PRIORITIZATION OF ROAD NETWORK CONSTRUCTION IN BACAN ISLAND OF NORTH MALUKU PROVINCE

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Abstract

Bacan Island, located in South Halmahera, North Maluku Province, is a potential region with a variety of important sectors, such as plantations, fisheries, mining, tourism, industry and trade. Until recently, this potential has not been exploited fully due to lack of transportation infrastructure systems. The government has prepared the plan to construct the road network systems, which consist of five road segments connecting the potential regions. With limited funding available, it would be impossible to build the road in the same time. Therefore, an optimum and carefully planned prioritization program should be applied. The purpose of this study was to determine the priority of road construction on the island of Bacan using Important Performance Analysis and Analytical Hierarchy Process methods. The result shows that the criteria considered important in determining the prioritization of road construction are as follows: (a) accessibility, (b) linkage, (c) land use, (d) cost, (e) technical aspects, (f) economic, and (g) environment. It is recommended that the construction phases of the road network in Bacan Island are Labuha-Babang, Babang-Songa, Songa-Wayaua, Labuha-Sawadai, Sawadai-Kubung, Babang-Yaba, Labuha-Belang-belang, Belang-belang-Yaba, Songa-Wayatim, and Wayatim-Wayaua, consecutively.

Keywords: road construction, Importance Performance Analysis , Analytical Hierarchy Process

Abstrak

Pulau Bacan, terletak di Halmahera Selatan, Provinsi Maluku Utara, merupakan suatu daerah potensial dengan berbagai sektor penting, seperti perkebunan, perikanan, pertambangan, pariwisata, industri dan trade. Hingga saat ini potensi ini belum dimanfaatkan sepenuhnya karena kurangnya sistem infrastruktur transportasi. Pemerintah telah menyiapkan rencana untuk membangun sistem jaringan jalan, yang terdiri atas lima ruas jalan yang menghubungkan daerah potensial tersebut. Dengan dana yang terbatas, tidak mungkin untuk membangun jalan dalam waktu yang bersamaan. Oleh karena itu suatu program prioritas harus direncanakan secara optimal dan cermat. Tujuan studi ini adalah menentukan prioritas pembangunan jalan di pulau Bacan dengan menggunakan metode-metode *Important Performance Analysis* dan *Analytical Hierarchy Process*. Hasil kajian menunjukkan bahwa kriteria penting dalam menentukan prioritas pembangunan jalan adalaht: (a) aksesibilitas, (b) hubungan, (c) penggunaan lahan, (d) biaya, (e) aspek teknis, (f) ekonomi, dan (g) lingkungan. Fase pelaksanaan konstruksi yang direkomendasikan secara berturut-turut adalah Labuha-Babang, Babang-Songa, Songa-Wayaua, Labuha-Sawadai, Sawadai-Kubung, Babang-Yaba, Labuha-Belang -belang, Belang-belang-Yaba, Songa-Wayatim, dan Wayatim-Wayaua.

Kata-kata Kunci: pembangunan jalan, Importance Performance Analysis, Analytical Hierarchy Process

INTRODUCTION

Transportation contributes as a driving force for economic development in an area. As part of transport infrastructure, road can play an important role in the distribution of goods and services. Along with increasing economic growth, especially in potential areas, the availability of road infrastructure is very important to support such growth.

One such potential area is located in the Bacan Island, North Maluku Province, Indonesia. This region has an important sector in the areas of plantation, fishery, mining, and tourism. These sectors, however, are not exploited optimally due to the lack of transportation infrastructure systems.

