therefore, in order to optimize this role, the road must have good performance. Good road performance requires good, systematically planned maintenance.

Road maintenance is a road management activity, in the form of prevention, maintenance and repairs needed to maintain road conditions so that they continue to function optimally. The road maintenance cycle starts from reconstruction to increase the value of the road pavement structure and/or to increase its usability through road widening, continuing through to routine maintenance, periodical maintenance and rehabilitation.

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Republic of Indonesia Government Regulation No. 34 of 2006 concerning Roads explains that road maintenance is the highest priority of all types of road management which includes routine maintenance, periodic maintenance and rehabilitation. The highest priority includes meeting the adequacy of maintenance funding from the local government.

The city of Kendari is a city and is also the capital of Southeast Sulawesi Province (Kete et al. 2019). Currently, this area continues to carry out road infrastructure development and maintenance programs. Based on the data, in 2018 there were 489.2 km of road infrastructure in good to moderate conditions, namely 323.7 km (66.2%) and damaged conditions, namely 165.5 km (33.8%). This shows that the condition of the road in this area is relatively good, but over time there has been a decrease in the road pavement index resulting in an increase in road damage. Therefore, in order to slow down the rate of deterioration and maintain road conditions at an acceptable level, the road network needs a road maintenance management system to make it sustainable.

Materials and Methods

This research was conducted in Kendari City, Southeast Sulawesi (Figure 1). The selection of the research location was carried out with the consideration that this region is the capital of Southeast Sulawesi Province and one of the areas that continues to carry out the construction and maintenance of road infrastructure. Determining the research location using the Kendari City road section by taking the road which is a secondary arterial road with the consideration that it is a road that connects the primary area with the secondary area with high average daily traffic.

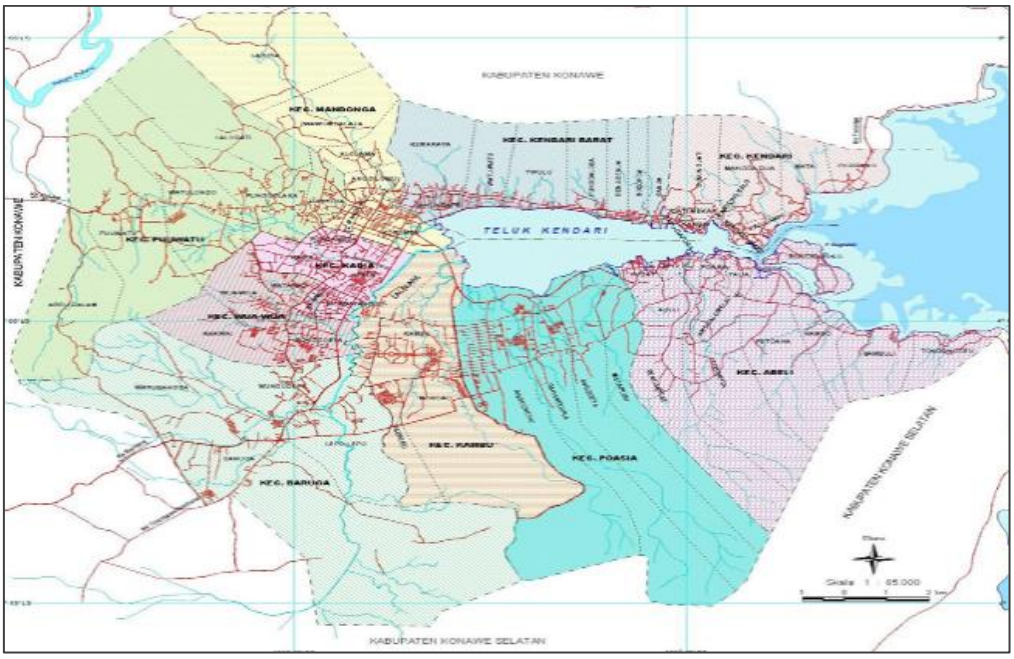

Figure 1. location study

Data collection technique. The data consists of secondary data and primary data. Secondary data related to highway maintenance management was obtained by tracing relevant agencies such as the PUPR Office of Kendari City, Bappeda and the Central Statistics Agency (BPS) as well as agencies related to this study, while primary data was obtained through Focus

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Group Discussions (FGD). FGD participants consisted of representatives from the Kendari City BAPPEDA, BLHD, the Department of Transportation, the PUPR Service, academics, NGOs, and community leaders.

