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Analytical Hierarchy Process for Decission Making in Managing Slum Area

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***Abstract*— In order to solve environmental and sanitation problem caused by slum area, Local Government of Tangerang Municipality plan to relocate slum area in Cisadane Riverside. Options in managing this problem are: (a) to relocate inhabittant of slum area to simple houses in other area (b) to relocate inhabittants of slum area to simple apartement but stil in the riverside (c) no relocation but facilitate them with sanitation infrastructures.**

There are four main criteria that should be considered in decission making for those option: (a). Cost (economic aspect); (b). Available technology (c). Environmental Impact (d). acceptability.

Metode analytical hierarchy process was employed to form best decission of this problem, survey was conducted to 25 respondent from stakeholders.

Keywords*— Slum Area, Relocation, Analytical Hierarchy Process

I. INTRODUCTION

About one third of the urban population in developing countries have very limited access to adequate housing, safe water and sanitation. These people live in overcrowded and slums, sometimes in a marginal and dangerous land. It's not easy for them to have access to public clean water, and sometimes even if there were access, they can't afford to pay to providers. They let their waste untreated, often surrounds them with their daily activities and affects their health.

Slum area with inadequately serviced happend over several decades where poor people in cities was noticed as negative aspect of urban growth. A squatter settlement can generally be defined as a residential area in an urban locality inhabited by the very poor who have no access to tenured land of their own, and hence "squat" on vacant land, either private or public (1)

Many governments around the world usually choose to solve the problems of urban squatter settlements by clearing away old old house and replace them with modern housing with much better sanitation. In these specific cases, slum clearance often form in urban renewal projects, and often the former residents were prohibited in the renewed housing.

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There are many critics about forced slum clearances because it ignores the social problems that cause the formation of slums. National approaches to informal settlements in particular, have generally shifted from that negative policies.

Many countries now shifted from confrontationist attitude to create an enabling environment, trying to find unique local solutions for their housing and shelter problems. As an example in Yogyakarta, Indonesia– government proposed slum improvement programs in the flood-prone squatter areas, without eviction of the whole living there. Social rehabilitation was included in this program, with the objective was to improve the settlements and clean the environment, renovate poor housings by their own resources. Program for socio-economic enhancement resulted into increasing household's income and harmonized social relationship among residents. The main themes of these projects were that all these programs were strongly participated by the local residents of the squatters of Yogyakarta (2).

This paper try to figure out what is the best option in managing slum area in Tangerang Municipality, especially those located in Cisadane Riverside. In order to get best decission considering all aspect, we employed analytical hierarchy process.

II. RESEARCH AREA

Tangerang Municipality is one of the city in Banten Province with highest population and economic growth compare with others city in Banten Province. Its strategic location support rapid economic growth and also population growth of the city. These are the main reason why urbanization in Tangerang Municipality become one of problems that burden the local government. High number of population could be considered as benefit but on the other hand it could be very challanging, especially if human resource quality of the population were low. Its location in west Jakarta and bordered with the international airport Soekarno-Hatta makes Tangerang Municipaity chosen as new central business development and alternative housing area after Jakarta which is already saturated with all the development activities.

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Tangerang municipality becomes one of the satellite cities for Jakarta. Urbanization from rural areas, now is taking place to the cities surrounding Jakarta such as Tangerang, Bekasi and Bogor. It makes contribution to the growth of population of Tangerang Municipality to 1,918,556 inhabitants. With total area about 164.55 km^2 (not included the area of international airport Soekarno-Hatta), the population density reach 122 inhabitant/Ha and population growth 4.62%/annum (3).

Geographical Information System (GIS) analysis shows that the Tangerang Municipality is mainly dominated by settlement areas, followed by industrial and commercial areas. GIS analysis also shows that there are about 430,094 building units in Tangerang Municipality in 2013 with ratio between regullar and irregular settlement for almost 3:7. Irregullar settlemet define as sttlemet that growth without certain planning, including slum and squatter area.

