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Public Participation in Selection of the Road Construction by Analytic Hierarchy Process for Supporting of CO_2 Emissions Reduction: A Case Study of Maros-Watampone Road

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Abstract*: This paper is aims to evaluation the best type of construction of the regional road in Indonesia, which passes through a criticalgeometric conservation area where it is a barrier to improve development. This study consists of the following steps:1)Invited community members to participate and applied an Analytic Hierarchy Process(AHP) approach,2)Calculation of CO_2 emissions with the estimation by using results of some of the literature published,3) Evaluation of the efficiency of economic resources based on: a) Benefit cost analysis, b) Net Present Value analysis,c) Internal Rate of Return analysis.*
The results showed that the public starts to pay attention for their quality of life and the environmental effect caused by their development activity. Finally, some recommendations are given for future improvement.
Keywords: *Analytic Hierarchy Process, CO_2 Emissions, Decision, Efficiency of Economic Evaluation, Public Participation*

I. Introduction

Road is a public good; therefore, to provide it should be by the government because nobody wanted to pay for something, which had benefited for all people who used those goods.Which one of the development programs must be applied, and how much money should be provided by the government for a road development; it is an issue. We cannot apply price system to reach efficiency of economic resources for provided it. Instead by a vote to do it because the public neither can explicate their references of the public goods. In a democratic society, preferences and willingness to pay for public sectors should be a way of voting.Distribution and a way of a vote are determinant of a result of voting.

Road construction is a specific sector which the professional reference is the one way of public participation in making of decision.Professional is a community who expert in road planning and development. Complexity of knowledge and understanding about road planning and development of the professional can be simplified through by an Analytic Hierarchy Process (AHP) approach. This is an approach a mathematic concept to make a structure of a problem by matrix.All factors are arranged and selected then descending in hierarchy structure to criteria and alternatives in successive levels. Determination of criteria of road construction selection is not the main parameters for road construction but should be considered in the decision-making.

While the construction sector is one of the major contributors to the economic development of Indonesia, instead of the construction process and operation had a fairly large consumption of energy and created of CO_2emissions significantly. We need to effort to estimate an amount of CO_2 emissions that potential produce by construction activities in order to do prevention or improvement of the environmental impact.The best construction by selection of public preferences must support the CO_2emissionsreduction program of the Government.

Government of Indonesia had a limited budget for the development implementation.Therefore,the result of selectioncan be conducted by an efficiency of economic resource evaluation. The road investment benefited purpose for community. The evaluation method of the economic resource provides an integrated framework to investment evaluation from a public view. Method of evaluation calculated based on: an analytic of Benefit-Cost (B/C), an analytic of Net Present Value (NPV), and an analytic of Internal Rate of Return (IRR); to be proved that reference of public is the best choice for implementation.

II. Community and the Road Development

Movement of the people and goods is like the lifeblood which created welfare and prosperity that made of the government development priority on the road network (KeironAudain, 2011).Population densities tend to follow the pattern of the way so that the existence of a new road will improve the sustainable economic growth

(Donald R. Glover, 1975; Miyata et al., 2008). There are two reasons to build or widen roads, namely: one, increase road capacity by adding lanes or building new construction in line with pre-existing; two, build new roads in the area of development. Roads have both horizontal and vertical curvature should be designed to fit the terrain to achieve the desired aesthetic qualities and be in harmony with the surrounding environment (Mackay City Council, 2008).

Lately environmental issues have gained a lot of public attention, where the people have become more aware that the consumption of goods and services because rendered both of them,had an impact on the natural resources. The public and private sectors have started taking a keen interest in reducing the adverse effects, and in evolving methods for prevention of these impacts. Selection of the best construction and material is one of the tools for evaluating the adverse impacts of our actions that have caused to the environment and the society for sustainability. The economic criteria, aesthetic value, environmental factors and design factors, are need to consider before deciding for the construction, especially for material of construction (Hovarth, 1997).

