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PROMETHEE METHOD FOR DECISION SUPPORT SYSTEM

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Abstract
The high demand for air conditioners (AC) from year to year has caused an increase the number of AC manufacturers from abroad entering Indonesia market. Here the author will research the PROMETHEE Method for Decision Support Systems. The author will design the application to recommend the best AC where each calculation methods can be tested using the Confusion Matrix Calculation. Confusion Matrix Calculation Results for ½ PK Air Conditioning PROMETHEE methods where, Recall, Precision, Accuracy are all 100% and Error is 0%.

Keywords: Ac, Promethee, Method, Confusion Matrix ,Application

1.0 INTRODUCTION

Air Conditioning is an electronic device that is one of the needs in every home in Indonesia, especially among the upper and middle economic community. The geographical location of the Republic of Indonesia which is crossed by the equator causes Indonesia to have a tropical climate with two seasons, namely the dry season and the rainy season. During the dry season, temperature conditions increase to reach 38°C. Rising temperatures and climate conditions in Indonesia also cause the community to provide air conditioning as a device that can cool the room (Imaniawan and Nur 2019).

In making a decision, a decision support system application is needed which is designed by using the method as an algorithm (Astuti 2014).
PROMETHEE is a method of determining the order (priority) in multicriteria analysis. The main problem is simplicity, clarity, and stability(Gusrianty, Oktarina, and Kurniawan 2019). The presumption of the predominance of the criteria used in PROMETHEE is the use of values in outranking relationships. This is a ranking method that is quite simple in concepts and applications compared to other methods for multi-criteria analysis(Yudha, Yuwono, and Kodong 2015).

Confusion matrix is a data set that only has two classes, one class as positive and the other class as negative(Nursetia wati, Abdul Syukur 2018). The value of True-Positive and True-Negative gives information when the classifier is doing data classification is true, while False-Positive and False-Negative provide information when the wrong classifier is in do data classification(Jollyta and Sukrianto 2019).

Previous research that has been made is titled: "AC Election Decision Support System Using Analytic Hierarchy Process (AHP) Method" By (Mulyoto, 2015). In this study, a system was made to make it easier for potential customers to make the decision to determine the best AC using the AHP method(Mulyoto 2015). Other research related to the decision system in determining the selection of AC is entitled "Decision Support System for Selection of CCTV Camera Types Using the PROMETHEE Method" By (FAUZI, WAHID AZHARI 2017).(FAUZI 2017) In this study developed a decision support system for choosing the ideal type of CCTV recommendation based on the type of CCTV camera to facilitate users in choosing CCTV.

2.0 METHODOLOGY

PROMETHEE Method (Preference Ranking Organizational Method for Enrichment Evaluation) is a method of determining the order (priority) in multi criteria analysis. The main problem is simplicity, clarity, and stability. The presumption of the dominance of the criteria used in PROMETHEE is the use of values in out-ranking relationships(Simamora 2014).

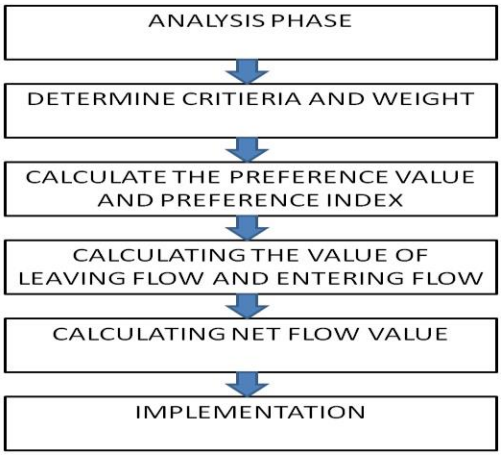

Figure 2.1 PROMETHEE method stage

a. Analysis Phase
Gathering what information is needed, defining system requirements.

b. Determine Critieria and Weight
At this stage determine the criteria and weights carried out to be able to make comparisons between variables.

c. Calculate the Preference Value and Preference Index
At this stage a comparison of each criterion is performed, then the results and comparison are divided by the number of criteria and multiplied by the weight of the criteria using a formula, then calculates the preference index value.

d. Calculating the value of Leaving Flow and Entering Flow
After obtaining all of the preference index values, the method of PROMETHEE 1 can be obtained leaving a flow index and entering flow to determine the relative preferences and alternatives to other alternatives.

e. Calculating Net Flow Value
After obtaining the value of leaving flow and entering flow, the next step is to determine the net flow value, after the net flow value is obtained, the ranking results are shown.

f. Implementation
Build software components, document systems, install systems.

