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DEVELOPMENT OF *ANEKA* EVALUATION MODEL BASED ON *TOPSIS* IN SEARCHING THE DOMINANT ASPECTS OF COMPUTER LEARNING QUALITY DETERMINANTS

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ABSTRACT

The implementation of this research was intended to obtain information about the design of *ANEKA* evaluation model based on *TOPSIS* which can describe the stages to obtain dominant aspects of the quality determinant of computer learning. This research was development research using Borg and Gall design that was limited up to preliminary field test stage in generating *ANEKA* evaluation model based on *TOPSIS*. The data collection in this research was done through documentation, interview, observation, and questionnaire distribution. Subjects involved in conducting the preliminary field test of evaluation model designs were two informatics experts and two education experts. The analyst technique used in this research was descriptive quantitative based on descriptive's percentage calculation. The results shown in this study was a design of *ANEKA* evaluation model based on *TOPSIS* that was ready to be used because evidenced from the average percentage of model design quality of 89.00% viewed from the results of the preliminary field test that was conducted by experts. Besides, it has also been proven from the simulation result of *TOPSIS* method accurately, can be determined the most dominant evaluation aspect.

Keywords: *Evaluation, ANEKA, TOPSIS, Dominant Aspect, Computer Learning.*

1. INTRODUCTION

Generally, the initial perception of most teachers stated that the learning process in school could run optimally if the students already have good intellectual ability and good manners. However, with the rapid development of information technology that's influenced and triggered by the emergence of the current era of industrial revolution 4.0, the balance between intellectual ability and character in the learning process began to fades away. This condition can happen because of a paradigm shift in the learning process in school in the era of industrial revolution 4.0 currently, where the learning process in schools undergoes changes and developments from conventional processes through face to face in the classroom into a learning process based on the digital form that can be done online (*asynchronous learning*) using internet facilities both at school and out of school. Face-to-face learning in classroom cause to direct interaction between teachers and students making it easier to supervise the different activities undertaken by students while in the classroom, but access to knowledge resources is limited only to material provided by the teachers. But, online learning makes it difficult for teachers to monitor the different activities that are undertaken by students while outside the classroom, but online learning provides the ease in obtaining a source of knowledge quickly.

Similar to the learning process in general subjects that occur in schools, in this era of industrial revolution 4.0, students who follow computer learning in schools do not need to memorize one by one all the basic knowledge and mathematical logic formula to support computer learning, because the current students have been able to find sources of knowledge directly from the internet without having to wait for instructions and can train their brain and logic through examples of problems or cases related to computer subjects via the internet instantly. However, behind the ease that was offered through the advancement of information technology that supports the process of computer learning in school, it raises new problems that are the declining quality of intellectual ability and character possessed by the students. The form of their intellectual degradation, indicated by the conditions such as reading interest that was decreased, lazy to make tasks, ability, and memory of students were limited, mathematical ability and ability to think logically they also were reduced. The form of the students' moral decline was shown by several conditions such as students often truant, brave against teachers, intercourse and early childhood sex, the emergence of gangster culture, etc.

Problems relating to the decline in intellectual ability and character in the computer learning process often occurs in students in the medium education level, especially vocational school in the field of information technology because psychologically students at the medium education level are experiencing a phase of mental development in their's life and tend to be unstable. Besides, organizational and institutional status, the vocational school in the field of information technology has directly provided complete computer facilities and internet network as an essential tool to support the learning process in each subject, so that students are easy to access the internet. The ease of internet access provided by the school and given freely to students to use it, but not accompanied by a strong mental from within the students, and even the students use the ease provided by the school to look for things that deviate from the learning material, so this condition to become a severe problem that must be solved.

Based on the problems found in the computer learning process in the vocational school in the field of information technology, shows a decrease in the computer learning quality. Therefore, it is necessary to make an effort to overcome these problems, by providing an appropriate recommendation. Appropriate recommendations can be obtained by conducting an evaluation activity. It is accordance with the opinions of some researchers, such as Prinsloo and Harvey [1]; Arnyana, *et al* [2]; Toyoda [3]; Divayana and Sanjaya [4]; Brink and Bartz [5]; Mahayukti, *et al* [6]; Chow and Hollo [7]; Divayana, Adiarta, and Abadi [8]; Põldoja, Duval, and Leinonen [9]; Divayana, *et al* [10]; Wotela [11]; Divayana, *et al* [12]; Saucier, *et al* [13]; Jampel, *et al* [14]; Liu, Xu, and Stronge [15]; Suandi, Putrayasa, and Divayana [16]; Harris-Packer and Ségol [17]; Divayana, *et al* [18]; Schwab [19]; Divayana, Ardana, and Ariawan [20]; Arnold and Reed [21]; Divayana, Adiarta, and Abadi [22]; Mengoni, Bardsley and Oates [23]; Divayana [24]; Climie and Henley [25]; Norman and Parker [26]; which states that good recommendations can be obtained through evaluation activities that were conducted thoroughly, completely and deeply using appropriate models.

Appropriate evaluation model used to evaluate the quality of computer learning is a model that can measure the intellectual level and character of students precisely and accurately. To be able to show fast and precise results in evaluating the quality of computer learning is evidenced by the discovery of the dominant aspects of the overall quality of computer learning (both concerning intellectual level and student character). Based on that statement, the evaluation model that can be developed to evaluate the quality of computer learning is the form of *ANEKA* evaluation model based on *TOPSIS*. This model can measure the intellectual level and student character based on the point of view of *ANEKA* component and can determine the dominant aspect of the quality determinant of computer learning comprehensively using *TOPSIS* method calculation.

Based on the problems findings and the solution model form so that it can be obtained the problems statements of this research, i.e.: 1) How the design of ANEKA evaluation model based on TOPSIS that used to evaluate the computer learning quality, 2) How the simulation of ANEKA evaluation model based on TOPSIS? From those problems statements, so the purpose of this research was to know the design and simulation of ANEKA evaluation model based on TOPSIS used to evaluate the computer learning quality.

This research based on several research results that have been done in 2017 by Divayana et al. [27]

about the development of *ANEKA* evaluation model instruments, have similarities with this research regarding the research object about *ANEKA* model, but the difference lies research objectives, where this research was more focused in developing *ANEKA* model to be able to determine the dominant aspect of determining of computer learning quality by evaluation calculation process applying *TOPSIS* method, while research that was done by Divayana, et al. only focuses on determining the validity and reliability of *ANEKA* model instruments, so has not been able to show precisely the dominant aspect that becomes a priority to be implemented in supporting the computer learning quality in schools.