Road construction had benefits and consequences. Maximize safety, served community, shorten the distance and travel time, increased economic output and quality of life,are the purpose of construction of roads where the speed of the vehicle greatly affects the achievement of benefits. One that limits the achievement of maximum service from the street is the geometric conditions (Zheng, 1997). Planning and good construction for roads located on steep slopes must be carefully due to the causing the impact on sedimentation (Beverly C W., et al, 2001; Reid 1981). The complicated geographic conditionswill significantly increasethe cost ofconstructionso theconstruction ofroadsmust be recommendedrealistictaking into account thelowerLevelof Service (LOS) andenvironmentalconstraints.

Planningshould beable to integrateallthese factorsinto accountenvironmentalandhuman changeas themainfactorformingprocessesagainstenvironmentalpolicy (MacHarg,1969). The success of a design depends on the character's design of the model and the responses to the environment to create a balance between the designsand the overall environment (Hough, 1984).

Road infrastructure in Indonesia is a vital role in national transportation,which servingof passenger approximately 92% and transportationby 90% on the existing road network.The continuous infrastructure development gives a positive impact for the regional economic competitiveness in the national economic and increasing of the national economic in international competitive level(Ministry of Public Works of Indonesia, 2010). This purpose is an appropriate with Indonesia's economic development strategy that is pro-green, pro jobs and pro poor.The infrastructure policy expected to choose the best alternative by public that is considered accurate yield benefits that can alleviate the problem(Simon H, 1947).

III. Research Methods

Method of selection construction by public and the evaluation of efficiency of the economic resource through the approach, namely:

3.1 Analytic Hierarchy Process (AHP) approach

3.1.1 Decisionstructure and pairwise comparison method

This approach built formed matrix of relative weights among the criteria performed by the value of the preference. The method used is AnalyticHierarchyProcess (AHP) todetermine the choice type ofconstruction.This methodwas first developedbySaaty(1988)and is commonly usedby decision-makers to be decided ona policyby performingthe synthesisofseveral optionsin a singlemethod. The main ofthis analysisis totransformasubjectiveassessmentbecomesawholehas a valueorweight. Acquisition ofdataweighting isderivedfromthe analysisofthe surveyinterview, inwhich respondentsare faced withthe question ofhow largeaninterestratecriterioncomparedwithother criteria. The criteria usedare theresults of identificationofthe thing thathave amajor influence onchoicethantoachieve thegoal. Relative of weightsamongthe criteriausedtoobtaincomparisonsbetweencriteriaweightingarenormalizedand determine thelevel of importanceamongthe criterionvariablescompared.Relative preference values obtained through analysis of interviews with questionnaires to respondents whom the importance level among the elements using a scale of 9. Table 1showsthat the scale of the interest rate criterion, as follows:

Table 1: The Scale of Assessment between the Criteria (Saaty, 1990)

Interest Rate	**Definitions**	**Explanation**
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Moderate favor than the other
5	Essential importance	Strong favor than the other
7	Very strong importance	Strongly favored and dominant than the other
9	Extreme importance	The favored highest of
2, 4, 6, 8	Intermediate values	When compromise is needed

Reciprocals	If the inverse element *i* has one of the above rates when compared to element *j*, then it has the reciprocal value when compared to the element i.	
Rational	Rations arising from the scale	If consistency were to be forced by obtaining n numerical values to span the matrix

Respondentsare assumed tobe consistentin providingan assessment ofeach pairwise ofcriteriaandall*n* criteriahave the same valuewhen a comparedagainst itself.Eachcriterionhasnelements, namely: w_1, w_2, w_3,...,$w_n$where the value ofthe comparison*n*criteriacan be describedbythe equation: ½ n(n-1). Overallcomparison ofeachpairwisein this analysisformsthereciprocalsquarematrixas illustratedbelow:

	A_1	A_2	A_3	…..	A_n
A_1	w_1/w_1	w_1/w_2	w_1/w_3	…..	w_1/w_n
A_2	w_2/w_1	w_2/w_2	w_2/w_3	…..	w_2/w_n
A_3	w_3/w_1	w_3/w_2	w_3/w_3	…..	w_3/w_n
:	:	:	:		:
:	:	:	:		:
A_n	w_n/w_1	w_n/w_2	w_n/w_3	…..	w_n/w_n

