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Multi Criteria Decision Model for Bank Location Selection

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***Abstract* - Depok is one of the areas in West Java - Indonesia which is the development of its territory very rapidly. The strategic location of the city of Depok, increasing the economic potential and the impact to the increasing growth of financial institutions in the city. Financial institutions that have an important role in the economy is the bank. As one of the national banks which won the trust of the community, the Bank is eager to improve the quality of services by opening a new sub branch office and new cash office in the region. factors considered in selecting a new location, it can be seen from the point of view of bankers and bank customers are inter-related, as for those factors are the accessibility and utility. Through calculations and analysis using Promethee retrieved ranked location in the following order: (1) Road of Nusantara Raya, Depok Jaya, Pancoran Mas, (2) Road of Proklamasi Raya, Abadijaya, Sukmajaya, (3) Road of Bunga 1, Sukatani, Tapos, (4) Road of Raya Muchtar, Sawangan, (5) Road of M. Nasir Raya, Cilodong, (6) Road of Swadaya Raya, Kemiri Muka, Beji. The recommended location for a new sub branch office was the location that became the first ranking on the road of Nusantara Raya, while for new cash office is on the second rank at the road of jalan Proklamasi Raya.**

Keyword - Promethee, Bank location, Rating, Multi Criteria Decision Making.

I. INTRODUCTION

One of the methods included in the technique of multiple-Criteria Decision Making (MCDM)-is the Promethee. Promethee method has been widely used by scholars and researchers in completing their research problems in particular in the areas of decision-making, sorting, or make your ranking[1],[3], [4],[6],[7]. Promethee method in this research was used to create rankings or against potential locations for established branch offices or cash Office of a bank.

The Bank was established with a view to assisting and encouraging the growth of the economy and the development of a national or regional scale in all fields as well as one of the sources of income of the area in order to improve the standard of living of the people [14]. The success of the development in the area of regional economic growth reflected in the area [2]. Where it was strongly influenced by its banking conditions. Credit flowing out to the people who used to do the investing and everyday activities will encourage the region's productivity will improve the region's economy, so that the activities of the banking industry as a financial intermediary institutions is an important institution in the economy [5].

Compared with other industries, banks are very sensitive to technological developments, especially in the field of information and telecommunications (ICT), the bank always take advantage of advance technology in doing its activities. In its activities, banks are always in touch with other parties, even within range of a distance (international). These conditions encourage banks to have the latest information technology and telecommunication facilities to improve the quality of their services to customers and facilitate their work activities. [8]

In a study conducted in the Philippines (Herrin and Perina, 1986: 538) it was concluded that one of the three main factors that have a huge influence in determining the choice of location of banking activities is telecommunications.

In addition, because one of the functions of the bank provides services to the community associated with the distribution of funds, it causes the location of the establishment of a bank office near the locations of staregis is in a place or region that became the growth of centers of commerce and industry. (McKinnon, 1973 and Levine, 1997) found that there was a positive relationship between the development of the banking sector and economic growth. Although financial institutions will encourage economic growth, but the number of banks in a region must

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see the aspect of density ratio or the number of banks divided by the population. The amount that accumulates in a region will cause a very tight competition that can lead to bank saturation (bank saturation) (Ritonga, 2008). Several studies have shown bank saturation in some areas. Sukaatmaja (2003) found that in Denpasar and Badung regency there has been bank saturation. While Jembrana, Bangli, Karangasem and Buleleng are still open areas for establishing new banks (Ritonga, 2008). Banks located in strategic locations greatly facilitate customers in dealing with the Bank.

In the city of Depok, the spread of the location of banks has begun to occur, initially the location of banks in the city of Depok tend to be in the center of the city, where the existence of banks is assumed to follow the economic activities of the community. Currently the needs of banks in the city of Depok seems increasing. The increasing trend of economic activity in Depok city has an impact on the need for banking services in this case from Bank XYZ which is the case study in this study. Banking service standards stipulated by Bank Indonesia refer to the threshold of the number of bank customers that can be served by a bank office. In the standard stated that for a branch office has a threshold of 15,000 customers, sub-branch of 8,000 people, and cash offices / BPR-BKK and BPR non BKK number 7,500 inhabitants. Therefore, it is necessary to establish a new sub-branch office and cash office of Bank XYZ to fulfill the optimal service to its customers.