The research that was conducted in 2016 by Oktarina about the actualization of the ANEKA values in the profession as lecturers at IHDN as the basis of public service quality commitment [28] has similarities with that done by researchers regarding utilizing the *ANEKA* values indicators. However, the difference lies in the purpose of the research, where this research focuses on developing the ANEKA evaluation model based on *TOPSIS* that is used to evaluate the quality of computer learning, while the research that was conducted by Oktarina focuses only on actualizing the *ANEKA* values for maintaining the quality commitment in providing services to the students at IHDN, so it has not been able to find out deeply the values of ANEKA that can determine the learning quality of students at IHDN comprehensively.

2. RESEARCH METHODOLOGY

This research uses development research approach using Borg and Gall model. Borg and Gall's model has 10 stages, including: (1) *Research and Information Collecting*, (2) *Planning*, (3) *Develop Preliminary Form of Product*, (4) *Preliminary Field Test*, (5) *Main Product Revision*, (6) *Main Field Test*, (7) *Operational Product Revision*, (8) *Operational Field Testing*, (9) *Final Product Revision*, and (10) *Dissemination and Implementation*. The implementation of this research was limited to Preliminary Field Test. Some of the activities undertaken in this study for each stage using the Borg and Gall model, including: (1) at the stage of *research and information collecting* was conducted the literature search and documentation study on *ANEKA* evaluation model and *TOPSIS* method used as the basis or preliminary study in making the design of *ANEKA* evaluation model based on *TOPSIS*; (2) at the stage of *planning* was conducted the personnel planning that involved and the time required to complete the design of *ANEKA* evaluation model based on *TOPSIS*; (3) at the *develop preliminary form of product* stage was conducted the initial design of ANEKA evaluation model based on TOPSIS; (4) at the stage of *preliminary field test* was conducted a limited trial toward the design of *ANEKA* evaluation model based on *TOPSIS* design which has been formed, with involving two informatics experts and two education experts.

The location of the Preliminary Field Test of design of ANEKA evaluation model based on TOPSIS was conducted in one of the existing vocational school of information technology field in Badung Regency (namely SMK TI Udayana), because that school has the vision and mission to realize the school of information technology that is superior, independent, character and cultured. The data were collected through documentation study to gain basic knowledge about ANEKA concept and TOPSIS method, interview with the headmaster, direct observation on the design of ANEKA evaluation model based on TOPSIS which tested at research location, and dispersion of test questionnaire to experts.

Data analysis technique used as the basis of interpretation of research result was quantitative descriptive technique, by using descriptive percentage calculation. The formula used for descriptive percentage calculation as follows [29].

$$\text{Percentage} = \frac{\sum(\text{Answer} * \text{Weight Each Choice of Answers})}{\text{n} * \text{Highest Weight}} * 100\% \quad (1)$$

Where:
Σ = Amount
n = Total number of questionnaire items

Furthermore, to calculate the percentage of all respondents involved in the study can use the following formula [29]:

$$\text{Percentage} = \frac{F}{N} \quad (2)$$

Where:
F = Total percentage of the entire subject
N = Number of subjects

To be able to give meaning and decision-making at the level of achievement of computer learning quality can use the scale conversion of quality level, as shown in Table 1 below:

Table 1. Conversion of Quality Level with Scales' Five

Quality Level	Category	Recommendation
90-100 %	Excellence	Not Revised
80-89 %	Good	Not Revised

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Quality Level	Category	Recommendation
65-79 %	Moderate	Revised
55-64 %	Less	Revised
0-54 %	Poor	Revised

3. RESULTS AND DISCUSSION

3.1 Results

Several items that are shown as the results of this research, including:

1) *Results at Stage of Research and Information Collecting*

The results obtained at this stage contain preliminary information about *ANEKA* aspects and *TOPSIS* method. Generally, *ANEKA* is an acronym of the following five words: (a) *Akuntabilitas* (in Indonesian) or Accountability (in English); (b) *Nasionalisme* (in Indonesian) or Nationalism (in English); (c) *Etika Publik* (in Indonesian) or Public Ethics (in English); (d) *Komitmen Mutu* (in Indonesian) or Quality Commitment (in English); dan (e) *Anti korupsi* (in Indonesian) atau anti-corruption (in English). Accountability related to the responsibilities of students doing all the tasks assigned by the teachers. The evaluation aspects included in the accountability component are clarity of target, responsibilities, neutral, honest, consistent, participatory, and prioritizing the public interest. Nationalism is related to students' loves sincerely and profoundly toward the school where they gain knowledge from the teachers. The evaluation aspects included in the nationalism component are transparent, tolerant, mutual cooperation, work ethic, self-confidence, deliberation, wise, kinship, mutual help, and un-greedy. Public ethics is related to the ethics of students in maintaining their behavior to maintain the good reputation of the school in the public sphere. The evaluation aspects included in the public ethics component are obey in the laws and regulations, respect, careful, high integrity, polite, and obey on commands. Quality commitment is related to the students' ability to show their intellectual qualities or achievements in a good and sincere way. The evaluation aspects included in the quality commitment component are efficiency, quality oriented, effectiveness, and innovation. Anti-corruption is related to the ability of students to avoid negative things that cause the existence of misappropriation and lies in the learning process. The evaluation aspects included in the anti-corruption component are discipline, independent, courageous, fair, hard work, simple, and care.

The TOPSIS (*Technique for Order Preference by Similarity to Ideal Solution*) method is one of the decision support methods that using the principle the chosen alternative must have the nearest distance from the positive ideal solution and the furthest distance from the negative ideal solution based on a geometric point of view by using the Euclidean distance to determine the relative proximity from an alternative with the optimal solution [30]. The stages of TOPSIS method calculation, consist of (a) making a normalized decision matrix, (b) making a weighted normalization decision matrix, (c) determining the positive ideal solutions matrix and the negative ideal solution matrix, (d) determining the distance between values any alternative with a positive solution ideal matrix and the negative solution ideal matrix, (e) determining the preference value for each alternative.

TOPSIS requires performance rating of each alternative A_i on each of the normalized C_j criteria, namely:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (3)$$

The positive ideal solution (A+) and the negative ideal solution (A-) can be determined based on the normalized weighted rating (y_{ij})) as follows:

$$y_{ij} = w_i r_{ij} \quad (4)$$

$$A^+ = \left(y_1^+, y_2^+, \cdots, y_n^+\right) \quad (5)$$

$$A^- = \left(y_1^-, y_2^-, \cdots, y_n^-\right) \quad (6)$$

Where :

$$y_j^+ = \begin{cases} \max_i y_{ij}; & \text{if j is an benefit attribute} \\ \min_i y_{ij}; & \text{if j is an cost attribute} \end{cases} \quad (7)$$

$$y_j^- = \begin{cases} \min_i y_{ij}; & \text{if j is an benefit attribute} \\ \max_i y_{ij}; & \text{if j is an cost attribute} \end{cases} \quad (8)$$

The distance between alternative Ai with the positive ideal solution is formulated as follows.

