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TRAFFIC IMPROVEMENT STRATEGY IN TRANSPORTATION SYSTEM USING AHP METHOD

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ABSTRACT

The main problem of cities in Indonesia is transportation, one of which is traffic. Motorized vehicle traffic that passes through a network affects the road's ability. Traffic flows and patterns of movement of urban residents are very diverse. Road handling is based on the high volume of vehicles, traffic density and the impact on the low speed. The decrease in vehicle speed results in optimal utilization of the road segment. The research was carried out in two data collections, the first was data collection in the densely populated area of Bogor city and in the potential area of Bogor district. Furthermore, in the buffer zone of the city and district borders for each selected location, 5 (five) locations were identified, at 1) intersection the three-arm signaled of the Salabenda in Kemang, 2) intersection the four-arm signaled of the Semplak in Semplak, 3) intersection the signalized the three arms of the Bubulak in Bubulak, 5) intersection the four-arm signaled of the POMAD in Ciluer and 5) intersection the four-arm signaled of the Ciawi in Ciawi. This study aims to obtain a strategic model of traffic engineering decision making in the transportation system. The technology criteria place a standardized and mutually supportive system for decision making. The real and supportive condition is technology. Experts agree that to model the strategic concept of traffic engineering in the transportation system is to focus on TECHNOLOGY criteria. Technology occupies the first level of 0.456%, so technology is a benchmark in the management of modern transportation that should be relied on. Technology both in terms of traffic engineering, APILL and geometric conditions as well as public transportation with the concept of multi-mode and mass public transportation as a substitute for public transportation that is no longer feasible to operate. The results of the pairwise comparison assessment of the five criteria above show that the value of the consistency ratio is 0.085, meaning that < 0.1, which is required by Saaty, has met. Where Saaty sets the Consystency Ratio (CR) value to be less than 0.1, so that the pairwise comparison calculation fulfills.

Keywords: traffic, strategy improvement, transportation, traffic volume, AHP method.

1. INTRUDUCTION

The city of Bogor with an area of 11,850 ha, is located at 106º 48' East Longitude and 6º 36' South Latitude, ± 56 Km South of the Capital City of Jakarta and ± 130 Km West of Bandung City, the Capital of West Java Province. The area of Bogor City is bordered by, to the north: Kemang District, Bojong Gede, and Sukaraja District, Bogor Regency. To the East: Sukaraja District and Ciawi District, Bogor Regency. On the west: Dramaga District and Ciomas District, Bogor Regency. To the South: Cijeruk Subdistrict and Caringin District, Bogor Regency [1]. The population of the city of Bogor in the statistical data collection is 1.097 million people [2].

Bogor Regency has an area of 2,663.81 km^2 located at 106º 01' and 107º 103' east longitude and 6º 47' south latitude and 6º 19' north latitude. Has a diverse morphology with an altitude of 15-100 masl at 29.28%, 42.62% at an altitude of 100-550 masl while 19.53% is in the range of 500-100 masl and 8.43% is at 1000-2000 masl, the rest the mountainous part is > 2000 masl which is 0.22%. Road conditions in Bogor district are 69.5% good, 7.5% badly damaged, 15.5% moderate damage and 7.5% damaged condition [3]. Meanwhile, the population of Bogor Regency is 6.088 million people [4].

The main problem of cities in Indonesia is transportation, one of which is traffic. Motorized vehicle traffic that passes through a network affects the road's ability. Traffic flows and patterns of movement of urban residents are very diverse. The diversity of the journey of the citizens of the city resulted in the number of residents passing through the area is also increasingly diverse. Population mobility requires adequate transportation facilities and infrastructure. Adequate facilities and infrastructure must meet criteria such as safe, comfortable, affordable for the community [5-8]. Driving safely, comfortably, carefully while traveling can ensure the safety of drivers on the road, especially from accidents. This is very influential on the safety of road transportation [9-10].

The highest vehicle traffic movement in Bogor City is on toll access roads. This is followed by movement to and from the city center and transition areas. There are three alternative urban villages as directions for regional activity centers in Bogor City, all three of which are located on the outskirts of Bogor. The three villages are Margajaya, Cimahpar and Bojongkerta villages. Among the three areas that are the direction of the Bogor City regional activity center based on this research, only Margajaya is in hierarchy 1, but if we look further, the relationship with its neighboring areas in Bogor Regency, all three have strategic values. Margajaya is adjacent to Dramaga, where is located the leading university in

Indonesia, namely IPB. Cimahpar can penetrate the Bogor Outer Ring Road toll road which is predicted to continue to grow [11].