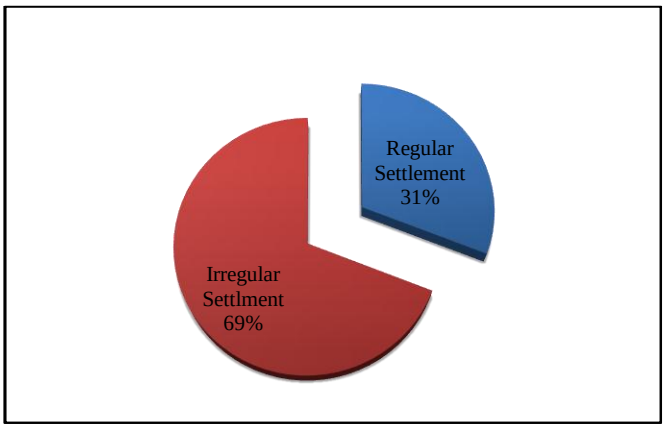

Figure 1. Ratio Irregular and Regular Settlement
Source: GIS Analysis, 2014

Industrial and trading sectors also grow very fast in Tangerang Municipality, caused by its strategic location to reach the international gate. Tangerang Municipality has a policy to develop the city as city of thousands industries with environmental friendly awareness. This policy brings to many consequences in environmental management for the Local Government.

Tangerang Municipality has special characteristic of the environment. There is no coastal zone because it was surrounded by other local areas; Tangerang Regency in northern and southern, and Jakarta in western part. One of the trade marks of Tangerang Municipality is that the area divided by Cisadane River in to two parts, eastern and western parts.

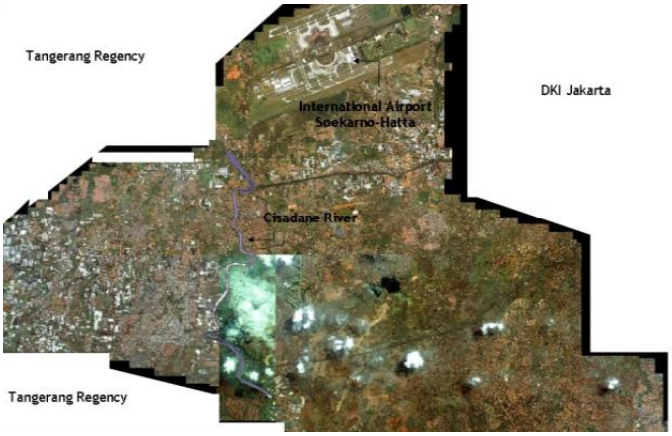

Figure 2. Tangerang Municipality Area
Source: SoER, Tangerang Municipality 2012

Cisadane River flows from Bogor Regency in the south to the Java Sea in the north which is located in the Tangerang Regency area. With the length about 15 km in Tangerang Municipality area and width about 100 m, Cisadane River becomes the main resource for clean water. Flow rate of Cisadane River reach about 414.01 m3/s in rainy season and only 11.42 m3/s in dry season and the average is about 212.7 m3/s (3). The available flow rate makes Cisadane River become very important water resource, not only for Tangerang Municipality, also for Tangerang Regency, Bogor Regency, Bogor Municipality and DKI Jakarta, the capital city. Since there are rising in development activities on the riverside, the quality of Cisadane River becomes lower and lower caused by industrial and domestic growth.

Figure 3. Settlement on Cisadane Riverside categorized as Squatter Area
Source: SoER, Tangerang Municipality 2014

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The growth of industrial sector, contribute to the forming of urban areas, which is signed by the growth of slum areas. The slum areas are categorized in to legal slum areas and illegal slum areas or squatter areas. Based on Local Government Spatial Planning 2012-2032, Cisadane Riverside should be utilized as free area for conservation about 20-50 m wide from the riverside line. Those makes all the slum areas on the Cisadane River are categorized as squatter areas.

Squatter area usually has no drainage system and sewerage treatment plant. They discharge the wastewater from domestic activities directly to the river. The value of BOD from annual monitoring activities, showed that Cisadane River condition already over the stream quality standard. The BOD of Cisadane River which is classified as Class I , has been higher than the stream quality standard (2mg/l). TSS as an indicator of pollution caused by solid matter also has been increasing higher than the stream quality standard in Cisadane River. This condition is a result of erosion of the river side and also caused by activities along the river.

There are about 10,989.22 Ha slum areas spread out in 518 point in Tangerang Municipality (3). The growth of slum areas is caused by low income population immigration from outside Tangerang Municipality. The slum areas in Tangerang Municipality are categorized in some typologies, based on the slum area characteristics as follow:

1. Properness to the land use (appropriate/ inappropriate to the land use)
2. Economic value of the land (low/high economic value)
3. Area function (Commercial/ Industrial/ Housing)

III. METHODS

Decision-making considered as some options, on some criteria, of one alternative among several alternatives. A decision may need to be taken on the basis of multiple criteria rather than a single criterion. It is the reason why then we need assessment for those criterias and evaluate all the alternatives by considering each criteria and then the aggregation of these evaluations, in order to achieve ranking of the alternatives for solving the problem. The problem is further compounded when there are several or more experts whose opinions need to be incorporated in the decision-making. It is lack of adequate quantitative information which leads to dependence on the intuition, experience and judgement of knowledgeable persons called experts.

