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GROUP DECISION SUPPORT SYSTEM SOLUTION BY ELECTRE METHOD AND PREFERENCES ORDERED VECTOR FORMAT (DETECTION OF GENE MUTATIONS SIMULATION)

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ABSTRACT:

The method of determining alternative group decision making has been widely developed. This method was developed to determine the best alternative from number of alternatives based on several criteria in decisions making. Decision-making to detect whether gene mutation affected genes that can cause cancer can be done by conducting MCDM with ELECTRE method. Modelling with ELECTRE method can assist in decision making to detect gene mutations that can cause cancer. In this paper the model will be made using the method ELECTRE with ordered vector format preferences for the detection of gene mutations that cause cancer simulation. This model made by using simulation of the criteria specified.

Keywords: MCDM, ELECTRE, an ordered vector

I. INTRODUCTION

Analysis of gene have been carried out by various studies in the medical field. One gene analysis performed for example detection of a mutated gene and can cause human suffering from a disease. Detection of mutated gene as cause of cancer can be done with the help of information technology. Determining a person has abnormal cancer-causing genes can be made from various areas of expertise in medicine, such as field pathologist, oncology or other disciplines in medicine. The opinions of experts in various fields of medical science requires a decision that could help to giving medical treatment to the person alleged to have abnormal genes to cause cancer. The decision is a series of actions that need to be followed in solving problems to avoid negative impacts and exploit opportunities. Decision making has been much help in solving problems in conducting activities. The decisions made to solve the problem. Sometimes decisions made from the decisions by group. Decisions by groups of people is called the group decision. To help make decisions of this group needed the system as supporter. This system is known as group decision support systems.

Group Decision Support System (group decision support system), or GDSS is a computer-based system as a support group of people who have a task (goal) together. These systems normally provide interfaces for users who are a group of people who are used together. GDSS can accelerate decision-making process or improve the quality of the resulting decisions, or both. This can be done with the support of the exchange of ideas, opinions and choices in the group on the system. Group Decision Support System can be applied to the field of information technology can assist in providing a person's decision contains a gene that is mutated and can cause cancer or not. The method of determining an alternative to group decision making has been widely developed. This method was developed to determine the best alternative from a number of alternatives based on several criteria in making decisions. One of the methods in use in decision-making group is the Multiple Criteria Decision Making (MCDM). Based on the objectives, the MCDM is divided into two models: Multi-Attribute Decision Making (MADM) and Multi-Objective Decision Making (MODM).

Decision-making to detect whether a gene mutation

ELECTRE (Elimination Et Choix Traduisant He realite) is based on the concept of ranking by paired comparisons between alternatives on the appropriate criteria. An alternative is said to dominate the other alternatives if one or more criteria exceeded (compared with the others criterion) and is equal to the remaining criteria. Ranking relations between two alternatives Ak from the A1 (Roy, 1973) in [4].

Pairwise comparison of each alternative criteria in the symbolic (x_{ij}). Normalization of values was done by comparison (r_{ij}) into a scale using the formula:

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}} \quad , \text{for } i = 1,2,..,m \text{ and } j = 1,2,..,n \quad (1.1)$$

Factors of importance (weight) given to each criterion which expresses the relative importance (w_j)

$$W = (w_1, w_2, w_3, ..., w_n)$$

$$\sum_{i=1}^{N} w_j = 1; \quad (1.2)$$

This weight multiplied by the matrix pairwise comparison matrix form V:

$$V_{ij} = w_j x_{ij} \quad (1,3)$$

Formation discorcodance concordance index and the index for each pair of alternatives is done through assessment of the relation ranking. For each pair of alternatives A_k and A_l (k,l= 1,2,...m dan k l), the decision matrix for criterion j, The set divided into two parts.

