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Optimation Hybrid Model in Selecting Banks for Housing Loans

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Abstract−Public housing loans (KPR) have so far become an alternative solution to the problem of the people who wish to have a house but do not have sufficient funds to buy or build it. The obstacle people often faced is finding the best bank from various sides to finance the housing loans. The concept of Islamic banks has recently become a quite reliable competitor for conventional banks in financing KPR. Its presence needs to be taken into account in terms of which bank people chooses to finance KPR, whether with conventional banks or Islamic banks. The research aims to provide alternative decisions for people who look for housing and intend to use public housing credit facilities by optimizing two methods of decision making. Some banks have become alternatives used as a comparison to each other. The alternatives used have their respective characteristics along with its advantages and disadvantages. Decision making methods used are analytical hierarchy process (AHP) and weighted product (WP) methods. Both of these methods are optimized to get banks that have the highest preference weights. The system development method used is user-centered design that captures all the needs of the end user. The parameters used in the selection of banks used for mortgages are the types of banks which consist of two types, namely conventional banks and Islamic banks, interest given by each type of bank, developers working with the bank, administration fees charged by the bank, contract and settlement based on the type of bank, and the last is the duration of the process which is calculated from the start of the contract agreement until the house is ready for occupancy. The output of this study is the weighting result using two methods as an alternative, in which the highest weight used as the best bank solution to finance the KPR. The most effective decision is obtained, namely BTN as a bank that is eligible to finance KPR with the highest preference weight of 14,969.

Keywords: People's Housing Loans; Banks; User Centered Design; Analytical Hierarchy Proces; Weighted Product

1. INTRODUCTION

Every person has the right to occupy, enjoy, and / or own / obtain a decent home in a healthy, safe, harmonious and orderly environment [1]. The law on housing has explained the rights of every citizen in ownership of a residence. Many methods are used by the community to be able to have a decent house to live in, starting from building a house, buying a fully finished one or even to build more than one house for investment purposes. The ability of each person is different in terms of ownership. Some choose to use the services of banks to finance the process of home built with public housing loan (KPR) facilities.

Most banks offer a KPR program with various supporting facilities as a promotional step to be able to attract as many customers as possible to choose the bank as a source of KPR financing [2]. The presence of banks with Islamic concepts adds to the competition to attract the customer's sympathy using their services. Conventional banks and Islamic banks each have advantages and disadvantages [3]. By choosing the most appropriate method, a decision support system can be used to compare several banks to find the most profitable bank decision solutions.

Utilization of decision support systems to find the best solution is often used by solving problems [4],[5]. Problems are analyzed starting from finding the criteria used, comparing several alternative decisions, calculating the most ideal weights for each criterion, calculating the preference weights for each alternative by comparing them against each criterion, ranking each alternative and determining the alternative with the highest weight [6], [7], [8]. All stages carried out in the decision-making process are adjusted to the decision-making method [9], [10]. Determination of the criteria used to find the most ideal bank is the initial stage of the decision making process. In the next phase, each bank is given a preference weight by considering the criteria used. Then the weight of each bank is calculated to determine the bank with the highest preference weight as a solution for the decision taken. Some decision support system research uses the AHP method, namely [11], [12], [13] and [14], using the WP method [15], [16] and [17] while the research combines the AHP method and the WP method namely [18] and this study will combines the AHP and WP methods which are optimized to produce a final decision that helps customers in determining the bank used for KPR.

This study aims to provide several decision recommendations to customers who will use the bank services to finance public housing loans. The difference between this research and the research that has been done is that the method used in this study is optimized analytical hierarchy process and weighted product, therefore it produces alternative decisions with the most optimum preference weight. Customers can use these decision recommendations as a solution to choose the most profitable bank. The system development method used is user-centered design, because this method accommodates all user aspirations [19], [20]. User needs are described in detail per stage of the process and designed according to user requirements [21], [22]. The design is then made into modules on a decision support system [23]. The final result is expected to be in accordance with user requests since each process has been through intense communication with end users [24]. Customers can use the decision support system to find the bank with the highest weight as a solution to help them decide on the bank for KPR. The ranking process uses a decision support information system that has been developed to provide recommendations for bank selection that will later be used for mortgage financing. The decision support system used has been tested on several respondents who will choose a bank for mortgage financing.