The results ofcalculationof eachrowin thematrixcomparisons willobtainthe value of eigenvectorwhich is theweightsvalue ofthenormalizedaverageof eachfactorin eachrow.The weightmatrix ofpairwise comparisons has acharacteristicmaximumvalueof nis positive, both simpleandcharacteristicvectorassociatedwithapositive(TheoremofPerroninGarminia, 2010). Therefore,can berepresentedthat thepairwise comparisonmatrixhas aconsistency indexis zero.
For the consistencyindex(CI)of the *n* matrix:

$$CI = \frac{\lambda_{\max} - n}{n-1}$$

where
CI = consistency index
$\lambda_{\max}$ =the largest eigenvalue of *n* matrix
And for consistency ratio is the defined as:

$$CR = \frac{CI}{RI}$$

where
CR = consistency ratio
CI = consistency index
RI = ratio index
Ratio index is the average value of consistency index obtained randomly as shown in table 1.The decision will be consistent if value of a consistency ratio no more than 10%.

Table 2: Value of Ratio Index (RI)

N	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

3.1.2 Selection of Road Construction

The government and previous study(Badriana, 2009) areidentified nine criteria which for choose the type of road construction. The problem was to decide which of three candidate construction to applied.Thus, we start to made structure of the problem as hierarchy.

Top level shows where the selection is the best type of construction. On the second level are the nine criteria that contribute to the selection of the best type of road construction. The definition of the criteria is following:

1. *Benefits*:Traffic safety, comfort and convenience;
2. *Environmental*:Minimize of pollutants, appreciable of nature environment, environmental friendly of material and technology;
3. *Economical:*Rising up the economic growth of the region, increasing household income;
4. *Cost of construction*:Efficiently, rate return rapidly;

5. *Technology*:Safe, quietly,minimization pollutant product, applicable;
6. *Maintenance costs*:Low cost, easy to repair, durable;
7. *Esthetics value*:Harmonized with area;
8. *Ease handling of implementation*:simple, humble;
9. *Time of construction*: Self explanation.

Those criteria are the important considerations used in the selection of construction based on the level of problems. Pairwise of the matrix of the criteria resulting vector of priorities which it's the principal eigenvector. It gives the relative priority of the criteria measured on a scale of ratio.

In the third level, pairwise comparisons of the type of constructions with respect to how much better one is than the other is suitable for each criterion in the second level.There are nine 3x3 matrices of judgments. We invited and collect of preference from the respondent who expert in planning and development of road construction. They consisted of government officials, planners, supervision of engineering and academia. The respondents are not representative of the population as a whole because their numbers a bit so that each group represented by 10 people. However, overall it is considered that the respondents have been representing whole of the community. Selection hierarchy is shown in Figure 1.

