SinkrOn
JURNAL & PENELITIAN TEKNIK INFORMATIKA
Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 2, April 2024
DOI : https://doi.org/10.33395/sinkron.v8i2.13085
e-ISSN : 2541-2019
p-ISSN : 2541-044X

Comparison of Smartphone Technology using AHP, ELECTRE, and PROMETHEE Methods

Akmaludin[1)*], Adhi Dharma Suriyanto [2)], Nandang Iriadi[3)], Kudiantoro Widianto[4)]
[1)]Universitas Nusa Mandiri, Jakarta, Indonesia
[2)3)4)]Universitas Bina Sarana Informatika, Jakarta, Indonesia
[1)]akmaludin.akm@nusamandiri.ac.id, [2)]adhi.ais @bsi.ac.id, [3)], nandang.ndi@bsi.ac.id [4)]kudiantoro.kdw@bsi.ac.id

Submitted : Oct 9, 2023 | **Accepted** : Nov 22, 2023 | **Published** : Apr 1, 2024

Abstract: The progress of smartphone technology is now very rapid, supported by many renewable features, even many users are competing to get the latest products without regard to the costs that have been incurred. The problem that arises is that it is increasingly difficult to select technology-based products with many criteria. The purpose of writing this paper is to provide the best solution for selecting technology-based products with multi-criteria to suit user needs by taking into account the costs incurred effectively and the use of contradictory multi-criteria applications. The presence of technology products always has many criteria that make it more difficult for users to choose products as the right choice according to their needs, thus the right method is needed as a solution to obtain technology-based products such as smartphones. The Analytic Hierarchy Process (AHP) method is used for the evaluation and selection process. This AHP method will collaborate with the ELECTRE and PROMETHEE methods as a comparison solution for smartphone product selection. The resulting comparison will be an applied model for smartphone selection that produces the best decision-making support according to user needs. The results of the collaborative implementation process of the ELECTRE and PROMETHEE methods provide a decision on the rating system. The collaborative application of the AHP method to the ELECTRE and PROMETHEE methods provides optimal decision support for the selection process, so that this can be used as a comparison material in making decisions regarding the selection of smartphones as technology-based products.

Keywords: AHP, ELECTRE, Multi-criteria, PROMETHEE, SmartPhone.

INTRODUCTION

Technology is needed to be able to communicate with each other, the communication tool needed is none other than a smartphone, even communication with a smartphone was used during a pandemic (Iyengar et al., 2020). The current development of smartphones has become a major requirement for users to be able to carry out communication processes and even exchange information through multi-purpose smartphones with the provision of varied feature facilities. Many users use smartphones in a short time and quickly replace them with the latest products without paying attention to the costs incurred, meaning that there is a waste of getting the latest smartphone products. Functional support found on smartphones makes users want to try and use the latest feature facilities attached to the smartphone (John et al., 2022). The purpose of writing this article is to provide the best solution for choosing technology-based products such as smartphones by using multi-criteria which are contradictory in their understanding and optimally implementing multi-criteria processing using the Analytic Hierarchy Process (AHP) method with multi-criteria which are contradictory. Thus the problem that arises is how best to evaluate and make a selection so that the need for technology products in the form of a smartphone is able to provide a reference so that the need for a smartphone becomes relevant to the needs that match its users. The functions of the features inherent in smartphones are very diverse, such as the need for memory both internal and external data storage memory in the form of RAM or ROM, the need for document storage in the form of text files, videos, sound recordings. Especially the need for a processor function with appropriate capacity, the need for image quality through the camera, the need for sound for listening to music, and other needs that give the best impression on smartphones.

There is a method that can be used to evaluate and select technology products in the form of smartphones, namely the Analytic Hierarchy Process (AHP) method. qualitative and quantitative problems. AHP has many techniques that can be applied, but for discussion in this paper using Multi-criteria Decision Making (MCDM)

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 2, April 2024 e-ISSN : 2541-2019
DOI : https://doi.org/10.33395/sinkron.v8i2.13085 p-ISSN : 2541-044X

(Marhavilas et al., 2022). MCDM has a very different technique and this difference is one of the advantages of other techniques, the advantage is the level of decision accuracy produced gives very optimal results, when compared to other methods with the concept of mathematical algebra matrices (Aschenbrenner, 2012). The mathematic algebra matrices method will apply iterative eigenvector values up to many times with the aim of obtaining eigenvector values without differences as a result of optimal eigenvectors. The eigenvector value without difference means that the resulting eigenvector value reaches the synthesis stage of completing the eigenvector value (Song et al., 2022). If this is proven by the mathematical algebra matrices, it must be able to give the same final value when tested with expert choice apps. The results of the eigenvector that have been declared optimal must be tested using the mathematical algebra matrices method by measuring the value of the consistency ratio (CR) (Apostolou & Hassell, 2002). According to Saaty, the acceptable CR value is less than 10 percent, this will be proven as a form of applied research in this article. The condition of the eigenvector value like this indicates that temporary decision support can be accepted until the synthesize decision is the end of the calculation process.

The number of criteria will provide a higher level of difficulty which makes decision making even more difficult, but the collaboration between the AHP method and the ELECTRE and PROMETHEE methods is able to provide comparisons in decision-making support for the selection and evaluation process with the concept of two-dimensional matrices (Corrente et al., 2013). The ELECTRE method is a method that can be used in the selection process with elimination techniques as outlined in the preference stage whose strength lies in determining concordance, discordance , and treshodl to the aggregate dominant matrices process. As with the PROMETHEE method, this method is used for the selection process using the preference stage as a selection whose steps are much different from the ELECTRE method (Akram et al., 2023). The PROMETHEE method strengthens the use of leaving flow, entering flow and net flow as a result of decision support (da Cunha et al., 2022).

With the above understanding, the contribution that can be made through this article is first to provide an overview in analyzing multi-criteria data, especially to criteria related to timing because the understanding will be different and the biggest influence lies in the process of normalization which gives an assessment of these criteria meaningful the lowest value is the best, in general the assessment is the highest value is the best. This is different from the criteria commonly used in research. The second contribution is to provide an analysis of a number of alternatives that are influenced by the optimal eigenvector value (da Cunha et al., 2022). The acquisition of eigenvector values must be in a truly optimal position with proof through mathematical algebra matrices and expert choice apps to be applied with the ELECTRE and PROMETHEE methods, this is to be the same reference for the results of the decision support of the two methods which are used as comparison material for alternative assessment in the form of technology products such as smartphones. This is a strong correlation for users of smartphone products that suit user needs by optimally utilizing costs that are tailored to user needs.

LITERATURE REVIEW

Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) method is widely applied in the selection of entities, both tangible and intangible which are determined by a number of criteria arranged hierarchically to make it easier to score as an accumulative ranking (Panchal & Shrivastava, 2022). The AHP method is widely accepted by the research community because the results are very optimal and easy for users to understand and it has various types of techniques for using AHP (Radomska-Zalas, 2022) that can be applied and adapted to the rules of the problems encountered (Akinlalu et al., 2021). Multi-criteria Decision Making (MCDM) is the best choice for researchers in conveying knowledge as a result of this study (Hamidah et al., 2022). MCDM is able to provide consistent results on the determination of eigenvector (Lacruz et al., 2021) values and can be proven correct by using mathematical algebra matrices, thus giving strong confidence to researchers to be able to continue the author's expectations for all users as a reference in selecting technology-based products in the form of smartphones that are tailored to user needs individually. relevant. The MCDM-AHP is used to determine the amount of weight for a number of criteria supported by expert choice apps (Hamidah et al., 2022) and the MCDM proof can be done with mathematical algebra matrices which will undergo a repetitive process to get the optimal value for the eigenvector (Xu & Wang, 2013). The eigvector value will be implemented and collaborated through different methods such as ELECTRE and PROMETHEE as a way to provide ranking for technology products in the form of smartphones.