Vehicles that pass through the road are very varied, both non-motorized vehicles, light vehicles and heavy vehicles. Road handling is based on the high volume of vehicles, traffic density and the impact on the low speed. The decrease in vehicle speed results in optimal utilization of the road segment. These include side barriers, bottlenecks, road physical conditions, and unbalanced development [12-16]. Traffic flow also affects optimally or almost all roads are close to saturation if it is known that the number of vehicles is close to solid [17].

The national road network has a very important role in the development of a region, not only in the field of infrastructure but also in the economic, social, cultural, and security aspects. Likewise, the Bandung-Purwakarta National Road which connects industrial areas in West Java, such as Purwakarta and Karawang with Bandung as the capital city of West Java province [18].

In analyzing the overall road performance service is an approach in solving the assignment model of the road network system. So the study trip assignment analysis model is the basis for estimating the transportation needs in the road network system in integrating with its environment. This change will improve the road network system in the destination zone for goods or people. The direction of movement of the distribution of the trip assignment analysis model will direct the movement according to the level of congestion experienced by the road network system. The resulting analysis trip simulation task will show a system wide road network burdened by large traffic volumes according to road capacity or exceeding the specified lane capacity on roads and highways [19-21].

Time series data from 2009 to 2013 which is secondary data obtained from IRMS data on the Losari - Cirebon road segment. This data will be used in the calculation of the cumulative value of the load and the estimated traffic growth rate for the analysis of structural conditions [22].

If the vehicle that passes through a certain road has a congested lane, it is called the service level of that road section is very low. It can be categorized that the level of service is poor for certain roads. In addition, motorized vehicle traffic requires regular and intensive regulation so that the conditions can be balanced and can be passed by motorized vehicles [23].

Vehicle traffic begins with a regular route and public transportation with a very regular route permit as well. This regularity will result in orderly traffic. Good and correct driving is followed by obeying traffic signs in a tested manner. Drivers are expected to comply [24]; [17]; [25]. The relationship between speed, volume and density is the relationship between speed (v), volume (q) and density (k) called the basic diagram of the level of road activity. This relationship in the form of a curve can empirically be described. The increase in vehicle speed is affected because the traffic volume on the road is low, if the traffic volume is high, the vehicle speed on the contrary is low [26-28].

Traffic in the city of Bogor is quite high. With this density level, the city of Bogor is classified as the second most congested city after DKI Jakarta. Based on these criteria, a real picture is given in the field. The description of Bogor city traffic can be taken into consideration in making policies regarding transportation. Spatial development policies for urban development are in accordance with the basic concepts of regional development [29].

The road sections, including those studied, require maintenance and are national roads that have a very high traffic volume. To maintain the structural and functional conditions, it is necessary to carry out road maintenance on a regular or periodic basis according to certain conditions and periods of time in the form of adding thick overlays. There are various methods and approaches from various countries that can be used to calculate overlay thickness. These methods and approaches from various countries certainly produce different overlay thicknesses based on the type of material and the geographical conditions of the country. So that the influence of high traffic affects road performance including the strength of the subgrade [30].

The pattern of utilization of potential areas within the scope of influence on transportation developments in certain areas has an impact and changes. Changes in the positive and negative levels will be the pattern of transportation trips from the adjacent environment. A real approach in utilizing space, can be done using the concept that some areas contribute to the progress of transportation. This assumption is realized by regional cooperation with one another with a clear pattern. Followed by rules that provide free movement of transportation developments in accordance with agreed regulations. [31-32]; [36].

Road infrastructure is one element that is quite strategic in supporting development in addition to accelerating the flow of activities, the economy and facilitating the mobility of the population between regions. With the increasing development activities, it is also required to have an increasingly adequate road network. The pattern of people's journeys in improving the economy is also highly demanded so that each trip has a direct influence in terms of economic, social and sustainability. The policy pattern of strength includes social aspects, recreational activities and two other aspects, namely security and comfort aspects in traveling [33-35].