The set of concordance index $\{c_{kl}\}$ shows the sum of weights of criteria for which A_k alternative is better than the A_l alternative .

$$C_{kl} = \{ j \mid v_{kj} \geq v_{ij} \} \text{ for } j = 1,2,...,n \quad (1.4)$$

The set of discordance index $\{ d_{kl} \}$ formula :

$$d_{kl} = \{ j \mid v_{kj} < v_{ij} \} \text{ for } j = 1,2,...,n \quad (1.5)$$

Matrix of concordance (C) contains elements that in calculating the concordance index, and is associated with attribute weights are:

$$C_{kl} = \sum_{j \in c_{kl}} w_j \quad (1.6)$$

Matrix of discordance (D) contains elements of the discordance index is calculated according to (Triantaphyllou, 2000) in [4]. This matrix associated with the values of attributes, namely:

$$d_{kl} = \frac{\max\{v_{kj} - v_{ij}\}_{j \in d_{kl}}}{\max\{v_{kj} - v_{ij}\}_{j \in v_j}} \quad (1.7)$$

These matrices can be built with the help of threshold (threshold), c

$$\underline{c} = \frac{\sum_{k=1}^{m}\sum_{l=1}^{m} c_{kl}}{m(m-1)} \quad (1.8)$$

A_k alternative may have a chance to dominate A_l, If concordance index exceeds the threshold c

$$c_{kl} \geq \underline{c} \quad (1.9)$$

and elements of the matrix F is determined if the dominant concordance :

$$f_{kl} = \begin{cases} 1, & jika \ c_{kl} \geq \underline{c} \\ 0, & jika \ c_{kl} < \underline{c} \end{cases} \quad (2.0)$$

The same is true for dominant discordance matrix G with d threshold. D values obtained with the formula:

$$\underline{d} = \frac{\sum_{k=1}^{n}\sum_{l=1}^{m} d_{kl}}{m(m-1)} \quad (2.1)$$

and elements of the dominant F discordance matrix is determined as :

$$g_{kl} = \begin{cases} 1, & jika \ d_{kl} \geq \underline{d} \\ 0, & jika \ d_{kl} < \underline{d} \end{cases} \quad (2.2)$$

Aggregation of the dominant matrix (E) showing the partial preference order of alternatives, obtained with the formula:

$$e_{kl} = f_{kl} \times g_{kl} \quad (2.2)$$

If $e_{kl} = 1$ indicates that the alternative A_k more to select from the alternative A_l [4]

Researches on the ELECTRE method has been widely applied, among others:

Zhang (2006) conducted a study: The ELECTRE method based on interval numbers and its application to the selection of leather manufacture alternatives in this study to learn how to make use of traditional methods for certain circumstances to solve the MADM with interval numbers. Propose an enhanced ELECTRE method based on the number of intervals. Considering the specificity of interval numbers, using the possibility degree for ranking alternatives, founded the discordance dominance matrix and aggregate dominance matrix, then eliminating inferior alternatives. This method can be used to MADM, where the values of attributes in the form of interval numbers, and solve the difficulties in

fected a gene that can cause cancer can be done y conducting MCDM ranking with ELECTRE ethod. That requires a modeling in decision-aking to detect gene mutations that can cause ncer. In this paper will be made of a Simulation odelling with ELECTRE method to detect gene utations. This model is made by using a mulation of the criteria specified.

II. BACKGROUND THEORIES

2.1 GROUP DECISION SUPPORT SYSTEM (GDSS)

GROUP DECISION SUPPORT SYSTEM (GDSS) is an interactive computer based system hat facilitates solution of unstructured problems by a few (sets) the decision makers who work together in a group.