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(y_i^+ - y_{ij}\right)^2} \quad (9)$$

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The distance between alternative Ai with the negative ideal solution is formulated as follows.

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(y_{ij} - y_i^-\right)^2} \quad (10)$$

The preference value for each alternative (Vi) is given as:

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (11)$$

A larger V_i score indicates that Ai alternatives are preferred.

2) *Results at Stage of Planning*

The results obtained at this stage contain information on the personnel involved in the design of *ANEKA* evaluation model based on *TOPSIS* (as shown in Table 2) and the time required for completion (shown in Table 3).

Table 2: Personnel that are Involves in the Design of ANEKA Evaluation Model Based on TOPSIS

No	Activity	Number of Personnel (Person)
1.	Determination of components and aspects of the evaluation	3
2.	Determination of the indicators of each evaluation aspect	3
3.	Create the design model	3
4.	The preliminary field test of design	4
	Total	**13**

Table 3: Time Required for the Design of ANEKA Evaluation Model Based on TOPSIS

No	Activity	Time (Day)
1.	Determination of components and aspects of the evaluation	5
2.	Determination of the indicators of each evaluation aspect	6
3.	Create the design model	5
4.	The preliminary field test of design	14
	Total	**30**

3) *Results at Stage of Develop Preliminary Form of Product*

At this stage was produced the design of ANEKA evaluation model based on TOPSIS that presented completely in Figure 1 below.

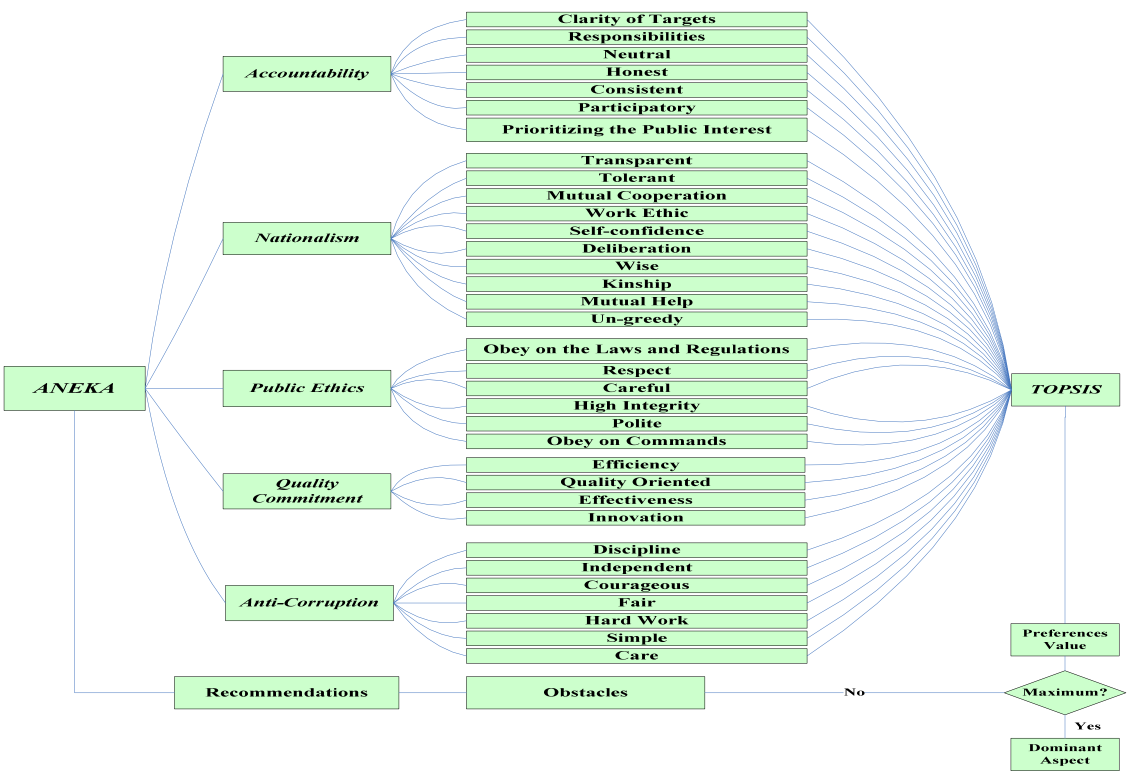

Figure 1: The Design of ANEKA Evaluation Model Based on TOPSIS

4) Results at Stage of Preliminary Field Test

At this stage, the preliminary field test results that conducted by two education experts and two informatics experts toward the *ANEKA* evaluation model based on *TOPSIS*, shown in Table 4 below.

Table 4: Results of the Preliminary Field Test that Conducted by Experts toward Design of ANEKA Evaluation Model Based on TOPSIS

No	Expert	Items										Total	Percentage (%)
		1	2	3	4	5	6	7	8	9	10		
1.	E-1	5	4	5	5	4	5	4	4	5	5	46	92.00
2.	E-2	4	5	4	4	5	4	5	5	4	5	45	90.00
3.	E-3	5	5	4	4	5	4	4	4	4	4	43	86.00
4.	E-4	4	4	5	4	4	5	5	5	4	4	44	88.00
												Average	**89.00**

Besides the results of preliminary field test, at this stage also shows the simulation of *TOPSIS* method calculation to determine the dominant aspects of computer learning quality determinants, which wholly explained as follows.
Known the data obtained from simulation test that was conducted by four experts, shown entirely in Table 5 below.

