Quest Journals
Journal of Architecture and Civil Engineering
Volume 8 ~ Issue 2 (2023) pp: 78-86
ISSN(Online) : 2321-8193
www.questjournals.org

Research Paper

Prioritization of Bridge Infrastructure Handling With Analytical Hierarchy Process (AHP) Method

[1]Darma Dana, [2]Nusa Sebayang and [3]Lila Ayu Ratna Winanda
[1](Magister of Civil Engineering Program Institut Teknologi Nasional Malang Indonesia)
[2](Magister of Civil Engineering Program Institut Teknologi Nasional Malang Indonesia)
[3](Magister of Civil Engineering Program Institut Teknologi Nasional Malang Indonesia)

ABSTRACT: *The bridge is an important infrastructure on the road that plays a role in spurring the economic growth of a region. The current problems are budget constraints, handling priorities that are not reviewed from various aspects and the number of proposals from various parties that each want to be prioritized, so that the prioritization of bridge handling is not subjective and less optimal. In this study using Analytical Hierarchy Process (AHP) method by considering several aspects and criteria including spatial structure (A) with four criteria, community Proposal (B) with three criteria, technical (C) with four criteria, basic services (D) with four criteria. Based on the results of AHP analysis obtained priority aspects in sequence, namely basic services (0.310), technical (0.303), spatial structure (0.236), and Community proposals (0.150). The priority order of handling bridge infrastructure is Jeru Bridge (E1) (0.353) in the first rank, then Petungsewu Bridge (E4) (0.223) in the second rank, followed by Sempol Bridge 2 (E5) (0.156) in the third rank, then Luminu bridge (E3) (0.141) in the fourth rank and Kalipare Bridge (E2) (0.126) in the last rank.*

KEYWORDS: *Analytical Hierarchy Process, Bridge, Handling, Prioritization*

R*eceived 12 Feb., 2023;* ***R****evised 22 Feb., 2023;* ***A****ccepted 25 Feb., 2023 © The author(s) 2023.*
P*ublished with open access at* ***www.questjournals.org***

I. INTRODUCTION

The bridge is a construction structure that can allow transport routes across rivers, lakes, rivers, highways, railways and others[11]. In addition, the bridge has an important role because together with the road becomes the backbone of the transportation system". It is also reinforced by the opinion [7] who stated that the bridge is an important infrastructure on the road that plays a role in spurring the economic growth of a region.

Optimal handling of bridge infrastructure certainly requires good management, starting from the planning stage to the construction stage. The current problem in determining the priority of bridge handling in Malang regency is the limited budget with a high number of handling needs. So far, the bridge handling proposal is based on the results of the bridge condition survey, Village/Kelurahan proposal submission, the proposal of each Technical Management Unit (UPT) and the office and Musrenbang, each of which wants to be prioritized, so that the prioritization of bridge handling is not subjective and does not consider various aspects.

Based on the background described above, research related to prioritization of aspects and criteria considered in determining the planting of bridge infrastructure in Malang regency using the AHP method is very necessary and is based on previous research and existing regulations in decision making. The results of this study are expected to overcome the problems that exist in the prioritization of bridge infrastructure handling.

II. RESEARCH LOCATION

This study was conducted in the Administrative Region of Malang regency, East Java province of Indonesia. Geographically, it is located at 112° 17' 10,90" " up to 112° 57' 00" east longitude and 7° 44' 55,11" up to 8° 26' 35,45" south latitude. The location of the study was carried out on several bridges located on the Regency Road with the function of JKP-4 and serves as a strategic route connecting transportation nodes with the Bromo Tengger Semeru National Parisiwata Strategic Area, South Beach Tourism (Pansela) and road network connectivity. For the location of the study can be seen in Figure 1.