Decision Support System

Decision Support System (DSS) is a system that is able to provide both problem solving and communication skills for problems with semi-structured and unstructured conditions(Saputra and Cahyana 2017) .Basically a decision support system is a further development of a computerized management system that is designed in such a way that is interactive with the wearer. This interactive nature is intended to facilitate integration between various components in the decision making process such as procedures, policies, technical, analysis, as well as managerial experience and insight to form a flexible decision framework(DAMIAN FARROW, JOSEPH BAKER 2015).

Confusion Matrix

Confusion matrix is a method used to calculate accuracy in the concept of data mining. Evaluation with confusion matrix results in accuracy, precision and recall. Accuracy in classification is the percentage of accuracy of data records that are classified correctly after testing the classification results(Mayadewi, P., & Rosely 2015). Precision or confidence is the proportion of positive predicted cases that are also positive true to the actual data. Recall or sensitivity is the proportion of positive cases that are actually correctly predicted correctly(Martin Ward Powers 2011).

PHP

PHP is a programming language in the form of a script that is placed on a server and processed on a server that was first created by Rasmus Lerdorf in 1995. The results of processing will be sent to the client, the user uses a browser. Specifically, PHP is designed to form a dynamic web. That is, it can form a view based on current demand. For example, it can display database contents to web pages(Meinawati, Satoto, and Nurhayati 2013).

XAMPP

XAMPP is an Apache web server software which has a MySQL database server available and can support PHP programming.

MySQL is a database server that can work on Windows, Linux and Unix operating systems with a freeware license so that users do not violate copyrights when using it(Dinata et al. 2015).

3.0 RESULTS AND DISCUSSION

PROMETHEE

PROMETHEE is a method that is used for the selection of air conditioners in accordance with the needs of customers that the authors examined using the PROMETHEE method using criteria that have a weight on each criterion. The criteria are processed to determine the alternative selection of AC brands. With this PROMETHEE method, it will help the customer to choose the air conditioner that suits the customer's needs. The following is a table of criteria for field research results for AC with a capacity of ½ PK.

Table 1 : Critieria and Weight

NO	Criterion	Sub-Criterion	PROMETHEE Weight
1	Service Center (K1)	>=5 Place 4 Place 3 Place 2 Place <=1 Place	5 4 3 2 1
2	Power (K2)	<=315 Watt >315 and <=350 Watt >350 and <=380 Watt >380 and <=400 Watt >400 Watt	5 4 3 2 1
3	Type (K3)	AC Inverter Low Wattage AC Standard AC	5 4 3
4	Price (K4)	<=Rp 2.700.000 >Rp 2.700.000 and <=3.200.000 >Rp 3.200.000 and <=3.700.000 >Rp 3.700.000 and <=4.200.000 >Rp 4.200.000	5 4 3 2 1

Table 2 : Research Results Data

CODE	ALTERNATIVE	SERVICE CENTER	AC POWER	AC TYPE	AC PRICE
A1	DAIKIN	2	3	3	3
A2	MITSHUBISHI	1	1	3	3
A3	PANASONIC	2	1	3	4
A4	SHARP	2	2	3	4
A5	SAMSUNG	1	1	3	4

Calculation of the Preference Value

At this stage a comparison is made between one alternative and another, by subtracting the value of the first alternative to the second alternative, then calculating the preference value according to the type of preference used. Because each criterion has the same priority, the usual preference type is used, with the following formula:

$$H(d) = \begin{cases} 1, if \geq 0 \\ 0, if < 0 \end{cases}$$

Where d = { f(a) – f(b) }

1. Criteria: Preference Value Service Center

FK1 (A1, A2)	FK1 (A2, A1)
d = FK1(A1) - FK1(A2)	d = FK1(A2) - FK1(A1)
d = 2 – 1	d = 1 – 2
d = 1 d = -1	
d > 0, maka H(d) = 1	d ≤ 0, maka H(d) = 0
FK1 (A1, A3)	FK1 (A3, A1)
d = FK1(A1) - FK1(A3)	d = FK1(A3) - FK1(A1)
d = 2 – 2	d = 2 – 2
d = 0 d = 0	
d ≤ 0, maka H(d) = 0	d ≤ 0, maka H(d) = 0
FK1 (A1, A4)	FK1 (A4, A1)
d = FK1(A1) - FK1(A4)	d = FK1(A4) - FK1(A1)
d = 2 – 2	d = 2 – 2
d = 0 d = 0	
d ≤ 0, maka H(d) = 0	d ≤ 0, maka H(d) = 0
FK1 (A1, A5)	FK1 (A5, A1)
d = FK1(A1) - FK1(A5)	d = FK1(A5) - FK1(A1)
d = 2 – 1	d = 1 – 2
d = 1 d = -1	
d > 0, maka H(d) = 1	d ≤ 0, maka H(d) = 0