We can evaluate a generic decision-making problem by following activities:

1. Evaluate the situation.
2. Arrange multiple criteria.
3. Assessing multiple criteria.
4. Evaluating alternatives based on assessed criteria.
5. Ranking the alternatives.
6. Incorporating the judgements of multiple experts.

The problem can be abstracted as how to derive weights, rankings that indicate the importance of activities according to their impact and the objective of decisions. This is the process of multiple-criteria decision-making (MCDM).

AHP (analytical hierarchy process) is one of model that support decission making process, developed by Thomas L. Saaty. This model describe how to solve problem of complex multi factors and multi criteria into a hierarchy. Saaty (1980) define hierarchy as representative of complex problem into multilevel structural whereas first level is objectives that followed by factors level, criteria, sub criteria and so on until final level of all the alternatives. By forming hierarchy, one complex problem could be defined into some groups which can be arranged in form of hierarchy, so it would be describe sistematically (4).

AHP is used to solve problem in decission making instead of others methods because it has several pre-eminence as follow:

1. Hierarcal structures, as consequences of selected criteria, give chance to develop more sub criteria
2. Consider about validity into limit of inconsistency for each selected criteria and alternative on decission making and also consider about sensitivity analysis in decission making

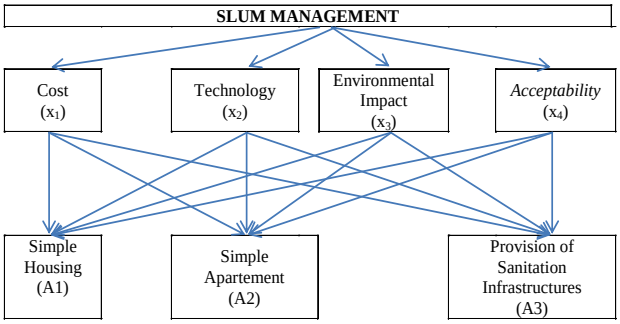

Figure 4. Hierarchy of Criteria and Alternatives
Source: Analysis, 2016

Qualitative criteria and quantitative criteria can be compared into level of importancies and priority, each of them in pair compare in Saaty's scale 1-9. Interpretation of Saaty's scale is as follow:

TABLE I. SAATY'S SCALE

Scale	"Importance" Definition
1	Equal Importance
3	Slightly more inportance
5	Materially more Importance
7	Significantly more Importance
9	Absolutely more Importance
2, 4, 6, 8	Comprimise Value

Source: Saaty, 1980

Saaty (1980) stated that to maintain consistency when deriving priorities from paired comparisons, the number of factors being considered must be less or equal to nine. AHP allows inconsistency, but provides a measure of the inconsistency in each set of judgments. The consistency can be determined by consistency ratio (CR), defined as:

$$CR = CI/RI \qquad (1)$$

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where CI is called the consistency index and RI is the Random Index. CR ≤ 0.1 means good consistency.

Furthermore, Saaty (1980) provided average consistencies (RI values) of randomly generated matrices. CI for a matrix of order n is defined as:

$$CI = (\lambda_{max} - n)/(n-1) \qquad (2)$$

In general, a consistency ratio of 0.1 or less is considered acceptable, this threshold is 0.08 for matrices of size four and 0.05 for matrices of size three. If the value is higher, the judgments may not be reliable and should be elicited again.

IV. RESULT AND ANALYSIS

A. *Comparation among criterias*

By applying the procedure, the results indicate the highest importance to the criteria "environmental impact" (50.9%) the other three criteria have various value between 5% to 27.9% as results from the eigenvector of the criteria comparison matrix, reported in Table 2. Thus, the results are consistent.

TABLE II. MATRIX OF CRITERIA COMPARISON

	Cost	Technology	Environmental Impact	Acceptability
Cost	1	1/3	1/7	1/5
Technology	3	1	1/3	1/2
Environmental Impact	7	3	1	3
Acceptability	5	3	1/3	1
Sum	16	7.333333333	1.80952381	4.7

	Cost	Technology	Environmental Impact	Acceptability	Score
Cost	0.063	0.045	0.079	0.043	0.0574
Technology	0.188	0.136	0.184	0.106	0.1536
Environmental Impact	0.438	0.409	0.553	0.638	0.5094
Acceptability	0.313	0.409	0.184	0.213	0.2796
Sum	1.0000	1.0000	1.0000	1.0000	1

Consistency Test	
Result	Ratio
0.2373	4.1362
0.6353	4.1358
2.2107	4.3400
1.1971	4.2808
CI	0.0744
CI/RI	0.0827

Source: Analysis, 2016

B. *Comparation among alternatives*

Next step is to compare each alternatives and find the best option among them.