Sourced from the instrumentation in the form of questionnaires filled out by the respondents using conventional methods, the determination of the eigenvector values of the criteria used must be completed with the concept of multiplication matrices. The matrices multiplication process that occurs aims to obtain the optimal eigenvector value which is known from the results of repetitions that occur repeatedly, to find no difference between the last eigenvector and the previous eigenvector value, if you still find the difference value of the eigenvector, then repetition must be done continuously to find the optimal eigenvector (Akmaludin et al., 2020). This process takes quite a long time because it is done using the mathematical algebra matrices method. The arrangement of the matrices used is as shown in equation 1 with predetermined rules and to find out how many must be tested in comparison criteria using equation 2. The contents of the respondents to be entered into the

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 2, April 2024
DOI : https://doi.org/10.33395/sinkron.v8i2.13085
e-ISSN : 2541-2019
p-ISSN : 2541-044X

matrices are formed by means of pairs called pairwise matrices. The solution technique is carried out to obtain the eigenvector value in two ways, namely using the expert choice application (Erdogan et al., 2017) and with the mathematical algebra matrices method, with the expert choice application through the input process as usual (Pagliuca & Scarpato, 2014) and can be generated directly to get the optimal eigenvector value , but by means of the methematic algebra matrices you have to through repeated calculations to obtain the optimal eigenvector value and a consistency test must be carried out through the amount of the consistency ratio (CR) which must be less than 10 percent (Zhao & Deng, 2022), this means that a temporary decision can be accepted.

$$M_{(i,j)} = \begin{bmatrix} a_{(1,1)} & a_{(1,2)} & a_{(1,3)} & \cdots & a_{(1,j)} \\ a_{(2,1)} & a_{(2,2)} & a_{(2,3)} & \cdots & a_{(2,j)} \\ a_{(3.1)} & a_{(3,2)} & a_{(2,4)} & \cdots & a_{(3,j)} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{(i,1)} & a_{(i,2)} & a_{(i,3)} & \cdots & a_{(i,j)} \end{bmatrix} \quad (1)$$

Before the CR value is found, in the process of obtaining the consistency (Zhang et al., 2023), you must first look for the consistency vector (CV), which means to determine the length of the vector, which is known as λ max, then determine the consistency index (CI) by including λ max and the number of orders of matrices used, of course. The equation that can be used to find CI is listed in equation 3, while the equation to find CR can be done using equation .

$$CN = \frac{n*(n-1)}{2} \quad (2)$$

$$CI = \frac{(\lambda\ \text{max} - \text{n})}{(n-1)} \quad (3)$$

$$CR = \frac{CI}{RI} \quad (4)$$

The calculation to get the CR value must be supported with the help of a random index that is adjusted to the number of criteria that will be used. The talbe random index can be seen in Table 1 which includes the order-adjusted random index size from both criteria and possible alternatives that can be applied
.

Table 1. Random Index (RI) (Ogonowski, 2022)

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.54	1.56	1.57	1.58

ELECTRE

Elimination Et Choix Traduisant La Realite (ELECTRE) is a ranking method that is influenced by a number of either similar or opposite understanding criteria, the criteria used largely determine the assessment of decision-making support in ranking by ranking the best alternatives. This method is very helpful for decision makers in determining a case that has uncertainty from an action. ELECTRE is used in conditions where alternatives that are not in accordance with the criteria will be eliminated, and suitable alternatives can be continued. The main advantage of the ELECTRE method is that it makes decision makers easier to make decisions out of ambiguity and uncertainty in issues (Akram et al., 2022) such as selecting a smartphone as a technology-based product. There are a number of steps that must be taken to use the ELECTRE method, some of these steps start with determining the weight of each criterion which can be done using the AHP method as a collaborative method with other ranking methods. The first thing to do is to establish data normalization $r_{(i,j)}$ this aims to determine the feasibility of processing data that is ready to be processed with other collaborative methods such as ELECTRE and PROMETHEE. How many equations can be done to complete data normalization by first paying attention to the data. For similar data, it means that all data has the same meaning as the largest one is the best, then the equation that can be used is that seen in equation 5.

$$r_{(i,j)} = \frac{x_{(i,j)}}{\sqrt{\sum_{i=1}^{m} x_{(i,j)}{}^2}}\ where\ \ i = 1,2,3, \dots, m\ and\ j = 1,2,3, \dots, n \quad (5)$$

For the formation of datasets with criteria that have opposite meanings, meaning they are not the same, then determine using different equations, there are those whose meaning is said to be the biggest is the best (HB) as the largest assessment is the best or vice versa the lowest is the best as the smallest assessment is the best (LB). For data conditions like this the normalization process will be used using a different equation from equation 5, with

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 2, April 2024
DOI : https://doi.org/10.33395/sinkron.v8i2.13085
e-ISSN : 2541-2019
p-ISSN : 2541-044X

the following usage, for the category of criteria with the presence of meaningful data the bigest is the best (HB) using equation 6 and for the existence of meaningful data the lowest is the best (LB) can use equation 7.

$$R_{(i,j)} = \frac{(X_{(i,j)} - X'_j)}{(X^*_j - X'_j)} \tag{6}$$

$$R_{(i,j)} = \frac{(X_{(i,j)} - X^*_j)}{(X'_j - X^*_j)} \tag{7}$$

The continuation of the normalization stage is the grouping of concordance and discordance membership. At this stage the aim is to establish a comparison of preferences for data elements in each row compared to each criterion, for data elements with positive values will be grouped into concordance membership, while those with negative values will be grouped into discordance membership. The determination of each data element is a comparison that is used as a two-dimensional matrix. Concordance membership in the formation of element matrices can be obtained by using equation 8 and equation 9 by taking the value of the criteria that the data element has positive value and discordance membership in the formation of element matrices discordance can be obtained by using equation 10 and equation 11 by finding the smallest value that is standardized and compared with the largest concordance value. The results of the concordance and discordance sets are integrated into two-dimensional matrices.

$$C_{(k,l)} = \sum_{j \epsilon C_{(k,l)}} W_j \tag{8}$$

$$C_{(k,l)} = \{j, y_{(k,j)} \geq y_{(i,j)}\}, untuk\ j = 1,2,3, \dots, n \tag{9}$$

$$D_{(k,l)} = \frac{max\{|V_{(k,j)} - V_{(i,j)}|\} j \in D_{(k,l)}}{max\{|V_{(k,j)} - V_{(i,j)}|\} \forall j} \tag{10}$$

$$D_{(\boldsymbol{k},\boldsymbol{l})} = \{j, y_{(k,j)} < y_{(i,j)}\}, untuk\ j = 1,2,3, \dots, n \tag{11}$$

The formation of the concordance and discordance matrices values is adjusted to the preference used as a comparison for each element matrices and in this stage the placement of the matrix elements must be done carefully, because if an error occurs it will cause problems at the elimination process stage. The elimination process is carried out with a size set at the threshold value, where the threshold value will compare all elements of the data matrices, both in the concordance and discordance matrices. To determine the magnitude of the threshold concordance value, you can use equation 12, while to determine the value of the threshold discordance, use equation 13.

$$\underline{C} = \frac{\sum_{k=1}^{n} \sum_{l=1}^{n} C_{(k,l)}}{m*(m-1)} \tag{12}$$

$$\underline{D} = \frac{\sum_{k=1}^{n} \sum_{l=1}^{n} \boldsymbol{D}_{(\boldsymbol{k},\boldsymbol{l})}}{\boldsymbol{m}*(\boldsymbol{m}-\mathbf{1})} \tag{13}$$

With the findings of both concordance and discordance matrices, of course the threshold process will produce matrices whose data elements only contain binary numbers consisting of 0 and 1, where the two matrices are the result of concordance and discordance elimination processes. Towards the end of the selection by multiplying both concordance and discordance eliminations which will form aggregate dominant matrices. To find data elements from aggregate dominant matrices using equation 14

.

$$e_{(k,l)} = f_{(k,l)} * g_{(k.l)} \tag{14}$$

PROMETHEE

The Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) method is an efficient decision-making support method by eliminating separate data elements called PROMETHEE I with the name leaving flow and this can be a decision that is not yet complete as a final decision because it sees an element incoming data and outgoing data elements and can be combined into a feasible decision and stand alone into one whole as a fulfilled decision is called PROMETHEE II . The PROMETHEE method will be used as a comparison in the process of selecting technology products in the form of smartphones. There are several equations in common with the ELECRE method, especially in preferences, but differ in the process of determining the ranking process. Because PROMETHEE applies the concepts of leaving flow, entering flow, and net flow for the ranking process. Several equations that can be used as a solution to the PROMETHEE method that can be applied (da Cunha et al.,

*name of corresponding author

2022). At the stage of the process of determining the weight of the criteria, it remains the same using the eigenvector value using AHP. The process for obtaining normalization is the same as in the ELECTRE method, because the results of normalization will be used as a basis for comparison with the ELECTRE and PROMETHEE methods (Corrente et al., 2013), the difference is clearly seen in the decision making process with ranking determination. To determine the equation for the leaving flow, use equation 15, while to find the equation for obtaining the entering flow, you can use equation 16, these two equations are known as PROMETHEE I (Lopes et al., 2018), where the resulting decisions are still in separate conditions, so combining them can be continued with PROMETHEE. II (Palczewski & Sałabun, 2019), so that a unanimous decision can be made into a decision, this process can use equation 17.