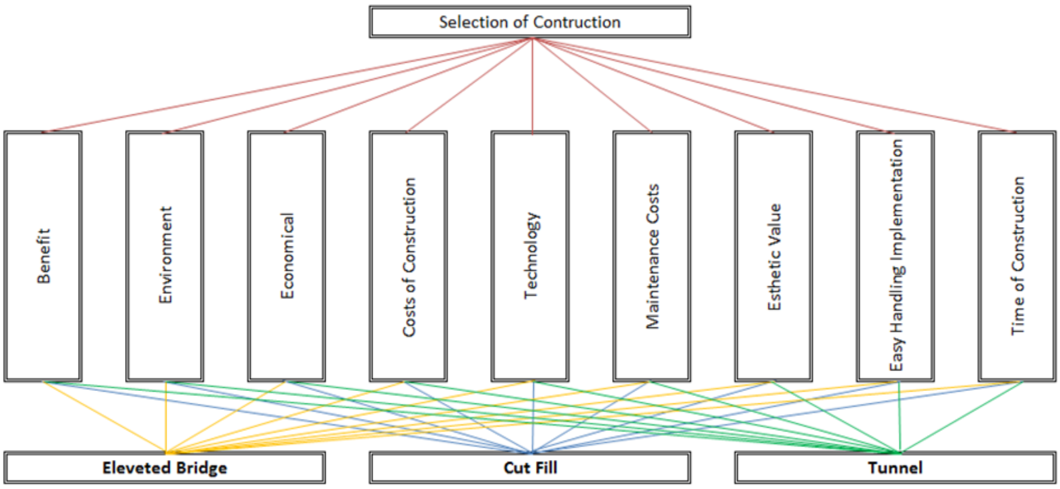

Figure 1: Selection of Alternative Handling Geometric Hierarchy

Analyses were performed using the expert choice version 11.5 where the perception of respondents made pairwise comparison matrices.

3.2. CO_2 emissions calculation

Calculation of the approximate number of environmental impacts such as CO_2 emissions caused by the best type of construction to using the value of emission factorresults of several studies of the scientific literature published. Due to limited data and literature, we made a lot of assumptions to simplify the calculation. We assumed the value of emissions factor was used to have indicators and geographical conditions is a similar with their research. The main construction was using the results of the greenhouse-gas calculations performed by Kato et al (2005), Sripple (2001), and Rajagopalan (2007). Emissions caused by transportation mode refer to the results of scientific research Rose (2010). It is important to note that the calculation results depend on the actual construction design.

Table 3: Embodied CO_2 Emissions for Construction and Road Activities
(Kato., et al, 2005; Stipple, 2001; Rajagopalan, 2007; and Rose, 2010)

Type of Construction	Ton CO_2/KM			
	Main Construction		Transportation	
	Construction	Maintenance	Construction	Maintenance
Elevated Bridge	3,680	120	0.000045	0.000039
Tunnel	5,310	210		
Cut fill	NA	NA	NA	NA
Asphalt Surface	47.09	10.41	0.000045	0.39

3.3 **Efficiency of economic evaluation**

Theimplementationofthepolicywaswelldoneprovingittheoreticallywithcalculatingeconomicvariablesthroughtheanalysisofthebenefitscost(B/C)forthebestconstructiontosupportdecisionmaking.Thisanalysisisusedforactivitiesthatcouldpotentiallyinterferewiththeenvironmentandthepublicinterest.Theconceptisverysimple,whichmeasuresthevalueofthebenefitsandcostsofanactivityarecomparableinsize.Activitieswillleadtotheallocationoffactorsofproductionmoreefficientifthevalueofthebenefitisgreaterthanthevalueofthecost.TheHighwayDevelopmentandManagementIVmethodcalculatedVehicleOperatingCosts(VOC)basedonthepreliminarydesignsimulationsassumingthecurrentpriceandgeometricparameters.ComponentofthevalueoftimewascalculatedbyusingIntegratedRoadManagementSystem(IRMS)andtheapproachofGrossOutput(HumanCapitalApproach)togetthecostofaccidents.

An expansion of the analysis of benefits cost is to use criteria Net Present Value (NPV) to calculate the level of investment feasibility, Internal Rate of Return (IRR) and Benefit Cost Ratio. Test sensitivity was calculated based on the eligibility conditions optimistic scenario (increase of the benefits cost by 25% and investment costs decrease by 25%) and the condition of pessimism (decrease of the benefit cost by 25% and investment costs increase by 25%).

IV. Case Study

Project Descriptions

Maros-Watamponeroad is located in South Sulawesi, Indonesia, where the road built by the Dutch government, and important for regional economic activity between South Sulawesi Province and Southeast Sulawesi Province. This road has a length of 145km with a width average of six meters in one line and passing through some mountain areas with steep contour's conditions. In general, cross slope is the more than 17%, horizontal curvature radius is an average of 13 meters, and the critical length is greater than 175 M that can be make slows vehicle speed 4.6 km/h with limited visibility. Number of the daily traffic has increased by 7.5% that caused to the higher accident rate by 2.9% in every year.This condition is become damaged by a geometric path which does unsuitable with the standards of road construction in Indonesia. There are 40 km need to repair of the geometric conditions to maximize the level of its services in this road. The government has done a maintenance only, because of the road is constrained by geographical condition and protection of natural habitat in the surrounding the street, and caused of some segments had a decrease in the level of service such as regional economic flows, comfort and safety.