GDSS can be applied to different groups of ecision situations (group), which includes a eview panel, task force executive meeting / board, emote workers, and so forth. Basic activities that ecurred in any group and who require support on a omputer are:

- calling information, involving the selection of data values from an existing database or calling a simple information.
- information sharing, meaning the viewer displays the data on the screen to be viewed by all groups (group).
- use of information, including application software technology, procedure, and group problem solving techniques to the data. [8]

2.2 *MULTI- CRITERIA DECISION MAKING*

Multi-criteria decision making (MCDM) is the ecision-making techniques alternatives options. ecision making MCDM technique is done hrough the selection or formulation attributes, bjectives, and different goals, then the attributes, bjective or purpose are considered as the criterion. riteria are measures, rules or standards that guide decision Making. Criteria built from basic human eeds and values of interest. There are two kinds of ategories of Multi-criteria decision making MCDM), (Fitriadi, 2006), namely:

1. Multiple Objective Decision Making (MODM)
2. Multiple Attribute Decision Making (MADM)

Multiple Objective Decision Making (MODM) omes to the design, where mathematical ptimization techniques are used, for a very large umber of alternative (to infinity) and to answer he question what and how much. In addition MODM used to solve problems in continuous pace, such as problems in mathematical programming. MODM design the best alternatif. [3]

Multiple Attribute Decision Making (MADM), comes to elections, in which mathematical analysis is not too much is needed or can be used for the election only to a small number of alternative course. MADM is used to solve problems in discrete spaces, typically used to solve problems in the assessment and selection of several alternatives in limited amounts.

MADM approach is done through two stages, namely:

1. Perform aggregation of the decisions that responds to the decisions that are responsive to all destinations on each alternative
2. Doing ranking alternatives based on the aggregation of the decision makers. [3]

According Kusumadewi (2008): MADM is evaluated against the alternative m Ai (i = 1,2 ,...., m) against a set of attributes or criteria Cj (j = 1,2 ,..., n) where each attribute are not mutually dependent with each other. Decision matrix of each alternative on each attribute, X is given as:

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$$

Where x_{ij} is an alternative performance rating in relation to the j-th attribute. Weight value indicates the relative importance of each attribute, given as, W:

$$W = \{ w_1, w_2, w_3, \ldots, w_n \}$$

Performance rating (X), and weight value (W) represents the core values that represent the absolute preference of decision makers. MADM problems in the end with an alternative process to get the best ranking obtained based on the overall value of preferences granted (Yeh, 2002) in [4].

2.3. Ordered Vector Format Prefernces

Format Preferences

There are several formats of the decision makers preferences for some alternatives Ma et al (2004).

a. Ordered Vectors.

Format preference is: Ok = (ok (1), ok (2), ..., ok (m)) with ok (.) Is a permutation function on the set of indices {1,2 ,..., m} and ok (i) represents the ranking given by the decision makers of alternative oak Si, i = 1,2 ,..., m. Writing ranking starts from the best to worst.

2.4 ELECTRE METHOD

ranking a number of intervals in the traditional method. Selection of leather-making problem solving with this method, and illustrated its application in real life.

In this study, using the possibility degree of interval to propose an alternative ranking and ELECTRE method based on interval numbers, and gives step in this method. This method can be used to solve the problem of multiple solutions atribbut decision attribute values are numbers intervals. [9]

Bashiri, M (2009) in his research on MADM methods associated with the decision maker's point of view about the Importance degree of responses. results given it is assumed that the response-means clustering is more important than the standard deviation. Another advantage of this method considers the standard deviations that contribute to the strength of experimental design, because only one appropriate response regression function, this method reduces the statistical error. Because this method attempts to obtain a value of several responses, then it can be grouped in the desirability function approach. [2]

Opricovic. S, Tzeng, GS (2006) in his research to develop methods that VIKOR compared with ELECTRE II method in the method of ranking out. Opricovic get the result that the similarity of ELECTRE and VIKOR development based on the equality principle as:

(A) Consider the global certainty measure (concordance and group utility).

(B) opsisi of other criteria-the-minority'"is not strong (nondiscordance).