$$\varphi^{+}(i) = \frac{1}{(n-1)} \sum_{i=1}^{n} \pi(i,i),\ \ n = the\ number\ of\ alternative \qquad (15)$$

$$\varphi^{-}(i) = \frac{1}{(n-1)} \sum_{i=1}^{n} \pi(i,i),\ \ n = the\ number\ of\ alternative \qquad (16)$$

$$\Phi(i) = \varphi^{+} - \varphi^{-}(i) \qquad (17)$$

METHOD

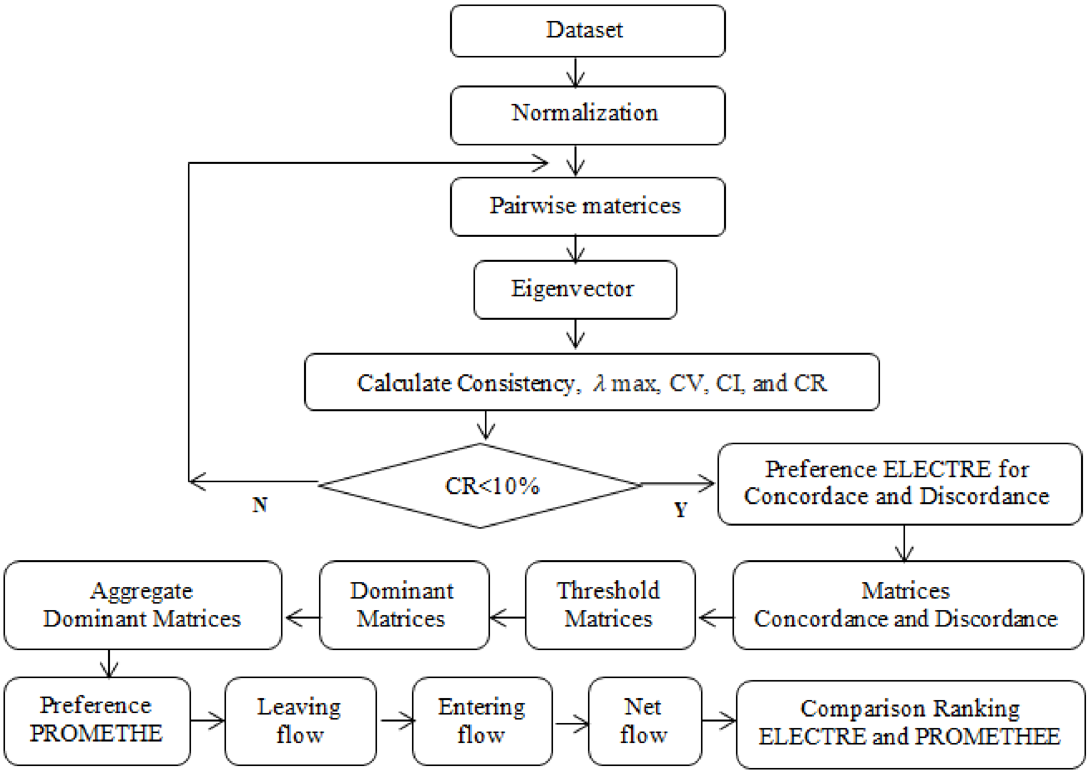

Fig. 1. AHP, ELECTRE, and PROMETHEE Algoritm

RESULT

Starting from the data collection process that has been carried out on technology-based products in the form of smartphones sourced from GSM Arena which provides many offers to consumers in various brands and specifications with many criteria providing an overview that automatically makes it difficult for each user to select the right product. for private use. To provide the best solution, this research can be a reference for providing implementation of product selection in the form of a smartphone. As a processed material that will be an example in the discussion of this study consists of eight Smartphone product names which will be processed using the Analytic Hierarchy Process (AHP) method as a determination of the amount of weight based on the eigenvector value on each criterion used as a barometer for selecting smartphone products. The criteria used as a barometer are Operating System, Processor, RAM, ROM, Back Camera, Front Camera, Battery, Casing, Screen, Weight, and Price. All of this data will be set forth in a collection of smartphone specifications listed in Table 2.

Table 2. Spesification of SmartPhone

*name of corresponding author

SinkrOn
JURNAL & PENELITIAN TEKNIK INFORMATIKA
Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 2, April 2024
DOI : https://doi.org/10.33395/sinkron.v8i2.13085
e-ISSN : 2541-2019
p-ISSN : 2541-044X

Nama SmartPhone	Operating System	Processor	RAM (Gyga Byte)	ROM (Gyga Byte)	Back Camera (Mega Pixcel)	Front Camera (Mega Pixcel)	Baterray	Cassing Model	Screen Size	Weight (gram)	Price (Rp)
Samsung Galaxy A3	V5.1.1 (Lollipop)	Quad-core 1.5 GHz Cotex-A53	1.5	16	13	5	2300	256	4.7	132	2.699
Samsung Galaxy J7 Prime	V6.0.1 (Marshmallow)	Octo-core 1.6 GHz Cotex-A53	3	32	13	8	3300	256	5.5	167	3.329
Xiaomi Mi 4C	V5.1.1 (Lollipop)	Hexa-core 4x1.4 GHz Cortex-A53 2x1.8 GHz Cortex-A72	2	16	13	5	3080	0	5	132	1.439
Xiaomi Mi Max	V6.0 (Marshmallow)	Hexa-core Ax1.4 GHz Cortex-A53 2x1.8 GHz Cortex-A72	3	32	16	5	4850	256	6.44	203	2.557
Asus Zenfone Max ZC550KL	V5.0.1 (Lollipop)	Quad-Core 1.2 GHz Cortex-A53	2	32	13	5	5000	64	5.5	202	1.999
Asus Zenfone 2 ZE551ML	V5.0 (Lollipop)	Quad-Core 2.3 GHz	4	32	13	5	3000	256	5.5	170	3.399
Lenovo Vibe K5 Plus	V5.0.1 (Lollipop)	Octa-core 4x1.5 GHz Cortex-A53 4x1.2 GHz Cortex-A53	2	16	13	5	2750	32	5	5	2.299
Lenovo Vibe Shot	V5.0.2 (Lollipop)	Octa-core 4x1.7 GHz Cortex-A53 4x1 GHz Cortex-A53	3	32	16	8	3000	256	5	5	3.28

Source: GSM Arena (2022)

The results from Table 2 can be converted into a dataset as a unified data that is ready to be obtained using the AHP method and will be collaborated with the ELECTRE and PROMETHEE methods and the results will be a comparison of the two ELECTRE and PROMETHEE methods with their ranking system (da Cunha et al., 2022). As for the dataset as a result of the conversion of the initial data, it will be formed as shown in Table 3. The type criteria used for selecting Smartphones appear to have opposite meanings, for the type criteria that need to be considered are the type criteria seen there are two kinds, namely the first type criteria that has the meaning of the assessment of the data is said to be the bigest is the best (HB), which means that the highest value is the value that is the first seed, while the second type of criterion means the lowest is the best (LB), meaning the smallest value is the first seed. So that under these conditions the normalization process does not apply equation 5.

Table 3. Dataset view

Name of SmartPhone	Operating System (HB)	Processor (HB)	RAM (GByte) (HB)	ROM (GByte) (HB)	Back Camera (Mega Pixcel) (HB)	Front Camera (Mega Pixcel) (HB)	Baterray (HB)	Cassing Model (HB)	Screen Size (Inch) (HB)	Weight (gram) (LB)	Price (Rp) (LB)
Samsung Galaxy A3	5.11	6	1.5	16	13	5	2300	256	4.7	132	2.699
Samsung Galaxy J7 Prime	6.01	12.8	3	32	13	8	3300	256	5.5	167	3.329
Xiaomi Mi 4C	5.11	9.2	2	16	13	5	3080	0	5	132	1.439
Xiaomi Mi Max	6	9.2	3	32	16	5	4850	256	6.44	203	2.557
Asus Zenfone Max ZC550KL	5.01	4.8	2	32	13	5	5000	64	5.5	202	1.999
Asus Zenfone 2 ZE551ML	5	9.2	4	32	13	5	3000	256	5.5	170	3.399
Lenovo Vibe K5 Plus	5.01	10.8	2	16	13	5	2750	32	5	5	2.299
Lenovo Vibe Shot	5.02	10.8	3	32	16	8	3000	256	5	5	3.28

The next process is the data set in Table 3 as a reference for data that has multi-criteria, of course it must be equalized first through the normalization stage. This normalization process pays attention to the type of each criterion used, so equation 5 cannot be applied to a data model like this, but what can be used for the HB data type uses equation 6 and for the LB data type uses equation 7, thus the normalized data can be seen in Table 5.