Calculate the preference Index

After obtaining preference values for all criteria, the next step is to calculate the preference index value, using the following formula:

$$\varphi(a,b) = \sum_{i=1}^{n} \pi_i P_i(a,b) : \forall a,b \in A$$

π(A1,A2) = 1/4 (1 + 1 + 0 + 0) = 0.50
π(A2,A1) = 1/4 (0 + 0 + 0 + 0) = 0.00
π(A1,A3) = 1/4 (0 + 1 + 0 + 0) = 0.25
π(A3,A1) = 1/4 (0 + 0 + 0 + 1) = 0.25
π(A1,A4) = 1/4 (0 + 1 + 0 + 0) = 0.25
π(A4,A1) = 1/4 (0 + 0 + 0 + 1) = 0.25
π(A1,A5) = 1/4 (1 + 1 + 0 + 0) = 0.50
π(A5,A1) = 1/4 (0 + 0 + 0 + 1) = 0.25

From the above calculation we can see the results for calculating the preference index value in the following table:

Table 3 : Data Table Calculation Results Index Value

ALTERNATIVE	A1	A2	A3	A4	A5
A1	-	0.50	0.25	0.25	0.50
A2	-	-	-	-	-
A3	0.25	0.50	-	-	0.25
A4	0.25	0.75	0.25	-	0.50
A5	0.25	0.25	-	-	-

Calculations of the Value Of Leaving Flow And Entering Flow

After obtaining all of the preference index values, the method of PROMETHEE 1 can be obtained leaving a flow index and entering flow to determine the relative preferences and alternatives to other alternatives. With the following formula:

$$\phi^{+}(a)=\frac{1}{n-1}\sum_{X\in A}\wp(a,x) \quad , \quad \phi^{-}(a)=\frac{1}{n-1}\sum_{X\in A}\wp(x,a)$$

a. Leaving Flow

φ +A1 = 1/5−1 (0.00 + 0.50 + 0.25 + 0.25 + 0.50) = 0.3750

φ +A2 = 1/5−1 (0.00 + 0.00 + 0.00 + 0.00 + 0.00) = 0.0000

φ +A3 = 1/5−1 (0.25 + 0.50 + 0.00 + 0.00 + 0.25) = 0.2500

φ +A4 = 1/5−1 (0.25 + 0.75 + 0.25 + 0.00 + 0.50) = 0.4375

φ +A5 = 1/5−1 (0.25 + 0.25 + 0.00+ 0.00 + 0.00) = 0.1250

b. Entering Flow

φ +A1 = 1/5−1 (0.00 + 0.00 + 0.25 + 0.25 + 0.25) = 0.1875

φ +A2 = 1/5−1 (0.50 + 0.00 + 0.50 + 0.75 + 0.25) = 0.5000

φ +A3 = 1/5−1 (0.25 + 0.00 + 0.00 + 0.25 + 0.00) = 0.1250

φ +A4 = 1/5−1 (0.25 + 0.00 + 0.00 + 0.00 + 0.00) = 0.0625

φ +A5 = 1/5−1 (0.50 + 0.00 + 0.25 + 0.50 + 0.00) = 0.3125

Calculation of Net Flow Value

After getting the value of leaving flow and entering flow for each alternative, the final step in the calculation of PROMETHEE is to find the net flow value. The following is a calculation to find the net flow value.

$$\phi=\phi^{+}(a)-\phi^{-}(a)$$

φA1 = 0.3750 – 0.1875 = 0.1875
φA2 = 0.0000 – 0.5000 = -0.5000
φA3 = 0.2500 – 0.1250 = 0.1250
φA4 = 0.4375 – 0.0625 = 0.3750
φA5 = 0.1250 – 0.3125 = -0.1875

Table 4 : Calculation Results Net Flow

KODE	ALTERNATIF	NET FLOW	RANKING
A1	DAIKIN	0.1875	2
A2	MITSHUBISHI	-0.5000	5
A3	PANASONIC	0.1250	3
A4	SHARP	0.3750	1
A5	SAMSUNG	-0.1875	4

Ranking in PROMETHEE depends on the net flow value, so in table 4 above SHARP (A4) is the best alternative because it has the best net flow value of 0.3750. For the second alternative is DAIKIN (A1) with a net flow value of 0.1875 and PANASONIC (A3) with a net flow value of 0.1250 for the third alternative.

