GIS BASED ENTROPY- ELECTRE II FOR PLANNING SITING MAPPING HYDROGRAPHY-OCEANOGRAPHY IN REGION ALKI I

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Abstract

Navigational chart is a dynamic map that should always be updated to ensure safety in navigation at sea. Indonesia's vast territorial waters is a challenge for policy makers to be able to prioritize areas that must be mapped / updated.
ELECTRE II method is widely recognized can be used to analyze a policy that involves both qualitative and quantitative criteria. This method involves the manufacture preceded by a directed graph that represents outranking relationship with Threshold determine concordance and discordance. Entropy methods are used to provide the weighting of criteria. This method was chosen because it can accommodate with some decision-makers or experts. The incorporation of multi-criteria method with GIS is very useful for solving problems related to geospatial. Sensitivity analysis is done by changing some threshold value. This research was conducted in waters ALKI I.

Keywords: Entropy, ELECTRE II, GIS, MCDM.

Introduction

The unitary state an archipelago of Indonesia (NKRI) is (Archipelagic State) in the world with a number of islands with an area of 17,499 islands ocean waters that reached 5.8 million km2 and a coastline ± 81,000 km. As set forth in the United Nations Convention on the Law of the Sea (UNCLOS, 1982), in terms of traffic to accommodate the rights of other countries in the Homeland based on Government Regulation No. 37 of 2002 as agreed by the International Maritime Organization (IMO), it has provided three Indonesian archipelagic sea lanes (ALKI) which can be used as an international shipping traffic. ALKI I consists of groove Sunda Strait, Karimata, Natuna and South China Sea. Hydrographic and Oceanography Department (Dishidros) is the institution of Indonesian government official who has the authority to create and publish a chart of the sea both for military purposes as well as for civilian purposes relating to the safety factor in navigation. DW Haslam (1977) in the journal "Basic Charting Sea Vital to All Users" stated that it was 80% of world trade by sea is therefore in the interests of marine navigation, marine maps can provide a guide to sailors by providing timely and accurate information. So that the sea map should always be updated (update) to maintain data accuracy of the information presented as aspects of marine navigation has a greater safety risk

Scientific studies on mapping the location of marine planning determination for the sake of the safety of shipping is still small, but there are few studies that underlie the writer that can be used for development planning decisions updates chart of which is the journal of use Geographic Information Systems (GIS) that can assist in the visualization and analysis. A. Şen, İ. Önden, T. Gökgöz, C. Sen in the journal "A GIS Approach to Fire Station Location Selection" utilizing GIS based on the data processing results Analytic Network Process (ANP) to determine the points for the fire station can cover an urban area in urban planning , While Daoud Brikci Hichem, M. Abdelhak Trache in the journal "Combining Geographical Information System and multicriteria Evaluation to Deal With Land Use Problem" using the combined methods of MCE, Idrisi, ELECTRE Tri and GIS to solve problems of land use in Nakuru (Kenya). Based on these studies the authors argue that the method of GIS can help simplify decision-makers to make decisions.

GIS is one method that can quickly visualize information needed by decision makers. Information contained in the GIS must be accurate so that decision-makers can take the appropriate decisions. To get an accurate GIS information can be supported by other methods as decision makers systems. In the field of ocean mapping, especially in the marine map updates, are faced with various criteria with a lot of alternatives in the process of map updates. to establish the priority of decision makers need tools in the form of analysis that is both logical and structured. MADM methods can help to improve the quality of decisions by making the decision-making process more rational and efficient (Isa Irawan, et al. 2012).

MADM methods one of which is ELECTRE, which is widely recognized to have high performance for analyzing policy involving quantitative and qualitative criteria. This method

was developed several versions of the ELECTRE (I, II, III, IV, IS). ELECTRE I in the design for the election and ELECTRE II used to perangkingan by using this type of simple criteria, while other versions use pseudo criteria (Isa Irawan, et al., 2012), one drawback of this procedure is that if there is cyclic in Graf formed, so that the process perangkingan becomes more complicated (Ciptomulyono U, et al., 2008).

Each criterion has a weight MADM methods which will affect the rankings of the selected alternative. There are many methods of weighting criteria, one of which is Entropy. Entropy weighting method is a method that gives a group decision-making criteria and assess the preferences of the weighting in the judgment of the decision maker. One of the advantages of Entropy approach is the ability to accommodate the weight value derived from multiple decision-makers (Isa Irawan, et al. 2012).