Since2007 until 2009, the Government has conducted a study and discussion for the planning of road development in an effort to improve the performance of Maros-Watamponeroad. This plan recommended to improvement three alternate geometric road construction options that can be applied to the elevated bridge, cut-fill and tunnel system. Implementation of the three construction alternatives could potentially have a negative impact on the environment. Thus, special attention is needed to the topography and geology, in particular, the choice of construction techniques and methods in order to maintain the sustainability of ecosystems especially in the national parks and heritage areas on the sides.

Figure 2: Existing Geometric Conditions in the Area of Babul National Park

The reason of the road development is to be increase road capacity by building a new construction in existing line or make other lines, depend of road line condition.

V. Analysis Results

5.1 Decision by AHP

The results of the pairwise comparison showed that the preferences of the respondents are consistent in selection. This is evidenced by inconsistencies value 0.08 (less than 0.10), and the weight of the criterion and alternative options given in Table 4.

Table 4: The Weighting of Criteria and Alternatives

Criteria	Global Weighting	Alternatif Weighting			Inconsistency
		Elevated Bridge	Cutfill	Tunnel	
Benefit	0.300	**0.534**	**0.150**	**0.316**	0.03
Environment	0.224	0.519	0.304	0.177	0.02
Technology	0.130	0.493	0.311	0.196	0.05
Economical	0.104	0.570	0.270	0.160	0.03
Construction Costs	0.081	0.550	0.210	0.240	0.02
Maintenance Costs	0.054	0.523	0.284	0.193	0.09
Esthetic Value	0.041	0.489	0.332	0.180	0.09
Easy Handling Implementation	0.038	0.581	0.282	0.137	0.04
Time of Implementation	0.029	0.534	0,.316	0.150	0.03
Inconsistency	0.090	0.528	0.248	0.223	**0.08**

Benefits and the environment the top sequence in the selection of criteria for consideration of construction indicated that the type of construction chosen should provide the maximum benefits to society and minimize impact on the environment. The benefits criteria for consideration of being the most contribute people's choice for the construction type because they are aware about the importance of service that they will be received from these the development. The road was built due to the need for the benefit of the road. They prioritize benefits but still considering the effects that will result to the environment so that take of the environmental criteria into the second consideration. People realize that the benefits must be balanced with the impact it would reach development sustainability.The road development will make increased mobility so that the economic growth of the area, traffic safety and comfort will be increased as well.

The use of environmentally friendly construction materials greatly affects the sustainability of the bio diversity conservation in the surrounding area. The use of alternative materials is needed in an effort to minimize the impact on the environment. If the technology criteria for the next sequence, this shows that the technology should be able to solve geometric problems without ignoring the impact of its use on the environment.

Economic criterion, the cost of construction and maintenance costs, are concerning the use of funds allocation for construction during the period of the plan. The community does not consider of the construction and maintenance costs that they should spend to build the construction. It shows that they have learned the amount of benefits they will earn and keep the balance of natural requires environment-friendly technology with a great cost in its implementation. These criteria can be calculated in several ways that will be discussed in the efficiency of economic evaluation.

Harmony between construction and the environment need to be considered through aesthetic criteria in order to avoid the impression of a patchwork landscape environment. While the criteria for easy handling and time of implementation tend to have a priority equal weight as both are directly proportional to each other. If construction is not experiencing difficulties in implementation,its mean work time will be faster and as well as the opposite.

Synthesis analysis of weight of criteria and weight of alternative showed that an elevated bridge construction has the highest priority value is 0.528. That's value showed that the construction is the suitable to solve geometric problems on that road. As for the cut and fill (0.428) and tunnel (0.223), each of which occupies the second and third priorities respectively. The results of the sensitivity analysis demonstrated in Figure 3.