Confusion Matrix

After the classification process with the PROMETHEE method is carried out, the next is to measure performance using the confusion matrix produced by calculating Recall, Precision, accuracy and error rate. Confusion matrix calculation can be seen in the Table of the calculation results with the following method:

Table 5 : Table of Results for the PROMETHEE Method Calculation

ALTERNATIF	NET FLOW	RANGKING	In Fact	Prediction
A1	0.1875	2	VERY RECOMMENDED	VERY RECOMMENDED
A2	-0.5000	5	RECOMMENDED	RECOMMENDED
A3	0.1250	3	VERY RECOMMENDED	VERY RECOMMENDED
A4	0.3750	1	VERY RECOMMENDED	VERY RECOMMENDED
A5	-0.1875	4	RECOMMENDED	RECOMMENDED

Table 6 : Table Confusion Matrix Method PROMETHEE

CLASS		PREDICTIONS	
		VERY RECOMMENDED	RECOMMENDED
ORIGINAL CLASS	VERY RECOMMENDED	3	0
		True Positive	False Negative
	RECOMMENDED	0	2
		False Positive	True Negative

To get the results of the confusion matrix from the table, the calculation of Recall, Precision, Accuracy, and Error rate is performed. To get a recall result (the proportion of positive cases correctly identified) with the following calculation:

Recall = TP/TP+FN*100% = 3/3+0*100% = 3/3*100% = 100%
So the Recall result obtained are 100%

Precision = TP/TP+FP*100% = 3/3+0*100% = 3/3*100% = 100%
So the precision result obtained are 100%

Accuracy = TP+TN/TP+TN+FP+FN*100% = 3+2/3+0+0+2*100% = 5/5 *100% = 100%
So the accuracy result obtained are 100%

Error Rate FP+FN/TP+TN+FP+FN*100% = 0+0/3+0+0+2*100% = 0/5 *100% = 0%
So the error rate result obtained are 0%

Table 7 : Results of the Confusion Matrix PROMETHEE Method

CONFUSION MATRIX	PROMETHEE
RECALL	100 %
PRECISION	100 %
ACCURACY	100 %
ERROR RATE	0 %

a. The recall (if the prediction result is positive and the data is actually positive) is 100%
b. Precision (if the prediction result is negative and the data is actually positive) is 100%
c. accuracy (if the result of the prediction is positive while the data is actually negative) is 100%
d. Error (if the prediction result is negative and the data is actually negative) is 0%

Application

This page is used for admin login validation whether the username and password entered are registered as admin.

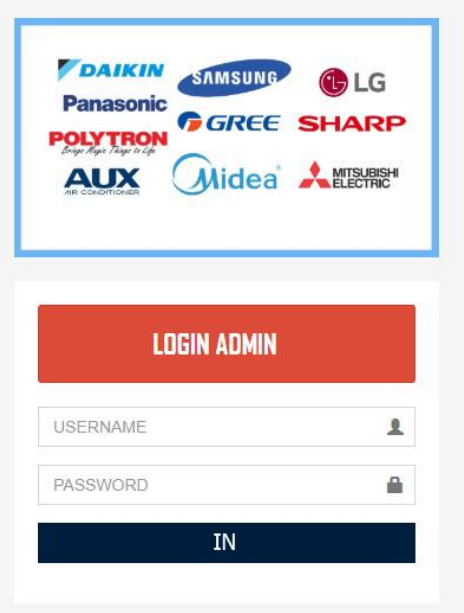

Figure 4.1 Admin Login Page

This page is used for editing, inputting data in the application of this AC recommendation.