TABLE III. MATRIX OF ALTERNATIVES FROM COST CRITERIA

	A1	A2	A3
A1	1	1/3	1/5
A2	3	1	1/3
A3	5	3	1
Sum	9.00	4.33	1.53

Normalized matrix

	A1	A2	A3	Score
A1	0.1111	0.0769	0.1304	0.1062
A2	0.3333	0.2308	0.2174	0.2605
A3	0.5556	0.6923	0.6522	0.6333
Sum	1.0000	1.0000	1.0000	1.0000

Consistency Test	
Result	Ratio
0.3197	3.0112
0.7901	3.0330
1.9456	3.0720
CI	0.01935734
CI/RI	0.0334

Source: Analysis, 2016

TABLE IV. MATRIX OF ALTERNATIVES FROM TECHNOLOGY CRITERIA

	A1	A2	A3
A1	1	5	3
A2	1/5	1	1/3
A3	1/3	3	1
Sum	1.53	9.00	4.33

Normalized Matrix

	A1	A2	A3	Score
A1	0.6522	0.5556	0.6923	0.6333
A2	0.1304	0.1111	0.0769	0.1062
A3	0.2174	0.3333	0.2308	0.2605
Sum	1.0000	1.0000	1.0000	1.0000

Consistency Test	
Result	Ratio
1.9456	3.0719734
0.3197	3.01120187
0.7901	3.03296877
CI	0.01935734
CI/RI	0.0334

Source: Analysis, 2016

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TABLE V. MATRIX OF ALTERNATIVES FROM ENVIRONMENTAL IMPACT CRITERIA

	A1	A2	A3
A1	1	1/3	5
A2	3	1	7
A3	1/5	1/7	1
Sum	4.20	1.48	13.00

Normalized Matrix

	A1	A2	A3	Score
A1	0.2381	0.2258	0.3846	0.2828
A2	0.7143	0.6774	0.5385	0.6434
A3	0.0476	0.0968	0.0769	0.0738
Sum	1.0000	1.0000	1.0000	1.0000

Consistency Test

Result	Ratio
0.8662	3.06238685
2.0083	3.12145699
0.2223	3.01269163
CI	0.03275591
CI/RI	0.0565

Source: Analysis, 2016

TABLE VI. MATRIX OF ALTERNATIVES FROM ACCEPTABILITY CRITERIA

	A1	A2	A3
A1	1	3	1/5
A2	1/3	1	1/7
A3	5	7	1
Sum	6.33	11.00	1.34

Normalized Matrix

	A1	A2	A3	Score
A1	0.1579	0.2727	0.1489	0.1932
A2	0.0526	0.0909	0.1064	0.0833
A3	0.7895	0.6364	0.7447	0.7235
Sum	1.0000	1.0000	1.0000	1.0000

Consistency Test

Result	Ratio
0.5878	3.04271913
0.2511	3.01365532
2.2726	3.14108156
CI	0.03290934
CI/RI	0.0567

Source: Analysis, 2016

V. CONCLUSION

From calculation, each of altervative has certain precentage compare to each criteria required, as follow:

TABLE VII. PRECENTAGE RESULT FROM COMPARATION BETWEEN ALTERNATIVES AND CRITERIA

	Cost	Technology	Environmental Impact	Acceptability	Combination Score
A1	0.1062	0.6333	0.2828	0.1932	0.3015
A2	0.2605	0.1062	0.6434	0.0833	0.3823
A3	0.6333	0.2605	0.0738	0.7235	0.3162
Sum	1.000	1.000	1.000	1.000	1.000

Source: Analysis, 2016

Table 7. show that AHP will describe best alternative of each criteria with detail:

1. Provision of sanitation infrastructures is the best option for cost criteria with score 0.6333
2. Relocation to simple housing is the best option for technology criteria with score 0.6333
3. Relocation to simple apartement is the best option for environmental impact criteria with score 0.6434
4. Provision of sanitation infrastructures is the best option for acceptability criteria with score 0.7235
5. But if all the criterias consider in the decission making process, alternativ A2 (Relocation to simple apartement) selected as the best option in managing slum area.

ACKNOWLEGDEMENT

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