Analisis Data

Data analysis used in this study includes: (a) observing the existing portrait of sustainable highway maintenance management governance by using equation 1 through weighting on each weighted average; (b) Using the RAT-HMM (Rapid Assessment Techniques for Highway Maintenance Management) program in determining the sustainable highway maintenance management index.

$$\text{Weighted Average} = \frac{\text{existing performance weights}}{\text{weighted attribute count}} \ldots (1)$$

Results and Discussion

Existing Conditions of the Road

Government Regulation of the Republic of Indonesia Number 34 of 2006 concerning Roads explains that the road network management program includes road maintenance programs, road improvement programs, and new road construction programs. Chapter 97 explains that road administrators have the obligation and responsibility to maintain roads according to their authority. Kendari City is the center of government, trade and industry at both the city and provincial levels. The city of Kendari is passed by national and provincial roads (Table 1). According to their authority, until 2022 the road length for Kendari City is 489.199 km.

Table 1. Road Status in Kendari City

Road status	Road length (km)
National road	41,560
Provincial road	53,950
City road	489,199
Total	**584,709**

Source: Dinas PUPR Kendari City, 2018

Road conditions in the city of Kendari in 2018 were dominated by the good condition category (248,090 km), then Heavily Damaged (111,497 km), Medium (74,190), and Light Damage (55,422). this pattern also occurs until the 2021 period, while in 2022 Heavily Damaged has decreased by 59,339 km and in good condition has increased 314,205 km (Table 2 and Figure 2). This is due to road improvements in this area.

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Table 2. Road Conditions in Kendari city

Road status	Road length (km)				
	2022	2021	2020	2019	2018
Good	314,205	343,083	320,205	261,126	248,090
Medium	40,190	21,710	38,673	89,770	74,190
Light Damage	75,465	49,050	63,299	48,391	55,422
Heavily Damaged	59,339	75,356	67,022	89,911	111,497
Total	**489,199**	**489,199**	**489,199**	**489,199**	**489,199**

Source: Dinas PUPR Kendari City, 2018

Source: Primary Data, 2022

In 2021 Road Stability Conditions are 364,793 Km (74.6%) and Non-Stability are 124,406 km (27.6%) (Table 3). Road construction and maintenance during the period 2018 to 2022 has resulted in Kendari City Road Stability Conditions being at least 65.9% or classified as in good

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condition. This has a positive impact on increasing the flow of transportation, logistics, goods and services.

Source: Dinas PUPR Kendari City, 2018

Table 3. Road Stability Conditions in Kendari City

Road status	Road length (%)				
	2022	2021	2020	2019	2018
Stability	72,4	74,6	73,4	71,7	65,9
Non-Stability	27,6	25,4	26,6	28,3	34,1
Total	**100**	**100**	**100**	**100**	**100**

Based on Table 4 it can be seen that in the last 5 (five) years there have been 4 (four) activity programs with a total budget of Rp. 980 Billion. The Maintenance Program, namely Road Maintenance and Road Rehabilitation, has the smallest allocation of Rp. 121.6 billion (12.4%) of the total budget. The Road Improvement and New Road Development Program has the highest budget allocation of Rp. 858.4 billion (87.6%) of the total road budget. This shows that T

The PUPR Office of Kendari City in determining the type of road handling did not use the right strategy based on road conditions where the biggest program was the Road Improvement Program. Road Improvement, also known as Road Reconstruction, is an activity to improve road structure or to handle roads that are heavily damaged. This means that the Kendari City road is handled not at the right time, not based on a priority scale and road handling is carried out when the road is on an Unsteady or Severely Damaged Condition, not when it is in good and moderate condition. Inappropriate handling conditions have an impact on the economic, social and environmental aspects.