The position of transportation is to bridge all human activities within the regional structure. The function of transportation is to mobilize the flow of movement of people and goods. Movement or travel occurs because humans carry out activities in different places from the area where they live. Mobility activities of producers and consumers from and to the location of interaction to move the wheels of the economy require transportation facilities and infrastructure [37].

The contribution of regional planning in traffic movement is to regulate the location of the activity of a land use or land use in order to also regulate the accessibility of the city. The problem of transportation is a multifactorial and multidisciplinary problem. It is impossible for transportation problems to be solved in one field of science, let alone one research. The limitation in this research is within the scope of regional planners, especially land use management. The process of land conversion generally takes place from activities with lower economic land rents to activities with higher economic land rents. On the other hand, land conversion generally takes place from activities with higher environmental rents to activities with lower environmental rents [38-39].

This study aims to obtain a strategic model of traffic engineering decision making in the transportation system. Research that requires transportation planning in accordance with the concept of regional planning, including public transportation services in inter-regional cooperation.

2. RESEARCH AND METHODS

The research was conducted in Bogor city and Bogor district. Bogor Regency was chosen as a buffer district for the city of Bogor and is the entry and exit access for motorized vehicles from outside the city of Bogor. The research was carried out in two data collections, the first was data collection in the densely populated area of Bogor city and in the potential area of Bogor district. Furthermore, in the buffer zone of the city and district borders for each selected location, 5 (five) locations were identified, at 1) intersection the three-arm signaled of the Salabenda in Kemang, 2) intersection the four-arm signaled of the Semplak in Semplak, 3) intersection the signalized the three arms of the Bubulak in Bubulak, 5) intersection the four-arm signaled of the POMAD in Ciluer and 5) intersection the four-arm signaled of the Ciawi in Ciawi. The following shows a map of the road network and research points in the Bogor city and Bogor districts and the five research locations are shown in Figure-1 below.

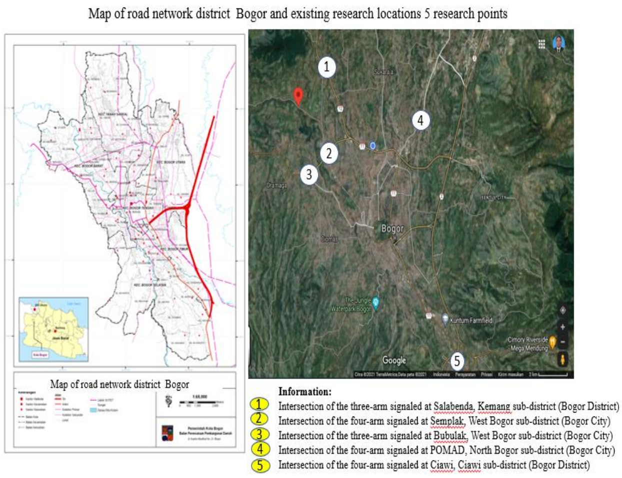

Figure-1. Map of the road network of Bogor city and Bogor district and research locations [36].

Data/Sampling Technique

Structured interviews with experts/experts including 2 (two) people from Academics, 2 (two) people from related institutions and 1 (one) person from the Indonesian Transportation Society/MTI.