For that matter need to do research to determine the location of branch offices and cash office proper and optimal in town Depok. The results of this study are expected to provide location recommendations in the form of ranking locations in accordance with the preferences of employers and general customers for the establishment of sub-branch offices and bank cash office XYZ.

From the point of view of banking service entrepreneurs as well as bank customer side there are interrelated location factors, on the rationale: (a) banking service entrepreneurs in choosing the location of bank offices to consider the location factor, in this case the considered factor is expected to facilitate the office's operational activities bank, where one of the objectives of the banking business is to find a consumer in this case is the bank's customers and site selection will directly affect the relationship between producers (bankers) and consumers (bank customers). (b) Bank customers in choosing a banking institution also consider the location factor, in which the customer benefits from the selection of a bank office based on its location.

From the rationale above, the corresponding factor between banker and bank customer is Accessibility and Utility factor.

a. Accessibility Factor

Bankers expect the easiness for customers to access the bank office, and vice versa, customers choose the bank office, in the hope that customers easily access the bank office, so there is a match between the two sides. The ease of location achievement consists of several subfactors, namely: (1) Bank office is located on a site that is easily searched by customers (Close to residence, workplace, educational place and business place). (2) Close to the main road. (3) Located on the road that is not jammed, (4) Passed by public transport routes, (5) Low fares to banks. Assessment of the subfactor above is divided into 3 classes, depending on the ease of reaching the location. The easier a location is achieved, the greater the score given. The location included in the class I is an alternative location that has accessibility to be very high, so given a score of 3. Class II is an alternative location that has the accessibility to be quite high, so given a score of 2. While class III is the alternative location of the xyz bank which is easy to reach (accessibility) is low, so it is only given a score of 1. For a subfactor transpot fare to the offices of the bank, divided into two classes. Locations that meet the subfactors of the cost of transport to these low-cost banks are assumed if the location is traversed by public transport routes. Class I is the location through which a public vehicle, then given a score of 2. Whereas including class II is a location that is not passed by public transport routes, then given a score of 1. [16], [17].

Table1. Scores of Accessibility Subfactors/Criteria

No.	Subfactors	Class	Score	Total Score
1	Located in locations that are easy to find customers.			24
	➢ Close to the residence (DTT)			6
	• < 1 Km from the residence	I	3	
	• 1-3 Km from the residence	II	2	
	• >3 Km from the residence	III	1	
	➢ Close to the workplace (DTK)			6
	• < 1 Km from the Offices	I	3	
	• 1-3 Km from the Offices	II	2	
	• >3 Km from the Offices	III	1	
	➢ Close to the place of education(DTP)			6
	• < 1 Km from the school	I	3	
	• 1-3 Km from the school	II	2	
	• >3 Km from the school	III	1	
	➢ Close to business places(DTB)			6
	• < 1 Km from the market/shops	I	3	
	• 1-3 Km from the market/shops	II	2	
	• >3 Km from the market/shops	III	1	
2	Close to the main road (DJU)			6
	• <50 Mfrom the main road	I	3	
	• 50 M – 1 Km from the main road	II	2	
	• >1 Km from the main road	III	1	
3	Located on the road that is not jammed(JTM)			6
	• The average speed of vehicles on the road > 60 Km/ H	I	3	
	• The average speed of vehicles on the road 30 Km/ H- 60 Km / H	II	2	
	• The average speed of vehicles on the road < 30 Km/ H	III	1	
4	Passed by public transport routes(RKU)			6
	• Traversed more than 2 public transportation routes	I	3	
	• Traversed 2 public transportation routes	II	2	
	• Traversed only 1 public transportation routes	III	1	
5	Low fares to banks(OTM)			3
	• Traversed by public transit	I	2	
	• Not traversed by public transit	II	1	