Table 5: Simulation Data that Input By Experts

Aspects	Components	*ANEKA*				
		Accountability	Nationalism	Public Ethics	Quality Commitment	Anti-Corruption
1	Clarity of target	4.25	1.00	1.00	1.00	1.00
2	Responsibilities	4.50	1.00	1.00	1.00	1.00
3	Neutral	4.50	1.00	1.00	1.00	1.00
4	Honest	4.25	1.00	1.00	1.00	1.00
5	Consistent	4.50	1.00	1.00	1.00	1.00
6	Participatory	4.25	1.00	1.00	1.00	1.00
7	Prioritizing the public interest	4.50	1.00	1.00	1.00	1.00
8	Transparent	1.00	4.25	1.00	1.00	1.00
9	Tolerant	1.00	4.50	1.00	1.00	1.00
10	Mutual Cooperation	1.00	4.25	1.00	1.00	1.00
11	Work Ethic	1.00	4.50	1.00	1.00	1.00
12	Self-Confidence	1.00	4.25	1.00	1.00	1.00
13	Deliberation	1.00	4.25	1.00	1.00	1.00
14	Wise	1.00	4.25	1.00	1.00	1.00
15	Kinship	1.00	4.50	1.00	1.00	1.00
16	Mutual Help	1.00	4.50	1.00	1.00	1.00
17	Un-Greedy	1.00	4.25	1.00	1.00	1.00
18	Obey in the Laws and Regulations	1.00	1.00	4.50	1.00	1.00
19	Respect	1.00	1.00	4.50	1.00	1.00
20	Careful	1.00	1.00	4.25	1.00	1.00
21	High Integrity	1.00	1.00	4.25	1.00	1.00
22	Polite	1.00	1.00	4.25	1.00	1.00
23	Obey on Commands	1.00	1.00	4.50	1.00	1.00
24	Efficiency	1.00	1.00	1.00	4.50	1.00
25	Quality Oriented	1.00	1.00	1.00	4.75	1.00
26	Effectiveness	1.00	1.00	1.00	4.50	1.00
27	Innovation	1.00	1.00	1.00	4.50	1.00
28	Discipline	1.00	1.00	1.00	1.00	4.50
29	Independent	1.00	1.00	1.00	1.00	4.00
30	Courageous	1.00	1.00	1.00	1.00	4.25
31	Fair	1.00	1.00	1.00	1.00	4.50
32	Hard Work	1.00	1.00	1.00	1.00	4.50
33	Simple	1.00	1.00	1.00	1.00	4.50
34	Care	1.00	1.00	1.00	1.00	4.25

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Based on the data in Table 5 above, we can calculate *TOPSIS* with the following steps.

a) Determining a normalized decision matrix

$$|x_1| = \sqrt{4.25^2 + 4.50^2 + 4.50^2 + 4.25^2 + 4.50^2 + 4.25^2 + 4.50^2 + 27(1.00)^2} = 12.735$$

$$r_{11} = \frac{x_{11}}{|x_1|} = \frac{4.25}{12.735} = 0.334$$

$$r_{21} = \frac{x_{21}}{|x_1|} = \frac{4.50}{12.735} = 0.353$$

$$r_{31} = \frac{x_{31}}{|x_1|} = \frac{4.50}{12.735} = 0.353$$

$$r_{41} = \frac{x_{41}}{|x_1|} = \frac{4.25}{12.735} = 0.334$$

$$r_{51} = \frac{x_{51}}{|x_1|} = \frac{4.50}{12.735} = 0.353$$

$$r_{61} = \frac{x_{61}}{|x_1|} = \frac{4.25}{12.735} = 0.334$$

$$r_{71} = \frac{x_{71}}{|x_1|} = \frac{4.50}{12.735} = 0.353$$

$$r_{81} = \frac{x_{81}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{91} = \frac{X_{91}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{101} = \frac{x_{101}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{111} = \frac{x_{111}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{121} = \frac{x_{121}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{131} = \frac{x_{131}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{141} = \frac{x_{141}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{151} = \frac{x_{151}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{161} = \frac{x_{161}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{171} = \frac{x_{171}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{181} = \frac{x_{181}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{191} = \frac{x_{191}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{201} = \frac{x_{201}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{211} = \frac{x_{211}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{221} = \frac{x_{221}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{231} = \frac{x_{231}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{241} = \frac{x_{241}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{251} = \frac{x_{251}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{261} = \frac{x_{261}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{271} = \frac{x_{271}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{281} = \frac{x_{281}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{291} = \frac{x_{291}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{301} = \frac{x_{301}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{311} = \frac{x_{311}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{321} = \frac{x_{321}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{331} = \frac{x_{331}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$r_{341} = \frac{x_{341}}{|x_1|} = \frac{1.00}{12.735} = 0.079$$

$$|x_2| = \sqrt{7(1.00)^2 + 4.25^2 + 4.50^2 + 4.25^2 + 4.50^2 + 4.25^2 + 4.25^2 + 4.25^2 + 4.50^2 + 4.50^2 + 4.25^2 + 17(1.00)^2} = 14.607$$

$$r_{12} = \frac{x_{12}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{22} = \frac{x_{22}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{32} = \frac{x_{32}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{42} = \frac{x_{42}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{52} = \frac{x_{52}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{62} = \frac{x_{62}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{72} = \frac{x_{72}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{82} = \frac{x_{82}}{|x_2|} = \frac{4.25}{14.607} = 1.237$$

$$r_{92} = \frac{X_{92}}{|x_2|} = \frac{4.50}{14.607} = 1.386$$

$$r_{102} = \frac{x_{102}}{|x_2|} = \frac{4.25}{14.607} = 1.237$$

$$r_{112} = \frac{x_{112}}{|x_2|} = \frac{4.50}{14.607} = 1.386$$

$$r_{122} = \frac{x_{122}}{|x_2|} = \frac{4.25}{14.607} = 1.237$$

$$r_{132} = \frac{x_{132}}{|x_2|} = \frac{4.25}{14.607} = 1.237$$

$$r_{142} = \frac{x_{142}}{|x_2|} = \frac{4.25}{14.607} = 1.237$$

$$r_{152} = \frac{x_{152}}{|x_2|} = \frac{4.50}{14.607} = 1.386$$

$$r_{162} = \frac{x_{162}}{|x_2|} = \frac{4.50}{14.607} = 1.386$$

$$r_{172} = \frac{x_{172}}{|x_2|} = \frac{4.25}{14.607} = 1.237$$

$$r_{182} = \frac{X_{182}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{192} = \frac{x_{192}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{202} = \frac{x_{202}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{212} = \frac{x_{212}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{222} = \frac{x_{222}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{232} = \frac{x_{232}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{242} = \frac{x_{242}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{252} = \frac{x_{252}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{262} = \frac{x_{262}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{272} = \frac{x_{272}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{282} = \frac{x_{282}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{292} = \frac{x_{292}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{302} = \frac{x_{302}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{312} = \frac{x_{312}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{322} = \frac{x_{322}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{332} = \frac{X_{332}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$r_{342} = \frac{x_{342}}{|x_2|} = \frac{1.00}{14.607} = 0.068$$

$$|x_3| = \sqrt{17(1.00)^2 + 4.50^2 + 4.50^2 + 4.25^2 + 4.25^2 + 4.25^2 + 4.50^2 + 11(1.00)^2}$$
$$= 11.956$$