2. RESEARCH METHODOLOGY

2.1 System Development Method

The user-centered design method is the chosen method for developing a decision support system to find a bank as a housing loan financier taken by the customer. The user-centered design stage begins by defining the user context of the system to be created [25]. In this study, users who will use a decision support system are the people who will become customers of a bank that takes public housing loans through banks that obtain the highest preference weights.
The next stage is defining the needs of system users that mean to define the relationship between system users and the data used in this study [26]. The data used is the bank data as an alternative which the weight of the preference will be calculated to be compared with other alternatives. Furthermore, the predetermined criteria data is checked with their respective preference weights. Then after the user and their needs are defined, the next step is to create a design from the development of a system that is made and the concept of decision support using two optimized decision support methods to obtain the best alternative. The last stage is the design evaluation that has been implemented into the decision support system modules in the system development process by using user feedback [21]. If there is an improvement / input from the user to the design implemented on a system that has been built, then the process is repeated again in accordance with the stages based on the user evaluation [25]. Evaluation will start from the stage of defining the user context or from the stage of defining user needs, or perhaps from the stage at the time of the design of the decision support system. After all stages of the user-centered design method are carried out, the process is continued to the stages of drawing conclusions from all stages from beginning to end [20]. User feedback is the most important part because without feedback from the user, the implementation of the user-centered design is not optimum in the system development process [24]. So one of the benchmarks of the successful implementation of this method is based on how improvements must be made to the modules, also about how the percentage of user needs poured into the system, the greater the percentage then the system built has successfully accommodated and implemented the user needs and wishes [21]. Each phase of the user-centered design method will be explained in Figure 1.

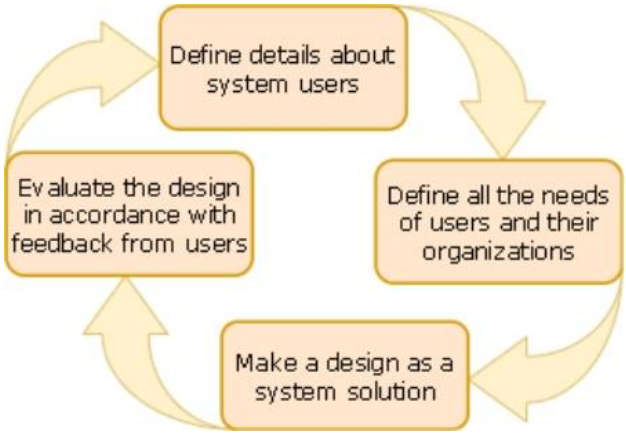

Figure 1. Stages of User-Centered Design Method

2.2 Decission Making Method

There are two decision support methods, namely the analytical hierarchy process (AHP) method and the weighted product (WP) method. Both of these methods are optimized to produce the most effective decisions to solve the problems, namely the selection of banks for house loan financing. AHP method is used because this method can provide systematic solutions and minimize inconsistencies in judgment [27]. The WP method is used more for alternative ranking that has been weighted against each criterion used [18].
The stages in the AHP method are able to detect discrepancies in weighting without the need for mathematical calculations [28], here are the detailed steps that must be performed on this method:

a. Determining the final goal of the decision making process and this final goal is the top of the hierarchy of the entire stages of the process in the AHP method.
b. Arranging the elements involved such as criteria, sub criteria, and selected alternatives as well as determining the weights for each criterion used in decision making and the weights for each alternative which are being compared. Determination of the weight for each criterion was determined based on the researcher's observations of several banks working together in the mortgage financing process, some respondents who were going to take a mortgage, some respondents whose mortgage process was already under way, several respondents who had completed the mortgage process and the data had also been consulted with several experts in economics and law such as accountants and notaries who usually handle the mortgage process.
c. Making a pairwise comparison matrix for each element involved in each group by determining the weight of each, which is oriented towards the final goal of the decision making process. Weighting criteria use the Saaty scale by

comparing the priority of each criterion used in the process of determining the bank's decision for KPR financing taken by the customer [29].