Table 5. Normalization

Name of SmartPhone	Operating System (HB)	Processor (HB)	RAM (GByte) (HB)	ROM (GByte) (HB)	Back Camera (Mega Pixcel) (HB)	Front Camera (Mega Pixcel) (HB)	Baterray (HB)	Cassing Model (HB)	Screen Size (Inci) (HB)	Weight (gram) (LB)	Price (Rp.) (LB)
Samsung Galaxy A3	0.109	0.150	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.359	0.357
Samsung Galaxy J7 Prime	1.000	1.000	0.600	1.000	0.000	1.000	0.370	1.000	0.460	0.182	0.036
Xiaomi Mi 4C	0.109	0.550	0.200	0.000	0.000	0.000	0.289	0.000	0.172	0.359	1.000
Xiaomi Mi Max	0.990	0.550	0.600	1.000	1.000	0.000	0.944	1.000	1.000	0.000	0.430
Asus Zenfone Max ZC550KL	0.010	0.000	0.200	1.000	0.000	0.000	1.000	0.250	0.460	0.005	0.714
Asus Zenfone 2 ZE551ML	0.000	0.550	1.000	1.000	0.000	0.000	0.259	1.000	0.460	0.167	0.000
Lenovo Vibe K5 Plus	0.010	0.750	0.200	0.000	0.000	0.000	0.167	0.125	0.172	1.000	0.561

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 2, April 2024
DOI : https://doi.org/10.33395/sinkron.v8i2.13085
e-ISSN : 2541-2019
p-ISSN : 2541-044X

Lenovo Vibe Shot	0.020	0.750	0.600	1.000	1.000	1.000	0.259	1.000	0.172	1.000	0.061

The normalization results shown in Table 5 mean that the data already has a standard of readiness for processing. As a benchmark the data must first determine the weight of the criteria used as a barometer of assessment, the barometer of judgment used against the criteria using AHP obtained from the input of a number of respondents using the convenient sampling method in stages. The results of processing the questionnaire data will be formed into pairwise matrices as shown in Table 6 in the form of two-dimensional matrices. The layout of the data elements in a matrix is arranged according to equation 1

.

Table 6. Pairwise matrices of criteria using mathematic algebra matrices

Criteria	OS	PC	IM	EM	BC	FC	BT	CM	SS	WE	PR	Eigenvector
Operating System (OS)	1.000	2.125	2.352	2.735	2.372	3.223	3.121	4.105	3.034	2.422	2.371	0.193
Processor (PC)	0.471	1.000	2.063	2.362	2.436	2.347	3.034	3.142	3.268	2.046	2.042	0.153
Internal Memory (IM)	0.425	0.485	1.000	2.042	2.302	2.435	2.554	2.563	2.945	3.032	2.047	0.128
External Memory (EM)	0.366	0.423	0.490	1.000	2.034	2.153	2.237	2.225	3.035	3.023	3.214	0.109
Back Camera (BC)	0.422	0.411	0.434	0.492	1.000	2.342	2.326	2.043	3.055	3.026	2.425	0.095
Front Camera (FC)	0.310	0.426	0.411	0.464	0.427	1.000	2.045	2.138	3.042	2.162	2.133	0.075
Baterray (BT)	0.320	0.330	0.392	0.447	0.430	0.489	1.000	3.033	2.136	2.034	3.201	0.067
Chassing Model (CM)	0.244	0.318	0.390	0.449	0.489	0.468	0.330	1.000	2.302	2.022	2.043	0.051
Screen Size (SS)	0.330	0.306	0.340	0.329	0.327	0.329	0.468	0.434	1.000	3.163	3.115	0.049
Weight (WG)	0.413	0.489	0.330	0.331	0.330	0.463	0.492	0.495	0.316	1.000	3.052	0.043
Price (PR)	0.422	0.490	0.489	0.311	0.412	0.469	0.312	0.489	0.321	0.328	1.000	0.036
The Result of λ Max =	12.162	; CI =	0.116	; CR =	0.077							

Based on the findings of the eigenvector resulting from the iteration of the pairwise matrices multiplication that occurred five times, it has given optimal results for the acquisition of the eigenvector value. The eigenvector proof is very complicated and very long, if it is not thorough it will give erratic results, so that is the uniqueness of this very different AHP method. The optimal eigenvector is a condition where there is no difference between the last eigenvector value and the previous eigenvector value, note Table 7 which is the final result of the eigenvector value without difference. This means that the eigenvector value is said to be optimal and can be used as support for decision making, so that this eigenvector value can be applied for collaboration between methods as will be applied in this study. The collaboration method that will be used is the Analytic Hierarchy Process (AHP) with the collaboration of the ELECTRE and PROMETHEE methods which will be compared between the two as support for decision making on the priority produced for technology products in the form of smartphones which are the object of research in this paper.

Proof of the eigenvector values must be tested further by using the mathematical algebra matrices by knowing the resulting consistency starting from knowing the number of comparisons that must be made, namely by using equation 2, knowing the length of the vector (λ max) which will produce a consistency index (CI) value, namely the listed in equation 3, so that in the end it will find the feasibility of decision support by finding the value of the consistency ratio (CR), namely by using equation 4 as a benchmark for accepting or rejecting a decision support. The size determined by Thomas L. Saaty is that the CR value must be less than or equal to 10 percent, if it is more than this value then decision support is not accepted, so one has to re-check the entries of a number of data elements in pairwise matrices. It is possible that there are still errors in the input of a number of respondents in the expected comparative assessment of the criteria

.

Tabel 7. Eigenvector difference

Criteria	Number of rows in the fourth iteration	EV	Eigenvector Difference
Operating System (OS)	1489279864807210000000000000000000.000	0.192	0.000000000060502658438821300
Processor (PC)	1182238367597260000000000000000000.000	0.153	0.000000000046468329184534700
Internal Memory (IM)	991628426392720000000000000000000.000	0.128	0.000000000021846191522456600
External Memory (EM)	839967923137697000000000000000000.000	0.108	0.000000000004825723154411320
Back Camera (BC)	733106054424947000000000000000000.000	0.094	0.000000000013177778313000500
Front Camera (FC)	578959739218411000000000000000000.000	0.074	0.000000000019586873789556600
Baterray (BT)	521013270176583000000000000000000.000	0.067	0.000000000026347826698192000
Chassing Model (CM)	396441707708873000000000000000000.000	0.051	0.000000000023213791999765500
Screen Size (SS)	379776465703165000000000000000000.000	0.049	0.000000000036171184103484000
Weight (WG)	334307290640492000000000000000000.000	0.043	0.000000000012324329057289400
Price (PR)	279052148582422000000000000000000.000	0.036	0.000000000006830438992189160
Total	7725771258389780000000000000000000.000	1.000	

Criteria	Number of rows in the fifth iteration	EV	Eigenvector Difference
Operating System (OS)	782555993865984000000000000000000000000000000000000000000000000000.000	0.192	0.000000000000000000000000000
Processor (PC)	621218175712955000000000000000000000000000000000000000000000000000.000	0.153	0.000000000000000000000000000
Internal Memory (IM)	521060404494202000000000000000000000000000000000000000000000000000.000	0.128	0.000000000000000000000000000
External Memory (EM)	441368978685318000000000000000000000000000000000000000000000000000.000	0.108	0.000000000000000000000000000
Back Camera (BC)	385217413185097000000000000000000000000000000000000000000000000000.000	0.094	0.000000000000000000000000000
Front Camera (FC)	304219794303809000000000000000000000000000000000000000000000000000.000	0.074	0.000000000000000000000000000

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 2, April 2024
DOI : https://doi.org/10.33395/sinkron.v8i2.13085
e-ISSN : 2541-2019
p-ISSN : 2541-044X

Baterray (BT)	27377128174171700000000000000000000000000000000000000000000000000.000	0.067	0.000000000000000000000000000
Chassing Model (CM)	20831399249878700000000000000000000000000000000000000000000000000.000	0.051	0.000000000000000000000000000
Screen Size (SS)	19955708566819500000000000000000000000000000000000000000000000000.000	0.049	0.000000000000000000000000000
Weight (WG)	17566488358968100000000000000000000000000000000000000000000000000.000	0.043	0.000000000000000000000000000
Price (PR)	14663055389030200000000000000000000000000000000000000000000000000.000	0.036	0.000000000000000000000000000
Total	772577125838978000000000000000000000.000	1.000	

The results of proving the feasibility of the results of the eigenvector values with the mathematic algebra matrices method can be proven by multiplying the initial matrix initialization with the optimal eigenvector value. If the results obtained for the acquisition of a consistency ratio (CR) are less than 10 percent, then decision support can be accepted and continued to the next stage, pay attention to Table 8 which proves the validity of this study.

