Development of Alternatives to Mitigate Deterioration of Segara Anakan Lagoon as Revealed by Analytical Hierarchy Process

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ABSTRACT

Segara Anakan is a lagoon located in estuary area of Citanduy and Cibeureum rivers. The main problem that exists in the region Segara Anakan is a shrinking area of Segara Anakan lead lagoon function becomes ineffective due to the increased volume of sediment in estuaries Citanduy. Refinement Segara Anakan will impact annual floods that occurred in the area downstream Citanduy. Have far-reaching is the decline in fish production, which makes the source of livelihood for the community residents of Kampung Laut, furthermore, the environmental changes that occurred in the area Segara Anakan have resulted in shrinking coastal fisheries resources and the expansion of land arising from silting. Assessment of the problem conducted by the method of approach of Analytical Hierarchy Process (AHP) to obtain the best alternatives among three alternatives being offered to sustain the function of Segara Anakan Lagoon. These three alternatives include the 1) Dredging the Lagoon and Upstream Watershed Conservation; 2) Dredging the Lagoon and Reclamation Work around Segara Anakan, and 3) Dredging the Lagoon and Citanduy Diversion. Some criteria and sub-criteria are adapted to support the selection of the alternatives and related questionnaires were developed, and the questionnaire filling was carried out through the implementation of Focus Group of Discussion or FGD. The criteria include several aspects of the criteria and sub-criteria are technical (floods, silting), socioeconomic (the tourist area, the local economy), as well as the environment (fisheries/shipping, agriculture and mangrove forests). Results of the analysis applying the AHP method showed the consistent value on the Alternative 3), i.e. the Dredging of the Lagoon and the Upstream Watershed Conservation (38%).

Keywords: Segara Anakan, Analytical Hierarchy Process, estuary sedimentation

1 INTRODUCTION

The main river of Citanduy River Basin is the Citanduy River which flows through two provinces, i.e. West Java Province and Central Java Province. The upstream part of Citanduy River Basin is mountainous area of Mt. Cakrabuana at Tasikmalaya District, whereas the downstream part is an estuary at Segara Anakan Lagoon of Cilacap District.

The main problem that appears in area of Segara Anakan is the decrease of the lagoon area that causes ineffective function due to the increased volume of sedimentation in the estuary of Citanduy River (Supraharmonia, 2014). Sedimentation of Segara Anakan will potentially increase annual flood at downstream area of Citanduy River. However, the sedimentation may give advantage to the people in area of Segara Anakan, especially at Kampung Laut. They use sedimentation in the estuary of Cimeneng River as farming area (Rosalina, 2016).

Mitigation of flood in the downstream area of Segara Anakan can be conducted by Analytic Hierarchy Process (AHP) method for decision-making process which is based on several alternatives, e.g. dredging at

the Lagoon and conservation of upstream watershed; dredging and reclamation at Segara Anakan area; and dredging at the Lagoon and shunt of Citanduy. This research is performed to give input to the Government Policy regarding the conservation plan of Segara Anakan Lagoon.

2 LITERATURE REVIEW

The AHP may give solution to some complex problems with various aspects and criteria. The previous research of Pertanto (2006) used AHP method as an approach methodology in irrigation water allocation by considering the 4 alternatives and 3 criteria. According to Saaty (1981), AHP can be used for decision making, which is designed and conducted rationally with a good selection on alternatives that already evaluated in multi criteria. During the process, the Decision maker produces a slightly difference result and develops all the priorities in order to make priority rank of several alternatives. In AHP, there is Consistent Decision and Inconsistent Decision (Pertanto, 2006)

According to the problems at Segara Anakan area, AHP can be used as a mitigation effort for physical

disaster and social conflict that may arise with rational approach to select the best alternatives of problem solving which will be evaluated in multi criteria.

Comparative judgment, as it is mentioned in the research of Universitas Sumatera Utara (2011), is conducted by relative interest scoring of two elements in certain level that is related to the upper level. Assessment is the core of AHP since it has significant influence to the priority rank of elements. The assessment result will be much easier to be shown in the form of matrix pairwise comparisons i.e. a pair of comparison matrix that has alternative preference level for each criterion. The preference scale of Saaty (1981) uses scale 1 as the lower level (equal importance), to scale 9 as the highest level (extreme importance).