b. Utility Factor

In this case, the bank office in conducting its operational activities requires communication with bank customers, as well as bank customers need to communicate with the bank office, so that both parties have the suitability of views in terms of communication, where communication can only be done if there is availability of facilities and supporters. The utility in question is that which can support the process of continuity of bank service to its customers, Utility consists of several subfaktor that is: (1) availability of telephone network, (2) availability of internet network, (3) Availability of adequate electricity. Assessment In this utility subfactor is divided into three classes. The greater the utility services available, the better the class and the greater the score given. The location included in class I is an alternative location that there is utility service is very high, so given a score of 3. Class II is for alternative locations that there is high utility services, so given a score of 2. While class III is an alternative location that there is service utility is low, so given a score of 1. The scores of each subfactor are adjusted to the subfactors in each class.

Table 2. Scores of Utility Subfactors/Criteria

No.	Subfactors	Class	Score	Total Score
1	Availability of telephone network (KJT)			6
	• Phone network service100%	I	3	
	• Phone network service<50%	II	2	
	• No Phone network service	III	1	
2	Availability of internet network(KJI)			6
	• Internet network services100%	I	3	
	• Internet network services<50%	II	2	
	• No Internet network services	III	1	
3	Availability of electricity(KJL)			
	• Electricity service100%	I	3	6
	• Electricity service<50%	II	2	
	• No Electricity service	III	1	

The object of this research is the locations around Depok which has the number of residents and the number of customers who meet the rules of Bank Indonesia.

The choice of six locations, determined using purposive sampling method or sample chosen for certain considerations. (Mustafa 2000). Data downloaded on December 1st, 2017.

Table3. Samples / alternate locations according to Bank Indonesia rules

No.	Locations	Code of Location	Population	Number of Bank XYZ Cusromers
1	Road of Swadaya Raya, Kemiri Muka, Beji	A001	128.094	7.685
2	Road of M. Nasir Raya, Cilodong	A002	151.441	9.086
3	Road of Raya Muchtar, Sawangan	A003	127.805	7.668
4	Road of Bunga 1, Sukatani, Tapos	A004	231.101	9.244
5	Road of Nusantara Raya, Depok Jaya, Pancoran Mas	A005	240.846	9.633

6	Road of Proklamasi Raya, Abadijaya, Sukmajaya	A006	225.166	9.006

The six locations are assessed for accessibility and utility factors, then analyzed by using the promethee method to obtain recommended site rankings up to the ones not recommended for new sub-branches and cash offices in Depok.

II. Matrials and Method

This type of research is constructive. This type of research aims to design a decision support system algorithm in choosing the location of sub-branch office and cash office in Depok.

The method of data analysis in this study is as follows, each alternative region that has been determined to do weighting in accordance with the criteria of bankers and customers, after that the evaluation process using the method of promethee with the sequence of activities are as follows: Looking for index preferences multicriteria, Calculating the leaving flow, Counting the entering flow, Calculating the net flow. [9], [10], [15].

From the process it generates a ranking of locations that can be sorted from the most recommended locations to the least recommended.

Promethee (*Preference Ranking Organization method for Enrichment Evaluation*).

Promethee is a method of determining the order (priority) in multicriteria analysis. The key issues are simplicity, clarity, and stability. The alleged predominance of the criteria used in Promethee is the use of value in outranking relationships. All the parameters that are stated have a real influence according to the economic view. This promethee belongs to the family of outranking methods, where the Promethee method was developed by Brans and Vincke in 1985.

The process of policy analysis requires the existence of criteria before deciding the choice of various alternatives. The criteria indicate the definition of the problem in a concrete form and is sometimes considered a target to be achieved (Sawiki, 1992). An analysis of the assessment criteria was conducted to obtain a set of measurement standards, to then be used as a tool in comparing alternatives.

III. Result and Discussions

Calculation and Data Analysis of location selection with Promethee.