Table 8. Proof of Consistency (CI and CR)

1.000	2.125	2.352	2.735	2.372	3.223	3.121	4.105	3.034	2.422	2.371		0.193		2.345
0.471	1.000	2.063	2.362	2.436	2.347	3.034	3.142	3.268	2.046	2.042		0.153		1.861
0.425	0.485	1.000	2.042	2.302	2.435	2.554	2.563	2.945	3.032	2.047		0.128		1.561
0.366	0.423	0.490	1.000	2.034	2.153	2.237	2.225	3.035	3.023	3.214		0.109		1.322
0.422	0.411	0.434	0.492	1.000	2.342	2.326	2.043	3.055	3.026	2.425		0.095		1.154
0.310	0.426	0.411	0.464	0.427	1.000	2.045	2.138	3.042	2.162	2.133	x	0.075	=	0.911
0.320	0.330	0.392	0.447	0.430	0.489	1.000	3.033	2.136	2.034	3.201		0.067		0.820
0.244	0.318	0.390	0.449	0.489	0.468	0.330	1.000	2.302	2.022	2.043		0.051		0.624
0.330	0.306	0.340	0.329	0.327	0.329	0.468	0.434	1.000	3.163	3.115		0.049		0.598
0.413	0.489	0.330	0.331	0.330	0.463	0.492	0.495	0.316	1.000	3.052		0.043		0.526
0.422	0.490	0.489	0.311	0.412	0.469	0.312	0.489	0.321	0.328	1.000		0.036		0.439

λ max =	12.162
Consistency Index=	0.116
Consistency Ratio=	0.077

Verifying the correctness of the consistency ratio (CR) value can be done by using an application called expert choice apps, this application can be used to prove the similarity of the results obtained through mathematical algebra matrices for the acquisition of eigenvector values and the advantages of expert choice apps can determine the amount of inconsistency of the results obtained from processing element data pairwise matrices as shown in Table 6. Observe Figure 2 and Figure 3 which explain the results of the synthesis of eigenvector quantities.

Compare the relative importance with respect to: Goal: Comparison Smartphone Technology Using AHP, ELECTRE and PROMETHEE Methods

	Operating System	Processor	RAM	ROM	Back Camera	Front Camera	Baterray	Cassing Model	Screen Size	Weight	Price
Operating System		2.125	2.352	2.735	2.372	3.223	3.121	4.105	3.034	2.422	2.371
Processor			2.063	2.362	2.436	2.347	3.034	3.142	3.268	2.046	2.042
RAM				2.042	2.302	2.435	2.554	2.563	2.945	3.032	2.047
ROM					2.034	2.153	2.237	2.225	3.035	3.023	3.214
Back Camera						2.342	2.326	2.043	3.055	3.026	2.425
Front Camera							2.045	2.138	3.042	2.162	2.133
Baterray								3.033	2.136	2.034	3.201
Cassing Model									2.302	2.022	2.043
Screen Size										3.163	3.115
Weight											3.052
Price	Incon: 0.08										

Figure 2. Pairwise matrices entry from Expert choice apps

As seen in Figure 2, which are pairwise matrices, will be processed using expert choice apps to the synthesis stage shown in Figure 3. The calculation process that is carried out must have been designed and coded for the way the application works in order to find results in the form of eigenvectors and inconsistency values, look at Figure 3 and the results will be compared with the results obtained using the mathematical algebra matrices method. The truth of the real results is to describe the results that are identical to the criterion eigenvector value of the two methods.

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 2, April 2024
DOI : https://doi.org/10.33395/sinkron.v8i2.13085
e-ISSN : 2541-2019
p-ISSN : 2541-044X

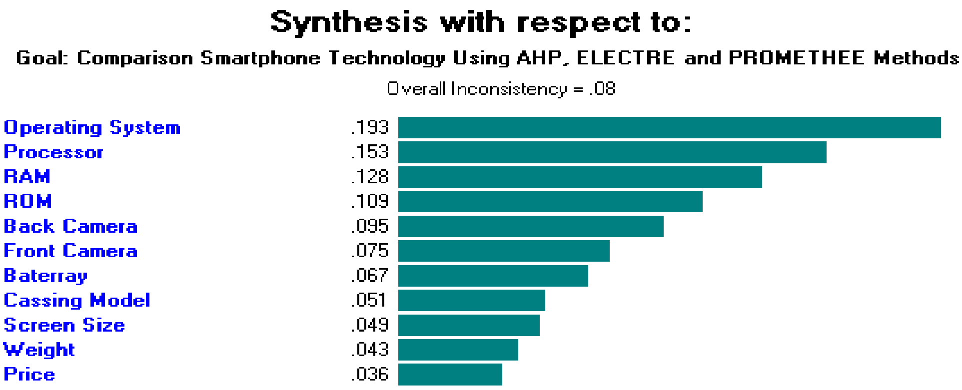

Figure 3. Synthesis of eigenvector from Expert choice apps

The magnitude of the eigenvector which has been known through the long and complicated stages as shown previously, provides an open space to continue research by creating collaboration and comparison of the results of the ELECTRE and PROMETHEE methods in determining the ranking of technological products in the form of smartphones. The ELECTRE method in this study will be used to provide a ranking system with the concept of elimination through preference for all alternatives through comparison with one another. Of all the alternatives being compared, they will be shown in Table 9 as a benchmark for evaluating the two ELECTRE and PROMETHEE methods..

The preference made is to compare all alternatives to the eleven criteria that are used as a determining barometer for selecting technology products in the form of smartphones, as shown in Table 6 which was obtained using mathematical algebra matrices and Figure 3 which was obtained through expert choice apps. The Preference Table listed in Table 9 will be used as a reference for calculations using different methods as a way to determine the top ranking for technology products in the form of smartphones. The preference results obtained using the ELECTRE method will be grouped into two parts in the form of matrices called concordance and discordance matrices and then the matrices will be processed into aggregate dominant matrices for ranking determination. The second stage of obtaining preference results will be processed using the PROMETHEE method in the form of two-dimensional matrices to produce two groups called Leaving flow and Entering flow which produce separate decisions, then integrated with Net flow to be used as a ranking system to be used as support for decision making.

The preferences listed in Table 9 are the branching stage of the calculation which will be carried out using the ELECTRE and PROMETHEE methods and will be compared with the ranking systems of the two methods. To further clarify the structured use of preferences for a number of alternatives with eleven criteria as the barometer, consider Table 9 below.

Table 9. Preference

Preference	OS	Processor	RAM	ROM	Back Camera	Front Camera	Baterray	Cassing Model	Screen Size	Weight	Price
Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
Eigenvector	0.193	0.153	0.128	0.109	0.095	0.075	0.067	0.051	0.049	0.043	0.036
P(1,2)	-0.172	-0.130	-0.077	-0.109	0.000	-0.075	-0.025	0.000	-0.023	0.008	0.012
P(1,3)	0.000	-0.061	-0.026	0.000	0.000	0.000	-0.019	0.051	-0.008	0.000	-0.023
P(1,4)	-0.170	-0.061	-0.077	-0.109	-0.095	0.000	-0.064	0.000	-0.049	0.016	-0.003
P(1,5)	0.019	0.023	-0.026	-0.109	0.000	0.000	-0.067	0.038	-0.023	0.015	-0.013
P(1,6)	0.021	-0.061	-0.128	-0.109	0.000	0.000	-0.017	0.000	-0.023	0.008	0.013
P(1,7)	0.019	-0.092	-0.026	0.000	0.000	0.000	-0.011	0.045	-0.008	-0.028	-0.007
P(1,8)	0.017	-0.092	-0.077	-0.109	-0.095	-0.075	-0.017	0.000	-0.008	-0.028	0.011
P(2,1)	0.172	0.130	0.077	0.109	0.000	0.075	0.025	0.000	0.023	-0.008	-0.012
P(2,3)	0.172	0.069	0.051	0.109	0.000	0.075	0.005	0.051	0.014	-0.008	-0.035
P(2,4)	0.002	0.069	0.000	0.000	-0.095	0.075	-0.039	0.000	-0.027	0.008	-0.014
P(2,5)	0.191	0.153	0.051	0.000	0.000	0.075	-0.042	0.038	0.000	0.008	-0.025
P(2,6)	0.193	0.069	-0.051	0.000	0.000	0.075	0.007	0.000	0.000	0.001	0.001
P(2,7)	0.191	0.038	0.051	0.109	0.000	0.075	0.014	0.045	0.014	-0.035	-0.019