$$r_{13} = \frac{x_{13}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{2} = \frac{x_{23}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{33} = \frac{x_{33}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{43} = \frac{x_{43}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{53} = \frac{x_{53}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{63} = \frac{x_{63}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{73} = \frac{x_{73}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{83} = \frac{x_{83}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{93} = \frac{x_{93}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{103} = \frac{x_{103}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{113} = \frac{x_{113}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{123} = \frac{x_{123}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{133} = \frac{x_{133}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{143} = \frac{x_{143}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{153} = \frac{x_{153}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{163} = \frac{x_{163}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{173} = \frac{x_{173}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{183} = \frac{X_{183}}{|x_3|} = \frac{4.50}{11.956} = 1.694$$

$$r_{193} = \frac{x_{193}}{|x_3|} = \frac{4.50}{11.956} = 1.694$$

$$r_{203} = \frac{x_{203}}{|x_3|} = \frac{4.25}{11.956} = 1.511$$

$$r_{213} = \frac{x_{213}}{|x_3|} = \frac{4.25}{11.956} = 1.511$$

$$r_{223} = \frac{x_{223}}{|x_3|} = \frac{4.25}{11.956} = 1.511$$

$$r_{233} = \frac{x_{233}}{|x_3|} = \frac{4.50}{11.956} = 1.694$$

$$r_{243} = \frac{x_{243}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{253} = \frac{x_{253}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{263} = \frac{x_{263}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{273} = \frac{x_{273}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{283} = \frac{x_{283}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{293} = \frac{x_{293}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{303} = \frac{x_{303}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{313} = \frac{x_{313}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{323} = \frac{x_{323}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$r_{333} = \frac{x_{333}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

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$$r_{343} = \frac{x_{343}}{|x_3|} = \frac{1.00}{11.956} = 0.084$$

$$|x_4| = \sqrt{23(1.00)^2 + 4.50^2 + 4.75^2 + 4.50^2 + 4.50^2 + 7(1.00)^2} = 10.645$$

$$r_{14} = \frac{x_{14}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{24} = \frac{x_{24}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{34} = \frac{x_{34}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{44} = \frac{x_{44}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{54} = \frac{x_{54}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{64} = \frac{x_{64}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{74} = \frac{x_{74}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{84} = \frac{x_{84}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{94} = \frac{x_{94}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{104} = \frac{x_{104}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{114} = \frac{x_{114}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{124} = \frac{x_{124}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{134} = \frac{x_{134}}{|x_5|} = \frac{1.00}{10.645} = 0.094$$

$$r_{144} = \frac{x_{144}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{154} = \frac{x_{154}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{164} = \frac{x_{164}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{174} = \frac{x_{174}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{184} = \frac{X_{184}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{194} = \frac{x_{194}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{204} = \frac{x_{204}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{214} = \frac{x_{214}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{224} = \frac{x_{224}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{234} = \frac{x_{234}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{244} = \frac{x_{244}}{|x_4|} = \frac{4.50}{10.645} = 1.902$$

$$r_{254} = \frac{x_{254}}{|x_4|} = \frac{4.75}{10.645} = 2.120$$

$$r_{264} = \frac{x_{264}}{|x_4|} = \frac{4.50}{10.645} = 1.902$$

$$r_{274} = \frac{x_{274}}{|x_4|} = \frac{4.50}{10.645} = 1.902$$

$$r_{284} = \frac{x_{284}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{294} = \frac{x_{294}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{304} = \frac{x_{304}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{314} = \frac{x_{314}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{324} = \frac{x_{324}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{334} = \frac{x_{334}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$r_{344} = \frac{x_{344}}{|x_4|} = \frac{1.00}{10.645} = 0.094$$

$$|x_5| = \sqrt{27(1.00)^2 + 4.50^2 + 4.00^2 + 4.25^2 + 4.50^2 + 4.50^2 + 4.50^2 + 4.25^2} = 12.654$$

$$r_{15} = \frac{x_{15}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{25} = \frac{x_{25}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{35} = \frac{x_{35}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{45} = \frac{x_{45}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{55} = \frac{x_{55}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{65} = \frac{x_{65}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{75} = \frac{x_{75}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{85} = \frac{x_{85}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{95} = \frac{x_{95}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

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$$r_{105} = \frac{x_{105}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{115} = \frac{x_{115}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{125} = \frac{x_{125}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{135} = \frac{x_{135}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{145} = \frac{x_{145}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{155} = \frac{x_{155}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{165} = \frac{x_{165}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{175} = \frac{x_{175}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{185} = \frac{X_{185}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{195} = \frac{x_{195}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{205} = \frac{x_{205}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{215} = \frac{x_{215}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{225} = \frac{x_{225}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{235} = \frac{x_{235}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{245} = \frac{x_{245}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{255} = \frac{x_{255}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{265} = \frac{x_{265}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{275} = \frac{x_{275}}{|x_5|} = \frac{1.00}{12.654} = 0.079$$

$$r_{285} = \frac{x_{285}}{|x_5|} = \frac{4.50}{12.654} = 1.600$$

$$r_{295} = \frac{x_{295}}{|x_5|} = \frac{4.00}{12.654} = 1.264$$

$$r_{305} = \frac{x_{305}}{|x_5|} = \frac{4.25}{12.654} = 1.427$$

$$r_{315} = \frac{x_{315}}{|x_5|} = \frac{4.50}{12.654} = 1.600$$

$$r_{325} = \frac{x_{325}}{|x_5|} = \frac{4.50}{12.654} = 1.600$$

$$r_{335} = \frac{x_{335}}{|x_5|} = \frac{4.50}{12.654} = 1.600$$

$$r_{345} = \frac{x_{345}}{|x_5|} = \frac{4.25}{12.654} = 1.427$$

Those result of normalization then converted into matrix form, which can be seen as follows.