*Corresponding Author: Darma Dana

Magister of Civil Engineering Program Institut Teknologi Nasional Malang Indonesia

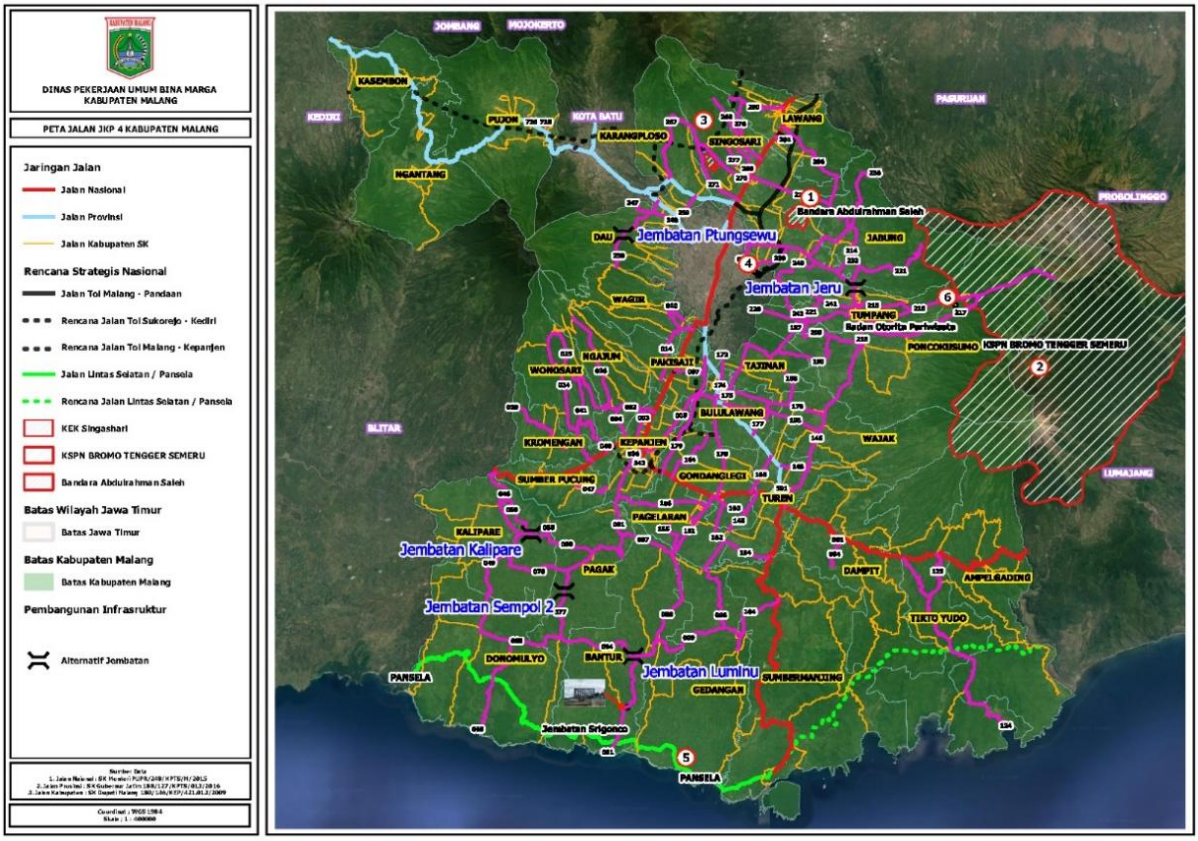

Figure 1: Research location map

Some of the bridge alternatives can be seen in Table 1.

No.	Bridge Name	Field Name	Length (m)	Width (m)	Location
1	Jeru (E1)	Mangliawan - Tumpang	6	7,5	Tumpang Dsitrict
2	Kalipare (E2)	Kalipare - Pagak	9	6	Kalipare Dsitrict
3	Luminu (E3)	Sumbermanjingkulon - Bantur	8,5	8,6	Bantur Dsitrict
4	Petungsewu (E4)	Sumbersekar - Dalisodo	6	5,5	Dau Dsitrict
5	Sempol 2 (E5)	Pagak - Sumbermanjing Kulon	7,5	5,8	Pagak Dsitrict

Table 1: Alternative data bridges that require handling

III. IDENTIFICATION OF RESEARCH VARIABLE

Determination of aspects and criteria based on the results of interviews with experts in this case are policy makers in the field of planning and technical staff in charge of planning and supervision of the bridge at the Department of Public Works Bina Marga Malang regency, consisting of the head of Engineering and functional development of Road and bridge experts and planning technical staff. In accordance with the purpose of the study, the identification of variables/aspects of the study and its definition in this study can be seen in Table 2. The hierarchy used is a functional hierarchy that brekas down complex problems into parts according to their essential relationships which are structurally hierarchy depicted in Figure 2.

