

Roads Widening Selection In Tulungagung: Application Of Ahp

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Abstract: Tulungagung District is one of the districts that has a very dynamic economic level, thus every year the number of population growth has increased. The addition of the population resulted in increased volume of movement between regions, thus increasing the volume of traffic on the roads. This occurs in almost all the main road segments in Tulungagung District, especially on roads that connect between the district capital and sub-district capitals (JKP-4) as well as connecting roads with community activity centers. The increase in the number of vehicle volumes also occurred in line with the increase in tourist sites in several points that spread throughout Tulungagung District. Therefore, widening the road at this time is very necessary, with the intention of reducing the impact of congestion and increasing the effectiveness of travel time. However, the limitations of the existing development budget have resulted in limited road widening work in the Tulungagung District section. Therefore, priority analysis of the road segments that will be widened earlier is necessary. The data analysis method used is Analytic Hierarchy Process (AHP) for answers from questionnaires distributed to 21 respondents who knew and were involved in allocating road widening funds in Tulungagung District. Based on the results of research and data analysis, it was found that the order of aspects as a priority consideration in determining the allocation of road widening funds in Tulungagung District is a Technical Aspect (C), Regional Development Aspects (A), Aspects of Benefit Value (D) and Aspects of Community Proposal (B), weighing respectively 0.369, 0.315, 0.246 and 0.070.

Index Terms: Alternative, Analytic Hierarchy Process, Government Development, increasing traffic, Priority, Selections, Widening Roads.

1. INTRODUCTION

TRANSPORTATION has a very important role and its position is very decisive for people's lives and the continuity of development. It is often said that transportation is the lifeblood of the economy and as a support for development, therefore the improvement of transportation is absolutely implemented not only in sectoral terms but effective and efficient transportation is very necessary to serve transportation activities in various economic sectors [1]. The transportation development policy is directed to the provision of transportation facilities and infrastructure needed to support the smooth flow of goods and people from the place of origin (point of origin) to the destination (point of destination) [2]. Tulungagung District is one of the districts that has a very dynamic economic level thus each year the number of population growth increases. The addition of the population resulted in increased volume of movement between regions, thus increasing the volume of traffic on the roads. This mostly occurs in several connecting roads between sub-districts, collector roads and even on several local roads. The increasing

incidence of traffic congestion mainly occurred in almost all the main road segments in Tulungagung District especially on roads that connect between the district capital and the sub-district capital (JKP-4) and connecting roads with community activity centers [3]. The increase in the number of vehicle volumes also occurred in line with the increase in tourist locations in several points that spread throughout Tulungagung District. At present almost in every sub-district even in villages have tourist attractions, both for local and outside visitors.

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The road capacity is often calculated mainly based on number of lane and their width, basically their physical conditions. In Indonesia, road capacity is calculated with Indonesian highway capacity manual (MKJI) method, by considering basic road capacity (determined by road type), and adjustment factors such as lane width factor in relation to total road width, separation factor, side friction factor which determined by roadside facilities (curb or shoulder) and roadside activities, and city size factor [4]. With the increase in the volume of vehicles from year to year which is not balanced with the addition of existing road capacity, it creates problems that must be resolved immediately. These problems if left unchecked will hamper community activities, especially in terms of economy and tourism. Examples of these problems include traffic congestion and even trigger congestion at several points on the connecting road segments between sub-districts and with increasingly dense volumes of vehicles that are not proportional to the capacity of roads, this will increase travel time and vehicle operating costs, thereby reducing the level of driving efficiency. Therefore, widening the road at this time is very necessary, with the aim of reducing the impact of congestion and increasing the effectiveness of travel time. Given the limited development budget, the road widening work in Tulungagung District section is also limited. Furthermore, Priority for Road Section Selection should be carried out by widening, thus it will help decision makers to allocate the limited funds to roads which indeed need to be prioritized in handling road widening. With an illustration in 2016, 2017, 2018 Tulungagung District has budgeted funds for widening roads as much as Rp 38.380.3200.000, Rp 16.250.000.000, Rp 47.950.000.000. This is very limited considering that Tulungagung district has 1024 roads in the entire Tulungagung area with a road width of less than 6.5 meters as much as 90% (Tulungagung District Head's Decree regarding the status of the road). For this reason, more budgets are needed for road widening activities in accordance with the Appendix of the Minister of Public Works Regulation Number 19 Year 2011, namely for environmental roads and roads that have the above road classes required to have a minimum road body width of 6.5 meters. In overcoming the problem of effective and efficient road widening subscription implementation, boundaries must be determined which cover the amount of