Source: Dinas PUPR Kendari City, 2018

Table 4. Road Handling Costs in Kendari city

Road Handling Costs	Years				
	2022	2021	2020	2019	2018
Road Maintenance	3.773.521.674	5.450.287.040			3.116.899.900
Road Rehabilitation	22.189.230.325	15.943.409.059	28.343.583.660	42.790.852.420	
Road Construction	210.302.657.690	137.828.152.221	28.560.000.000	107.810.087.850	
Road and Bridge Improvements				95.266.112.490	278.673.915.228
Total	**236.265.409.689**	**159.221.848.320**	**56.903.583.660**	**245.867.052.760**	**281.790.815.128**

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The City of Kendari in planning for road maintenance has not thoroughly used a road maintenance management system. The Kendari City PUPR Service carried out road maintenance without prioritizing Preventive Actions but rather Reactive Actions due to limited funds, namely road maintenance carried out when conditions were Severely Damaged. When conditions are Good and Moderate maintenance is not carried out where the road is left as it is as long as it can still be passed by vehicles. This action increases maintenance costs, disrupts the comfort and safety of road users and increases Vehicle Operating Costs. In addition, it also has an impact on the social aspect, namely, social unrest arises in the community due to an increase in the number of accidents due to avoiding road damage. This disturbs the comfort of the people of Kendari City when driving. On the environmental aspect, there was a flood disaster due to the drainage not functioning because a lot of mud sediment had accumulated, and the drainage channels were damaged. Therefore, a road management program is needed based on a priority scale based on road conditions and budget optimization.

Based on road conditions and availability of funds, the road management program is divided into two programs, namely on roads with good conditions and Heavily Damaged implementing the Regular Maintenance program, while in Light Damage conditions in the form of a rehabilitation program.

Table 5. Road Handling Programs in Kendari City

Field Name	Condition	Programs
Jl. Ir. H. Alala	Good	Regular Maintenance
Jl. H. Edy. Sabara	Good	Regular Maintenance
Jl. Brigjend M. Joenoes	Medium	Periodic Maintenanc
Jl. Budi Utomo	Medium	Periodic Maintenanc
Jl. Malik Raya	Medium	Periodic Maintenanc
Jl. KH. Ahmad Dahlan	Light Damage	Rehabilitation
Jl. Chairil Anwar	Light Damage	Rehabilitation
Jl Laute	Light Damage	Rehabilitation
Jl. Brigjend ZA. Sugianto	Heavily Damaged	Periodic Maintenanc
Jl. Madusila	Heavily Damaged	Periodic Maintenanc

Source: Primary Data, 2022

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Sustainable Roads Maintenance Management

The concept of sustainability is a concept that is widely used in various industries (Simaite and Keliuotyte-Staniuleniene, 2023). Determination of the status and leverage factors for the sustainability of highway maintenance management in Kendari City uses the RAT-HMM (Rapid Assessment Techniques for Highway Maintenance Management) Program. This program is a modification of the RAPFISH (Rapid Appraisal Techniques for Fisheries) Program developed by the Fisheries Center, University of British Columbia, Canada. The modifications that have been made are only on the dimensions and indicators. The indicator was developed based on the hexagonal concept of highway maintenance management, which consists of three dimensions, namely: (a) social dimension; (b) economic dimension; and (c) environmental dimensions.

The results of the analysis with the RAT-HMM Program are in the form of sustainability indexes and leverage factors for each management indicator in road maintenance. Determination of HMM status as a whole uses another program, namely the weighting program for road maintenance indicators.

Sustainability of Road Maintenance Management Based on Social Dimensions

The results of this study indicate that the social dimension of sustainability in road maintenance in Kendari City is in the fairly sustainable category with an index value of 64.64% (Figure 3). This condition shows that the government of Kendari City has been quite active in road maintenance.