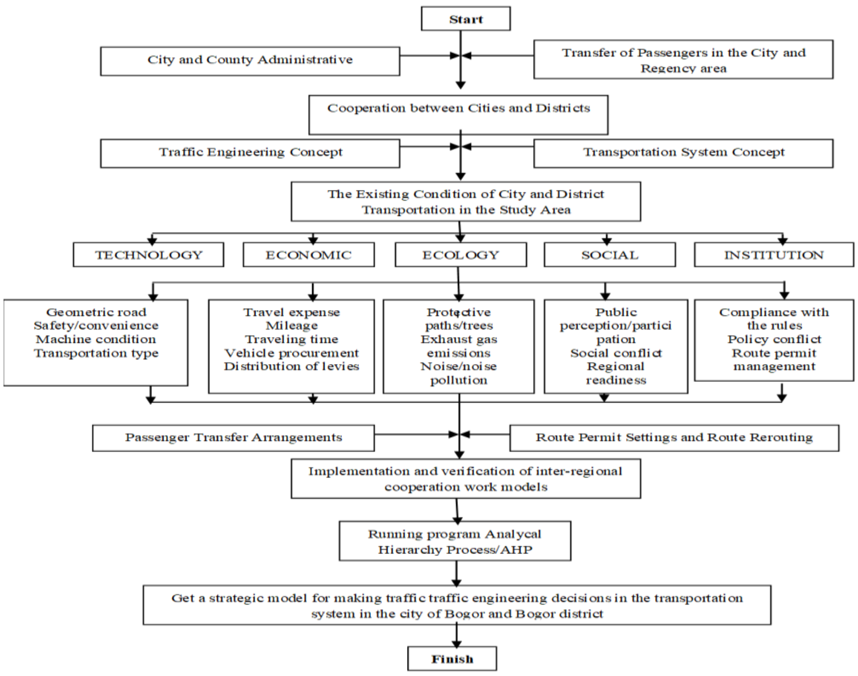

Figure-2. Flowchart of the traffic engineering model framework in the transportation system.

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Furthermore, in the calculations and studies to determine the priority scale with alternative traffic engineering decisions in the transportation system in the study area. The form of the priority scale is by compiling a 4-level scale presented in the structure/hierarchy in Figure-3 below.

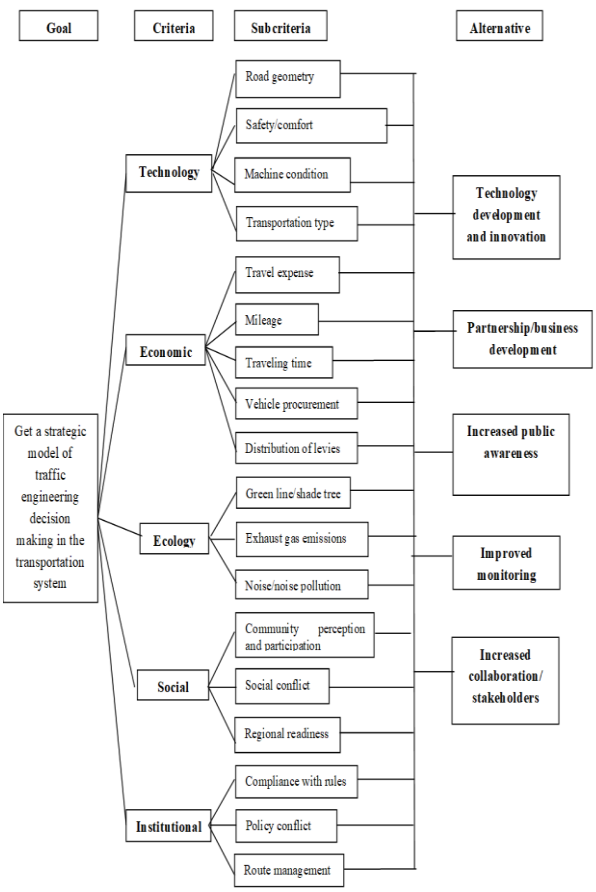

Figure-3. The alternative hierarchy structure in formulating a strategic model of traffic engineering decision making in the transportation system.

3. RESULTS AND DISCUSSIONS

After conducting structured interviews and in-depth studies in determining the criteria and research weights, the results obtained from the installed alternatives for each criterion and hierarchy. The descriptions submitted in the expert system to get the results of the interrelationships with each other will get important concepts in determining a choice. The following description presents 5 interrelated alternatives, namely technology development and innovation, partnership and business development, increasing public awareness, increasing monitoring and evaluation and increasing collaboration between stakeholders. This study describes four sub-criteria of the five development criteria, namely technological, economic, ecological, social and institutional. The assessment model is a pairwise comparison with the value of the consistency ratio [40].

The Criteria for the Sub-Criteria Relate To,

Technology with sub-criteria

a. road geometric,
b. safety/comfort,
c. engine condition and,
d. transportation type.

Results of Pairwise Comparison of Technology Criteria

The results of the pairwise comparison of technological criteria against the road geometric sub-criteria obtained a value of 0.531%. Placing technology criteria in this case geometric road, road surface conditions, traffic light / APILL and side barriers that exist at each intersection greatly affect the technology applied. The results of this pairwise comparison are shown in the form of Table-1 and Figure-4 below.

Table-1. Results of pairwise comparisons on technology criteria.