R=

1.418	0.068	0.084	0.094	0.079
1.590	0.068	0.084	0.094	0.079
1.590	0.068	0.084	0.094	0.079
1.418	0.068	0.084	0.094	0.079
1.590	0.068	0.084	0.094	0.079
1.418	0.068	0.084	0.094	0.079
1.590	0.068	0.084	0.094	0.079
0.079	1.237	0.084	0.094	0.079
0.079	1.386	0.084	0.094	0.079
0.079	1.237	0.084	0.094	0.079
0.079	1.386	0.084	0.094	0.079
0.079	1.237	0.084	0.094	0.079
0.079	1.237	0.084	0.094	0.079
0.079	1.237	0.084	0.094	0.079
0.079	1.386	0.084	0.094	0.079
0.079	1.386	0.084	0.094	0.079
0.079	1.237	0.084	0.094	0.079
0.079	0.068	1.694	0.094	0.079
0.079	0.068	1.694	0.094	0.079
0.079	0.068	1.511	0.094	0.079
0.079	0.068	1.511	0.094	0.079
0.079	0.068	1.511	0.094	0.079
0.079	0.068	1.694	0.094	0.079
0.079	0.068	0.084	1.902	0.079
0.079	0.068	0.084	2.120	0.079
0.079	0.068	0.084	1.902	0.079
0.079	0.068	0.084	1.902	0.079
0.079	0.068	0.084	0.094	1.600
0.079	0.068	0.084	0.094	1.264
0.079	0.068	0.084	0.094	1.427
0.079	0.068	0.084	0.094	1.600
0.079	0.068	0.084	0.094	1.600
0.079	0.068	0.084	0.094	1.600
0.079	0.068	0.084	0.094	1.427

b) Determining a weighted normalization decision matrix

Making a weighted normalization decision matrix, conducted by multiplying the R matrix by the weight of each evaluation component has given by the experts. The weighted detail given by the experts for each *ANEKA* evaluation component was

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[4 4 4 4 4], so we can calculate the weighted normalization decision matrix as follows.

Y= [R]*[4 4 4 4 4]

Y=

5.672	0.272	0.336	0.376	0.316
6.360	0.272	0.336	0.376	0.316
6.360	0.272	0.336	0.376	0.316
5.672	0.272	0.336	0.376	0.316
6.360	0.272	0.336	0.376	0.316
5.672	0.272	0.336	0.376	0.316
6.360	0.272	0.336	0.376	0.316
0.316	4.948	0.336	0.376	0.316
0.316	5.544	0.336	0.376	0.316
0.316	4.948	0.336	0.376	0.316
0.316	5.544	0.336	0.376	0.316
0.316	4.948	0.336	0.376	0.316
0.316	4.948	0.336	0.376	0.316
0.316	4.948	0.336	0.376	0.316
0.316	5.544	0.336	0.376	0.316
0.316	5.544	0.336	0.376	0.316
0.316	4.948	0.336	0.376	0.316
0.316	0.272	6.776	0.376	0.316
0.316	0.272	6.776	0.376	0.316
0.316	0.272	6.044	0.376	0.316
0.316	0.272	6.044	0.376	0.316
0.316	0.272	6.044	0.376	0.316
0.316	0.272	6.776	0.376	0.316
0.316	0.272	0.336	7.608	0.316
0.316	0.272	0.336	8.480	0.316
0.316	0.272	0.336	7.608	0.316
0.316	0.272	0.336	7.608	0.316
0.316	0.272	0.336	0.376	6.400
0.316	0.272	0.336	0.376	5.056
0.316	0.272	0.336	0.376	5.708
0.316	0.272	0.336	0.376	6.400
0.316	0.272	0.336	0.376	6.400
0.316	0.272	0.336	0.376	6.400
0.316	0.272	0.336	0.376	5.708

c) Determining the positive ideal solutions matrix and the negative ideal solution matrix

Making the matrix of positive and negative ideal solutions is largely determined by the categorization of each evaluation component. Categorization for each component of ANEKA evaluation was included in the category of benefit attribute, so it can be calculated the matrix of positive and negative ideal solutions as follows.

(1) Positive ideal solution matrix

y_1^+ = max{5.672; 6.360; 6.360; 5.672; 6.360; 5.672; 6.360; 0.316} = 6.360

y_2^+ = max{0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 4.948; 5.544; 4.948; 5.544; 4.948; 4.948; 4.948; 5.544; 5.544; 4.948; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272} = 5.544

y_3^+ = max{0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 6.776; 6.776; 6.044; 6.044; 6.044; 6.776; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336} = 6.776

y_4^+ = max{0.376; 7.608; 8.480; 7.608; 7.608; 0.376; 0.376; 0.376; 0.376; 0.376; 0.376; 0.376} = 8.480

y_5^+ = max{0.316; 6.400; 5.056; 5.708; 6.400; 6.400; 6.400; 5.708} = 6.400

A^+ = {6.360; 5.544; 6.776; 8.480; 6.400}

(2) Negative ideal solution matrix

y_1^- = min{5.672; 6.360; 6.360; 5.672; 6.360; 5.672; 6.360; 0.316} = 0.316

y_2^- = min{0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 4.948; 5.544; 4.948; 5.544; 4.948; 4.948; 4.948; 5.544; 5.544; 4.948; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272; 0.272} = 0.272

y_3^- = min{0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 6.776; 6.776; 6.044; 6.044; 6.044; 6.776; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336; 0.336} = 0.336

y_4^- = min{0.376; 7.608; 8.480; 7.608; 7.608; 0.376; 0.376; 0.376; 0.376; 0.376; 0.376; 0.376} = 0.376

$y_5^- = \min\{0.316; 6.400; 5.056; 5.708; 6.400; 6.400; 6.400; 5.708\} = 0.316$

$A^- = \{0.316; 0.272; 0.336; 0.376; 0.316\}$

d) Calculates the distance between the value of each alternative with the positive ideal solution matrix and the negative ideal solution matrix

(1) The distance between the value of each alternative with the positive ideal solution matrix

$D_1^+ = \sqrt{(5.672-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.131$

$D_2^+ = \sqrt{(6.360-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.113$

$D_3^+ = \sqrt{(6.360-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.113$

$D_4^+ = \sqrt{(5.672-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.131$

$D_5^+ = \sqrt{(6.360-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.113$

$D_6^+ = \sqrt{(5.672-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.131$

$D_7^+ = \sqrt{(6.360-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.113$

$D_8^+ = \sqrt{(0.316-6.360)^2+(4.948-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.455$

$D_9^+ = \sqrt{(0.316-6.360)^2+(5.544-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.442$

$D_{10}^+ = \sqrt{(0.316-6.360)^2+(4.948-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.455$

$D_{11}^+ = \sqrt{(0.316-6.360)^2+(5.544-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.442$

$D_{12}^+ = \sqrt{(0.316-6.360)^2+(4.948-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.455$

$D_{13}^+ = \sqrt{(0.316-6.360)^2+(4.948-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.455$

$D_{14}^+ = \sqrt{(0.316-6.360)^2+(4.948-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.455$

$D_{15}^+ = \sqrt{(0.316-6.360)^2+(5.544-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.442$

$D_{16}^+ = \sqrt{(0.316-6.360)^2+(5.544-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.442$

$D_{17}^+ = \sqrt{(0.316-6.360)^2+(4.948-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 13.455$

$D_{18}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(6.776-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 12.923$

$D_{19}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(6.776-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 12.923$

$D_{20}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(6.044-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 12.944$