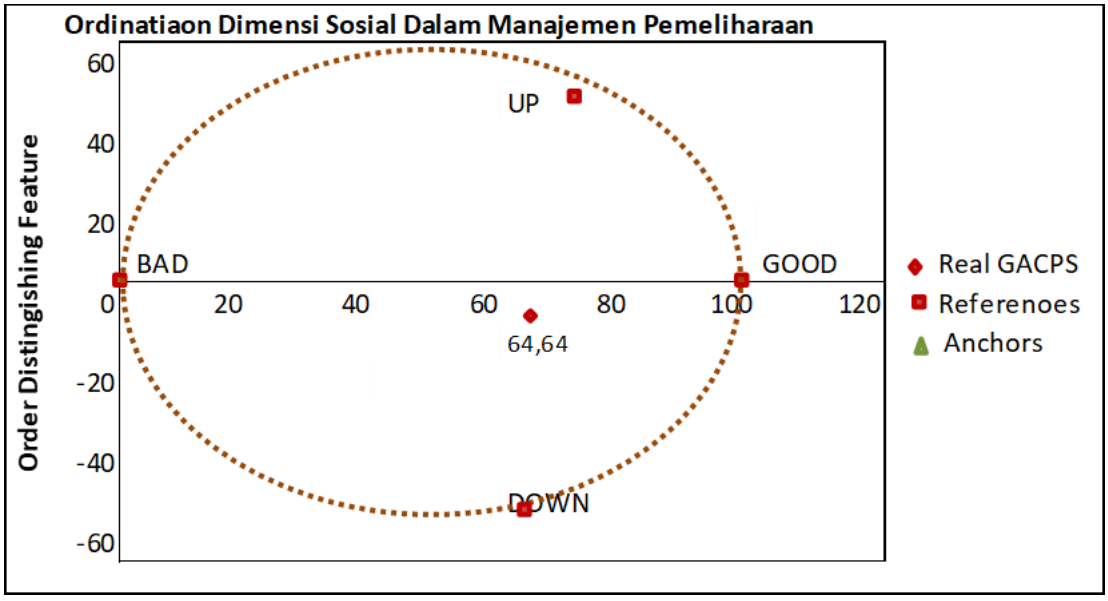

Figure 3. Road maintenance sustainability index based on the social dimension.

Furthermore, Figure 4 shows that on the social dimension there are several attributes as leverage sensitive which influence the management of road maintenance in Kendari City, which consist of: (a) The frequency of worker accidents during construction; (b) Participation in the form of input at meetings with the community at the kelurahan level; (c) Ease of access for all users of motorized and non-motorized vehicles; (d) Frequency of road user accidents during construction; and (e) Community participation in the planning and implementation of road construction.

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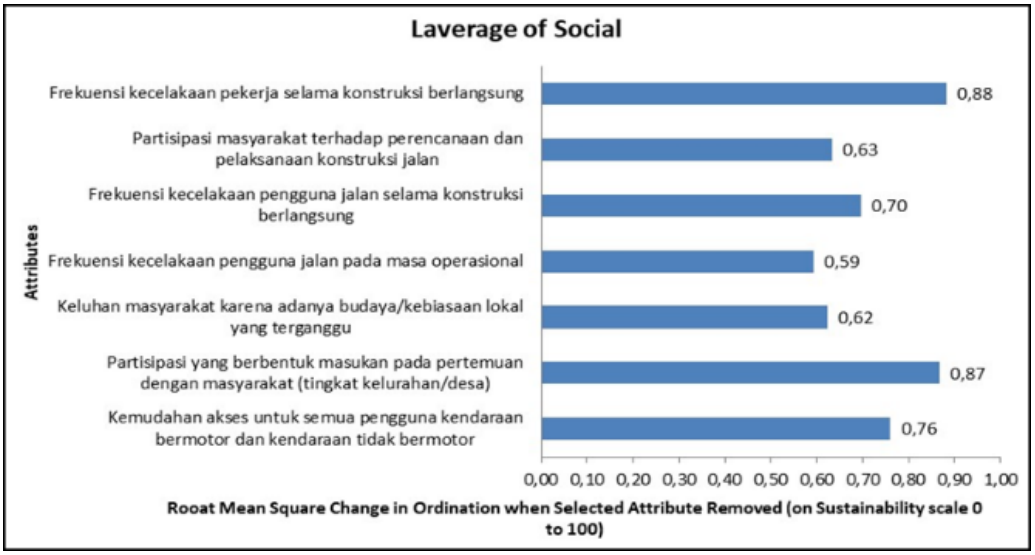