3 RESEARCH METHODOLOGY

3.1 Location Study

Several villages in Segara Anakan area are chosen to become the research area, i.e. Village of Bagolo, Pamotan, Rawa Apu, and Ujung Gagak, as shown in Figure 1.

3.2 Research Stages

The first stage of the research was a preparation, which was performed in the following steps:

a) Literature study, to collect and study literature and theories that are relevant to the research;
b) Collecting primary data which consist of respondent data, field survey, interview, and give questionnaire to the respondents;
c) Collecting secondary data from related Institutions, population data per District, and Maps that relevant to the research;
d) Data analysis which consists of scoring analysis on questionnaire result and analysis of AHP method.

The research stages are summarized in a Flowchart, as it is shown in Figure 2.

3.3 Three Diagram of AHP

The physical and social problem-solving at Segara Anakan Lagoon needs to be conducted in decomposition hierarchy structure method to obtain decision which will be the priority. The tree diagram of AHP can be seen in Figure 3.

3.4 Discussion

Several problems will be discussed in this research, i.e. determination of respondent by distribution of variables, how to fill and analyze the questionnaire, and decision making process with AHP method.
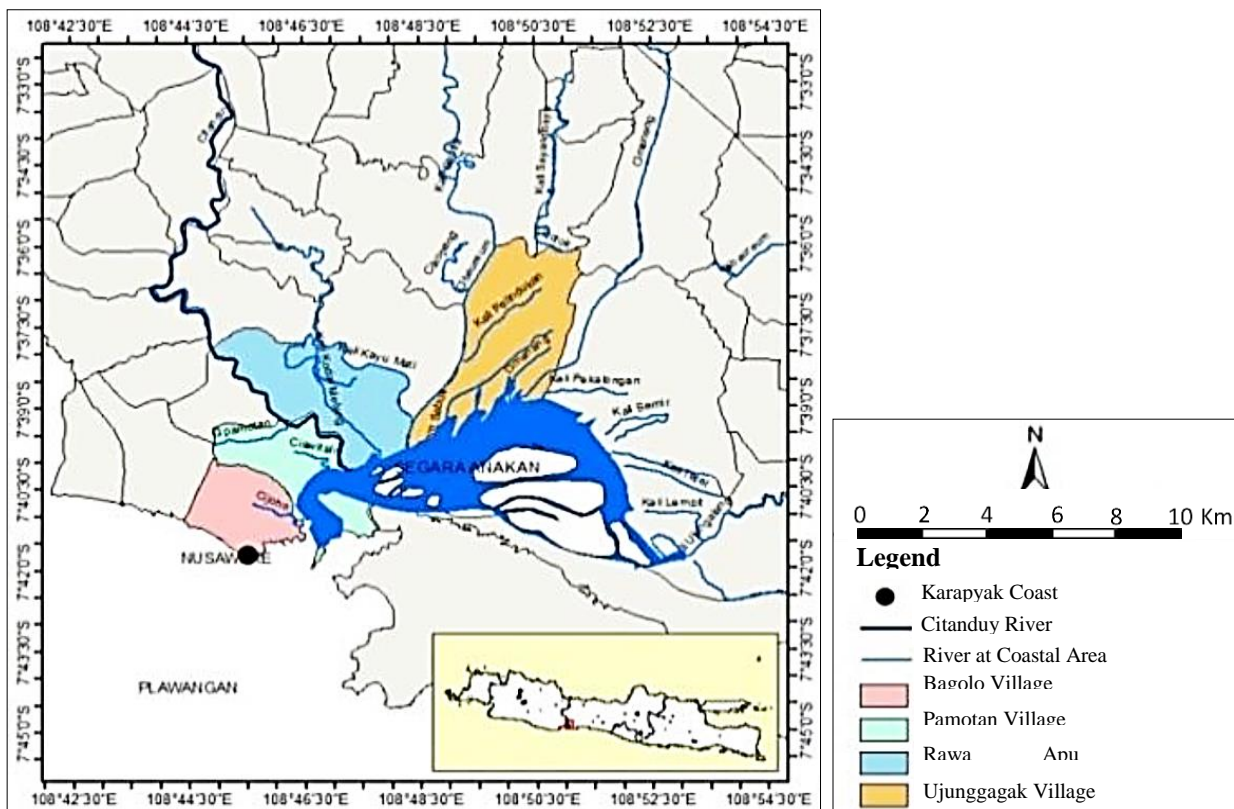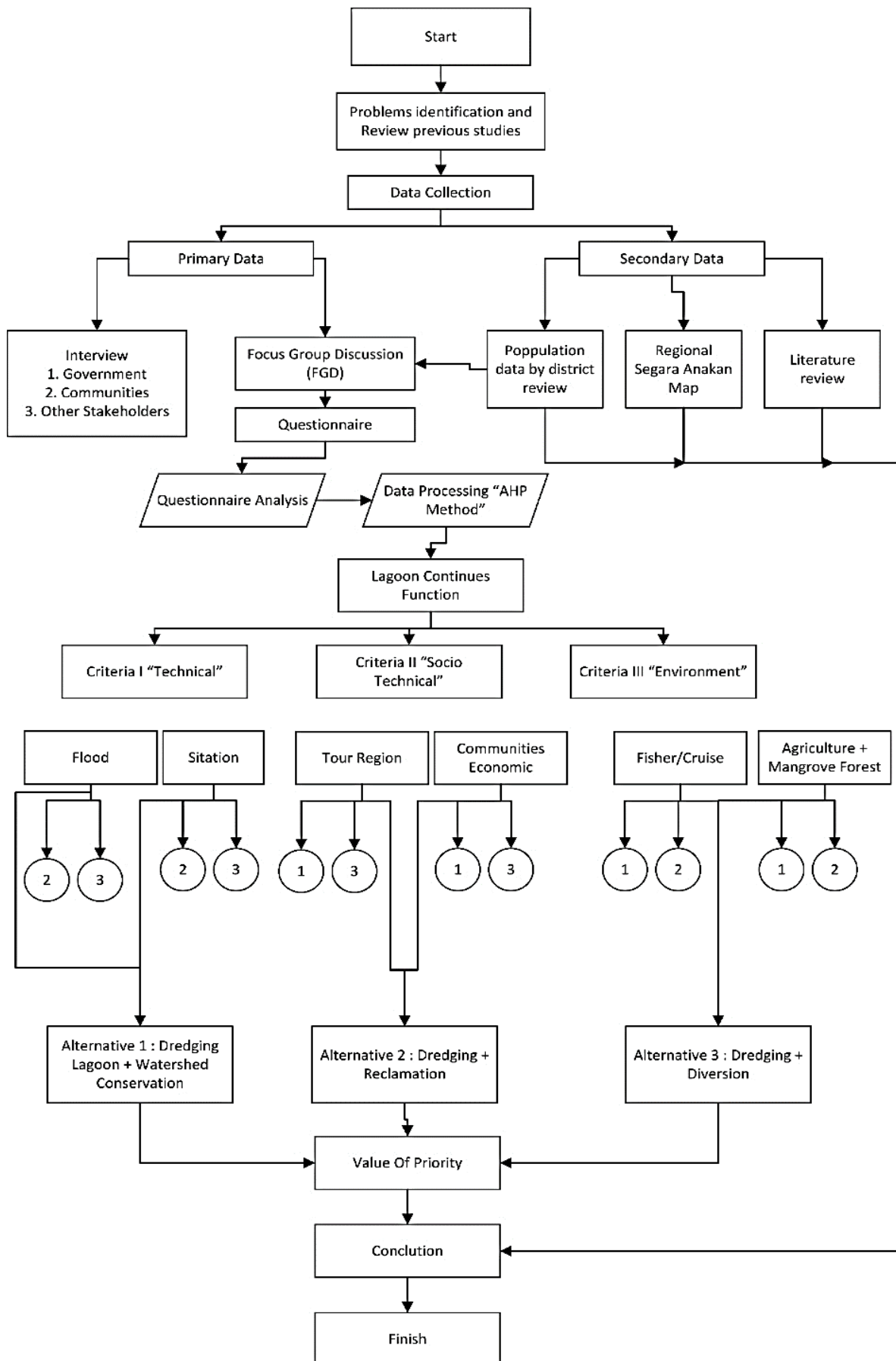