The South Halmahera Regency has actually put a planto developa road network in South Halmahera Island, as has been shown in the South Halmahera Regency Land Use documents. Figure 1 shows the proposed road network development plan. With limited funding available, however, it would be impossible to build the road entirely in the same time. Therefore, it needs a good prioritization strategy in planning the construction. Since it may take years before the construction of the whole road network systems are completed, the strategy should provide the highest benefit to the community. That way, the government can convince the people that the road construction can provide a good benefit to the people, especially in terms economic development.
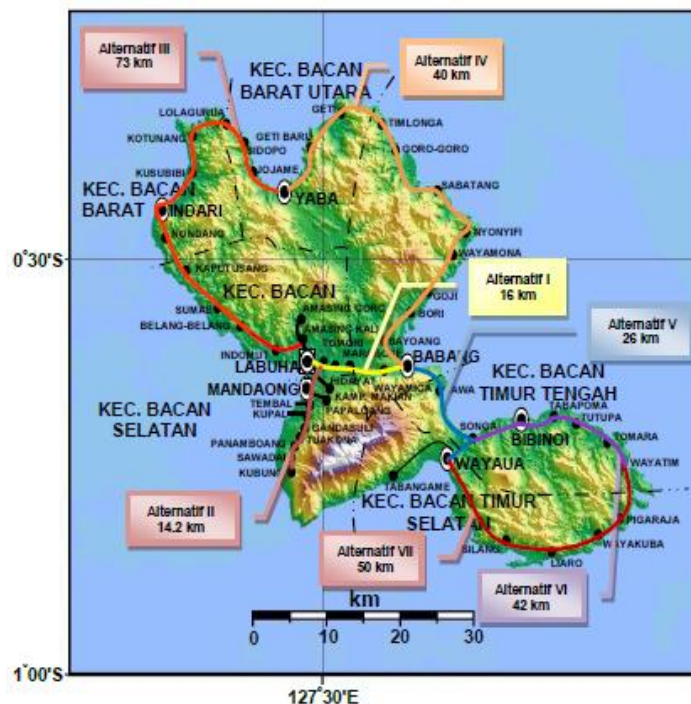

Figure 1 Road Network Plan of Bacan Island

To ensure that the road construction provides a maximum benefit to the community, their involvement becomes one of the key factors. This involvement should be initiated even from the early stage, through public dialogue, as well as in the form of representation on the stakeholder. Therefore, for the construction of roads in the Bacan Island to fit with the aspirations and desires of the community, then they should be involved even during the development of prioritization strategy.

The purpose of this study is as follows:
1. To identify factors that influence the prioritization process based on the perception stakeholders. These factors then become the basis for setting criteria in determining the prioritization of road construction.
2. To determine the most dominant factors influencing the preference of the community (stakeholders) in determining the prioritization of road construction
3. To determine prioritization of road construction based on an assessment of stakeholders.

To achieve the above objectives, the first thing that needs to be done is to determine the criteria influencing the selection of priority road construction on road networks in the Bacan Island. Then,based on these criteria a prioritization of the road construction can be proposed.

The method widely used in determining prioritization technique is the technique of Importance Performance Analysis (IPA) and Analytical Hierarchy Process (AHP). IPA was first proposed by the Martilla and James (1977), whereas AHP was first developed by Saaty (1982). In the IPA technique, respondents were asked to judge the importance of the various relevant attributes and levels of performance *(perceived performance)* on each of these attributes. The level of interest is generally measured by the Lickert scale, ranging from 1 to 5, in which score 1 shows the least satisfaction and score 5 shows the highest level of satisfaction. Then, the average value of importanceattribute and performance were analyzed to obtain the overall picture of the level of interest. In the AHP, the preparation of the hierarchy starting from the top down, starting from the goals, followed by criteria and finally the alternative. Prioritization is performed by calculating the relative weights between variables (elements) with its known weight factor (high importance) of each element against a criterion (local priorities) or to the achievement of objectives (global priority). Prioritization is done by using paired comparison method *(pairwise comparison)* among the elements at the same hierarchy level, namely by using a scale of 1 to 9.

To carry out this research, the following steps were undertaken:
1. Identification of alternative plans;
2. Identification of factors that influence the prioritization of development;
3. Analysis of influential factors using the IPA technique; and
4. Analysis of road prioritization using the AHP technique.

The list of roads to be constructed in Bacan Island Bacan is presented in Table 1.