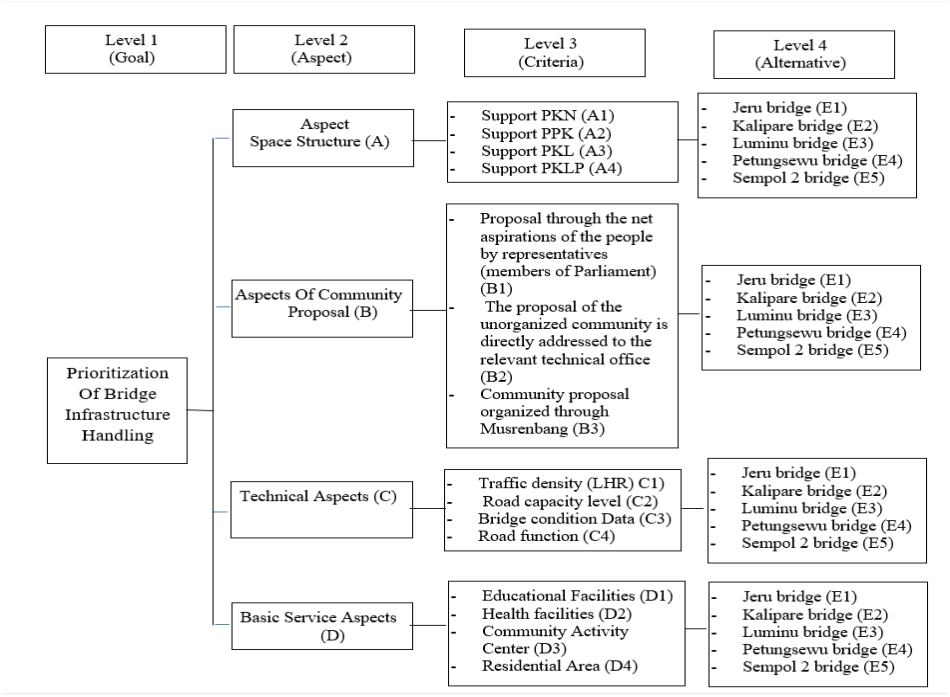

Figure 2: Struktur Hirarki

Aspect	Criteria	Determination Basis
Aspect Space Structure (A)	Support PKN (A1)	- Government regulation of the Republic of Indonesia number 13 of 2017 on amendments to Government Regulation Number 26 of 2008 on National Spatial Plan [3]; - Regional Regulation No. 3 of 2010 on Spatial Planning Malang [2]. - [1]
	Support PPK (A2)	
	Support PKL (A3)	
	Support PKLP (A4)	
Aspects Of Community Proposal (B)	Proposal through the net aspirations of the people by representatives (members of Parliament) (B1)	[5]
	The proposal of the unorganized community is directly addressed to the relevant technical office (B2)	
	Community proposal organized through Musrenbang (B3)	
Technical Aspects (C)	Traffic density (LHR) (C1)	[5]
	Road capacity level (C2)	[5]
	Bridge condition Data (C3)	[6], [8], [10].
	Road function (C4)	[5], [10]
Basic Service Aspects (D)	Educational Facilities (TK, SD/MI, SMP/MTS, SMA/SMK/MA, PTN/PTS) (D1)	Government Regulation Number 2 Of 2018 Minimum Service Standards [4]
	Health facilities (Pukesmas, clinics, hospitals) (D2)	
	Community Activity Center (Market, Village/Sub-District Office) (D3)	
	Residential Area (D4)	

Table 2: Aspects dan Criteria

IV. RESULTS OF RESEARCH AND DISCUSSION

After preparing the hierarchy as described in the previous subchapter, the next step is to prepare the hierarchy in software Expert Choice V.11 in the form of goals,aspects, criteria and alternatives. After the preparation of the hierarchy, the next step is to enter the number and names of respondents in the participants menu. Furthermore, the data from the respondents ' questionnaires are entered into a paired comparison matrix to analyze the level of importance of aspects.