Problem Formulation

As described in the above background problems that the main problem in this research is how to create a decision support system that is fast, precise, accurate and well-planned in the priority-setting process mapping local elections hydro-oceanographic surveys for map updates are faced with budget constraints, multi criteria with many alternatives.

Literature Review

Navigational chart is a special map to navigate at sea. Other maps include a custom map eg Map of Air Navigation, Joint Combat map, and map Amphibious landings. Sea maps present information numbers depth and contours, topographical features can be used for navigation, navigation aids, shipping hazards, and other information necessary for the sailors.

Changes in marine and coastal areas necessitates periodic updating of nautical maps and continuously in order to maintain the safety of navigation and marine map information update in accordance with the state of the region in the field (DW Haslam 1977). The accuracy of the data in the sea map is a representation of knowledge hydrographic capability of a country-oceanographic cartographer sea standardized according to the standard International Hydrographic Organization (IHO). Information is delivered to the user updates a map through four ways, namely:

a. Notice of Marines
b. Radio Navigation
c. Global Maritime Distress and Safety System (GMDSS)
d. The new edition of the map / updated

In required to renew chart data into information sources and used as a reference for correcting the map. This data is generally derived from hydrographic survey ship owned offices that regularly and routinely monitor grooves major shipping in the waters of a country. In addition, information about navigational hazards invention can also be derived from the ship does not belong passing hydrographic offices or conduct hydrographic surveys in the sea and discover the dangers shipping new and uncharted and report the matter through a special document called Hydrograhic Notes issued by hydrographic office. Data were derived not from hydrographic offices are secondary data must be verified in advance by the hydrographic office. Information is generally conveyed to update nautical maps are:

a. Shoal, reef, rock, ship skeleton, charred, or other depth anomalies at depths less than 30 meters of newly discovered and uncharted.
b. Installation of Navigational aids (SBNP) new, SBNP changes that have been there before, or damage SBNP and its impact on shipping lanes. Provisions concerning SBNP in Indonesia stipulated in the Regulation of the Minister of Transport 7, 2005.
c. The position of the underwater pipeline or cable or pipeline installation activities or the cable.
d. Construction work outside the port area and the outside or in the shipping lanes.
e. Information relating to the special operations (training or weapons testing AL).
f. Coastal and ocean dynamics is a process of change in the form of coastal and marine areas that can be caused by natural factors (water, land, and air) and human activity factors.
g. Other types of hazards such as reports on hijacking ships by pirates at sea, a tsunami, or meteorological warnings communicated by radio navigation.

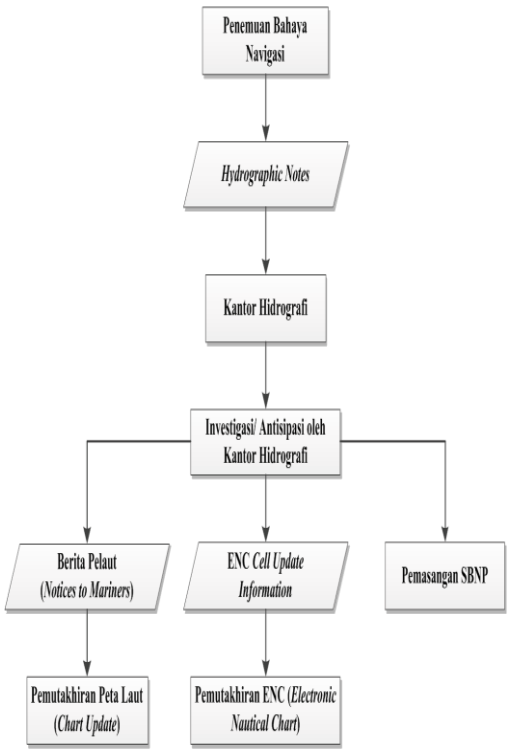

Chart Update Process

Entropy methods

Entropy method can be used to determine a weight. Entropy method can produce a variety of criteria with the highest scores will receive the highest weight.