d. Next is using the results of the pairwise comparison matrix to determine the value of the eigenvector and the total amount taken from the overall value of each vector that corresponds to the lowest level of the decision making hierarchy. Calculations performed on the AHP method begin by normalizing each column j in matrix A with the formula:

$$\sum_i aij = 1 \quad (1)$$

Calculating the average value of each row i in matrix A:

$$W = \sum_i n(ij) \quad (2)$$

The last stage in this method is evaluating each alternative that is used based on the value of the weights criteria by checking the consistency of the AHP process hierarchy [30]. The formula used to calculate the weight vector consistency value is:

$$(A)(W)^T = (n)(W)^T \quad (3)$$

e. Calculating the consistency index value, the formula is:

$$Ci = \frac{t-n}{n-1} \quad (4)$$

Finally calculating the value of the consistency ratio, using the formula:

$$CR = \frac{Ci}{(R)(n)} \quad (5)$$

For calculations using the weighted product (WP) method, the process is as follows [15]:

a. Normalizing to obtain an alternative weight value that has been fixed

$$Wj = \frac{Wj}{\sum Wi} \quad (6)$$

Where:
Wj = value of alternative weight
j = Total of alternatives
$\sum Wj$ = total number of alternative weight values

b. Counting S Vector value

$$Si = \prod_{j=1}^{n} Xij^{Wj} \quad (7)$$

Where :
Si = S Vector value
X = Criteria value
W = criteria weights
i = alternative i
j = Criteria j
n = Amount of criteria
$\sum Wj$ = 1, where *Wj* is positive for benefit attribute and *Wj* is negative for cost attribute

c. Counting V Vector value

$$Vi = \frac{\prod_{j=1}^{n}(Xij)(Wj)}{\prod_{j=1}^{n}(Xj)(Wj)} \quad (8)$$

Where:
Vi = V vector value
X = Criteria value
W = Criteria weights
i = alternative i
j = criteria j
n = Amount of criteria

3. RESULT AND DISCUSSION

3.1 Optimation of AHP and WP

Implementation of the analytical hierarchy process method for bank selection to finance KPR taken by a customer who will buy a house use 6 criteria, namely:

a. Bank type (C1), namely Islamic based bank or conventional based bank
b. Bank interest (C2) provided by the bank for a period of 15 to 20 years with an equal advance fee for 10 alternative banks to be compared and sought by banks which obtain the highest preference weights for KPR financing solutions
c. Coverage or developer (C3) in collaboration with the bank in the housing construction with a predetermined location
d. Administrative costs (C4) charged by the bank which are used for notarial deed and renaming for housing ownership
e. The contract and method of repayment (C5) for each vessel such as take-over before the completion of the KPR period, because there are some banks that do not allow the take-over process before the KPR period ends
f. The duration of the process (C6) is calculated at the time of contract signing to take the KPR to the housing construction process

With 10 alternative banks that will be compared to get the bank with the highest preference weight as a solution to the problems faced, namely:

a. BRI (A1)
b. BRI Syariah (A2)
c. BNI (A3)
d. BNI Syariah (A4)
e. Bank Mandiri (A5)
f. Bank Mandiri Syariah (A6)
g. BCA (A6)
h. BTN (A8)
i. Bank Permata (A9)
j. CIMB Niaga (A10)

The combination of optimized AHP and WP methods is done so that it produces the best decision. The AHP process is used at the beginning of the weighting because it is in accordance with the characteristics of the AHP method where the process begins by giving weight to each criterion used in the bank selection process for KPR financing. First the criteria must be grouped into benefit criteria and cost criteria. Still using the AHP method, the next step is to determine a pairwise comparison matrix for each alternative involved. The next stage uses the weighted product (WP) method. At this stage the pairwise comparison matrix is normalized to obtain the value of each alternative with the weight that has been fixed. Then look for the value of S vector for each alternative by multiplying all the criteria used, namely C1 to C6 which have been normalized with alternatives and given a positive rank for the benefit criteria and given a negative rank for the cost criteria. The last stage is to rank 10 alternative banks by first looking for the value of vector V. The vector value is the basis for decision making because the highest value of the 10 alternative banks compared is already known. Figure 1 shows the process hierarchy using the analytical hierarchy process (AHP) method where the ultimate goal of the decision making process is the selection of a bank among 10 (ten) banks compared using 6 (six) criteria to obtain the bank with the highest value.