4.1 ASPECT WEIGHTING ANALIYSIS

There are four aspects that are taken into consideration in determining the priority of bridge handling including aspects of spatial structure (A), aspects of Community proposals (B), technical aspects (C) and aspects of basic services (D). The calculation of Aspect priority weighting is done by the following steps:

1. Calculation Of The Initial Matrix
   The calculation begins by analyzing the answers to questionnaires from 15 respondents with the reverse calculation in accordance with the pairwise comparison matrix. Furthermore, the calculation data is poured into the initial matrix of pairwise comparison on the aspect under consideration.
2. Value Calculation Eigen vector
   The calculation is done by adding the numbers in each row in the initial matrix of criteria, then the calculation of the amount of *wi* value in each row. Value wi used to find the amount of value Eigen vector from each aspect.
   $Wi = \sqrt[n]{number\ of\ rows}\,; where\ \ n = number\ of\ aspects$

   Then the value *wi* calculated in each row of the Matrix. The next step is to calculate the value Eigen vector by the following formula:
   Value Eigen vector (Xi) = $\frac{wi}{\Sigma\, Wi}$
3. Value Calculation Eigen Maximum
   Value Eigen Maximum obtained from the initial matrix of aspects multiplied by the value Eigenvector each matrix, then the multiplication results are added to determine the value of Eigen The maximum (λ Max) used in the calculation of the value Consistency Ratio (CR) .
4. Calculation of CR value as control of Consistency Index
   After calculating the value Eigen Maximum (λ Max), then the calculation value Consistency Ratio (CR) by comparing the value Consistency Index by value Random Consistency Index. In this stage, the thing to note is that the CR value should not exceed the required threshold of 10%. Inconsistency Ratio or inconsistency ratio of respondent data is a parameter used to check whether the pairwise comparison has been carried out with consequent or not. The data inconsistency ratio is considered good if the CR value is ≤ 0.10. If the CR value is greater than 10% (inconsistency > 0,10), then the questionnaire must be repeated. The value calculation Consistensy Index (CI) as follows.
   Consistensy Index (CI) = $\frac{(\lambda\ maks - n)}{(n-1)}$, where n = number of aspects considered.
   After calculating the CI value, the next step is to calculate the CR value with the following formula.
   Consistensy Ratio (CR) = $\frac{CI}{RI}$, for n = 4 then the value Random Index (RI) can be seen in Table 3 [9] .

Matriks Sequence	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.58	0.90	1.12	1.32	1.41	1.45	1.49

Table 3: Random Index Value (RI)

5. Aspect Weighting
   The element weight is obtained from the value Eigenvector expressed as a percentage. Selanjunya for the calculation of weighting aspects using the help software Expert Choice V.11.

The results of weighting analysis (combination) of each apek shown in Figure 3.

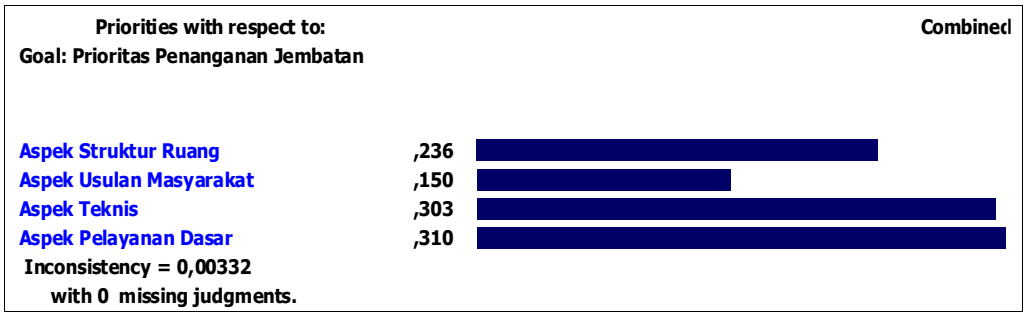

Figure 3: Aspek Weighting Results

Based on Figure 3 shows that the weighting of each aspect that has the largest weight is the aspect of basic services (D) of 0.310 in the first order, then followed by technical aspects (C) of 0.303 in the second order. As for the aspect of Space Structure (A) of 0.236 in the third order and aspects of Community proposals (B) of 0.150 is in the last order. The value of Consistency Ratio (CR) is 0.003, where the value is still below the minimum requirement of CR < 0.10, so it shows a consistent answer. The recapitulation of the results of the weighting of the four aspects contained in Table 4.