$D_{21}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(6.044-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 12.944$

$D_{22}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(6.044-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 12.944$

$D_{23}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(6.776-6.776)^2+(0.376-8.480)^2+(0.316-6.400)^2} = 12.923$

$D_{24}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(7.608-8.480)^2+(0.316-6.400)^2} = 11.982$

$D_{25}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(8.480-8.480)^2+(0.316-6.400)^2} = 11.950$

$D_{26}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(7.608-8.480)^2+(0.316-6.400)^2} = 11.982$

$D_{27}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(7.608-8.480)^2+(0.316-6.400)^2} = 11.982$

$D_{28}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(6.400-6.400)^2} = 13.095$

$D_{29}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(5.056-6.400)^2} = 13.164$

$D_{30}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(5.708-6.400)^2} = 13.113$

$D_{31}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(6.400-6.400)^2} = 13.095$

$D_{32}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(6.400-6.400)^2} = 13.095$

$D_{33}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(6.400-6.400)^2} = 13.095$

$D_{34}^+ = \sqrt{(0.316-6.360)^2+(0.272-5.544)^2+(0.336-6.776)^2+(0.376-8.480)^2+(5.708-6.400)^2} = 13.113$

(2) The distance between the value of each alternative with the negative ideal solution matrix

$D_1^- = \sqrt{(5.672-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2} = 5.356$

$D_2^- = \sqrt{(6.360-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2} = 6.044$

$D_3^- = \sqrt{(6.360-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2} = 6.044$

$D_4^- = \sqrt{(5.672-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2} = 5.356$

$D_5^- = \sqrt{(6.360-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2} = 6.044$

$D_6^- = \sqrt{(5.672-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2} = 5.356$

$D_7^- = \sqrt{(6.360-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2} = 6.044$

$D_8^- = \sqrt{(0.316-0.316)^2+(4.948-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2} = 4.676$

$D_9^- = \sqrt{(0.316-0.316)^2+(5.544-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2} = 5.272$

$D_{10}^- = \sqrt{(0.316-0.316)^2+(4.948-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2} = 4.676$

$D_{11}^- = \sqrt{(0.316-0.316)^2+(5.544-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2} = 5.272$

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$D_{12}^{-} = \sqrt{(0.316-0.316)^2+(4.948-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2}$
$= 4.676$

$D_{13}^{-} = \sqrt{(0.316-0.316)^2+(4.948-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2}$
$= 4.676$

$D_{14}^{-} = \sqrt{(0.316-0.316)^2+(4.948-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2}$
$= 4.676$

$D_{15}^{-} = \sqrt{(0.316-0.316)^2+(5.544-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2}$
$= 5.272$

$D_{16}^{-} = \sqrt{(0.316-0.316)^2+(5.544-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2}$
$= 5.272$

$D_{17}^{-} = \sqrt{(0.316-0.316)^2+(4.948-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2}$
$= 4.676$

$D_{18}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(6.776-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2}$
$= 6.440$

$D_{19}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(6.776-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2}$
$= 6.440$

$D_{20}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(6.044-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2}$
$= 5.708$

$D_{21}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(6.044-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2}$
$= 5.708$

$D_{22}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(6.044-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2}$
$= 5.708$

$D_{23}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(6.776-0.336)^2+(0.376-0.376)^2+(0.316-0.316)^2}$
$= 6.440$

$D_{24}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(7.608-0.376)^2+(0.316-0.316)^2}$
$= 7.232$

$D_{25}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(8.480-0.376)^2+(0.316-0.316)^2}$
$= 8.104$

$D_{26}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(7.608-0.376)^2+(0.316-0.316)^2}$
$= 7.232$

$D_{27}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(7.608-0.376)^2+(0.316-0.316)^2}$
$= 7.232$

$D_{28}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(6.400-0.316)^2}$
$= 6.084$

$D_{29}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(5.056-0.316)^2}$
$= 4.740$

$D_{30}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(5.708-0.316)^2}$
$= 5.392$

$D_{31}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(6.400-0.316)^2}$
$= 6.084$

$D_{32}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(6.400-0.316)^2}$
$= 6.084$

$D_{33}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(6.400-0.316)^2}$
$= 6.084$

$D_{34}^{-} = \sqrt{(0.316-0.316)^2+(0.272-0.272)^2+(0.336-0.336)^2+(0.376-0.376)^2+(5.708-0.316)^2}$
$= 5.392$

e) Calculates the preference value for each alternative.

$$V_1 = \frac{D_1^-}{D_1^- + D_1^+} = \frac{5.356}{5.356 + 13.131} = 0.290$$

$$V_2 = \frac{D_2^-}{D_2^- + D_2^+} = \frac{6.044}{6.044+13.113} = 0.315$$

$$V_3 = \frac{D_3^-}{D_3^- + D_3^+} = \frac{6.044}{6.044 + 13.113} = 0.315$$

$$V_4 = \frac{D_4^-}{D_4^- + D_4^+} = \frac{5.356}{5.356+13.131} = 0.290$$

$$V_5 = \frac{D_5^-}{D_5^- + D_5^+} = \frac{6.044}{6.044 + 13.113} = 0.315$$

$$V_6 = \frac{D_6^-}{D_6^- + D_6^+} = \frac{5.356}{5.356+13.131} = 0.290$$

$$V_7 = \frac{D_7^-}{D_7^- + D_7^+} = \frac{6.044}{6.044 + 13.113} = 0.315$$

$$V_8 = \frac{D_8^-}{D_8^- + D_8^+} = \frac{4.676}{4.676+13.455} = 0.258$$

$$V_9 = \frac{D_9^-}{D_9^- + D_9^+} = \frac{5.272}{5.272+ 13.442} = 0.282$$

$$V_{10} = \frac{D_{10}^-}{D_{10}^- + D_{10}^+} = \frac{4.676}{4.676+13.455} = 0.258$$

$$V_{11} = \frac{D_{11}^-}{D_{11}^- + D_{11}^+} = \frac{5.272}{5.272+ 13.442} = 0.282$$

$$V_{12} = \frac{D_{12}^-}{D_{12}^- + D_{12}^+} = \frac{4.676}{4.676+13.455} = 0.258$$

$$V_{13} = \frac{D_{13}^-}{D_{13}^- + D_{13}^+} = \frac{4.676}{4.676+13.455} = 0.258$$

$$V_{14} = \frac{D_{14}^-}{D_{14}^- + D_{14}^+} = \frac{4.676}{4.676+13.455} = 0.258$$

$$V_{15} = \frac{D_{15}^-}{D_{15}^- + D_{15}^+} = \frac{5.272}{5.272+13.442} = 0.282$$

$$V_{16} = \frac{D_{16}^-}{D_{16}^- + D_{16}^+} = \frac{5.272}{5.272+13.442} = 0.282$$

$$V_{17} = \frac{D_{17}^-}{D_{17}^- + D_{17}^+} = \frac{4.676}{4.676+13.455} = 0.258$$

$$V_{18} = \frac{D_{18}^-}{D_{18}^- + D_{18}^+} = \frac{6.440}{6.440+12.923} = 0.333$$