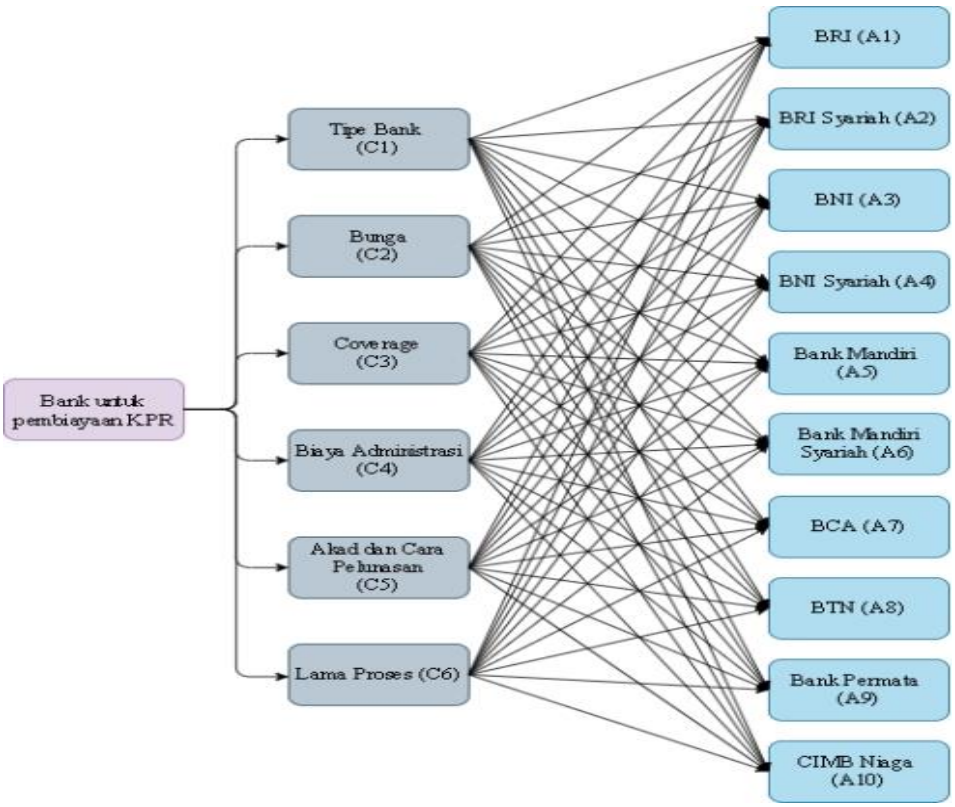

Figure 2. Hierarchy process AHP

3.2 Result of Study

Of the 6 (six) criteria used, C1, C3, C5, C6 are benefit attributes and C2, C4 are cost attributes. The priorities for each criterion are explained as follows:

a. The type of bank (C1) is less important than bank interest (C2) and administrative costs (C4)
b. Bank type (C1) is more important than coverage / developer (C3)
c. Bank interest (C2) is as important as administrative costs (C4)
d. Bank interest (C2) is more important compared to the contract, payment method (C5) and processing time (C6)
e. Coverage / developer (C3) is a little more important than the duration of the process (C6)
f. Administrative costs (C4) are more important than coverage / developer (C3)
g. The contract and method of repayment (C5) are as important as the duration of the process (C6)
h. Administrative costs (C3) are more important than the contract, payment method (C5) and processing time (C6)
i. The contract and method of repayment (C5) are slightly more important than coverage / developer (C3)
j. Bank type (C1) is slightly more important than contract, payment method (C5) and processing time (C6)

The first step is to determine the pairwise comparison matrix of criteria weights from bank type criteria (C1), bank interest (C2), coverage / developer (C3), administrative costs (C4), contract and method of repayment (C5) and processing time (C6). Using the scale of time by determining the priority scale of each criterion, the step is taken to determine the value of the pairwise comparison matrix of criteria weights using equations (1) and (2) and the paired comparison matrixes that have been normalized using equations (3) and (4). The results of the pairwise comparison matrix after normalization are shown in table 1.