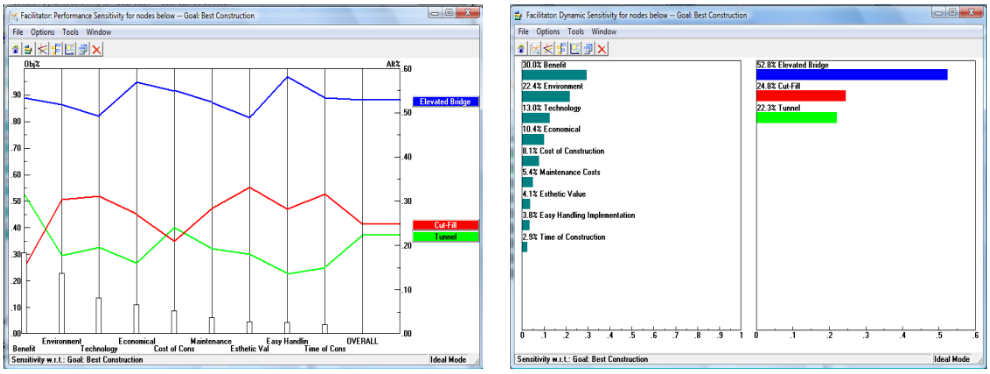

Figure 3: Graph of Sensitivity

All considerations criteria contributed the highest value on the elevated bridge construction. Criteria benefit (0.150) and the construction costs (0.210) gives priority smaller for the cut and fill weights than the tunnel(respectively: 0.316 and 0.240). However, on the other criteria have contributed to an enough weight for the cut and fill construction as the second priority for possible to apply.

Choosing the elevated bridge construction as the most suitable to be applied to Maros-Watampone road is a right decision because the implementation does not change the landscape and hasa little effect on the nature. Wildlife habitat will keep maintainingof sustainability in the conservation area. It assumed that the construction pillar/abutment used as same as the principle of the high-tension tower of electric was legal traverse some conservation areas. Reach appropriate geometric standards with limited land uses can be made through environmentally friendly technology. However, based on the economic value, the cost of construction and maintenance, require highest costs, needed a special expertise for implementation and considerable time when compared to other types of construction. These criteria are not dominant influence on the value of contribution.

When compared with other types of construction the tunnel and cut-fill both of them have the possibility to destroy the balance of the ecosystem of the road. To get a road grade by 10%, both constructions should be done realignment and extend the trace so that it requires larger land and can damage the rock massif that is widely available around the site. Esthetic value (0.489) constructs the elevated bridge superior to apply because it promotes harmony between development and conservation areas that potentially have a high selling value and can eventually increase community incomes.

The most important advantage of road improvement is including higher potential for the transportation of goods, reduced in cost pertaining to a problem caused by low-quality roads and notable effect on the thriving of the region.

5.2 Application of the Elevated Bridge Construction

The assumptions of an elevated bridge construction design by considering some parameters through the land development program and 3dmax can be seen in Figure 4:

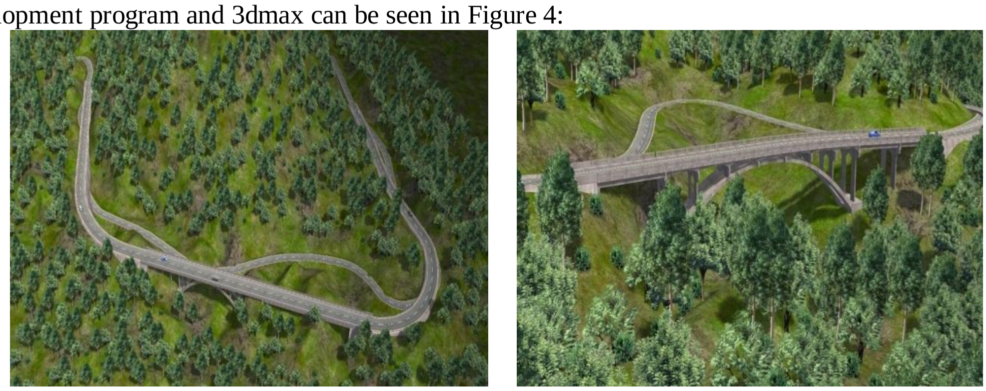

Figure 4: Simulation by the Elevated Bridge Construction

Table 5 shows that the geometric changes of an existing condition to the implementation of the construction of an elevated bridge. There are several geometrical conditions, which cannot be adapted to the National Road Standard because we keep trying to be realistic with the conservation zones and critical area by use the lower level of service.

Table 5: The Geometric Change Parameters

Road Condition	Before Implementation	After Implementation	Unit
Length	10	11.5	Km
Width	4.5	7	M
Width shoulder	1	2	M
Topography condition	Hill	Flat	-
Average sloperise(RR)	22.5	2.5	m/km
Average slope falling(FR)	22.5	3.5	m/km
Slope rise+falling (TTR)	45	5	m/km
Degree of Turn (DTR)	200	15	°/km
Surface condition (IRI)	5	7	m/km
Average speed	40	65	Km/jam

5.3 Construction Impacts on CO_2 Emissions

Considering the amount of CO_2 emissions generated by construction activities and transport are need to take into account because these roads are in the conservation area, which is a reserve of oxygen and water supply in the South Sulawesi province. The uses of environmentally construction materials are concerned it can be preserve of the environment sustainability of the areas, in particular, and the region in general.

The study conducted by Horvath (1997), shows that for the construction phase of the bridge has a lower environmental burden, especially in the concrete process. This is similar with our calculation by comparing between three type construction where the elevated bridge is the lowest produce CO_2 emissions in its process and operation construction.

Table 6illustrates that the amount of CO_2 emissions and the relative contribution of the main construction, maintenance and transportation of type of existing construction and two construction alternatives. Cut and fill construction is post-dispatch construction, and therefore, we cannot display the data on the number of the resulting CO_2 emission.

Overall CO_2 emissions resulting from the construction of the elevated bridge (1.31tCO_2/km) is lower than from tunnel construction (1.79tCO_2/km). Contribution of CO_2 emissions from the process and maintenance of main construction has a major impact on the value of the total emissions produced. This is shown in process and maintenance the tunnel construction (1.57tCO_2/km) has a greater emission than the construction of the elevated bridge (1.08tCO_2/km). Transport emissions contribute the equivalent value to both types of construction is due to the use of concrete surface in the construction are the same. This is in accordance with the regulations in Indonesia to ban the use of two types of main construction on road construction surface.

The calculation of emissions in existing construction has a lower value because not considering grade road, acceleration and vehicle speed in emission factor evaluation but the emissions produced by asphalt surface only.Therefore, the value contribution of transportation to total emissions in each alternative construction is the same.

Table 6: Estimate the Total Emissions Produced by Each Type of Alternative Construction

Type of Construction	Ton CO_2/KM			
	Main Construction		Transportation	Total
	Construction	Maintenance		
Elevated Bridge	1.05	0.03	0.23	1.31
Tunnel	1.50	0.07	0.23	1.79
Cut fill	NA	NA	NA	NA
Asphalt Surface	0.05	0.01	0.29	0.35

5.4 Analysis of the Efficiency of Economic Resources

5.4.1 Component of Benefit Cost

Vehicle operating costs was decrease after the implementation of the construction can be seen in Table 7 that shows that the vehicle type truck having a lot of benefits caused by the project improvement. This condition is very supportive of the smooth operation of shipping goods between the South and Southeast Sulawesi province which use type of thatvehicle. The economic activity of the region will increase as well. Public transport fare reductions (respectively: 938, 537 and 3984) can also be performed due to the large decline in value after the project is operational.