Figure 4. Social dimension sensitive attribute or leverage

Sustainability of Road Maintenance Management Based on Economic Dimensions

The results of the sustainability analysis show that the economic dimension of the sustainability index in road maintenance management in Kendari City is 72.19%, which means that economically the management of road maintenance in Kendari City is in the fairly sustainable category (Figure 5).

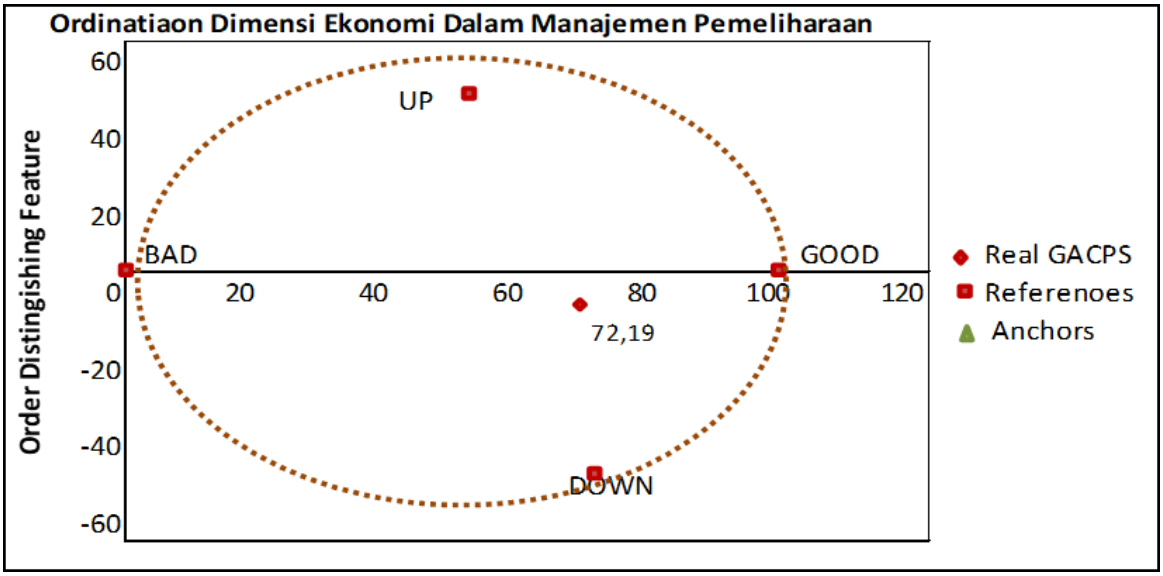

Figure 5. Road maintenance management sustainability index based on economic dimension