Subcriteria	Weight (%)	Ranking
Road geometry	0,531	1
Safety	0,244	2
Machine condition	0,124	3
Transportation type	0,101	4

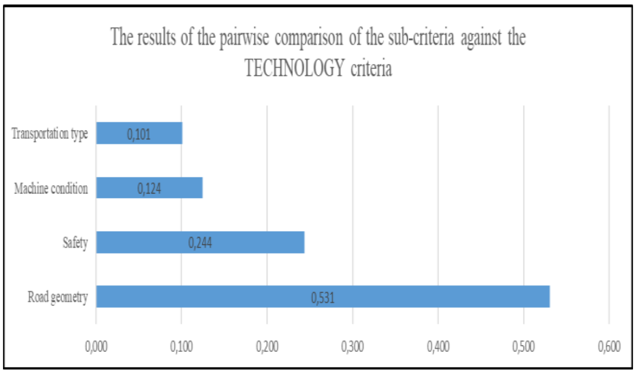

Figure-4. Graph of pairwise comparison results on technology criteria.

Results of Pairwise Comparison of Economic Criteria

The results of the pairwise comparison of economic criteria against sub-criteria obtained mileage ranks first with a value of 0.441%. Placing the economic criteria in this case the mileage includes the use of fuel, maintenance of motorized vehicles and the length of the road affect the distance traveled by public transport. The results of this pairwise comparison are shown in Table-2 and Figure-5 below.

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Table-2. Results of pairwise comparisons on economic criteria.

Sub-criteria	Weight (%)	Ranking
Mileage	0,441	1
Travel expense	0,204	2
Traveling time	0,165	3
Distribution sharing	0,119	4
Transportation procurement	0,071	5

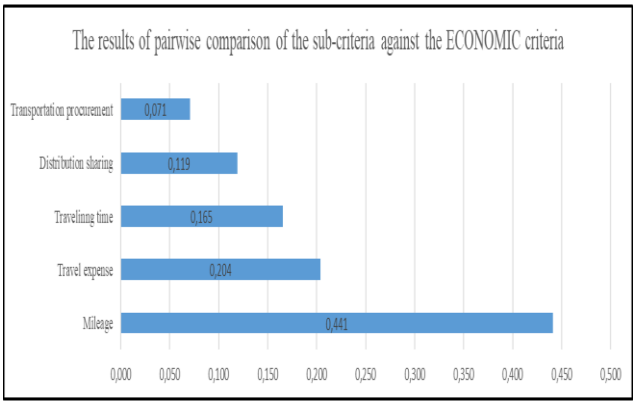

Figure-5. Graph of pairwise comparison results on economic criteria.

Results of Pairwise Comparison of ecological Criteria

The results of the pairwise comparison of ecological criteria with their sub-criteria, the green line ranks first with a value of 0.714%. Placing ecological criteria including reforestation activities carried out in every motorized vehicle lane, especially around bus stops, road medians with between, planting protective trees, so as to produce shady and cool conditions at each stop/stop at each selected point. The results of this pairwise comparison are shown in the form of Table-3 and Figure-6 below.

Table-3. Results of pairwise comparisons on ecological criteria.

Sub-criteria	Weight (%)	Ranking
Green line	0,714	1
Exhaust gas Emissions	0,146	2
Noise pollution	0,140	3

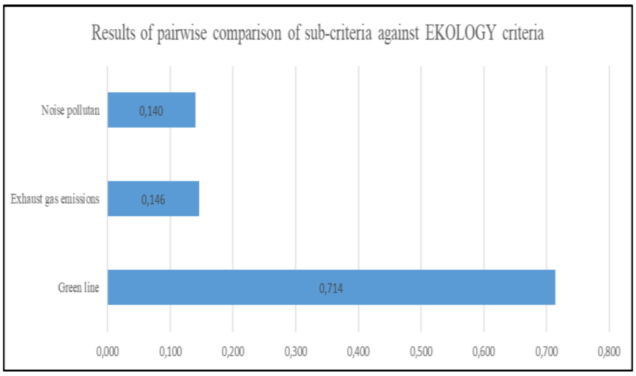

Figure-6. Graph of pairwise comparison results on economic criteria.