Analysis and ELECTRE VIKOR comparison shows that with the assumptions, conditions and decisions by Rj"discordance"in VIKOR have in common with the basic MCDM (minimum individual regret). [5]

Amiri (2008), in his research to develop new ELECTRE Method with Interval Data in Multiple Attribute Decision Making Problem This study aims to provide new and unique method for ranking alternatives with intervaldata in multi-attribute decision making. The use of interval data is considered better to use the interval data for the deterministic problem and the exact data (eg, time, distance, temperature) or can not easily be expressed as deterministic and specific numbers. in this study, developed a method for decision making solution of problems (especially, when it is not possible to present the data so that the use of fuzzy fuzzy decision making. [1]

Soltanmohammadi (2008) in applied research Analysis by an outranking multiattribute decision-making technique, called Elimination et choix traduisant He realite method. This approach is applied to an illustrative example where Analytical hierarchy process method applied to calculate the global weights of the attributes of the couple through the comparison matrix. This study shows the proposed AHP-ELECTRE algorithm; outranking relations between the alternatives and in this way, non-dominated sets of land-use alternatives other alternatives can be identified. In this approach, the worst alternative for the examples given can be recognized as well. Results obtained by ELECTRE outranking is better than the TOPSIS ranking. This approach is beneficial especially when the number of alternatives more. This means that, further research is still needed to facilitate decision making MADM tool more appropriate to apply in the field of MLSA. [7]

2.4 ELECTRE METHOD FOR GENE MUTATIONS DETECTION SIMULATION

This paper will make modeling MADM with ELECTRE method to detect gene mutations simulation in humans who suffered. Mutations that might occur is that there is activation of the Rb gene c-myc gene or inactivation of p53 gene. In order to detect whether a person identified to have cancer cells or not. Data were collected from the study of gene mutations [6]

Table.1 Expression of protein p53,Rb and c-myc

No. sampel	p53	Rb	c-myc
1.	30*	40	40
2.	30*	40	50
3.	30*	30*	60
4.	40	30*	70
5.	50	50	40
6.	40	40	50
7.	50	40	70
8.	40	30*	60
9.	30*	20*	40
10.	50	50	30*
11.	40	20*	50
12.	40	30*	50
13.	40	20*	30*
14.	40	50	60
15.	50	40	70
16	40	10*	30*
17	40	60	70
18.	40	40	60
19.	30*	30*	50
Rata-rata	40	30,8	50,1

In this simulation can be applied to the three alternatives in the set to the identification of cancer cells in the human gene, namely:

A1 = Inactivasi p53

A2 = activation Rb

A3 = c-myc activation

Of gene expression in reference [6] there are three 3 which is a reference in making decisions to

namely:

C1 = p53 protein expression (in%)
C2 = Rb expression (in%)
C3 = c-myc expression (in%)

Suitability rating alternatives on each criterion will be the value of the numbers one to five, namely:

1 = very bad
2 = bad
3 = enough
4 = Good
5 = Very good

Level of importance of each criterion in value by one to five, namely:

1 = very low
2 = Low
3 = enough
4 = High
5 = very high

From the above criteria then made suitability rating of each alternative on each criterion, the ratings this match made in simulation, which in the determination of the gene is mutated or not that actually match all the criteria and the rating is obtained from the opinions of experts. suitability rating was also determined preferences by several experts in the format of an ordered vector. After that vectror an ordered format is determined weight is the weight for each attribute. Simulation suitability rating of each criteria is indicated by the following table:

Table.2 Suitability of each alternative on each criterion

Alternatif	Kriteria		
	C1	C2	C3
A1	4	4	5
A2	4	5	4
A3	4	3	5

The calculation is done with the completion method Elimination Et Choix Traduisant He realite (ELECTRE), which is based on the concept of ranking by paired comparisons between alternatives on the appropriate criteria. An alternative is said to dominate the other alternatives if one or more criteria exceeded (compared to the criteria of other alternatives) and is equal to the remaining criteria. Ranking relationship between the two alternatives A_k and A_l are denoted as A_k ® A_l if alternative-k no-one dominates the alternative to the quantitative, thus better decision makers to take risks A_k than A_l (roy, 1973) in [4].
Decision matrix of the simulation above obtained as follows:

$$\begin{bmatrix} 4 & 4 & 5 \\ 4 & 5 & 4 \\ 4 & 3 & 5 \end{bmatrix}$$

Pairwise comparison of each alternative in each krtiteria expressed by values (Xij). This value must be normalized to a scale comparable to (r_{ij}). This value is calculated with the formula as below:

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}} \quad \text{dengan i = 1,2,.....m, j = 1,2.....n}$$

(1.1)

$|x_1| = \sqrt{4^2 + 4^2 + 4^2}$
$|x_3| = \sqrt{5^2 + 4^2 + 5^2}$

From the results of calculations using the above formula is obtained as the matrix below:

$$\begin{bmatrix} 0{,}57735 & 0{,}565685 & 0{,}615457 \\ 0{,}57735 & 0{,}707107 & 0{,}662266 \\ 0{,}57735 & 0{,}424264 & 0{,}615457 \end{bmatrix}$$

Furthermore, the V matrix is calculated based on the equation:

$V_{ij} = w_j \times x_{ij}$

From the above calculation results obtained by matrix V:

$$\begin{bmatrix} 2{,}886751 & 1{,}697056 & 2{,}46183 \\ 2{,}886751 & 2{,}12132 & 1{,}96950 \\ 2{,}886751 & 1{,}27280 & 2{,}46183 \end{bmatrix}$$

Calculated for the Association of concordance index (C_{kl}) that shows the sum of weights of criteria, according to the formula;

$C_{kl} = \{ j \mid v_{kj} \geq v_{lj} \}$ for j = 1,2,...,n

(1.5)

The results obtained with this calculation is as follows:

C_{12} : $v_{11} \geq v_{21}$ → 2,886751 ≥ 2,886751
$V_{12} \geq v_{22}$ → 1,697056 ≥ 2,12132
$V_{13} \geq v_{23}$ → 2,46183 ≥ 1 ,96950
$C_{12} = \{1,3\}$

The same calculation for each C_{kl} then obtained value of C as follows:

$C_{12} = \{1,3\}$
$C_{13} = \{1,2,3\}$
$C_{21} = \{1,2\}$
$C_{23} = \{1,2\}$
$C_{31} = \{1,3\}$
$C_{32} = \{1, 3\}$

Calculating the value set for the matrix discordonce discordonce associated with the attribute is the following:

$d_{kl} = \{ j \mid v_{kj} < v_{lj} \}$ untuk j = 1,2,...,n

(1.6)

$d_{12} = v_{11} < v_{21}$ → 2,886751 < 2,886751
$V_{12} < v_{22}$ → 1,697056 < 2,12132

With a similar calculation for each element of the set obtained value D:

$d_{12} = \{2\}$
$d_{13} = \{\}$
$d_{21} = \{3\}$
$d_{23} = \{3\}$
$d_{31} = \{2\}$
$d_{32} = \{2\}$

c_{kl} concordance matrix elements calculated using the formula :

$$C_{kl} = \sum_{j \in c_{kl}} w_j$$

(1.7)

Furthermore Concordance matrix will be given weight. These weights are obtained from calculations based on the preferences given by the experts. This preference is made in ordered vector format. The yield obtained is:

W = 5,3,4

From the above, the weight calculation for

w = 5,3,4

For w = 5,3,4

$C_{12} = \{1,3\} = w_1 + w_3 = 5+4 = 9$
$C_{13} = \{1,2,3\} = w_1 + w_2 + w_3 = 5+3+4 = 12$
$C_{21} = \{1,2\} = w_1 + w_2 = 5+3 = 8$
$C_{23} = \{1,2\} = w_1 + w_2 = 5+3 = 8$
$C_{31} = \{1,3\} = w_1 + w_3 = 5+4 = 9$
$C_{32} = \{1,3\} = w_1 + w_3 = 5+4 = 9$