The steps used in the method of entropy are as follows:

1. All decision makers must provide a value that indicates the interest of a particular criterion for decision making. Each decision makers should judge each according his preference.
2. Subtract each number is the most ideal value, the reduction results declared by kij.
3. For each value (kij) with a total value in all criteria

$$a_{ij} = \frac{k_{ij}}{\sum_{i=1}^{m}\sum_{i=1}^{n} k_{ij}} \quad \text{for m>1}$$

Where
m = a number of decision makin
n = a number kriteria

4. Calculate the entropy values for each criterion with the following formula:

$$E_j = \left(-\frac{1}{\ln(m)}\right) x \sum a_{ij} \ln(a_{ij})$$

5. Calculate dispersion for Beach criterion with the following formula:

$$D_j = 1 - E_j$$

6. Because it is assumed total weight is 1, then to get the weight of each criterion, the dispersion value should be normalized in advance, so that:

$$Wj = \frac{D_j}{\sum D_j}$$

One of the advantages of entropy approach is its ability to accommodate the weight value derived from multiple decision makers.

ELECTRE II Metthod

Methods ELECTRE (Elimination Et Choix Traduisant la réalité) including the multiple criteria decision analysis methods that originated in Europe in the 1960s. Janco and Bernoider (2005) ELECTRE is one of multiple criteria decision making method based on the concept of outranking using pairwise comparison of alternatives based on any appropriate criteria. This method is used under conditions where alternatives are not in accordance with the criteria in the elimination and appropriate alternatives can be generated. An alternative is said to dominate another alternative if one or more of the criteria are exceeded (in comparison to other alternative criteria) and together with other criteria remaining. ELECTRE is one method of MADM high performance to analyze a policy that involves both qualitative and quantitative criteria. ELECTRE method has evolved has progressed through a number of versions (I, II, III, IV, IS). ELECTRE II method designed to perangkingan (Isa Irawan, et al, 2012). According Ciptomulyono, U and Triyanti in 2008 stated that one of the drawbacks to the procedure by Graf that if there is cyclic in Graf formed perangkingan process will be more complicated. Chen, C.H. and Huang, W.C. (2005) using a benchmark absolute value of the maximum of differentiated performance and the absolute value of the roar of differentiated performance to determine the discordance index. Normalization is done by dividing the value of the alternative by the number of alternative values on a single criterion.

Step-by-step application method ELECTRE II are as follows:

Step 1: Get a normalized value for all criteria

This step begins by forming a pairwise comparison matrix for each alternative for each criterion (xij). Then normalized into a single scale which can be compared (rij). In general,

the method ELECTRE II using the formula normalized as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \text{ for i = 1,2,...,m}$$

and j = 1,2,...,n

The formula can not be used if there is a cost to the alternative assessment criteria unless these criteria have been changed into the form of a scale of importance so that all the criteria to be an advantage. Linear normalization formula that takes into account the criteria of cost and benefit criteria one of which is as follows:

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{\underset{i}{Max}\ x_{ij}} & \text{jika } j \text{ adalah atribut keuntungan (benefit)} \\ \dfrac{\underset{i}{Min}\ x_{ij}}{x_{ij}} & \text{jika } j \text{ adalah atribut biaya (cost)} \end{cases}$$

Step 2: determining the normalized decision matrix pairs weighted by the forumla:

$$v_{ij} = w_j \times r_{ij}$$

With wj is the weight of the interests of criteria to - j

Step 3: develop a matrix of concordance and discorcondance.

Determine concordance index by the formula:

$$c(j,k) = \sum_{gj(Aj) \geq gi(Aj)} W_i \quad \text{j,k = 12,...n j≠k}$$

And discordance index with the formula:

$$d(j,k) = \begin{cases} 0 & \text{jika } g_i(A_j) \geq g_i(A_k) \\ \dfrac{\underset{gi(Ak)>gi(Aj)}{\max}\ (g_i(A_k) - g_i(A_j))}{\underset{i=1,...,m}{\max}\ (g_i(A_k) - (g_i(A_j))} & \end{cases}$$

j,k = 1,2,...,n j≠k

with gi (Aj) is an evaluation / value alternative j on criteria i.

Step 4: to establish three levels of reduction in concordance threshold value P *, Po, P (0≤P-≤Po≤P * ≤1) and 0 <qo <q * <1 indicates a decrease in the level two threshold value disconcordance, decision makers can determine outranking relationship strong and weak outranking.