Result of Pairwise Comparison of Social Criteria

The results of the pairwise comparison of social criteria against their sub-criteria, it was found that public perception and participation ranked first with a value of 0.6321%. Placing social criteria with community perception and participation in maintaining every social facility around bus stops/stops and intersections using signals/APILL and taking care of the existing assets properly and responsibly. The results of this pairwise comparison are shown in Table-4 and Figure-7 below.

Table-4. Results of pairwise comparisons on social criteria.

Sub-criteria	Weight (%)	Ranking
Social conflict	0,2234	2
Community perception and participation	0,6321	1
Regional readiness	0,1445	3

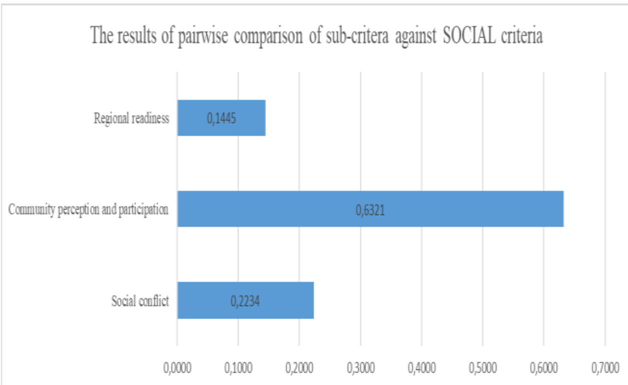

Figure-7. Graph of pairwise comparison results on social criteria.

Results of Pairwise Comparison of Institutional Criteria

The results of the pairwise comparison of institutional criteria against their sub-criteria, it is found that policy conflict ranks first with a value of 0.6173%. Placing institutional criteria with policy conflicts between agencies, especially the Bogor district and the city of

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Bogor in the border area so as to maintain the investment climate in the border buffer area. The results of this pairwise comparison are shown in the form of Table-5 and Figure-8 below.

Table-5. Results of pairwise comparisons on institutional criteria.

Sub-criteria	Weight (%)	Ranking
Route permit	0,1069	2
Policy conflict	0,6173	1
Regulatory compliance	0,2758	3

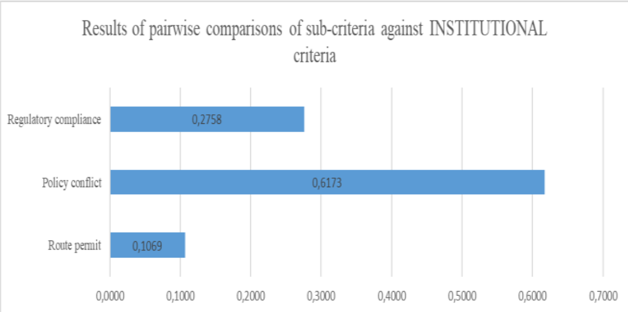

Figure-8. Graph of pairwise comparison results on institutional criteria.

The Results of Pairwise Comparisons between Criteria and Goals

The results of data processing using a pairwise comparison model, the technology criteria have the highest score by experts. The role of technology in determining the pattern of cooperation between regions produces good and accountable policies and concepts in order to increase development in border areas to build new CBD centers at every point of regional development. The results of the pairwise comparison between criteria placing the technology criteria against the road geometric sub-criteria obtained a value of 0.456%. Placing technology criteria in this case geometric road, road surface conditions, traffic light/APILL and side barriers that exist at each intersection greatly affect the technology applied. The results of this pairwise comparison are shown in the form of table 6 and figure 9 below.

Table-6. Results of pairwise comparisons between criteria.

Subcriteria	Weight (%)	Ranking
Technology	0,456	1
Economic	0,212	2
Ecology	0,148	3
Social	0,112	4
Institutional	0,072	5

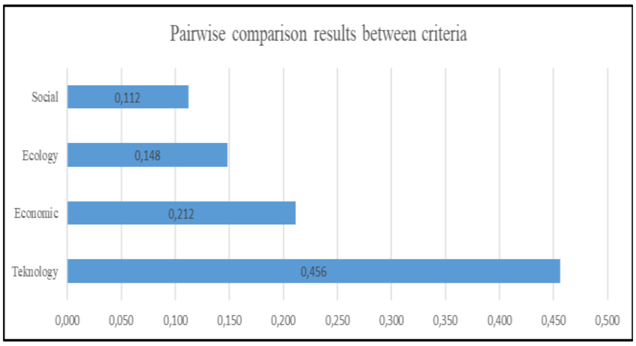

Figure-9. Graph of pairwise comparison results between criteria.