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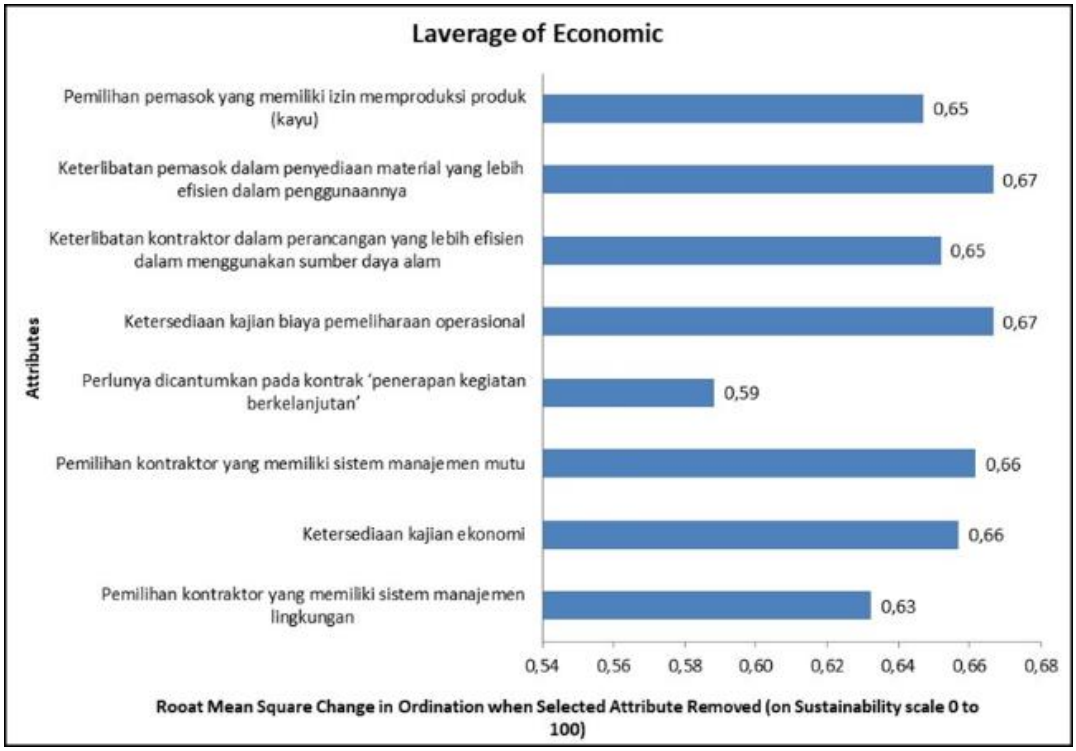

Figure 6. Economic dimension sensitive attribute or leverage

Figure 6 shows that road maintenance management pays enough attention to the economic aspect as the main variable in determining sustainability in Kendari City highway maintenance. In order to increase the sustainability of highway maintenance management in Kendari City, the availability of an operational maintenance cost review is absolutely necessary to maintain road conditions so that they continue to function optimally to serve traffic, so that the specified design life can be achieved. To realize this, the attribute or sensitive leverage (Figure 6) in maintaining road quality requires the involvement of suppliers in the supply of materials that are more efficient in their use as well as the availability of studies on operational maintenance costs. This is intended so that activities related to road maintenance and repair continue to function optimally.

Sustainability of Road Maintenance Management Based on Environmental Dimensions

The results of the analysis of the sustainability index show that road maintenance management in Kendari City has paid attention to environmental aspects as the main variable in determining sustainability with a value of 65.82% or quite sustainable category. However, there are four sensitive attributes or leverage that affect the sustainability of road maintenance management (Figure 8), namely: (a) the level of noise arising from the presence of the road; (b) solid waste that can still be seen on the side of the road; (c) roaming animals are often found in several places in Kendari City; and (d) seepage of rainwater still floods the roadside.