Table 1 Road Network Plan Area Bacan Island District. South Halmahera

No.	Road Name	Existing			Plan		Notes
		Length (km)	Average Width (m)	Condition	Length (km)	Average Width (m)	
Alternative I							
1	Labuha-Babang	16.00	4.50	Asphalt	16.00	7.00	Widening
Alternative II							
1	Labuha-Sawadai	10.20	4.50	Asphalt	6.20	4.50	Maintenance
2	Sawadai-lemur	2.00	4.50	Land	2.00	4.50	Development
Alternative III							
1	Labuha-Belang-striped	12.00	4.50	Asphalt	12.00	4.50	Maintenance
2	Piebald-Yaba	-	-	-	61.00	4.50	Development
Alternative IV							
1	Babang-Yaba	5.00	4.50	Asphalt/ Soil	35.00	4.5	Development
Alternative V							
1	Babang-Songa	20.00	4.50	Asphalt/ Soil	15.50	4.50	Improvement
2	Songa-wayaua	6.00	4.50	Sand	6.00	4.50	Improvement
Alternative VI							
1	Songa-Wayatim	10.00	4.50	Land	32.00	4.50	Development
Alternative VII							
1	Wayatim-Wayaua	-	-	-	50.00	4.50	Development

Identification of Influential Factors

Based on review of previous studies, factors usually have an influence on the development of road network are as follows:

1. Technical factor; refers to the physical condition of the road and topographic conditions.

2. Land Use Factor; refers the space used for a variety of activities (residential, education, commerce, industry, offices, estates and others).

3. Economic factor; refers to factors associated with increased economic activities in the area due to road construction.

4. Social Factor; refers to social facilities that will benefit people when the road id constructed.

5. Cost Factor; refers to the cost of construction and its maintence during its life time.

6. Linkage Factor; refers to interconnection among the regions in its surrounding area.

7. Infrastructure Integration factor; refers to integrated transportation infrastructure to be implemented when the road is constructed.

8. Accessibility factor; refers to the level of accessibily of a region from or to others

9. Environmental Impact Factor; refers to environmentalproblems that may be caused or initiated when the road is constructed.

Table 2 The Proportion of Samples for Each District

Sub-district	Population Age 15 Years and Over	Minimum Sample Size	Sample Size
Bacan	8838	113	136
South Bacan	5493	70	84
West Bacan	3565	46	55
North West Bacan	2599	33	40
East Bacan	3399	43	52
Bacan Middle East	3383	43	52
South East Bacan	3719	47	56
Total	30996	395	475

Based on those factors, questionnaires were prepared. In addition, the following questions were also prepared in the questionnaire:

1. If the road were costructed, how important are the factors?
2. Has the government usually taken into account these factors when constructing roads?

Since there are two analyses required for this study, IPA and AHP, two types of questionnaires were also prepared for different groups of respondents. Table 2 presents the samples of the IPA questionnaire. It was distributed proportionally among population in each sub-district. For the AHP questionnaire, as many as 17 respondents were selected from Department of Public Works, Department of Planning, Department of Transportation, and from Community leaders.

RESULTS AND DISCUSSION

Out of 475 IPA questionnaires distributed, 455 were returned, while for the AHP, all 17 questionnaires were returned. Tables 3 and 4 present the result of the IPA questionnaire.

Determining the important level for each criteria (Question No. 1)

For each criteria viewed important by repondents, an analysis was conducted to determine its weighting, as presented in Table 5. It was found that Cost Criteria was viewed as the most important (score 1933), while Social Criteria was viewed the least important (score 1830).

Determining the important factor of respondent view on government's performance (Question No. 2)

Table 6 presents the respondents' view on government performance on criteria stated in the questionnaire. The majority of respondents viewed that government should consider Cost as the most important criteria when constructing the road, while the Accessibility criteria was viewed as the least important.