Strong outranking relationship is defined as follows:

$c(j,k) \geq p^*$ $d(j,k) \leq q^*$ dan $W^+ \geq W^-$

or

$c(j,k) \geq p^o$ $d(j,k) \leq q^o$ dan $W^+ \geq W^-$

whereas weak outranking relationship is defined as follows:

$c(j,k) \geq p^-$ $d(j,k) \leq q^o$ dan $W^+ \geq W^-$

Step 5: develop a graph that represents the relationship of domination between alternatives.

Step 6: determining alternative priorities

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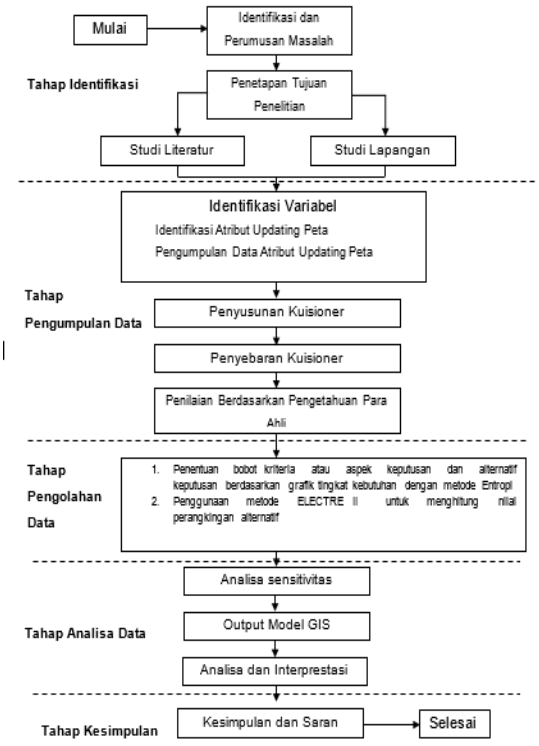
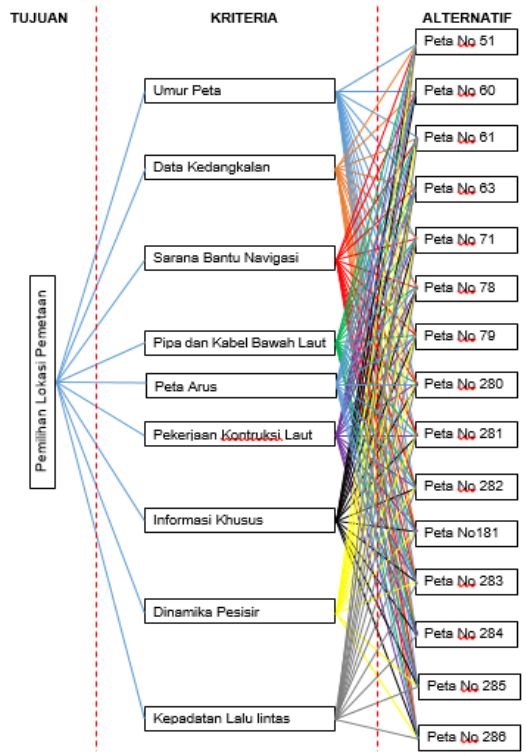
Geographical Information Systems (GIS)

Geographic Information Systems (Geographic Information System / GIS) or the SIG has an idea in general is an organized collection of computer hardware, software, geographic data and personnel designed to efficiently acquire, store, update, manipulate, analyze, and display all forms of geographically referenced information. Understanding narrowly GIS is a computer-based system used to store, manipulate, and display information - geographic information.

Research Methodology

An outline of the entire course of this research is described in a flowchart (Flowchart) as follows:





Results and Discussion

The data used in this study is questionnaire data from marine experts mapping used for weighting of criteria and data attributes of each alternatives for prioritization.