budget needed / allocated, schedule / time, location of activities and quality / performance to be achieved. The problem that often occurs in the District is the lack of budget / costs in carrying out road widening activities, where the number of roads that must be handled immediately is not balanced with the budgeted funds for these activities. Therefore there is a need to prioritize / determine the road segment to be carried out by widening the road segment. This selection certainly requires the right criteria and methods so that the policies taken are appropriate, effective and accountable. Alternative selection with several criteria can be done by various methods including Dominance method, Feasible Ranges, Lexicography, Effectiveness Index or Analytical Hierarchy Process [5]. Each method has its own advantages and disadvantages, and the selection of methods to be applied should be adjusted to the problems to be addressed. Every year Tulungagung district government holds a Regional Development Planning Meeting (Musrenbang), aimed at increasing regional development evenly with the medium-term development plan program or Tulungagung district RPJMD [6]. In addition Musrenbang aims to determine the direction of development policy in Tulungagung District for the following year. To determine the order of priority for road customers in Tulungagung District is currently based on community proposals through the Musrenbang (Development Planning Deliberation) mechanism with the Regional Planning and Development Agency of Tulungagung District or through requests for proposals from each region starting from the village level by determining budget and road technical criteria. However, the selection of criteria that affect the order of priority is still limited to agreement on the Musrenbang forum and has not been based on certain methods that can be scientifically accounted for, so the issue of the priority order of road segment subscriptions, especially road widening, is still uncertain. The choice of which alternative should be chosen, makes a problem that must be solved thus alternatives can be obtained which can be used as a reference to determine priori activities that must be implemented immediately. From the description above it is necessary to do research to obtain a way of decision making in handling road widening, thus it can be accounted for and effectively adjusted to the existing budget. For that, excavation of aspects and criteria used in this study can support the selection of alternatives to be determined priorities, one of the appropriate methods in determining the selection of priorities and the order of alternatives is the Analytical Hierarchy Process (AHP) method. This method is also used in previous studies that are relevant to research on Priority Analysis of Widened Roads Selection in Tulungagung District. Until now no research has been conducted on the application of AHP method to determine the alternative selection of road widening activities in Tulungagung District, so research using AHP method is very necessary.

2 LITERATURE REVIEW

2.1 ROAD

According to the Master Plan for the Acceleration and Expansion of Economic Development (MP3EI, 2011), infrastructure, including roads, ports, airports, power plants, availability of water, waterways, telecommunications and other infrastructure is needed to strengthen relations within and outside of economic growth in the future. The aim is to improve the efficiency of distribution services and support

economic growth, especially in areas that have high levels of development [7]. Roads are land transportation infrastructure covering all parts of the road, including complementary buildings and equipment intended for traffic, which are on the surface of the land, above the ground, below the surface of the land and / or water, and above the surface of the water, except railroads, lorry roads and cable roads [8]. Road is a land transportation infrastructure that connects two or more locations. Road consists of several parts with specific goals and functions that are formed in a construction. Road construction generally consists of different layers of material, according to the properties used. Broadly speaking, there are three types of pavement construction, namely flexible, rigid and composite pavement [9].

2.2 ROADS WIDENING

By definition, road widening is the addition of the width of the cross-section of the road both in the space of the road and outside the road space which is done by land acquisition to get more benefits related to the function of the road. Road space is a space for road benefits and a certain amount of land outside the benefits of the road intended for space for road benefits, widening the road, adding traffic lines in the future as well as space requirements for road security and is limited by a certain width, depth and height. Rumija as intended besides being used for space for road benefits, can be used for:

1. Roads widening or adding traffic lanes in the future;
2. Space requirements for road security;
3. Green open space that functions as a road landscape;
4. Space requirements for placement of utilities [10].

Widening of the road is very necessary to do with the following objectives:

1. Increase road capacity by reason of reducing traffic congestion so as to increase travel effectiveness and travel time.
2. Meeting road width standards aimed at providing comfort and security for road users.
3. Attract investors from outside the region, because proper infrastructure will encourage investors to invest in the region.
4. Increasing tourism with easy access to tourist attractions will further encourage people to visit.

Improving the economy because with adequate traffic capacity it will facilitate the expansion of economic commodities.