Types Of Aspect	Weight
Structural Aspects Of Space (A)	0.236
Aspects Of Community Proposal (B)	0.150
Technical Aspects (C)	0.303
Basic Service Aspects (D)	0.310
CR (Consistency Ratio)	**0.003**

Table 4: Recapitulation Of Aspect Weighting Results

4.2 CRITERION WEIGHTING ANALYSIS

In this study using 4 aspects including aspects of spatial structure (A), aspects of community Usulana (B), technical aspects (C) and aspects of basic services (D). Each of these aspects there are several criteria into consideration in the selection of weighting. As explained in the previous Subchapter on the AHP analysis as a whole, among others, the calculation of the initial Matrix, eigenvector calculation, calculation of the maximum Eigenvalue, control of the Consistency Index, and weighting criteria. The results of the criterion weighting analysis are described below.

1. Criterion weighting based on aspects of spatial structure (A)

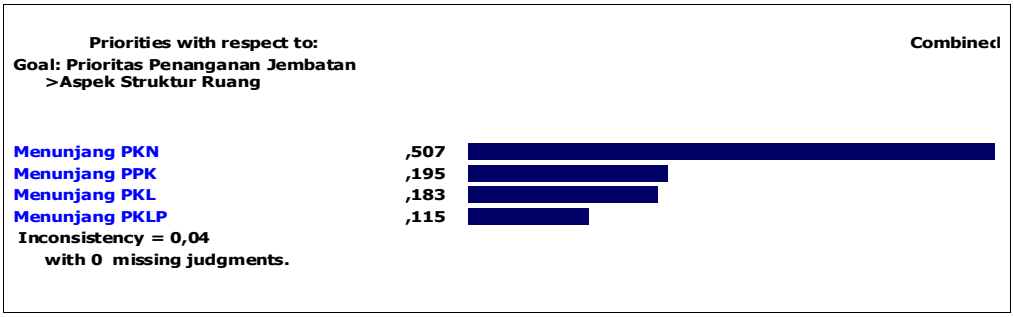

Figure 4: The Results Of The Analysis Of Weighting Criteria Based On Aspects Of Spatial Structure

Based on Figure 4 shows that the results of weighting criteria on the aspect of spatial structure (A) which has the largest weight is the criteria to support PKN (A1) of 0.507, followed by the criteria to support PPK (A2) of 0.195. While the criteria for supporting street vendors (A3) became the third priority with a weight of 0.183 and the criteria for supporting PKLP (A4) was in the last priority with a weight of 0.115. Based on the results of AHP analysis obtained Consistency Ratio (CR) value of 0.040, where the value is still below the minimum requirement of CR < 0.10, thus showing consistent answers.

2. Weighting criteria based on aspects of community Proposal (B)

Figure 5: The Results Of The Analysis Of Weighting Criteria Based On Aspects Of Community Proposals

Based on Figure 5 shows that the results of weighting criteria on aspects of community Proposal (B) which has the greatest weight is the criteria of community proposal organized through Musrenbang (B3) of 0.490, followed by criteria of proposal through the net aspirations of the community by representatives (members of Parliament) (B1) of 0.379. while the unorganized Community proposal criteria directly addressed to the relevant technical Office (B2) is in the last priority with a weight of 0.132. Based on the results of AHP analysis obtained Consistency Ratio (CR) value of 0.001, where the value is still below the minimum requirement of CR < 0.1, thus indicating a consistent answer.

3. Criterion weighting based on technical aspects (C)

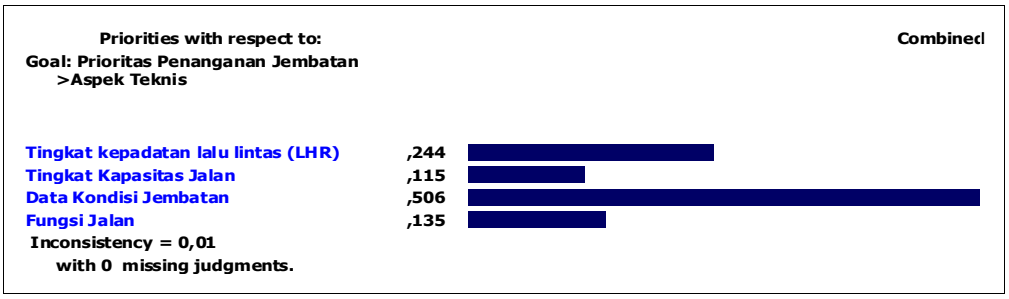

Figure 6: Criteria Weighting Analysis Results Based On Technical Aspects

Based on Figure 6 shows that the results of weighting criteria on the technical aspect (C) which has the largest weight is the criteria of bridge condition Data (C3) of 0.506 followed by criteria of traffic density (LHR) (C1) of 0.244. While the criterion of Road function (C4) is the third priority with a weight of 0.135 and the criterion of road capacity level is in the last priority with a weight of 0.115. Based on the results of AHP analysis obtained Consistency Ratio (CR) value of 0.01, where the value is still below the minimum requirement of CR < 0.1, thus showing consistent answers.