The promethee method has been widely used in various fields, in economics, education, politics and even banking. In this study promethee applied in the field of banking, especially in assessing and ranking some alternative locations that will be selected for sub-branch offices and cash offices of banks in Depok. [12], [13],

The analytical steps of several alternative bank locations by using the promethee method are: (a) enter the value of accessibility criteria ratio consisting of DTT, DTK, DTP, DTB, DJU, JTM, RKU, and OTM, while Utility criteria consisting of KJT , KJI and KJL for each location sample that will analyze the extent of its level. (b) Calculate the difference of value of DTT, DTK, DTP, DTB, DJU, JTM, RKU, OTM, KJT, KJI and KJL ratio among location alternatives against certain criteria. (c) Calculate the preference function between samples. (d) Calculate the aggregate of preference functions. (e) Calculate the value of leaving flow. (f) Calculate the value of entering flow. (g) Calculate the net flow value.

Based on the table below, we can get the recapitulation of score or criteria value consisting of DTT, DTK, DTP, DTB, DJU, JTM, RKU, OTM, KJT, KJI and KJL for each sample alternative location.

Table 4. Recapitulation Total score Alternative location

Code of Location	Criteria Score											Total Score
	DTT	DTK	DTP	DTB	DJU	JTM	RKU	OTM	KJT	KJI	KJL	
A001	1	1	1	3	2	1	3	3	3	3	3	24
A002	3	2	2	2	1	2	2	3	3	3	3	26
A003	2	2	2	2	3	3	2	3	3	3	3	28
A004	3	2	3	2	2	3	2	3	3	3	3	29
A005	3	3	3	3	2	2	3	3	3	3	3	31
A006	3	3	3	3	1	2	3	3	3	3	3	30

The data obtained is converted to composite rank so that the resulting value is normal then there is no need to normalize the data again.

1. Calculate the value of preferences between sample/alternative

At this stage, do a comparison between one sample with another sample for each of the criteria, the Bank as the next sample will be referred to by the term alternative. The comparison of the obtained by way of subtracting the value of the first alternative with the second alternative, then calculated the value of preference in accordance with the type of preference is used [4] [11]. If the results obtained from the difference between both the smaller value equal to zero (0), then the value of the preference of H (d) is zero (0), and if the result value is greater than zero (0), then the value of the prefernsi H (d) is one (1). To compute the function preferences between sample equations are as follows:

$$Pij\ (i,i') = Rij - Ri'j, jika\ Rij > Ri'j$$

$$Pij\ (i,i') = 0, jika\ Rij < Ri'j$$

Description:

Rij = Data sample *i*, criteria *j*

From the recapitulation data, the number of alternative locations scores above will be determined the preference function between samples. For more details it can be seen in the calculation below, for example below calculation for comparison of samples A001 and A002.

Example : DTT(A001, A002)
d= DTT(A001) – DTT(A002)
d= 1– 3
d= -3
than H(d)= 0

With the same steps, will be obtained as a function of the value of the preference between samples from all of the criteria.

Table 5. The results of the calculation of the value of the preference between the sample locations

	DTT	DTK	DTP	DTB	DJU	JTM	RKU	OTM	KJT	KJI	KJL
A001, A002	0	0	0	1	1	0	1	0	0	0	0
A001, A003	0	0	0	1	0	0	1	0	0	0	0
A001, A004	0	0	0	1	0	0	1	0	0	0	0
A001, A005	0	0	0	0	0	0	0	0	0	0	0
A001, A006	0	0	0	0	1	0	0	0	0	0	0
A002, A001	1	1	1	0	0	1	0	0	0	0	0
A002, A003	1	0	0	0	0	0	0	0	0	0	0
A002, A004	0	0	0	0	0	0	0	0	0	0	0
A002, A005	0	0	0	0	0	0	0	0	0	0	0
A002, A006	0	0	0	0	0	0	0	0	0	0	0
A003, A001	1	1	1	0	1	1	0	0	0	0	0
A003, A002	0	0	0	0	1	1	0	0	0	0	0
A003, A004	0	0	0	0	1	0	0	0	0	0	0
A003, A005	0	0	0	0	1	1	0	0	0	0	0
A003, A006	0	0	0	0	1	1	0	0	0	0	0
A004, A001	1	1	1	0	0	1	0	0	0	0	0
A004, A002	0	0	1	0	1	1	0	0	0	0	0
A004, A003	1	0	1	0	0	0	0	0	0	0	0
A004, A005	0	0	0	0	0	1	0	0	0	0	0
A004, A006	0	0	0	0	1	1	0	0	0	0	0
A005, A001	1	1	1	0	0	1	0	0	0	0	0
A005, A002	0	1	1	1	1	0	1	0	0	0	0
A005, A003	1	1	1	1	0	0	1	0	0	0	0
A005, A004	0	1	0	1	0	0	1	0	0	0	0
A005, A006	0	0	0	0	1	0	0	0	0	0	0