Table 3 Summary of Respondent Perception on The No. 1 Question

No.	Research Parameters	Respondent's Perception					
		Unimportant	Less Important	Quite Important	Important	Very Important	Total
1	Technical	1	1	61	249	143	455
2	Land Use	1	1	67	232	154	455
3	Economic	1	8	56	216	174	455
4	Social	1	20	74	233	127	455
5	Cost	1	5	74	175	200	455
6	Linkage Antarkawasan	1	16	73	225	140	455
7	Infrastructure integration inter-mode	1	1	61	250	142	455
8	Accessibility	1	1	84	203	166	455
9	Environmental Impact	4	12	78	166	195	455
	Total	12	65	628	1949	1441	4095

Table 4 Summary of Respondent Perception on The No. 2 Question

No.	Research Parameters	Respondent's Perception					
		Disagree	Less Agree	Simply Agree	Agree	Strongly Agree	Total
1	Technical	1	1	64	251	138	455
2	Land Use	1	3	76	252	123	455
3	Economic	1	1	65	179	209	455
4	Social	1	11	99	180	164	455
5	Cost	1	14	51	162	227	455
6	Linkage Antarkawasan	1	1	73	241	139	455
7	Infrastructure integration inter-mode	1	9	141	185	119	455
8	Accessibility	1	7	166	149	132	455
9	Environmental Impact	11	9	69	156	210	455
	Total	19	56	804	1755	1461	4095

Table 5 Important Level for Each Criteria

No.	Value Criteria	Unimportant	Less Important	Quite Important	Important	Very Important	Weight
		1	2	3	4	5	
1	Technical	1	2	183	996	715	1897
2	Land Use	1	2	201	928	770	1902
3	Economic	1	16	168	864	870	1919
4	Social	1	40	222	932	635	1830
5	Cost	1	10	222	700	1000	1933
6	LinkageAntarkawasan	1	32	219	900	700	1852
7	Infrastructure integration inter-mode	1	2	183	1000	710	1896
8	Accessibility	1	2	252	812	830	1897
9	Environmental Impact	4	24	234	664	975	1901
	Total	12	130	1884	7796	7205	17027

Table 6 Government Performance Level Weighting

No.	Value Criteria	Disagree	Less Agree	Simply Agree	Agree	Strongly Agree	Weight
		1	2	3	4	5	
1	Technical	1	2	192	1004	690	1889
2	Land Use	1	6	228	1008	615	1858
3	Economic	1	2	195	716	1045	1959
4	Social	1	22	297	720	820	1860
5	Cost	1	28	153	648	1135	1965
6	Linkage Antarkawasan	1	2	219	964	695	1881
7	Infrastructure integration inter-mode	1	18	423	740	595	1777
8	Accessibility	1	14	498	596	660	1769
9	Environmental Impact	11	18	207	624	1050	1910
	Total	19	112	2412	7020	7305	16868
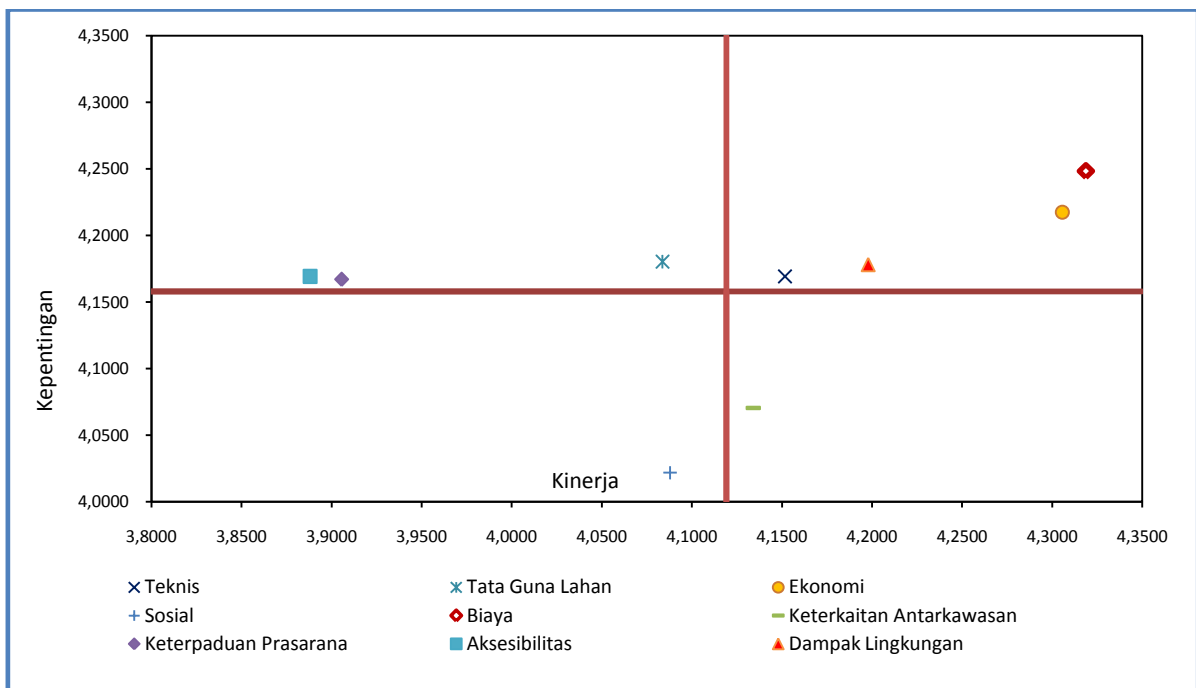
Figure 2 Cartesian Diagram of IPA Analysis