2.3 RELATIONSHIP OF TRAFFIC FLOW WITH TRAVEL TIME

The amount of travel time on a road depends on the size of the current and the capacity of the road. The relationship between current and travel time can be expressed as a function where if the flow increases, the travel time will also increase. According to, this is actually a basic concept in queuing theory which states that delays that occur at arrival and service levels are randomly distributed. The concept of queuing in service time refers to the minimum time needed for a vehicle to pass through a road in accordance with the level of road services available. Service time is the travel time needed when there are no other vehicles on the road (free flow conditions). Thus the queue delay can be considered as an increase in travel time due to the presence of other vehicles that can be stated as follows:

$$T_q = T_o + W_q \dots\dots\dots(2.1)$$

where

TQ : Travel Time
 TO : Service Time
 WQ : Delay

Travel time also affects costs, in this case the time value affects the value of money. If the road is widened, of course it will increase road capacity and reduce travel time. With the increase in the width of the road it will shorten the travel time, this will affect the cost. This makes the Vehicle Operating Costs (BOK) more efficient by decreasing the fuel used and extending vehicle maintenance, thus it will be more economical [11]. In addition, with the reduced travel time increasing the level of the economy of the rider if the time of productivity is calculated per hour, the driver will get faster thus they will quickly carry out their goals, especially for motorists who will conduct economic transactions.

3 RESEARCH METHOD

This study used a survey method by capturing opinions, experiences and attitudes of respondents who knew the problems experienced in determining the selection of road widening alternatives in Tulungagung District, by taking primary data through a questionnaire. Based on the priority aspects and criteria for road widening in Tulungagung District, therefore Aspects, criteria and alternatives will be determined to be used as questions to be measured in the form of questionnaires. Furthermore, from the results of the questionnaire the data will be processed using the AHP data processing software tools (Expert Choice version 11).

3.1 RESEARCH LOCATION

The location of this research was carried out on several roads in Tulungagung District which functioned as a strategic lane that connected between sub-districts, agricultural centers, markets and tourist attractions can be seen in the following figure :

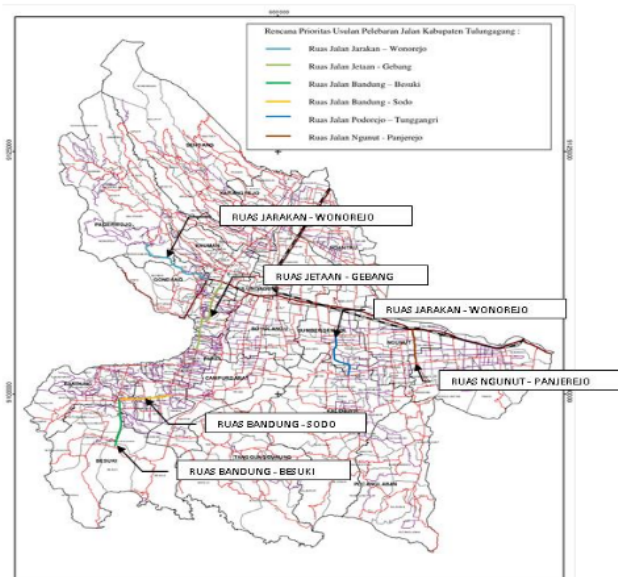


Figure 3.1 Map of Research Location

Then, for technical data on the road to be widened can be seen in Table 1.

3.2 PRIORITY ASPECTS AND SELECTION CRITERIA

- Regional Development Aspects
 - Economic Activities (A1)
 - Geographic Position (A2)
 - Tourist attraction (A3)
 - Natural products (A4)
- Aspects of community proposal
 - Proposal through the Community Aspiration Net by representatives of the people (DPRD members) (B1)
 - Community proposals that are not organized are directly addressed to the relevant technical services (B2)
 - Found in RPJMD (B3)
 - Community proposals that are organized through Musrenbang (B4)

Table 1. Road Section Technical Data to be widened in Tulungagung District

No.	Roads	Road Function	Length (km)	Width	Widening plan (right, left)
1	Jarakan – Wonorejo	Collector	7,411	3,50	1,5 m x 2
2	Jetaan - Gebang	Collector	7,976	4,50	1 m x 2
3	Bandung – Besuki	Collector	4,988	5,00	1 m x 2
4	Bandung - Sodo	Collector	4,722	4,50	1 m x 2
5	Podorejo – Tunggangri	Collector	5,128	5,50	1 m x 2
6	Ngunut - Panjerejo	Collector	3,486	5,50	1 m x 2