A006, A001	1	1	1	0	0	1	0	0	0	0	0
A006, A002	0	1	1	1	0	0	1	0	0	0	0
A006, A003	1	1	1	1	0	0	1	0	0	0	0
A006, A004	0	1	0	1	0	0	1	0	0	0	0
A006, A005	0	0	0	0	0	0	0	0	0	0	0

2. Count aggregate function preferences

The next stage is to calculate the aggregate function preferences obtained from the sum of weights of the criteria multiplied by the value of the function preferences between samples. as for the formula or equation to be used is as follows:

$$\pi\ (i,i') = \sum_{j=1}^{m} wj\ x\ Pj\ (i,i')/\ \sum_{j=1}^{m} wj$$

Description:
Pj = the value of the function preferences
Wj = the weighting of criteria

Here is an example of calculating the aggregate of the preference function of the weighted number of criteria multiplied by the value of the preference function, since the weight of the criteria is the same for each criterion, the aggregate value of the preference function is derived from the total value of the DTT, DTK, DTP, DTB, DJU, JTM, RKU, OTM , KJT, KJI and KJL for each alternative sample location divided by the number of criteria, in this case the number of criteria is 11 which consist of DTT, DTK, DTP, DTB, DJU, JTM, RKU, OTM, KJT, KJI and KJL. Here is a sample calculation looking for the aggregate value of preference comparison function of A001 and A002 samples.

π (A001, A002)
= (0+0+0+1+1+0+1+0+0+0+0) /11
= 0.27273

With the same steps, will aggregate value function obtained as a preference between samples from all of the criteria.

Table 6. The results of the calculation of the value of the aggregate preferences between the sample locations

	A001	A002	A003	A004	A005	A006	Total
A001		0.27273	0.18182	0.18182	0.00000	0.09091	0.72727
A002	0.36364		0.09091	0.00000	0.00000	0.00000	0.45455
A003	0.45455	0.18182		0.09091	0.18182	0.18182	1.09091
A004	0.36364	0.27273	0.18182		0.09091	0.18182	1.09091
A005	0.36364	0.45455	0.45455	0.27273		0.09091	1.63636
A006	0.36364	0.36364	0.45455	0.27273	0.00000		1.45455
Total	1.90909	1.54545	1.36364	0.81818	0.27273	0.54545	

3. Calculate flow entering and leaving flow

a) leaving (positive) flow

The value of leaving flow is derived from the aggregate calculation of the preference function summed for each row (horizontally) then divided by 5 (as much as the number of samples is reduced by one). The formula or equations used are as follows:

$$\varphi^{+}(i) = \frac{1}{n-1}\sum_{i=1}^{n} \pi(i,i'),$$

Description :

n = number of sample
The following is an example of the calculation values for the leaving flow sample A001.

φ^{+}(A001) = $\frac{1}{6-1}$ x (0.27273 + 0.18182 + 0.18182 + 0.00000 + 0.09091)
= 0.14545

With the same steps, the value obtained will be leaving flow for all samples.

b) *Entering (negative) flow*

The value of entering flow is derived from the aggregate calculation of the preference function summed for each column (vertically) then divided by 5 (as much as the number of samples is reduced by one). The formula or equations used are as follows:

$$\varphi^{-}(i) = \frac{1}{n-1}\sum_{i=1}^{n}\pi(i,i'),$$

Description:

n = number of sample

The following is an example of the calculation values for the leaving flow sample A001.