4. Weighting criteria based on aspects of basic services (D)

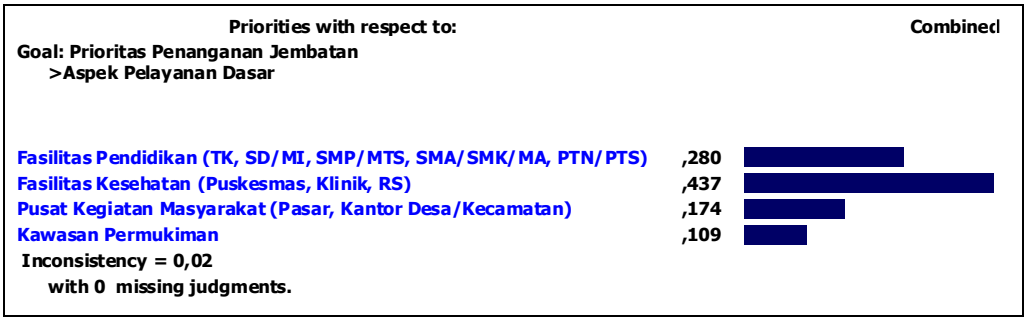

Figure 7: The Results Of The Analysis Of Weighting Criteria Based On Aspects Of Basic Services

Based on Figure 7 shows that the results of weighting criteria on aspects of Community proposals that have the greatest weight are the criteria of Health Facilities (Pukesmas, clinics, hospitals) (D2) of 0.437 followed by criteria of educational facilities (TK, SD/MI, SMP/MTS, SMA/SMK/MA, PTN/PTS) (D1) of

0.280. While the criteria of Community Activity Centers (markets, village/Sub-District Offices) (D3) became the third priority with a weight of 0.174 and the criteria of residential areas (D4) was in the last priority with a weight of 0.109. Based on the results of AHP analysis obtained Consistency Ratio (CR) value of 0.02, where the value is still below the minimum requirement of CR < 0.1, so it shows a consistent answer.

4.3 BRIDGE HANDLING PIORITY

Prioritization of bridge handling as a whole is the final conclusion of several priorities obtained based on consideration of aspects and criteria with AHP analysis. The results of AHP analysis on the selection of bridge handling priorities can be seen in Figure 8.

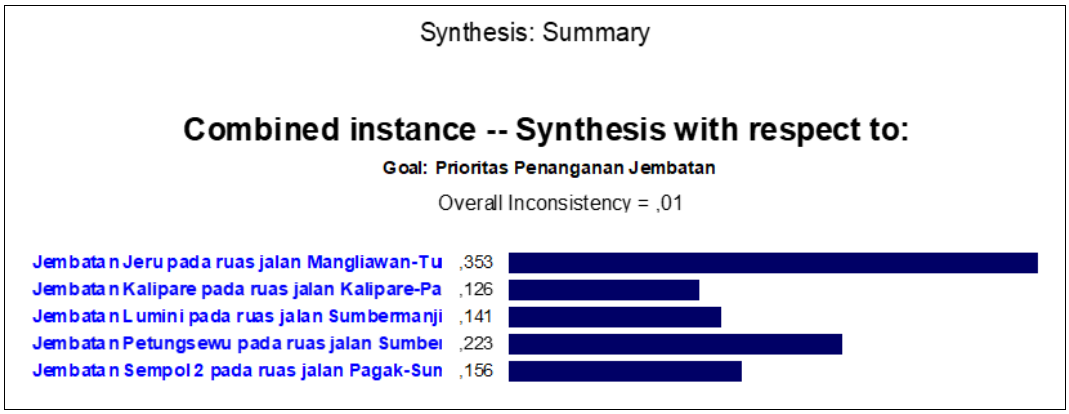

Figure 8: Bridge Handling Priority

Based on Figure 4.28 the results of the synthesis of the combination as a whole obtained first priority is Jeru Bridge (E1) with a weight of 0.353, followed by Petungsewu Bridge (E4) in the second priority with a weight of 0.223. As for the bridge Sempol 2 (E5) is on the third priority with a weight of 0.156, Luminu Bridge (E3) is on the fourth priority with a weight of 0.141 and Kalipare Bridge (E2) on the last priority with a weight of 0.126. The recapitulation of the results of weighting the priority of bridge handling can be seen in Table 5.