*name of corresponding author

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 2, April 2024
DOI : https://doi.org/10.33395/sinkron.v8i2.13085
e-ISSN : 2541-2019
p-ISSN : 2541-044X

P(2,8)	0.189	0.038	0.000	0.000	-0.095	0.000	0.007	0.000	0.014	-0.035	-0.001
P(3,1)	0.000	0.061	0.026	0.000	0.000	0.000	0.019	-0.051	0.008	0.000	0.023
P(3,2)	-0.172	-0.069	-0.051	-0.109	0.000	-0.075	-0.005	-0.051	-0.014	0.008	0.035
P(3,4)	-0.170	0.000	-0.051	-0.109	-0.095	0.000	-0.044	-0.051	-0.041	0.016	0.021
P(3,5)	0.019	0.084	0.000	-0.109	0.000	0.000	-0.048	-0.013	-0.014	0.015	0.010
P(3,6)	0.021	0.000	-0.103	-0.109	0.000	0.000	0.002	-0.051	-0.014	0.008	0.036
P(3,7)	0.019	-0.031	0.000	0.000	0.000	0.000	0.008	-0.006	0.000	-0.028	0.016
P(3,8)	0.017	-0.031	-0.051	-0.109	-0.095	-0.075	0.002	-0.051	0.000	-0.028	0.034
P(4,1)	0.170	0.061	0.077	0.109	0.095	0.000	0.064	0.000	0.049	-0.016	0.003
P(4,2)	-0.002	-0.069	0.000	0.000	0.095	-0.075	0.039	0.000	0.027	-0.008	0.014
P(4,3)	0.170	0.000	0.051	0.109	0.095	0.000	0.044	0.051	0.041	-0.016	-0.021
P(4,5)	0.189	0.084	0.051	0.000	0.095	0.000	-0.004	0.038	0.027	0.000	-0.010
P(4,6)	0.191	0.000	-0.051	0.000	0.095	0.000	0.046	0.000	0.027	-0.007	0.016
P(4,7)	0.189	-0.031	0.051	0.109	0.095	0.000	0.052	0.045	0.041	-0.043	-0.005
P(4,8)	0.187	-0.031	0.000	0.000	0.000	-0.075	0.046	0.000	0.041	-0.043	0.013
P(5,1)	-0.019	-0.023	0.026	0.109	0.000	0.000	0.067	-0.038	0.023	-0.015	0.013
P(5,2)	-0.191	-0.153	-0.051	0.000	0.000	-0.075	0.042	-0.038	0.000	-0.008	0.025
P(5,3)	-0.019	-0.084	0.000	0.109	0.000	0.000	0.048	0.013	0.014	-0.015	-0.010
P(5,4)	-0.189	-0.084	-0.051	0.000	-0.095	0.000	0.004	-0.038	-0.027	0.000	0.010
P(5,6)	0.002	-0.084	-0.103	0.000	0.000	0.000	0.050	-0.038	0.000	-0.007	0.026
P(5,7)	0.000	-0.115	0.000	0.109	0.000	0.000	0.056	0.006	0.014	-0.043	0.006
P(5,8)	-0.002	-0.115	-0.051	0.000	-0.095	-0.075	0.050	-0.038	0.014	-0.043	0.024
P(6,1)	-0.021	0.061	0.128	0.109	0.000	0.000	0.017	0.000	0.023	-0.008	-0.013
P(6,2)	-0.193	-0.069	0.051	0.000	0.000	-0.075	-0.007	0.000	0.000	-0.001	-0.001
P(6,3)	-0.021	0.000	0.103	0.109	0.000	0.000	-0.002	0.051	0.014	-0.008	-0.036
P(6,4)	-0.191	0.000	0.051	0.000	-0.095	0.000	-0.046	0.000	-0.027	0.007	-0.016
P(6,5)	-0.002	0.084	0.103	0.000	0.000	0.000	-0.050	0.038	0.000	0.007	-0.026
P(6,7)	-0.002	-0.031	0.103	0.109	0.000	0.000	0.006	0.045	0.014	-0.036	-0.020
P(6,8)	-0.004	-0.031	0.051	0.000	-0.095	-0.075	0.000	0.000	0.014	-0.036	-0.002
P(7,1)	-0.019	0.092	0.026	0.000	0.000	0.000	0.011	-0.045	0.008	0.028	0.007
P(7,2)	-0.191	-0.038	-0.051	-0.109	0.000	-0.075	-0.014	-0.045	-0.014	0.035	0.019
P(7,3)	-0.019	0.031	0.000	0.000	0.000	0.000	-0.008	0.006	0.000	0.028	-0.016
P(7,4)	-0.189	0.031	-0.051	-0.109	-0.095	0.000	-0.052	-0.045	-0.041	0.043	0.005
P(7,5)	0.000	0.115	0.000	-0.109	0.000	0.000	-0.056	-0.006	-0.014	0.043	-0.006
P(7,6)	0.002	0.031	-0.103	-0.109	0.000	0.000	-0.006	-0.045	-0.014	0.036	0.020
P(7,8)	-0.002	0.000	-0.051	-0.109	-0.095	-0.075	-0.006	-0.045	0.000	0.000	0.018
P(8,1)	-0.017	0.092	0.077	0.109	0.095	0.075	0.017	0.000	0.008	0.028	-0.011
P(8,2)	-0.189	-0.038	0.000	0.000	0.095	0.000	-0.007	0.000	-0.014	0.035	0.001
P(8,3)	-0.017	0.031	0.051	0.109	0.095	0.075	-0.002	0.051	0.000	0.028	-0.034
P(8,4)	-0.187	0.031	0.000	0.000	0.000	0.075	-0.046	0.000	-0.041	0.043	-0.013
P(8,5)	0.002	0.115	0.051	0.000	0.095	0.075	-0.050	0.038	-0.014	0.043	-0.024
P(8,6)	0.004	0.031	-0.051	0.000	0.095	0.075	0.000	0.000	-0.014	0.036	0.002
P(8,7)	0.002	0.000	0.051	0.109	0.095	0.075	0.006	0.045	0.000	0.000	-0.018

*name of corresponding author

SinkrOn
JURNAL & PENELITIAN TEKNIK INFORMATIKA
Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 8, Number 2, April 2024 e-ISSN : 2541-2019
DOI : https://doi.org/10.33395/sinkron.v8i2.13085 p-ISSN : 2541-044X

Pay attention to Table 9 which is used as a preference which consists of eleven criteria and has been completed with the eigenvector values obtained from the AHP method which will be used as a calculation for the ELECTRE and PROMETHEE methods which will be compared to the priority results of the two ranking methods as a comparison to the product selection and evaluation process technology such as smartphones.

The first stage of the ranking elimination method that will be carried out is the ELECTRE method. The preference table will be grouped into two matrices, namely concordance and discordance matrices. To produce concordance matrices, it can be done by using equation 8 and equation 9. Note the first row of Table 9. Preference values that are greater than or equal to zero will be entered into the concordance group which is summed, namely in the criteria group {5,8,10, and 11} with a total value of 0.226; as the first concordance matrices data element and so on in the same way. The results obtained from the two equations can be seen in Table 10.