Concordance matrix :

$$C = \begin{bmatrix} - & 9 & 12 \\ 8 & - & 8 \\ 9 & 9 & - \end{bmatrix}$$

d_{kl} discordance matrix elements calculated using the formula:

$$d_{kl} = \frac{\max\left\{v_{kj} - v_{ij}\right\}_{j \in d_{kl}}}{\max\left\{v_{kj} - v_{ij}\right\}_{j \in r_j}}$$

Matriks discordance:

$$D = \begin{bmatrix} - & 0{,}8969 & 0 \\ 1 & - & 1 \\ 1 & 1 & - \end{bmatrix}$$

$$\underline{c} = \frac{\sum_{k=1}^{m}\sum_{l=1}^{m} c_{kl}}{m(m-1)}$$

(1.9)

$\underline{c} = 7{,}1$

$\underline{d}$ is calculated using the formula:

$$\underline{d} = \frac{\sum_{k=1}^{m}\sum_{l=1}^{m} d_{kl}}{m(m-1)} \qquad (2.0)$$

$\underline{d} = 0{,}81615$

Concordance matrix calculated based on the dominant

$$f_{kl} = \begin{cases} 1, & jika\ c_{kl} \geq \underline{c} \\ 0, & jika\ c_{kl} < \underline{c} \end{cases}$$

$$F = \begin{bmatrix} - & 1 & 1 \\ 0 & - & 0 \\ 1 & 1 & - \end{bmatrix}$$

elements of the matrix F is determined as the dominant discordance:

$$g_{kl} = \begin{cases} 1, & jika\ d_{kl} \geq \underline{d} \\ 0, & jika\ d_{kl} < \underline{d} \end{cases}$$

$$G = \begin{bmatrix} - & 1 & 0 \\ 1 & - & 1 \\ 1 & 1 & - \end{bmatrix}$$

Aggregation of the dominant matrix (E) showing a partial preference order of alternatives, obtained with the formula:

$$e_{kl} = f_{kl} \cdot g_{kl}$$

2.2)

I

$$\text{Hilm FnC} = \begin{bmatrix} - & 0 & 1 \\ 0 & - & 0 \\ 0 & 0 & - \end{bmatrix} \begin{bmatrix} - & 1 & 1 \\ 0 & - & 1 \\ 1 & 1 & - \end{bmatrix}$$

$$= \begin{bmatrix} - & 1 & 0 \\ 0 & - & 0 \\ 0 & 0 & - \end{bmatrix}$$

From the above calculations A_3 dominate A_1, A_2 also dominate A_1. In this simulation, which determined the criteria in Group Decision Support System in simulated from existing data. To simulate the model with the ELECTRE method is A_3 dominated A_1 and A_2dominate A_1. This means that in this simulation of the criteria for determining the simulation showed that the activation of c-myc and Rb more likely to cause cancer.

I. Concluding Remarks and Further Works

ELECTRE method is one method in group decision making that can assist in making decisions to determine whether a mutated gene can cause cancer or not based on existing criteria in the gene mutation. In this paper simulation criteria made for modeling. The result of decisions taken based on the determination of criteria for modeling. Determination of criteria for determining whether a mutated gene can cause cancer or do not have to refer to experts in their field. Preference given the experts usually will vary based on individual interests. Preference given to the format of an ordered vector of various experts to determine the weight which is a process of transformation from a given preference. But in this paper only made modeling of prefence provided by ordered vector format to the calculations so that the decision to modelling of these calculations. This modell is flexible which will be made in accordance criteria established by the experts for decision making. The determination of someone mutated gene or not the criteria derived from expert opinion in the medical field. This modelling can be used for actual criteria, based on criteria established by experts.

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