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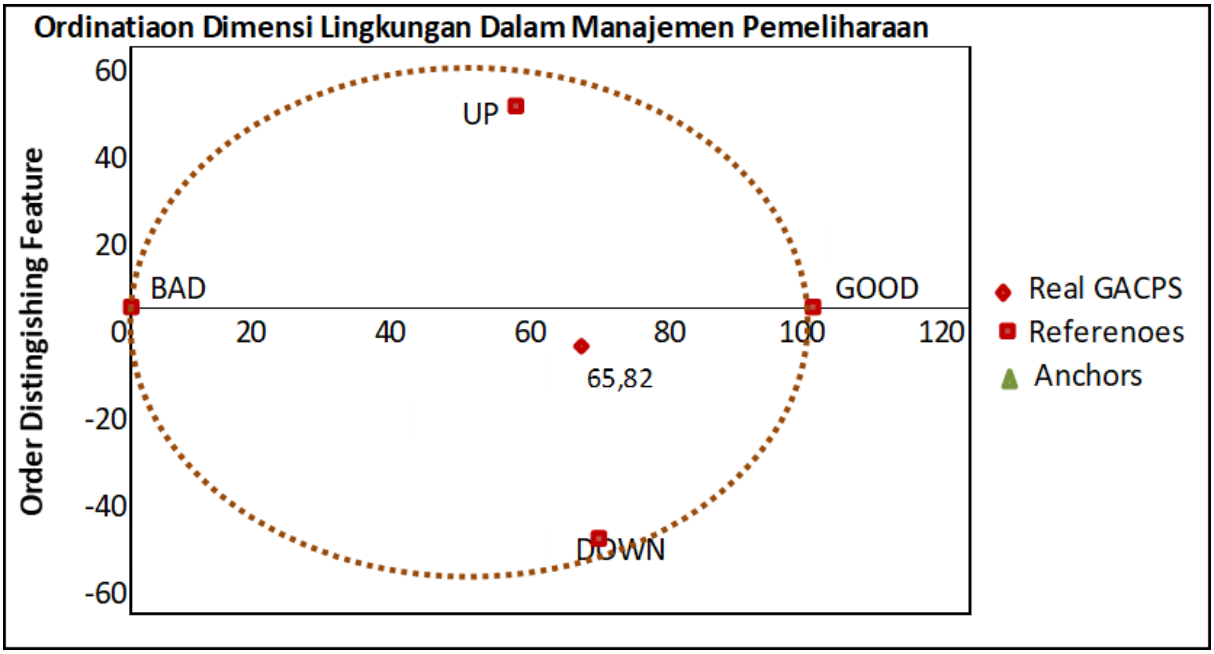

Figure 7. Road maintenance management sustainability index based on environmental dimensions.