Table 10. Concordance matrices

Alt	Name of SmartPhone	A1	A2	A3	A4	A5	A6	A7	A8
A1	Samsung Galaxy A3	0.000	0.226	0.566	0.170	0.610	0.493	0.523	0.280
A2	Samsung Galaxy J7 Prime	0.921	0.000	0.921	0.752	0.896	0.872	0.921	0.826
A3	Xiaomi Mi 4C	0.949	0.174	0.000	0.307	0.723	0.662	0.752	0.345
A4	Xiaomi Mi Max	0.957	0.536	0.921	0.000	0.853	0.828	0.768	0.729
A5	Asus Zenfone Max ZC550KL	0.560	0.356	0.575	0.330	0.000	0.624	0.804	0.261
A6	Asus Zenfone 2 ZE551ML	0.728	0.432	0.660	0.560	0.704	0.000	0.575	0.405
A7	Lenovo Vibe K5 Plus	0.756	0.174	0.704	0.307	0.687	0.595	0.000	0.282
A8	Lenovo Vibe Shot	0.771	0.538	0.704	0.655	0.847	0.822	0.964	0.000

By paying attention to Table 10 on the concordance matrices, there are eight alternative results obtained from preference Table 9 to proceed with the process of determining the magnitude of the threshold value which can be found using equation 12. Threshold is a reference for the elimination process for element data matrices. The resulting threshold value is 0.620, which means that the element matrix value that is smaller than the threshold value will be computationally eliminated to be 0 and a value that is greater than the threshold will be 1 and only recognize a number such as a binary number.

The next step is to determine the group of discordance numbers originating from Table 9 Preference which can be done using equation 10 and equation 11. As a filtering process for the group of discordance matrices by finding the minimum absolute value and dividing it by the largest value of the data element in that row. Pay attention to the first row of Table 9 Preferences, the discordance group namely {1,2,3,4,6,7, and 9} the smallest value to be absolute is -0.172 ; then divided by the largest value of the first row, which is 0.012, so the result is 14,795 and continue with the same steps. The results of the formation of the discordance matrices can be seen in Table 11.

Table 11. Discordance matrices

Alt	Name of SmartPhone	A1	A2	A3	A4	A5	A6	A7	A8
A1	Samsung Galaxy A3	0.000	14.795	1.193	10.947	2.825	6.114	2.045	6.329
A2	Samsung Galaxy J7 Prime	0.068	0.000	0.203	1.266	0.222	0.266	0.185	0.502
A3	Xiaomi Mi 4C	0.838	4.932	0.000	8.245	1.292	3.010	1.604	3.205
A4	Xiaomi Mi Max	0.091	0.790	0.121	0.000	0.054	0.269	0.229	0.401
A5	Asus Zenfone Max ZC550KL	0.354	4.495	0.774	18.375	0.000	2.056	1.056	2.297
A6	Asus Zenfone 2 ZE551ML	0.164	3.755	0.332	3.717	0.486	0.000	0.332	1.848
A7	Lenovo Vibe K5 Plus	0.489	5.391	0.624	4.367	0.947	3.015	0.000	6.014
A8	Lenovo Vibe Shot	0.158	1.991	0.312	2.496	0.435	0.541	0.166	0.000

Paying attention to Table 11 Discordance matrices, the process of determining the threshold value of the discordance matrices will be carried out by using equation 13. This stage is to carry out the elimination process for the element concordance matrices which are assigned to the binary concept through computation, element matrices that are more than the threshold magnitude will be given a value of 1 and conversely those that are less than the threshold quantity will be given 0. The results obtained can be seen in Table 12. The results of the process of threshold concordance matrices and discordance matrices are called dominant matrices. The names of the results of the two tables are called concordance dominant matrices and discordance dominant matrices, where the contents of the two matrices are the result of a computation that only contains binary numbers zero and one. The end of the ELECTRE method is to multiply the two dominant matrices to find out the ranking resulting from this long process stage, of course by using equation 14. The final result can be seen in Table 13 which is called the aggregate dominant matrix. The highest score is recognized as the first rank and the smallest result is recognized as the last rank in the priority selection process for technology products in the form of Smartphones.

Table 13. Aggregate dominant matrices

Alt	**Name of SmartPhone**	A1	A2	A3	A4	A5	A6	A7	A8	Total	Priority
A1	Samsung Galaxy A3	0	0	0	0	0	0	0	0	0	No

*name of corresponding author

A2	Samsung Galaxy J7 Prime	0	0	0	0	0	0	0	0	0	No
A3	Xiaomi Mi 4C	0	0	0	0	0	1	0	0	1	**Yes**
A4	Xiaomi Mi Max	0	0	0	0	0	0	0	0	0	No
A5	Asus Zenfone Max ZC550KL	0	0	0	0	0	0	0	0	0	No
A6	Asus Zenfone 2 ZE551ML	0	0	0	0	0	0	0	0	0	No
A7	Lenovo Vibe K5 Plus	0	0	0	0	0	0	0	0	0	No
A8	Lenovo Vibe Shot	0	0	0	1	0	0	0	0	1	**Yes**

Look at Table 13 of the aggregate dominant matrices, in the last column on the right there is priority which explains that there is a value of 0 and a value of 1, where the total number of alternative Smartphone products from A1 to A8 which has a priority value of 1 is only owned by A3 and A8. This means that these two smartphone products can be accepted as the best smartphone products.

After successfully determining the priority of technology products in the form of smartphones using the ELECTRE method, the second stage is determining priorities using the PROMETHEE method. This process has the same source from Table 9 Preferences. The formation of matrices resulting from preferences is by multiplying the elements in the first row with each of the eigenvector quantities that have been determined through the AHP method. Data elements that come out are called leaving flow and conversely elements that enter are called entering flows. The results are obtained by observing Table 14. To calculate the leaving flow value using equation 15 and to calculate the entering flow value using equation 16.

Table 14. Leaving dan entering flow

Alt	A1	A2	A3	A4	A5	A6	A7	A8	Leaving Flow
A1	0.000	0.001	0.003	0.001	0.010	0.005	0.006	0.004	0.028
A2	0.083	0.000	0.071	0.017	0.075	0.054	0.071	0.043	0.414
A3	0.015	0.002	0.000	0.000	0.018	0.005	0.006	0.004	0.050
A4	0.080	0.013	0.068	0.000	0.068	0.051	0.072	0.042	0.393
A5	0.018	0.002	0.014	0.000	0.000	0.003	0.014	0.003	0.054
A6	0.040	0.007	0.028	0.007	0.028	0.000	0.028	0.007	0.146
A7	0.020	0.002	0.006	0.007	0.019	0.007	0.000	0.001	0.063
A8	0.053	0.011	0.042	0.012	0.043	0.022	0.036	0.000	0.218
Entering Flow	0.309	0.037	0.232	0.044	0.261	0.147	0.233	0.104	

Look at Table 14 which describes the gains for PROMETHEE-I where each decision is conditioned to be separate, with the alternative resulting from the highest value leaving flow being A2, while the alternative resulting from entering flow having the largest value is A1. To determine a unanimous decision, it is necessary to carry out one stage, namely PROMETHEE-II whose function is to unify decision support which is called net flow. The equations that can be used to determine the value of net flow using equation 17 and the final results can be seen in Table 15.

Table 15. Net flow

Alt	Name of SmartPhone	Leaving Flow	Entering Flow	Net Flow	Priority
A1	Samsung Galaxy A3	0.004	0.044	-0.040	8
A2	Samsung Galaxy J7 Prime	0.059	0.005	0.054	1
A3	Xiaomi Mi 4C	0.007	0.033	-0.026	6
A4	Xiaomi Mi Max	0.056	0.006	0.050	2
A5	Asus Zenfone Max ZC550KL	0.008	0.037	-0.030	7
A6	Asus Zenfone 2 ZE551ML	0.021	0.021	0.000	4
A7	Lenovo Vibe K5 Plus	0.009	0.033	-0.024	5
A8	Lenovo Vibe Shot	0.031	0.015	0.016	3

DISCUSSIONS

Step by step that has been carried out starting from determining the eigenvector values obtained based on questionnaire instrumentation giving very good results in comparisons that have been made to multi-criteria values and have been tested based on the consistency of all criteria used to give weight to the two methods being compared, namely ELECTRE and PROMETHEE as decision support for technology products in the form of smartphones. In this case there is a very important thing to note, namely in determining the comparison of a number of respondents, if the respondent is wrong in giving an assessment of the multi-criteria comparison then the optimal value of the eigenvector will not be found, it will even be an extraordinary deviation from the optimal value of the eigenvector generated through the AHP method. The finding of the optimal value of the eigenvector provides the best solution for applying decision comparisons to the ELECTRE and PROMETHEE methods. With the ELECTRE method, the decision-making support was won by A3 and A8, namely Xiaomi Mi 4C and followed by Lenovo Vibe Shot, the two alternatives both have a weight of 1 resulting from the aggregate dominant matrices, apart from that there is an elimination process and do not get the same priority very. Meanwhile, the application of the PROMETHEE method provides different decision results than the ELECTRE method. The decision support obtained using the first rank PROMETHEE method was given to A2 and the second rank fell to A4, namely the Samsung Galaxy J7 Prime and Xiaomi Mi Max. Thus it can be concluded that the two resulting elimination methods give different decisions, when viewed from the stages of the two methods it is clear that the stages are not the same, thus providing decision support that is different from one another. This can be used as a reference which states that both the ELECTRE and PROMETHEE methods both apply the concept of elimination to alternatives, but the results for decision support provide different priorities for evaluating technology products in the form of smartphones.