Table appraisal experts

No	Penilaian / Kriteria	Ahli 1	Ahli 2	Ahli 3	Ahli 4	Ahli 5
1	Umur Peta (K1)	4	4	4	4	4
2	Kedangkalan (K2)	5	5	5	5	5
3	SBNP (K3)	5	5	5	5	5
4	Pipa dan Kabel BL (K4)	3	5	5	4	5
5	Konstruksi Laut (K5)	3	4	5	5	4
6	Informasi Khusus (K6)	4	4	4	4	5
7	Dinamika Pesisir (K7)	4	4	4	4	4
8	Peta Arus (K8)	3	4	4	4	4
9	Kepadatan Lalu-lintas (K9)	2	4	5	4	5

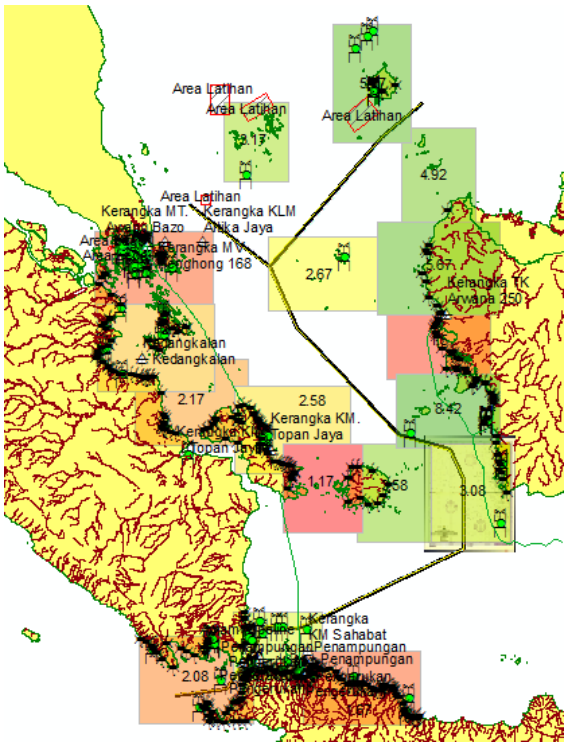
the above data is then processed using entropy method as previously described steps, so that the final result weighting entropy as follows:

No	Kriteria	Ej	Dj	Wj
1	K1	0.492914	0.507086	0.083713
2	K2	0	1	0.165087
3	K3	0	1	0.165087
4	K4	0.256315	0.743685	0.122773
5	K5	0.354898	0.645102	0.106498
6	K6	0.394331	0.605669	0.099988
7	K7	0.492914	0.507086	0.083713
8	K8	0.552064	0.447936	0.073949
9	K9	0.399164	0.600836	0.09919

by calculating the entropy obtained by weighting the biggest criteria are criteria shallowness (K2) and SBNP (K3) is equal to 0.165087. with the result means K2 and K3 are criteria that most affect the next calculation. While the criteria are weighted smallest coastal dynamics that weighs criteria 0.073949, which means it has a relatively small effect compared with other criteria. This weighting results then used for weighting in the calculation of ELECTRE II in order to obtain the normalized weighted matrix. The selected alternative data is as follows:

No	Kriteria / Alternatif	K1	K2	K3	K4	K5	K6	K7	K8	K9
1	Peta No 40(A1)	1.67	3.00	70.00	147.09	2.30	0.00	38.45	15.00	592.20
2	Peta No 41(A2)	2.25	2.00	8.00	56.47	2.65	0.00	0.00	38.00	435.80
3	Peta No 51(A3)	3.58	0.00	1.00	0.00	1.42	0.00	0.00	7.00	138.00
4	Peta No 60(A4)	2.17	0.00	2.00	54.20	2.88	0.00	0.00	26.00	403.20
5	Peta No 61(A5)	2.58	2.00	14.00	20.11	2.38	0.00	0.00	27.00	278.00
6	Peta No 63(A6)	1.17	0.00	0.00	0.00	1.86	0.00	0.00	9.00	329.20
7	Peta No 71(A7)	2.08	1.00	23.00	18.47	1.06	2.00	0.00	49.00	458.00
8	Peta No 78(A8)	2.83	21.00	51.00	120.46	0.72	35.00	222.08	47.00	814.60
9	Peta No 79(A9)	1.67	0.00	17.00	154.11	0.58	17.00	0.00	59.00	453.20
10	Peta No 181(A10)	3.17	0.00	1.00	0.00	1.49	0.00	3582.00	0.00	61.40
11	Peta No 280(A11)	2.67	0.00	15.00	0.00	1.18	0.00	2108.00	4.00	57.60
12	Peta No 281(A12)	4.92	0.00	1.00	0.00	0.93	0.00	0.00	0.00	36.60
13	Peta No 282(A13)	1.50	0.00	0.00	0.00	1.90	0.00	0.00	1.00	102.80
14	Peta No 283(A14)	8.42	0.00	0.00	0.00	1.07	0.00	0.00	8.00	98.80
15	Peta No 284(A15)	3.08	1.00	0.00	67.83	1.41	0.00	0.00	18.00	204.20
16	Peta No 285(A16)	5.67	0.00	13.00	109.47	1.74	0.00	0.00	15.00	172.80
17	Peta No 286(A17)	5.67	0.00	5.00	110.55	0.66	0.00	0.00	7.00	186.80