- Technical aspects
 - Traffic density (LHR) (C1)
 - Road capacity level (C2)
 - Vehicle tonnage load level (C3)
 - Road function (C4)
- Aspects of Benefit Value
 - Vehicle Operational Cost Savings (BOK) (D1)
 - Economic Development Potential (D2)
 - Improved Driving Safety (D3)
 - Time Efficiency (D4)

3.3 POPULATION AND SAMPLES

What is meant by population is a collection of all individuals with predetermined quality, quality or characteristic is called a variable. While what is meant by sample is a collection of sampling units drawn and are sub-populations. Population is determined based on experience in the field of people who are considered experienced and know about the development process from the aspect of initial planning, the auction process and the physical development process in the field. Where these people are in each agency / company. While the sample is taken from the population considered to represent all agencies / companies [12].

3.4 AHP METHOD (ANALYTIC HIERARCHY PROCESS)

AHP method is a method of decision making that structures complex problems in a hierarchy consisting of several levels that contain objectives, several aspects and or criteria of consideration and a number of alternative solutions [13]. These aspects, criteria, and alternatives are then referred to as decision elements. These elements are compared with each other in pairs and their respective relative priority weights are determined to get overall priority as the final result of AHP [14]. AHP Working Principle is a simplification of a complex problem that is unstructured, strategic, and dynamic into its parts and organized in a hierarchy. Then the level of importance of each variable is subjectively assigned a numerical value about the relative importance of these variables compared to other variables. From these various considerations, a synthesis is carried out to determine variables that have high priority and play a role in influencing the results of the system. Graphically, the AHP decision process can be constructed as a multilevel diagram, which starts with the goal / target, then the first level aspect, finally alternative criteria. Some of the benefits obtained when solving problems and making decisions using AHP are [15]:

- a. Complexity

AHP combines deductive steps and system-based steps in solving complex problems.

- b. Dependency
AHP can handle the interdependence of elements in a system and does not impose linear thinking.
- c. Hierarchy Organization
AHP reflects the natural tendency of the mind to sort out elements of a system at different levels and classify similar elements in each level.
- d. Consistency
AHP tracks the logical consistency of the considerations used to set priorities.
- e. Assessment and Consensus
AHP does not impose consensus but synthesizes a representative result from a variety of different judgments.

- f. Process Repetition

AHP allows organizations to refine their definition of a problem and improve their considerations and understanding through repetition.

AHP is used to determine the weight of each aspect, criterion, and alternative. This weighting process is carried out with the help of Expert Choice version 11 software. The following are the steps of analysis using AHP:

1. Arrange a hierarchical structure based on the results of the questionnaire and develop a hierarchical structure consisting of aspects, criteria and alternatives.
2. Collect pairwise comparison data for all aspects, criteria and alternatives using simple random sampling technique.
3. Compile pairwise comparison matrix for all aspects, criteria and alternatives.
4. Calculate the respondent's average geometric answer based on the equation for all aspects, criteria and alternatives.
5. Input all results of step 4 into the Expert Choice software.
6. Check the correlation test results in each paired comparison matrix.
 - Calculate CI based on the equation.
 - Calculate CR based on the equation; if $CR = 0$ for $n = 2$, $CR \leq 5\%$ for $n = 3$, $CR \leq 8\%$ for $n = 4$ and $CR \leq 10\%$ for $n = 5$, then the matrix is consistent. If there is a pairwise comparison matrix that is inconsistent, pairwise comparisons are made. Then, change the a_{ij} the cause of inconsistency to be w_i/w_j based on the equation.
7. Make decision
 - Calculate alternative score tables in pairs with alternative aspects, criteria and scores.
 - The end result is a priority scale or rank that is sorted by the highest total score to the lowest [16].

3.5 DATA COLLECTION

Data collection was done through a questionnaire with statement items relating to the assessment of each Aspect and Criteria and the alternative uses a 9-1-9 scale pairwise comparison where number 1 was the code of respondent's response stating that both elements are equally important, while number 9 was the respondent's response code which states that one absolute element is more important than the other elements.

3.6 DATA PROCESSING AND ANALYSIS

Data obtained from survey results (questionnaires) will be processed to obtain information in table form. The processed data results are used to answer questions in the formulation of the problem. Data processing should pay attention to the type of data collected by concentrating on the objectives to be achieved. The accuracy of analytical techniques greatly influences the accuracy of the results of the study. The data analysis technique used was the AHP method with Expert software tool Choice version 11.