CONCLUSION

The conclusion that can be drawn is that the comparison of the AHP method against multi-criteria provides a similar starting point for using eigenvector values in providing comparison techniques, after being used in the application of the elimination method with the ELECTRE and PROMETHEE methods it turns out to give different decisions. From a series of processes that have been carried out using the ELECTRE method for concordance and discordance values and the final result of the aggregation dominant matrices process, it gives results to a different ranking system with the PROMETHEE method through the stages of leaving flow, entering flow, and net flow from the PROMETHEE-I stage and PROMETHEE-II. Applying the results with the elimination method can be used as a comparison simulation for decision support which is commendable, because not all the methods applied give the same results as expected. This becomes a solution to support decision making which can be used as a conception of selection evaluation for technology products and not only for smartphones but also for other technology products..

ACKNOWLEDGMENT

Thank you to the research team for making this article possible with a very useful contribution of thought, time and energy. We hope that this article can be published on an even better scale and will continue to discuss different articles and different methods.

REFERENCES

Akinlalu, A. A., Olayanju, G. M., Adiat, K. A. N., & Omosuyi, G. O. (2021). Mineralisation potential assessment using analytical hierarchy process (AHP) modeling technique: A case study of Ilesha schist belt, southwestern Nigeria. *Results in Geophysical Sciences*, *7*(January), 100026. https://doi.org/10.1016/j.ringps.2021.100026

Akmaludin, A., Hartati, T., Purwanto, H., & Sukendar, T. (2020). The Best Selection of Programmers in Generation 4 . 0 Using AHP and ELECTRE Elimination Methods The Best Selection of Programmers in Generation 4 . 0 Using AHP and ELECTRE Elimination Methods. *Journal Conference Series*, 0–7. https://doi.org/10.1088/1742-6596/1477/3/032001

Akram, M., Luqman, A., Carlos, J., & Alcantud, R. (2022). An integrated ELECTRE-I approach for risk evaluation with hesitant Pythagorean fuzzy information. *Expert Systems With Applications*, *200*(May 2021), 116945. https://doi.org/10.1016/j.eswa.2022.116945

Akram, M., Noreen, U., & Deveci, M. (2023). Enhanced ELECTRE II method with 2-tuple linguistic m-polar fuzzy sets for multi-criteria group decision making. *Expert Systems with Applications*, *213*(PC), 119237. https://doi.org/10.1016/j.eswa.2022.119237

Apostolou, B., & Hassell, J. M. (2002). Note on consistency ratio: A reply. *Mathematical and Computer Modelling*, *35*(9–10), 1081–1083. https://doi.org/10.1016/S0895-7177(02)00071-7

Aschenbrenner, M. (2012). Logarithms of iteration matrices, and proof of a conjecture by Shadrin and Zvonkine. *Journal of Combinatorial Theory. Series A*, *119*(3), 627–654. https://doi.org/10.1016/j.jcta.2011.11.008

Corrente, S., Greco, S., & SŁowiński, R. (2013). Multiple Criteria Hierarchy Process with ELECTRE and PROMETHEE. *Omega (United Kingdom)*, *41*(5), 820–846. https://doi.org/10.1016/j.omega.2012.10.009

da Cunha, R. A., Rangel, L. A. D., Rudolf, C. A., & Santos, L. dos. (2022). A decision support approach employing the PROMETHEE method and risk factors for critical supply assessment in large-scale projects. *Operations Research Perspectives*, *9*(April), 100238. https://doi.org/10.1016/j.orp.2022.100238

Erdogan, S. A., Šaparauskas, J., & Turskis, Z. (2017). Decision Making in Construction Management: AHP and Expert Choice Approach. *Procedia Engineering*, *172*, 270–276. https://doi.org/10.1016/j.proeng.2017.02.111

Hamidah, M., Mohd Hasmadi, I., Chua, L. S. L., Yong, W. S. Y., Lau, K. H., Faridah-Hanum, I., & Pakhriazad, H. Z. (2022). Development of a protocol for Malaysian Important Plant Areas criterion weights using Multi-criteria Decision Making - Analytical Hierarchy Process (MCDM-AHP). *Global Ecology and Conservation*, *34*(October 2021), e02033. https://doi.org/10.1016/j.gecco.2022.e02033

Iyengar, K., Upadhyaya, G. K., Vaishya, R., & Jain, V. (2020). COVID-19 and applications of smartphone technology in the current pandemic. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, *14*(5), 733–737. https://doi.org/10.1016/j.dsx.2020.05.033

John, B., McCreary, C., & Roberts, A. (2022). Smartphone technology for communications between clinicians –

*name of corresponding author

e-ISSN : 2541-2019
p-ISSN : 2541-044X

A scoping review. *Journal of Dentistry*, *122*(April), 104112. https://doi.org/10.1016/j.jdent.2022.104112

Lacruz, M., León-Saavedra, F., Petrovic, S., & Rodríguez-Piazza, L. (2021). Extended eigenvalues of composition operators. *Journal of Mathematical Analysis and Applications*, *504*(2), 125427. https://doi.org/10.1016/j.jmaa.2021.125427

Lopes, A. P. F., Muñoz, M. M., & Alarcón-Urbistondo, P. (2018). Regional tourism competitiveness using the PROMETHEE approach. *Annals of Tourism Research*, *73*(December 2017), 1–13. https://doi.org/10.1016/j.annals.2018.07.003

Marhavilas, P. K., Filippidis, M., Koulinas, G. K., & Koulouriotis, D. E. (2022). Safety-assessment by hybridizing the MCDM/AHP & HAZOP-DMRA techniques through safety's level colored maps: Implementation in a petrochemical industry. *Alexandria Engineering Journal*, *61*(9), 6959–6977. https://doi.org/10.1016/j.aej.2021.12.040

Ogonowski, P. (2022). Integrated AHP and TOPSIS Method in the Comparative Analysis of the Internet Activities. *Procedia Computer Science*, *207*, 4409–4418. https://doi.org/10.1016/j.procs.2022.09.504

Pagliuca, M. M., & Scarpato, D. (2014). The Olive Oil Sector: A Comparison between Consumers and "experts" Choices by the Sensory Analysis. *Procedia Economics and Finance*, *17*(14), 221–230. https://doi.org/10.1016/s2212-5671(14)00897-1

Palczewski, K., & Sałabun, W. (2019). Influence of various normalization methods in PROMETHEE II: An empirical study on the selection of the airport location. *Procedia Computer Science*, *159*, 2051–2060. https://doi.org/10.1016/j.procs.2019.09.378

Panchal, S., & Shrivastava, A. K. (2022). Landslide hazard assessment using analytic hierarchy process (AHP): A case study of National Highway 5 in India. *Ain Shams Engineering Journal*, *13*(3), 101626. https://doi.org/10.1016/j.asej.2021.10.021

Radomska-Zalas, A. (2022). The AHP method in the optimization of the epoxidation of allylic alcohols. *Procedia Computer Science*, *207*, 456–464. https://doi.org/10.1016/j.procs.2022.09.100

Song, J., Yao, J., & Yuan, W. (2022). Recent advances on eigenvalues of matrix-valued stochastic processes. *Journal of Multivariate Analysis*, *188*, 104847. https://doi.org/10.1016/j.jmva.2021.104847

Xu, Y., & Wang, H. (2013). Eigenvector method, consistency test and inconsistency repairing for an incomplete fuzzy preference relation. *Applied Mathematical Modelling*, *37*(7), 5171–5183. https://doi.org/10.1016/j.apm.2012.10.008

Zhang, R., Gao, C., Chen, X., Li, F., Yi, D., & Wu, Y. (2023). Genetic algorithm optimised Hadamard product method for inconsistency judgement matrix adjustment in AHP and automatic analysis system development. *Expert Systems with Applications*, *211*(August 2022), 118689. https://doi.org/10.1016/j.eswa.2022.118689

Zhao, Y., & Deng, C. (2022). Analysis of project benefit of solar energy collection and irrigation system based on AHP. *Energy Reports*, *8*, 122–130. https://doi.org/10.1016/j.egyr.2022.05.085

*name of corresponding author