Importance Performance Analysis

Figure 2 presents the cartesian diagram of the IPA Analysis. The Figure reveals the following points:

1. The government did not put accessibily as the important point in its program, which is opposite with the people's view.
2. For cost, technical, economic and environtal impact handling, the people viewed that government has performed satisfactorily, which is inline with people wishes.
3. People viewed that government program did not affect to the social condition, as expected. Therefore, in the future, it should also consider social aspect in its program. This also apllies for linkage program.

4. The result also shows that the most important to the least important factors when making prioritization is as follows: (a) Technical, (b) Land use, (c) Economy, (d) Cost, (e) Linkage (f) Accessibility, and (g) Environment

AHP Analysis

Table 7 presents the sample analysis of weighted criteria for 1 sample. The compelte calculation is presented in Figure 3. It can be seen that cost is the most important criteria, while environmental impact is least important.

Table 7 Sample calculation Weight Criteria

| Factor	Tech-nical	Land Use	Eco-nomic	Cost	Link-age	Acces-sibility	Environ-mental	Eiqen vector	Weight
Technical	1.00	1.00	0.125	0.143	5.000	5.00	7.00	1.177	0.10045
Land Use	1.00	1.00	0.125	0.143	5.000	5.00	7.00	1.177	0.10045
Economic	8.00	8.00	1.000	1.00	8.000	8.00	8.00	4.416	0.37699
Cost	7.00	7.00	1.000	1.00	7.000	7.00	7.00	4.015	0.34270
Linkage	0.02	0.20	0.125	0.143	1.000	1.00	1.00	0.252	0.02153
Accessibility	0.20	0.200	0.125	0.143	1.000	1.000	1.00	0.355	0.03033
Environment	0.143	0.143	0.125	0.143	1.000	1.000	1.00	0.323	0.02755
Total	17.36	17.543	2.625	2.714	28.00	28.00	32.0	11.715	1.00000
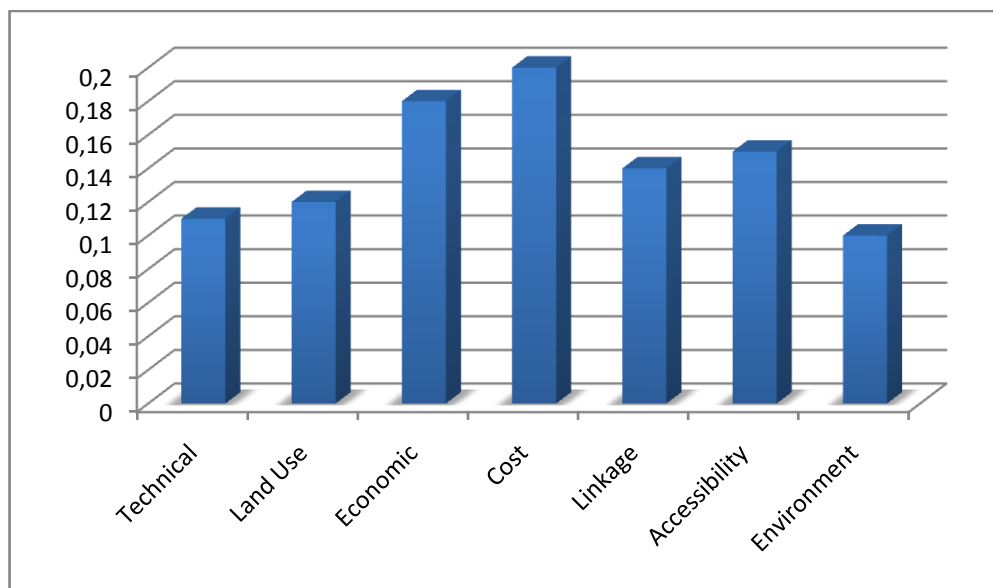
Figure 3 Weighted Value for Each Factor