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$$V_{19} = \frac{D_{19}^-}{D_{19}^- + D_{19}^+} = \frac{6.440}{6.440+12.923} = 0.333 \qquad V_{20} = \frac{D_{20}^-}{D_{20}^- + D_{20}^+} = \frac{5.708}{5.708+12.944} = 0.306$$

$$V_{21} = \frac{D_{21}^-}{D_{21}^- + D_{21}^+} = \frac{5.708}{5.708+12.944} = 0.306 \qquad V_{22} = \frac{D_{22}^-}{D_{22}^- + D_{22}^+} = \frac{5.708}{5.708+12.944} = 0.306$$

$$V_{23} = \frac{D_{23}^-}{D_{23}^- + D_{23}^+} = \frac{6.440}{6.440+12.923} = 0.333 \qquad V_{24} = \frac{D_{24}^-}{D_{24}^- + D_{24}^+} = \frac{7.232}{7.232+11.982} = 0.376$$

$$V_{25} = \frac{D_{25}^-}{D_{25}^- + D_{25}^+} = \frac{8.104}{8.104+11.950} = 0.404 \qquad V_{26} = \frac{D_{26}^-}{D_{26}^- + D_{26}^+} = \frac{7.232}{7.232+11.982} = 0.376$$

$$V_{27} = \frac{D_{27}^-}{D_{27}^- + D_{27}^+} = \frac{7.232}{7.232+11.982} = 0.376 \qquad V_{28} = \frac{D_{28}^-}{D_{28}^- + D_{28}^+} = \frac{6.084}{6.084+13.095} = 0.317$$

$$V_{29} = \frac{D_{29}^-}{D_{29}^- + D_{29}^+} = \frac{4.740}{4.740+13.164} = 0.265 \qquad V_{30} = \frac{D_{30}^-}{D_{30}^- + D_{30}^+} = \frac{5.392}{5.392+13.113} = 0.291$$

$$V_{31} = \frac{D_{31}^-}{D_{31}^- + D_{31}^+} = \frac{6.084}{6.084+13.095} = 0.317 \qquad V_{32} = \frac{D_{32}^-}{D_{32}^- + D_{32}^+} = \frac{6.084}{6.084+13.095} = 0.3711$$

$$V_{33} = \frac{D_{33}^-}{D_{33}^- + D_{33}^+} = \frac{6.084}{6.084+13.095} = 0.317 \qquad V_{34} = \frac{D_{34}^-}{D_{34}^- + D_{34}^+} = \frac{5.392}{5.392+13.113} = 0.291$$

Based on the calculation of the preference values for each of the alternatives shown above, the highest or maximum value amount of 0.404 found on V_{25}, so the "Quality Oriented" aspect is called the dominant aspect the computer learning quality determinants.

3.2 Discussion

The design of ANEKA evaluation model based on TOPSIS was shown in Figure 1 above is an evaluation model design that is a combination of ANEKA model with TOPSIS method. ANEKA evaluation model consists of five evaluation components, such as accountability, nationalism, public ethics, quality commitment, and anti-corruption. In each ANEKA evaluation component, there are several aspects can be used as a tool to measure the computer learning quality. In the *accountability* component, has several evaluation aspects, such as clarity of target, responsibilities, neutral, honest, consistent, participatory, and prioritizing the public interest. In the *nationalism* component, has several evaluation aspects, such as transparent, tolerant, mutual cooperation, work ethic, self-confidence, deliberation, wise, kinship, mutual help, and un-greedy. In the *public ethics* component, has several evaluation aspects, such as obey in the laws and regulations, respect, careful, high integrity, polite, and obey on commands. In the *quality commitment* component, has several evaluation aspects, such as efficiency, quality oriented, effectiveness, and innovation. In the *anti-corruptions* component has several evaluation aspects, such as discipline, independent, courageous, fair, hard work, simple, and care. The measurement data from every aspect of ANEKA evaluation model then processed using TOPSIS method calculation so that the maximum and minimum preference values are obtained. The maximum preference values are used as the basis for searching the dominant aspect of computer learning quality determinants, while the preference that hasn't get the maximum value, then meaning there are still constraints on evaluation aspects. Therefore that recommendation should be given to the improvement on aspects in ANEKA evaluation model.

Based on preliminary field test conducted by the four experts toward the design of *ANEKA* evaluation model based on *TOPSIS* that was shown in table 4, obtained the average percentage of the evaluation model quality amount of 89.00%. That results are compared with the table of conversion of the quality level with scales' five that shown in Table 1, it can be interpreted that the design of *ANEKA* evaluation model based on *TOPSIS* is included in the good quality category, so there is no need to revise that evaluation model design.

The simulation data used to test the accuracy of TOPSIS method as indicated earlier in Table 5 was the average scoring score entered by all four experts. The score ranges entered by each expert are between 1 until 5. Score "5" means excellent, score "4" means good, score "3" means moderate, score "2" means less, and score "1" means poor or not given score by experts.

The results of this study are the answer or solution to the constraints found from several studies that have been done before by some researchers, including Divayana et al. and Oktarina which in principle have not been able to show the dominant aspects that become the priority or the determinants of learning quality overall. Through the results of this study, those constraints can be solved by the discovery of an evaluation model capable of showing the accurate calculation process in determining the dominant aspects of learning quality determinants (especially those implemented in computer learning).

Although the results of this research have become an innovation and the answer to other research constraints, in this study also found the obstacle that has not explained in detail about aspects that need serious attention to improve. Based on the constraints found in this study, it is necessary to do future work in the form of evaluation model development that can determine the evaluation measurement aspects that need to be optimized its performance from the lowest level to the highest level.

4. CONCLUSIONS

The results of this research have been able to show the design of ANEKA evaluation model based on TOPSIS with good category and ready to be used because it is proven from the result of the preliminary field test and simulation test of TOPSIS calculation which has shown the accurate calculation result in determining the most dominant aspect as the determinants of computer learning quality. The inovation that can be done to overcome obstacles in this research is to make the development or evaluation model in the form of artificial intelligence based application that is able to determine the optimization of the evaluation aspects that rising from the lowest value to the highest value.

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