Figure 1. Map of Research Area

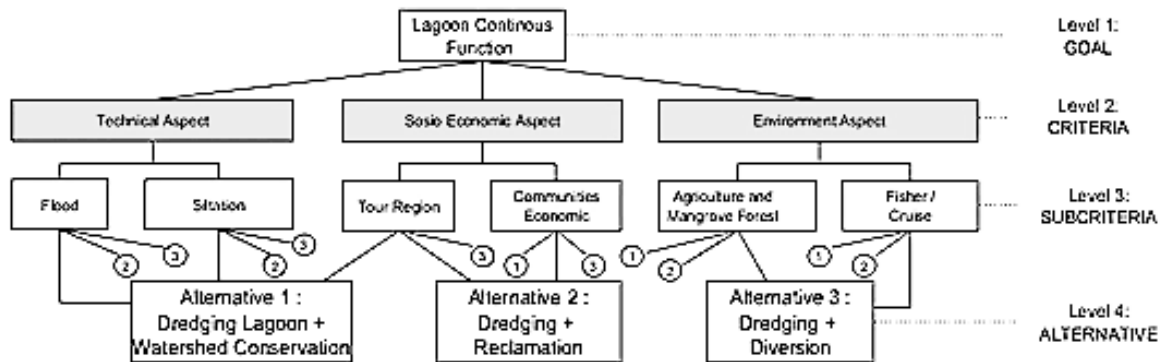Figure 2. Flowchart of research implementation.

Figure 3. Three diagrams of AHP

The research variable is determined by several people as respondents, which consist of :

a) Variable of interest groups, with several attributes, i.e. governments, communities, and other stakeholders.
b) Variable of age, with attributes >35 years old dan <35 years old. In considering that the group age of > 35 years old has broader knowledge.
c) Variable of insight and knowledge, with attribute of not involved (inexperienced) and attribute of involved (experienced) into Segara Anakan environment.
d) All Variable, with attribute from all respondents.

Analysis of questionnaire in this research is conducted in the following steps :

a) Separating and determining score and questionnaire validity based on variable of group/interest of each respondent.
b) Making list of respondent from all respondent of the first step.

c) Making range or value of each respondent based on the questionnaire result and producing table of criteria level. Table of interest range based on questionnaire score/value is shown in Table 1.
d) Making different choices of two interests that were derived from the third step, as it is shown in Table 2 and Table 3.
e) Assessment of level also takes the opinion directly drawn from the respondent into consideration, not only based on questionnaire score.
f) A respondent with value of 1 in the questionnaire has not taken into consideration in the calculation.
g) There is also consideration, on some occasion, where value of 1 will be calculated.
h) The next step is following the 1st step, which is creating groups based on age, knowledge, and mixed variable.
i) Test of consistency ratio value of pairwise comparison matrix result, if the CR< 0.1. When the CR result is inconsistent, thus the calculation result need to be repeated or there should be a reason to show that it is inconsistent (Singarimbun, 1987; Handayani, 1987).

Table 1. Range of AHP criteria scale of questionnaire score/value

Parameter	Scale of AHP from values questionnaire				
	Do not know	Strongly disagree	Disagree	Agree	Strongly agree
Siltation	1 - 3	4 - 6	7 - 9	10 - 12	13 - 15
Flood	1 - 3	4 - 6	7 - 9	10 - 12	13 - 15
Economic Society	1 - 3	4 - 6	7 - 9	10 - 12	13 - 15
Tour Region	1 - 3	4 - 6	7 - 9	10 - 12	13 - 15
Agriculture + forest	1 - 3	4 - 6	7 - 9	10 - 12	13 - 15
Fishery/Cruise	1 - 3	4 - 6	7 - 9	10 - 12	13 - 15
Technical, Social, Environment	1 - 5	6 - 10	11 - 15	16 - 20	21 - 25

Table 2. Table of different value of average of average interest scale criteria

Equally important	Some more important	Quite important	Very important	Absolute more important
0	0.1 – 0.9	1 – 1.9	2-2.9	3-4

Table 3. Table of different value of sub criteria interest scale

Equally important	Some more important	Quite important	Very important	Absolute more important
0	1	2	3	4

4 RESULT AND DISCUSSION

4.1 List of Respondents Research

There are 95 respondents in this research (see Table 4).

Table 4. Number of respondents research

Group	Insight / Knowledge		Number of Respondents
	No Experience	Experience	
Government	9 persons	8 persons	17
Communities	36 persons	26 persons	62
Other Stakeholders	6 persons	10 persons	16
Total	51 persons	44 persons	95

4.2 Focus Group Discussion and Completion of Questionnaires

The Focus Group Discussion (FGD) and questionnaire survey were conducted in villages in the research area, as it is shown in Table 5.