4 ANALYSIS AND DISCUSSION

4.1 GENERAL OVERVIEW OF RESEARCH

The data in this study were obtained from the results of questionnaires to 21 respondents, then followed by an analysis to find the priority aspects and criteria for road widening that require allocation of funds to the Public Works and Spatial Planning Department of Tulungagung, Aspects, Criteria and Alternatives to be used as questions to be measured in the form of questionnaires. Furthermore, the results of the questionnaire will be analyzed to obtain the weight of aspects, criteria and alternatives. This research was carried out on several roads in Tulungagung District which functioned as a strategic route that connects sub-districts, agricultural centers, markets and tourist attractions.

4.2 DETERMINATION OF ALTERNATIVE PRIORITIES

A functional hierarchy is needed to bring this research towards the desired goal. Hierarchy used is a functional hierarchy by describing complex problems into their parts according to their essential relationships. The first level is the goal, namely the determination of criteria for determining the widening of the road. The second level is the criteria where there are four types of aspects. The third level is the sub criteria where there are 16 types of criteria. The fourth level is alternative. For the initial stage of data processing was to enter data from the results of comparison questionnaire obtained from 21 respondents with the weight of the assessment into Expert choice version 11. After all the data were declared consistent then the geometric mean values for each pair of aspects will be obtained, which then an aspect weighting calculation will be carried out. There were four aspects considered as factors in allocating funds for the construction of road improvements, namely: Regional Development Aspects, Aspects of Community Proposals, Technical Aspects, and Cost Aspects. From the results of the research, the weight of the criteria for each aspect, criteria and alternatives were calculated. The most recent results were obtained by alternatives as a whole which were the final conclusions of the main priorities based on aspects and criteria. The results of the priority weights for widening road sections obtained from the calculations are presented in Table 2.

Table 2. Priority Weight for the Selection of Widened Roads

Alternative	Weight
Jarakan – Wonorejo (E1)	0.120
Jetaan - Gebang (E2)	0.301
Bandung – Besuki (E3)	0.158
Bandung - Sodo (E4)	0.132
Podorejo – Tunggangri (E5)	0.130
Ngunut - Panjerejo (E6)	0.161

5 CONCLUSIONS AND SUGGESTIONS

5.1 CONCLUSIONS

From the results of the analysis and discussion in the previous chapter, conclusions can be taken as follows:

- The order of magnitude of aspects used in determining the allocation of road widening funds in Tulungagung District are Technical Aspect (C), Aspects of Regional Development (A), Aspects of Benefit Value (D) and Aspects of Community Proposal (B), weighing 0.369, respectively. 0.315, 0.246 and 0.070. While the weighting criteria for A1 A2, A3, A4, B1, B2, B3, B4, C1, C2, C3, C4, D1, D2, D3 and D4 with weights respectively 0.310, 0.098, 0.407, 0.185, 0.114, 0.067, 0.343, 0.476, 0.281, 0.508, 0.072, 0.139, 0.309, 0.474, 0.069 and, 0.148.
- The order of alternative ranking of roads in Tulungagung District which needs to be expanded are (1). Jetaan - Gebang (E2) with the weight of 0.301, (2). Ngunut - Panjerejo (E6) with the weight of 0.161, (3). Bandung – Besuki (E3) with the weight of 0.158, (4). Bandung - Sodo (E4) with the weight of 0.132, (5). Podorejo – Tunggangri (E5) with the weight of 0.130 and (6). Jarakan – Wonorejo (E1) with the weight of 0.120.

5.2 SUGGESTIONS

Based on the results of the analysis of this study, it is suggested to the parties involved (policy makers) to:

- The budgeting for determining the selection of road widening activities in Tulungagung District should use clear and measurable mechanisms. Analytical Hierarchy Process (AHP) is one of the selection methods suggested in alternative selection.
- The Regional Government needs to formulate a mechanism for determining aspects and criteria in the selection of alternatives. This mechanism can be carried out by conducting socialization through official meetings involving all elements of government and community representatives as well as the population used in the research above.
- It is advisable to hold a discussion between stakeholders in determining the criteria that are in accordance with the conditions in the future, thus all interests in the form of criteria can be accommodated according to the needs at that time. Thus the people in Tulungagung District will better understand the direction of local government development thus it is hoped that conflict will not occur and development will be more accountable.
- Subsequent research can be carried out using aspects, criteria and other alternatives to obtain more applicable research results.

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