Alternative Bridges	Weight	Ranks
Jembatan Jeru (E1)	0.353	1
Jembatan Petungsewu (E4)	0.223	2
Jembatan Sempol 2 (E5)	0.156	3
Jembatan Luminu (E3)	0.141	4
Jembatan Kalipare (E2)	0.126	5

Table 5: Bridge Handling Priority Ranking Order

V. CONCLUSION

Based on the results of the analysis of aspects and criteria considered in determining the priority of handling bridge infrastructure using AHP method obtained aspects of spatial structure (A) (0.236), aspects of Community proposals (B) (0.150), technical aspects (C) (0.303) and aspects of basic services (D) (0.310). As for the criteria such as supporting PKN (A1) (0.507), supporting PPK (A2) (0.195), supporting PKL (A3) (0.183), supporting PKLP (A4) (0.115), the proposal through the net of community aspirations by representatives (DPRD members) (B1) (0.379), the proposal of unorganized communities directly addressed to the relevant technical Office (B2) (0.132), the proposal of organized communities through Musrenbang (B3) (0.490), the level of traffic density (LHR) (C1) (0.244), the level of road capacity (C2) (0.115), condition Data bridges (C3) (0.506), road functions (C4) (0.135), educational facilities (D1) (0.280), health facilities (D2) (0.437), Community Activity Centers (D3) (0.174) and residential areas (D4) (0.109). The priority order of handling bridge infrastructure is Jeru Bridge (E1) (0.353) in the first rank, then Petungsewu Bridge (E4) (0.223) in the second rank, followed by Sempol Bridge 2 (E5) (0.156) in the third rank, then Luminu bridge (E3) (0.141) in the fourth rank and Kalipare Bridge (E2) (0.126) in the last rank.

REFERENCES

[1]. Alexander., A study on prioritization of steel frame Bridge Construction in Sintang Regency. Ex. 1. 2016.
[2]. Anonymous., Malang regency Regulation No. 3 of 2010 on Spatial Plan of Malang regency. Malang, Indonesia. 2010.
[3]. Anonymous., Government regulation of the Republic of Indonesia number 13 of 2017 concerning amendments to Government Regulation Number 26 of 2008 concerning National Spatial Plan. Jakarta, Indonesia. 2017.

[4]. Anonymous., Government regulation of the Republic of Indonesia Number 2 of 2018 concerning Minimum service standards. Jakarta, Indonesia. 2018.
[5]. Brahmantoro, W., Hidayat, S., & Sebayang, N., Roads widening selection in Tulungagung: Application of AHP. International Journal of Scientific and Technology Research, 8(10), 1517–1522. 2019.
[6]. Kholilah., Determining the priority scale of the bridge location that needs to be widened as an effort to break down congestion on the Lawang-Malang Road segment with the Analytical Hierarchy Process (AHP). ITN Malang Thesis. 2017.
[7]. Paksi Aan Syuryadi., Development of Bridge condition Rating Model based on Analytical Network Process in Bridge Management System. Parahyangan Catholic University Thesis. 2017.
[8]. Rakhmatika, R., Setiadji, B. H., & Riyanto, B., Determining the Order of priority handling maintenance of National Road bridges on Bangka island Bangka Belitung Islands province. Media Communication Civil Engineering, 23 (1), 38. https://doi.org/10.14710/mkts.v23i1.12870. 2017.
[9]. Saaty, T.L., Decision making (prints to II), PT. Pustaka Binaman Presindo, Jakarta. 1993.
[10]. Sudradjat, H., Djakfar, L., & Zaika, Y., Prioritization of Bridge handling on East Java provincial road network (UPT Surabaya region: Surabaya City, Sidoarjo regency and Gresik Regency). Civil Engineering, 9 (3), 219-228. 2015.
[11]. Yosephine L Shintike, Jusf J.S. Pah, W. B., Analysis Of The Residual Value Of Building Capacity On Bahanapu Bridge Using Rating Factor Method. Journal Of Civil Engineering, 2015. Iv (1), 79-90.