Table 5. FGD Location and schedule of implementation

No	FGD Location	Number of participants	Number of respondents	Population	%	Date
1	Ujung Gagak Village, Kampung Laut District, Cilacap Regency	21	19	4,861	0.39	Monday, 18 April 2016
2	Rawa Apu Village, Patimuan District, Cilacap Regency	11	11	8,886	0.12	Wednesday, 20 April 2016
3	Pamotan Village, Kalipucang District, Pangandaran Regency	19	19	4,852	0.39	Friday, 22 April 2016
4	Bagolo Village, Kalipucang District, Pangandaran Regency	13	13	3,123	0.42	Monday, 25 April 2016

The questionnaire scoring results can be described as follows:

a) Scoring based on total score of each aspect or criteria (see Table 7).
b) Scoring based on total score of each parameter or sub criteria (see Table 8).
c) Produce score from comparison table to get comparison matrix of each criterion and/or sub criteria (see Table 9).
d) Produce score from comparison table to get comparison matrix of each alternative from each criterion and/or sub criteria (see Table 10).

The value of questionnaire result of all respondents is shown in Table 6

4.3 Data of Respondent Consistency Test

Each variable shows consistency ratio less than 0.1, which means the result is inconsistent. Several questionnaire scoring and opinion of respondents show inconsistent value. There are several factors that may cause inconsistent on the result, e.g.:

a) There is no feasibility test on the questionnaire and its analysis on some example respondent.
b) The misunderstanding of respondent on the meaning of questionnaire and the main problem.
c) Unequal number of respondent on each variable.
d) Impropriety or mismatch on the experience and profession of respondent that is related to the problems mentioned in the questionnaire.
e) The instrument is confusing and not related to the respondent.
f) There is more choices or comparator, thus there is also bigger chance to have inconsistent result.
g) The available score is not suitable with respondent opinion, which tends to give inconsistent result.

Table 6. Questionnaire scoring result

Group Variable		Government	Communities	Other Stakeholders	Total
Number of Respondents (persons)		17	62	16	95
Technical Aspects	Dredging + Watershed Conservation	329	1210	305	1844
	Dredging + Reclamation	284	1054	262	1600
	Dredging + Citanduy Diversion	298	1136	271	1705
Sosio Economic Aspects	Dredging + Watershed Conservation	275	1065	273	1613
	Dredging + Reclamation	310	1189	262	1761
	Dredging + Citanduy Diversion	286	1137	274	1697
Environment Aspects	Dredging + Watershed Conservation	297	1101	284	1682
	Dredging + Reclamation	306	1120	269	1695
	Dredging + Citanduy Diversion	272	1077	276	1625
Total Aspect	Dredging + Watershed Conservation	901	3376	862	5139
	Dredging + Reclamation	900	3363	793	5056
	Dredging + Citanduy Diversion	856	3350	821	5027

Table 7. Questionnaire scoring on criteria of government group variable

No	Name	Result of the questionnaire											
		Technical				Socio economic				Environment			
		A	B	C	Average	A	B	C	Average	A	B	C	Average
1	Achmad Chumaidi	20	17	17	18	17	20	18	18.33	19	20	20	19.67
2	Daddy Moerhadio	21	19	20	20	17	21	21	19.67	18	19	21	19.33
3	Agus Tri Wibowo	20	19	19	19.33	21	17	19	19	19	18	19	18.67
4	Edwin Martha P	21	20	19	20	18	19	17	18	18	19	18	18.33
5	Bagus Prio Utomo	19	18	18	18.33	20	19	18	19	19	18	17	18

Inquiries
A: Dredging Lagoon and Upstream Watershed Conservation
B: Dredging and Reclamation
C: Dredging and Citanduy Diversion

Table 8. Questionnaire scoring on sub criteria of government group variable

No	Name	Sub Criteria					
		Siltation	Flood	Economic society	Tour region	Agriculture + forest	Fishery/cruise
		Score	Score	Score	Score	Score	Score
1	Achmad Chumaidi	12	10	12	11	12	12
2	Daddy Moerhadio	13	13	15	13	13	12
3	Agus Tri Wibowo	11	12	12	11	13	11
4	Edwin Martha P	12	13	12	11	12	11
5	Bagus Prio Utomo	12	10	12	11	11	11
6	Suhada	11	10	12	11	13	9