$\varphi^{-}(\text{A001}) = \frac{1}{6-1}\,x\,(0.36364 + 0.45455 + 0.36364 + 0.36364 + 0.36364)$

$= 0.38182$

With the same steps, the value obtained will be leaving flow for all samples.

c) Leaving & Entering Flow Value

The following table presents the results of the value of leaving and entering flow of each of all samples of the locations of the research object.

Table 7. Value of Leaving and Entering Flow sample / alternative location

Sample/Altrnative	Leaving Flow	Entering Flow
A001	0.14545	0.38182
A002	0.09091	0.30909
A003	0.21818	0.27273
A004	0.21818	0.16364
A005	0.32727	0.05455
A006	0.29091	0.10909

d) *Net outranking flow*

The value net value obtained from outranking leaving flow minusi flow entering values. The sample with the greatest or highest outranking value will occupy the top position in the rankings.

The formula or equation used in calculating net outrangking flow is as follows:

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

Description :

$\varphi^{+}(i)$ = *value of Leaving Flow*

$\varphi^{-}(i)$ = *value of Entering Flow*

The following is an example of the calculation of values of sample outranking A001

$\varphi(i) = 0.14545 - 0.38182$

$= -0.23636$

With the same steps, the value obtained will be net outrangking flow for all samples.

Table 8. The value of Net OutRangking Flow Sample locations

Sample/Alternative	Leaving Flow	Entering Flow	Net OutRangking Flow
A001	0.14545	0.38182	-0.23636
A002	0.09091	0.30909	-0.21818
A003	0.21818	0.27273	-0.05455
A004	0.21818	0.16364	0.05455
A005	0.32727	0.05455	0.27273
A006	0.29091	0.10909	0.18182

From calculations using Promethee method obtained the order as indicated in table above. The rank was first occupied by samples or alternative A005 with Net Out Ranking value 0.27273, it showed that the best alternative is A005.

Table 9. Results rank with PROMETHEE method

Rank	Sample /Alternative	Net OutRangking Flow
1	A005	0.27273
2	A006	0.18182
3	A004	0.05455
4	A003	-0.05455
5	A002	-0.21818
6	A001	-0.23636

The first rank is the one with the highest net outranking flow value. Samples or alternatives A005 which became the first rank with a value of 0.27273 which means the most recommended location to be selected to become a sub-branch office and cash office in Depok. While having the smallest net outrangking flow value is the lowest rank, it means that its location is not recommended for the sub-branch office and the new xyz bank cash office in Depok.

IV. CONCLUSION

Based on this research, it can be concluded that the factors considered in choosing the location of auxiliary branch offices and cash office at xyz bank can be seen from the point of view of bankers and related bank customers, while those factors are Accessibility and Utilities. Accessibility is the convenience of customers and bankers to reach the location. The ease of location achievement consists of several subfactors, namely: (1) Bank office is located on a site that is easily searched by customers (close to residence, workplace, educational place and business place). (2) Close to the main road. (3) Located on the road that is not jammed, (4) Passed by public transport routes, (5) Low fares to banks. While Utilities in question is a utility that can support the process of sustainability of bank services to its customers such as: Availability of telephone network, Internet network availability, and Availability of sufficient electricity flow.

The ranking of six alternative locations using the promethee method is in the following order:

(1) Road of Nusantara Raya, Depok Jaya, Pancoran Mas
(2) Road of Proklamasi Raya, Abadijaya, Sukmajaya
(3) Road of Bunga 1, Sukatani, Tapos
(4) Road of Raya Muchtar, Sawangan
(5) Road of M. Nasir Raya, Cilodong
(6) Road of Swadaya Raya, Kemiri Muka, Beji

RECOMENDATION

The recommendation of this study is to rank the appropriate locations for bank offices in terms of competition with other banks.

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