From the table calculation by the method ELECTRE II thus obtained matrix concordance and discordance as the basis for determining the priority of location update sea maps. Furthermore, the results of calculations by the method ELECTRE II is visualized in a GIS to facilitate decision-making. Expected results are as follows:



From the results of the final maps with Entropy-ELECTRE weighting can be seen that the black and green symbols in the map shows the density of data changes that occur in each sea maps located around the area ALKI I. From these data it can be seen that map No. 40 (Riau Islands) has a large data density changes so mengasilkan degradation of red color it means to be a priority to do a survey to update the map of the sea. Can be seen also on the map No. 71 Pacific region despite the region there have been few changes in the density of map data but degraded to red which means to be a priority for marine map updates. This is possible because although the data that there is a slight change but it is possible that area there are criteria that have great weight thus affecting the decision. It is inversely proportional to the map of Jakarta can dik; see that change occurs Jakarta sufficient data density change meeting. However, the map is yellow, which means stated otherwise still feasible and a priority on the second layer. This is possible because although the data changes there are quite tightly but these data may have considerable influence small weight, so less influence on the decision. To map the green expressed as a map that is still feasible and safe to use.

In this study Entropy method ELECTRE II has a significant role in determining policy. And GIS is quite helpful in facilitating decision-makers to see visually in decision making.

In this study the influence of each criterion has particularly specific role in determining the location of sea map updates. In this study, no specific viewing a shoreline change as maps used in this study was quite comprehensive map with a map scale of 1: 200,000 so detailed location on this map is not drawn in detail. So I do not see aspects of regional development plans. This could be the object of further research using the planning development of coastal areas by using a map with a large scale.

Conclusion

Integration with GIS decision-making method is very helpful in making decisions for issues relating to spatial data and financial nature. It is easier for decision makers to analyze and look at the specific changes in territorial information depicted in the map. GIS integration with other methods is still very possible for people to make a decision that is better and more precise.

Bibliography

Aep Saiful, (2013), Aplikasi metode ANP dalam penentuan prioritas pengembangan Lanal (Pangkalan TNI AL) menjadi Lantamal (Pangkalan Utama TNI AL). Surabaya : STTAL

A Sen, I Onden, T Gokgoz, C sen, A gis approach to fire station location Election, Turkey 2007

Alemu, Gulilat (2011), *GIS based and analytical network process based multi criteria decision aid for sustainable urban form selection of the stockholm region*

Guneri, A. F, M Cengiz, S. Seker (2008) *A fuzzy ANP approach to shipyard location Election*

Kasum, Sc. D. Josip dan Zlatimir Bićanić,Tonći Jelićić (2003), *Accuracy of sea charts and navigational publications and the influence of Printing*

M.A. Harits Ariyawan, Strategi pencegahan kecelakaan pesawat terbang militer dalam perspektif ketahanan nasional, studi kasus di lanud atang Sendjaja, Pascasarjana Universitas Indonesia, Jakarta 2011

Saaty, T. L. (1993), Pengambilan Keputusan Bagi Para Pemimpin (terjemahan). Jakarta: PT Pustaka Bina Ilmu

Saeedi, Sarra. Malek, Mohammadreza. Delavar, Mohammadreza dan Tayybi, Amin (2008), *Intuitionistic fuzzy analytic network process (IF-ANP) for spatial multi criteria decision making under uncertainty*

Sakawa, Masatoshi. Nik, Ebrahim Rezaee. Zegordi, Seyed Hessameddin. Nazari Ahad dan Choobar, Fereydoon Honari. (2011), *A combined fuzzy analytic network process and fuzzy-topsis model for project risk assessment*

Yuen, Kevin Kam Fung (2011), *Using the primitive cognitive network process for location analysis: comparisons with the analytic hierarchy process*