Table 9. Comparison pairwase matrix of each sub criteria

	Flood	Siltation	Tour region	Economic society	Fishery/cruise	Agriculture + forest	Total	Weight priority
Flood	1	1.053	1.154	0.821	0.904	0.931	5.863	0.151
Siltation	0.95	1	1.889	1.439	1.036	1.207	7.521	0.194
Tour Region	0.867	0.529	1	0.488	0.8	0.486	4.17	0.108
Sosio Economic	1.218	0.695	2.048	1	2	1.933	8.894	0.23
Fishery/cruise	1.106	0.965	1.25	0.5	1	1.059	5.88	0.152
Agriculture + forest	1.074	0.828	2.056	0.517	0.944	1	6.419	0.166
Total							38.747	1.00

Table 10. Comparison pairwise matrix of each alternative based on technical criteria

Method	Dredging + Watershed Conservation	Dredging + Reclamation	Dredging + Cit.Diversion	Total	Weight Priority	Eigen Vector'
Dredging + Watershed Conservation	1	1.56	1.08	3.64	0.39	0.39
Dredging + Reclamation	0.64	1	0.68	2.32	0.25	0.25
Dredging + Cit.Diversion	0.93	1.48	1	3.41	0.36	0.36
Total				9.37	1	1

Table 11. Table of Percentage Alternative Priority based on 6 Subcriteria

| Alternative | Variable | | | | | | | |
	All Variable	Government	Community	Others	Age <35	Age ≥35	Experience	No Experience
Dredging Lagoon + Watershed Conservation	37.17%	37.19%	37.79%	37.35%	36.09%	38.10%	37.77%	38.02%
Dredging + Reclamation	30.18%	26.16%	29.45%	31.50%	32.43%	29.29%	28.29%	30.83%
Dredging + Cit.Diversion	32.65%	36.20%	32.76%	31.15%	31.48%	32.61%	34.07%	31.14%

4.4 Results of Analysis

Based on comparison of 3 criteria, i.e. technical, social-economic, and environmental aspect, it shows that generally alternative of dredging+shunt of Citanduy has the highest score, it is 37.13%. The different result as happened in research with comparison of 6 criteria which explained that the highest score is the alternative of Lagoon dredging + conservation of upstream drainage basin. Therefore, analysis result of 3 criteria cannot be used in decision making for priority value because the score determinant factors come from the average value of question in the questionnaire. The result of 3 criteria is generally irrelevant with respondent aspiration and not focused in the management purpose.

Meanwhile, the comparison value of sub criteria has determinant factors of direct interview that focused on the sub criteria choices. Table 11 shows that the highest score happens to alternative of Lagoon dredging and Conservation of upstream drainage basin, i.e. 38.1%, and average percentage is 37.4%. The result describes effort on Segara Anakan Lagoon conservation that might be performed by sediment dredging in the Lagoon, also river normalization along the Segara Anakan area, which is conducted periodically and they are divided into several dredging areas that are supported by optimization on drainage basin of Conservation area. The plan will start at Upstream area.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The research results can be concluded as follows:

a) There are some respondents who have inconsistent value based on assessment and consideration of the questionnaire,
b) Number of respondents which is not in balance for each variable and incompetent respondent gives inconsistent analysis result,
c) The highest value of the 6 sub criteria is for dredging of Lagoon + Conservation of upstream watershed, i.e. 38.1% with average percentage of 37.4% to solve the silt problem,
d) The analysis result of all respondents which considers value of 1 gives different priority rank than that which does not consider the value of 1,
e) The rescue effort of Segara Anakan Lagoon gives priority on sediment dredging and river normalization which can be conducted in certain areas and in the periodic time. It should be supported by the optimization of drainage basin of Conservation which is started from Upstream area.

5.2 Recommendations

Based on the obstacle during research, there are several recommendations that can be suggested as follows:

a) Prior to questionnaire distribution and value determination, feasibility test of questionnaire needs to be conducted towards some respondents and the analysis,
b) Type of questions in the questionnaire should be comprehensible by respondent to avoid confusion,
c) Each respondent should be clearly directed before they start to fill the questionnaire to avoid misunderstanding and inconsistency,

d) The inconsistency ratio of more than 0.1 needs to be clarified to respondents on their interest value choice.

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