Table 7: Operational Cost of Vehicle (Before and After the Project)

Vehicle	Before Project	After Project	Different VOC
Sedan/city car	3,720	3,133	588
Sport utility vehicle	4,678	3,740	938
Mini Bus	8,140	7,603	537
Bus	11,568	7,584	3,984
Light Truck	7,725	6,670	1,055
Medium Truck	12,901	11,208	1,693
Heavy Truck	14,813	8,671	6,142

The private vehicle type sedan/city car user (588) did not receive a big impact so chances are people will switch to using public transport which has decreased tariff. If more people using a public transport that condition will cause a decrease the level of energy consumption and emission be generated by transport activities.Thus, impact on sustainability of environment can be reduced.

Geometric changes will have a major impact on travel time. The average vehicle travels time reduced of 20-30% of original condition. The accident rate will be decreased. Overall travel time changes before and after project can be seen in the following table:

Table 8: Value Time Travel Before and After the Project

Vehicle	Before Project	After Project	Time Rate
Sedan/city car	73,821	45,428	28,393
Sport Utility vehicle	53,176	32,724	20,452
Mini Bus	106,352	65,447	40,905
Bus	212,703	130,894	81,809
Light Truck	14,960	9,206	5,754
Medium Truck	14,960	9,206	5,754
Heavy Truck	14,960	9,206	5,754

5.4.2 Feasibility and Sensitivity Analysis of Investment

Table 9 illustrates that the value of the benefits arising from the application of elevated bridge construction at the time and in different conditions. The values of the evaluation of the implementation of this work are placed in the scale of priorities and investment feasible.

Table 9: Sensitivity Test on 25% of Profits and Costs Change

Test	NPV (in Billion Rupiah)	IRR (in Billion Rupiah)	BCR (12%)	BCR (15%)
Scenario 1: without accident cost saving				
Condition	899,849	20.07%	2.78	2.21
Test 1: cost investment increased by 25%, benefit decreased 25% (condition pessimistic)	385,052	17.91%	1.78	1.41
Test 2: cost investment decreased by 25%, benefit increased by 25% (condition optimistic)	1,459,639	21.32%	4.34	3.45
Scenario 2: with accident cost saving				
Condition	1,078,678	20.36%	3.09	2.45
Test 1: cost investment increased by 25%, benefit decreased by 25% (condition pessimistic)	563,881	18.60%	2.03	1.61
Test 2: cost investment decreased by25%, benefit increased by 25% (condition optimistic)	1,638,468	21.43%	4.73	3.75

VI. Conclusions

An AHP method has been applied to select of the best type construction road on Maros-Watampone, Indonesia, for decision-making. To support these decisions for handling geometric construction on Maros-Watampone roads should consider the non-economic aspects such as benefits, environment, technology, economic, construction costs, maintenance costs, aesthetic value, easyforimplementation and time of implementation. All criteria have to contribute with significantly in construction process and operation for keep environmental sustainable.

The results of analysis showed that elevated bridge construction is the best alternative for geometric improvements at Maros-Watampone road. This decision is supported by the results of an analysis of the environmental impact and evaluation of the economic aspects to the selectionroad construction. Overall, the selection of elevated bridge construction provided great benefits, have a little impact on the environment, the achievement of geometric standards through technology, and the value of BCR> 1.0 which indicates that the cost of the benefit is greater than the cost of investing in an optimistic and pessimistic condition. Besides, it has esthetic value that can support increased conservation area as an area of natural and cultural heritage.

If a government decided to invest on roads development, the quality and quantity of roads will increase. So that the potential of the region for transportation of good will be improved which,can be making booming of the economy and higher income for the government. Furthermore, problems such as accidents and gradual damaged on vehicles that are be caused by low-quality roads will be reduced. So, the roads will be safer and fewer damages will caused on drivers. Finally, a region with a vast number of high-quality roads is more apt to prosperity; it will give more opportunities for the people to have access to various resources and lead to greater development.

The calculation of the ecological impacts out of the scope this project will work but need to be prepared as a follow-up of the value of CO2 emissions generated after a simple calculation. Future study should be concentrated on the environmental impact of the energy consumption, especially in the construction and transportation activities thoroughly involving all components in the construction, maintenance and transportation.

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