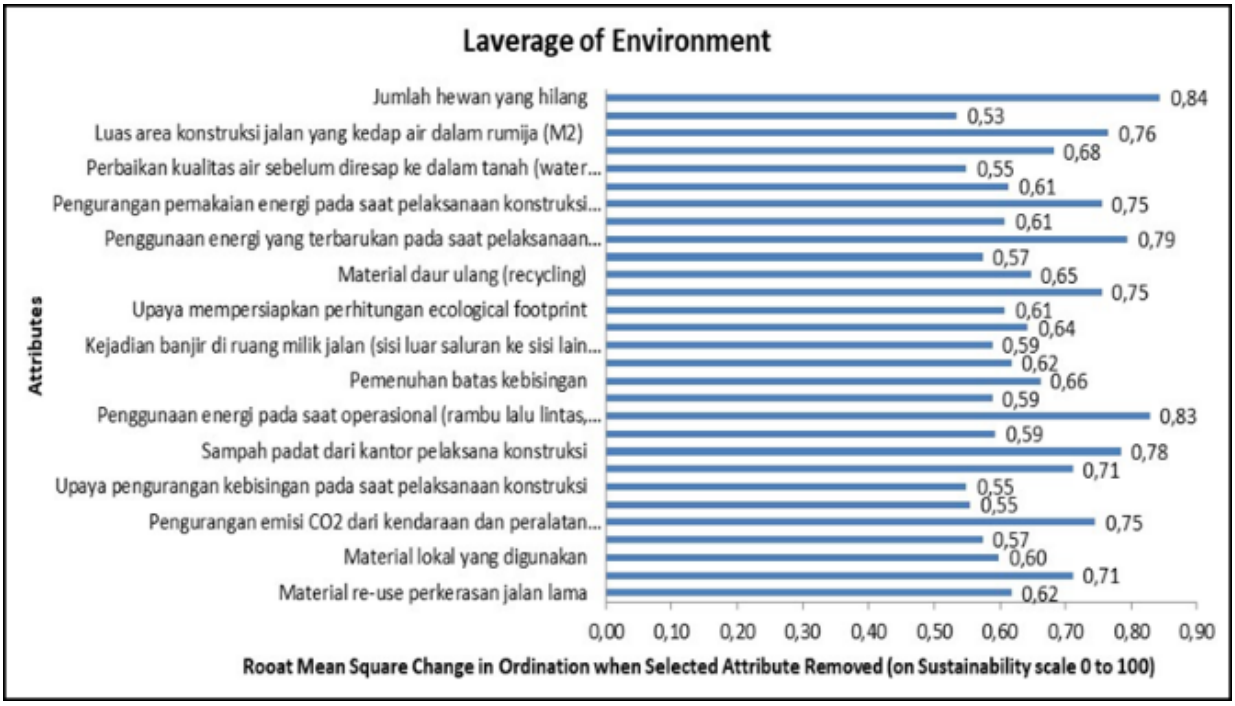

Figure 8. Environmental dimension sensitive attribute or leverage

Road Maintenance Management Sustainability Index in Kendari City

The results of the analysis of the sustainability index of highway maintenance management in Kendari City show that it is included in the Sufficiently Sustainable category with a value range of 50% to 75%, with a social dimension of 64.64%, an economic dimension of 72.19%, and an environmental dimension of 65.82% (Figure 9).

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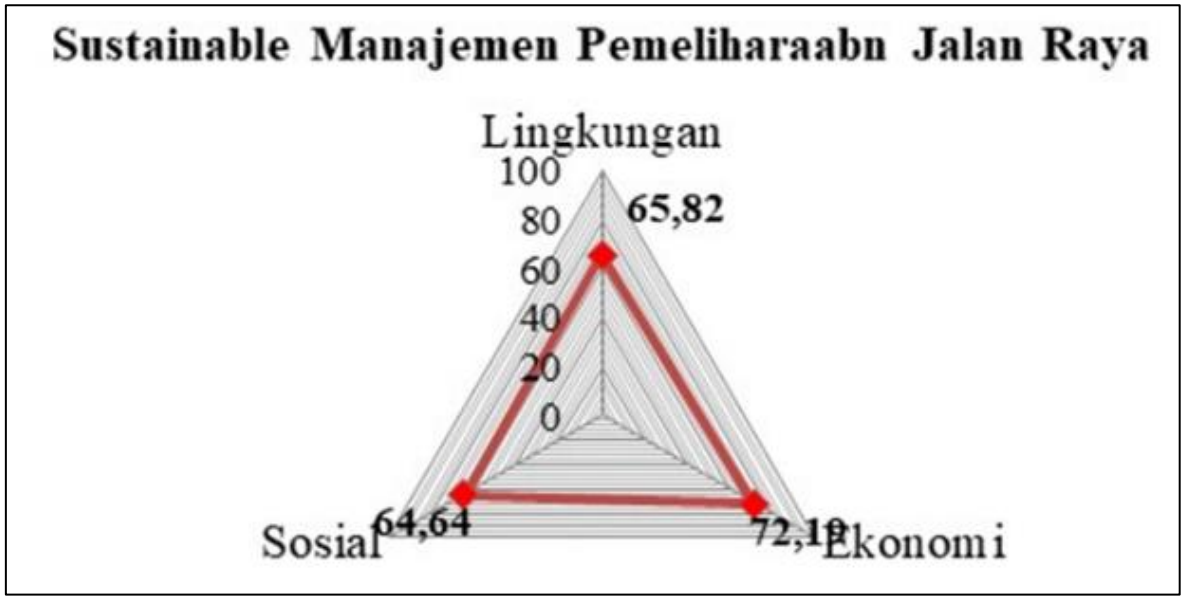

Figure 9. Kite diagram of index analysis and sustainability status of road maintenance management in Kendari City.

Conclusion

The conclusion from the results of this study is that road conditions in Kendari City are in the Light to Moderate Damage Category with road maintenance status, namely Periodic Maintenance to Rehabilitation conditions. The status of the sustainability of road maintenance in the city of Kendari in terms of social, economic and environmental dimensions is in the Sufficiently Sustainable category (> 64 – 72%).

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