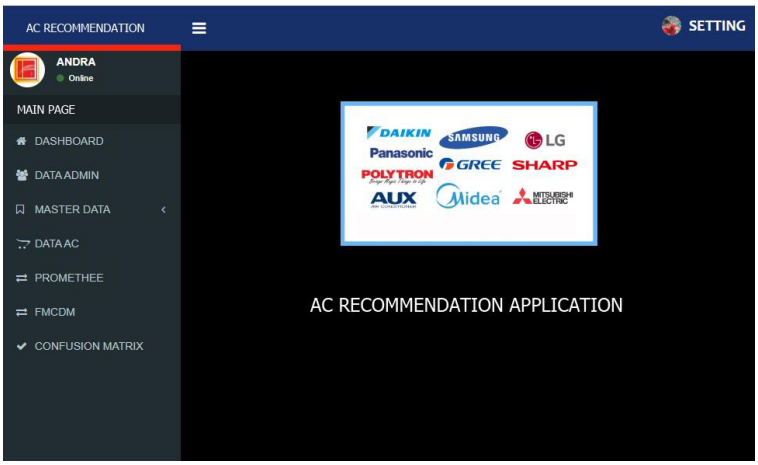

Figure 4.2 Admin Main Page

a. Admin Data Master Input page

This page is used for the admin master data input process. Add, save, edit and delete admin data.

b. Data Master page

• Input Criteria Data Master Input Page

This page is used for inputting the criteria of interest data to save, edit and delete the criteria of interest data.

• Match Criteria Master Input Page

This page is used for inputting match criteria data to save, edit and delete match criteria data.

• Criteria Data Master Input Page

This page is used for inputting criterion data to save, edit and delete criteria data. Inputting the criteria data is inputted based on the master data criteria of interest.

• Sub Data Criteria Master Input Page

This page is used for inputting sub criteria data to save, edit and delete sub criteria data.

• Alternative Data Master Input Page

This page is used for inputting alternative data to save, edit and delete alternative data.

Main Page Application Recommendations AC

The main page is the page when consumers access the application to find AC recommendations in accordance with consumer needs.

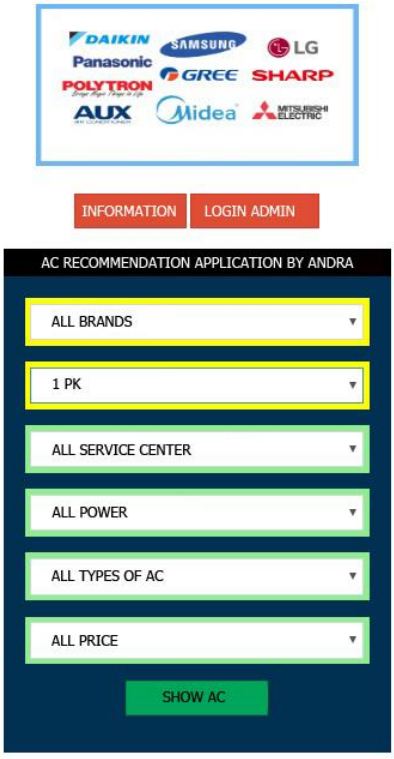

Figure 4.3 Main Page Application Recommendation AC

AC Recommendation Result Page

This page is to display the best AC recommendations in accordance with the criteria of consumer needs that have been previously chosen.

PROMETHEE

RANGKING	AC RECOMMENDATION FROM AC TYPE
1	SHARP - SHARP AC Split 1 PK AH-X9VEY
2	PANASONIC - PANASONIC AC Split 1 PK Standard Non Inverter CS-YN9TKJ
3	DAIKIN - DAIKIN AC Split 1 PK Standard R32 Thailand FTC25NV14
4	MITSUBISHI - MITSUBISHI AC SPLIT 1 PK HK 10VA ELECTRIC MR - SLIM
5	SAMSUNG - SAMSUNG AC Split 1 PK AR10KVFNAWKNSE

Figure 4.4 AC Recommendation Results Page

Ranking in PROMETHEE depends on the net flow value, so in table 4 above SHARP (A4) is the best alternative because it has the best net flow value of 0.3750. For the second alternative is DAIKIN (A1) with a net flow value of 0.1875 and PANASONIC (A3) with a net flow value of 0.1250 for the third alternative.

4.0 CONCLUSION

1. With the application of the PROMETHEE method for the selection of air conditioners can make it easier for consumers to find the air conditioner they want with a quick and precise time efficiency.

2. With the application of the FMCDM method for the selection of air conditioners can make consumers more easily find the air conditioner they want with fast and precise time efficiency.

3. By using the Confusion Matrix in measuring the calculation results of the PROMETHEE Method and the FMDCM Method, the AC ½ PK calculation results "RECALL, PRECISION, ACCURACY are 100% and ERROR is 0%, AC calculation 1 PK" RECALL = 100%, PRECISION = 67% , ACCURACY 80%, ERROR 20%.

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