Determination of Prioritization

The prioritization is obtained by multiplying the total weight of criteria with alternative scoring by the *stakeholders*. Scoring is based on the perception of alternative *stakeholders* by filling questionnaires from seven alternative road section selected in accordance with the level of priority. Table 8 shows the result of the

analysis. Based on Table 8, the order of prioritization of road network development on the island of Bacan is defined as shown in Table 9.

Table 8 Recapitulation of Criteria Weights Multiplication with Alternative Weighting

Alter-native	Weigh Factor								Average
	Tech-nical	Land Use	Econo-mic	Cost	Linkage	Acces-sibility	Environ-ment	Total	
I	15.585	16.870	26.162	28.124	19.404	21.230	10.346	137.722	8.101
II	13.538	15.424	23.295	27.120	18.412	19.913	10.444	128.146	7.538
III	12.855	13.737	20.249	25.312	16.004	17.863	10.151	116.171	6.834
IV	13.651	13.858	19.353	25.111	16.713	18.009	10.151	116.846	6.873
V	15.244	15.063	22.937	27.120	19.262	20.059	9.956	129.640	7.626
VI	11.831	13.496	20.607	24.508	16.854	17.716	9.468	114.481	6.734
VII	11.376	12.653	18.995	24.910	15.580	17.131	9.663	110.307	6.489

Table 9 Priority Order On Road Development Area Road Network Bacan Island

No.	Alternative	On the Road Island Road Network in the Territory Bacan	Weight
1.	I	Jl. Labuha - Babang	8.101
2.	V	Jl. Babang - Songa, Jl. Songa - Wayaua	7.626
3.	II	Jl. Labuha - Sawadai, Jl. Sawadai - lemur	7.538
4.	IV	Jl. Babang - Yaba	6.873
5.	III	Jl. Labuha - Belang-striped, Jl. Piebald - Yaba	6.834
6.	VI	Jl. Songa - Wayatim	6.734
7.	VII	Jl. Wayatim - Wayaua	6.489

CONCLUSION

Based on the analysis, the following conclusions can be drawn:

1. The important factors viewed by stakeholders in determining prioritization based on analysis of IPA are accessibility, linkage, land use, cost, technical, economic and environmental impact, respectively.

2. The list of priority when constructing the road should be Labuha-Babang, Babang-Songa, Songa-Wayaua, Labuha-Sawadai, Sawadai-Kubung, Babang-Yaba, Labuha-Belang-belang, Belang-belang-Yaba, Songa-Wayatim, and Wayatim-Wayaua.

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