Discussion of the Value of Pairwise Comparisons

The discussion of pairwise comparisons of the five determinants of data processing using the AHP model is as follows with technology criteria with four sub-criteria. The road geometric sub-criteria is 0.531%. This means that it is very dominant from a technical point of view to maintain the concept of transportation. The concept of regional arrangement in the form of geometric roads, visibility and distance between road surface conditions, so that the application of APILL and the application of clear concepts need to be followed up. The pair comparison from an economic point of view is the distance traveled that ranks first. The mileage of public transportation has a positive economic effect of 0.441% including vehicle maintenance, fuel use and rejuvenation of public transportation. So the concept offered in the rejuvenation of public transport is very necessary. Meanwhile, in terms of ecology, the highest sub-criteria is the green line, the concept that must be followed up with a value of 0.714% is that the experts have agreed that at every stopping place/ bus stop, comfort must be considered and there are parks and protective trees so that the users of the stopping place are comfortable and safe. protected from the effects of heat and rain. The social criteria place the sub-criteria for public perception and participation in managing public places such as bus stops/stopping places, the stopping environment and the concept offered must be properly maintained. The value of the sub-criteria for public perception and participation of 0.6321 provides an understanding that areas that should be considered by all users and the government maintain public facilities properly. The condition of public facilities at the research locations is very worrying, traffic signs are not taken care of, zebra crosses at each intersection are no longer visible, pedestrian/pedestrian facilities are not comfortable, boundary canstеen is no longer feasible. This is a joint concern of the community and the government. Institutional criteria place policy conflicts in the highest order, which is 0.6173%, meaning that it is very high and it is necessary to anticipate that policy conflicts will always occur both from an executive and judicial perspective, in the Bogor city government and Bogor district. Included in policy conflicts are stakeholder responses in the management of public transportation, management of bus stops/stops at the border, maintenance of the place.

4. CONCLUSIONS

The result of the pairwise comparison above is a strategic model obtained for making traffic engineering decisions in the strengthening transportation system on the most important and prominent technology criteria. The technology criteria place a standardized and mutually supportive system for decision making. The real and supportive condition is technology. Experts agree that to model the strategic concept of traffic engineering in the transportation system is to focus on TECHNOLOGY criteria. Technology occupies the first level of 0.456%, so technology is a benchmark in the management of modern transportation that should be relied on. Technology both in terms of traffic engineering, APILL and geometric conditions as well as public transportation with the concept of multi-mode and mass public transportation as a substitute for public transportation that is no longer feasible to operate. Understanding to operators that public transportation that is more than 10 years old must be rejuvenated. Likewise, the condition of the road surface must be taken care of, traffic signs, street lighting, waterways and gutters must be completely clean. In supporting technology, the number two order is economy of 0.212%, meaning that the economy plays an important role in the traffic engineering management system so that it has something to do with technology, including the concept of cooperation that is agreed to be mutually beneficial between regional governments. How to prepare the border area, especially at the three-arm signalized intersection Salabenda intersection, three-arm signaled intersection Bubulak intersection and four-arm signaled intersection Ciawi intersection. Experts agree that these three points must be the main concern to be able to act as a buffer for the city. Because every resident activity, public transportation, private transportation and goods transportation entering the city of Bogor pass through these three intersection points. Bogor must accept the consequence that the needs of the people of Bogor are highly dependent on the district of Bogor. The third criterion puts ECOLOGY as a supporting pillar. Ecology gets a pairwise comparison weight of 0.148% that proves that ecology has a great influence on the continuity of the condition of public transportation itself, which has an age of over 10 years, of course, high exhaust emissions, noisy engine flares and physical conditions are no longer male. Also, the environmental conditions at each intersection must have reforestation, addition of pots and replacement of protective plant pots that are no longer worthy of being replaced. Dead shade trees are rejuvenated. The results of the pairwise comparison assessment of the five criteria above show that the value of the consistency ratio is 0.085, meaning that < 0.1, which is required by Saaty, has met. Where Saaty sets the Consystency Ratio (CR) value to be less than 0.1, so that the pairwise comparison calculation fulfills.

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