Table 1. Comparative Matrix Comparison of Normalized Criteria

Criteria	C1	C2	C3	C4	C5	C6
C1	0.080	0.024	0.021	0.441	0.017	0.323
C2	0.241	0.074	0.017	0.088	0.415	0.014
C3	0.321	0.370	0.085	0.353	0.014	0.016
C4	0.016	0.074	0.021	0.088	0.415	0.485
C5	0.321	0.013	0.427	0.015	0.069	0.081
C6	0.020	0.444	0.427	0.015	0.069	0.081

Next is to use the normalized criterion value using the AHP method to find the S vector value of 10 (ten) compared bank alternatives. The vector S value is obtained by multiplying the value of all the criteria used in the decision making process, namely C1 to C6 which has been normalized with alternatives being compared and given a positive rank for the benefit criteria and given a negative rank for the cost criteria. Using equation (7), the S vector values for 10 (ten) alternative banks are shown in Table 2.

Table 2. S Vector Value

Alternative	Criteria					
	C1	C2	C3	C4	C5	C6
A1	2.266	0.408	5.768	0.436	5.480	3.956
A2	1.505	0.269	4.524	0.436	5.480	3.956
A3	1.912	0.408	5.768	0.269	5.480	5.671
A4	2.585	0.269	4.524	0.436	5.480	3.956
A5	1.912	0.408	5.768	0.269	5.480	5.671
A6	2.585	0.269	4.524	0.436	5.480	3.956
A7	2.266	0.408	5.768	0.269	4.328	5.671
A8	1.912	0.408	4.524	0.269	5.480	7.499
A9	1.505	0.408	4.524	0.269	4.328	5.671
A10	2.266	0.408	4.524	0.269	4.328	5.671

The final step in the decision-making process for choosing a bank to finance KPR taken by a customer is to look for the value of Vector V and then rank the overall results of the 10 (ten) alternative banks. The value of vector V is the weight of preference obtained by adding up all the values of each criterion obtained by each alternative bank. Using equation (8), the value of vector V is shown in table 3. Then ranking is made by comparing the preference weights of all alternatives. An alternative with the highest preference weight is taken which become the result of a decision making process that optimizes two decision making methods namely the AHP method and the WP method.

Table 3. V Vector Value

Alternative	Criteria					
	C1	C2	C3	C4	C5	C6
A1	3.072	0.222	2.649	0.162	5.185	2.528
A2	2.041	0.146	2.078	0.162	5.185	2.528
A3	2.592	0.222	2.649	0.100	5.185	3.624

A4	3.504	0.146	2.078	0.162	5.185	2.528
A5	2.592	0.222	2.649	0.100	5.185	3.624
A6	3.504	0.146	2.078	0.162	5.185	2.528
A7	3.072	0.222	2.649	0.100	4.095	3.624
A8	2.592	0.222	2.078	0.100	5.185	4.792
A9	2.041	0.222	2.078	0.100	4.095	3.624
A10	3.072	0.222	2.078	0.100	4.095	3.624

Figure 3 shows the ranking results for the 10 (ten) alternative banks that were compared along with the preference weights of all alternatives for criterion C1 through C6. From the results of calculations that optimize the two AHP and WP methods, we get A8, namely BTN (State Savings Bank) which gets the highest preference weight of 14,969. The ranking of the alternatives that get the highest to lowest preference weights, namely:

a. A 8 that is BTN with preference weight of 14.969
b. A3 that is BNI and A5 that is Mandiri with the same preference weight of 14.372
c. A1 that is BRI with preference weight of 13.818
d. A7 that is BCA with preference weight of 13.763
e. A4 that is BNI Syariah andn A6 that is Mandiri Syariah with preference weight of 13.603
f. A10 that is CIMB Niaga with preference weight of 13.191
g. A9 that is Bank Permata with preference weight of 12.160
h. A2 that is BRI Syariah with preference weight of 12.140

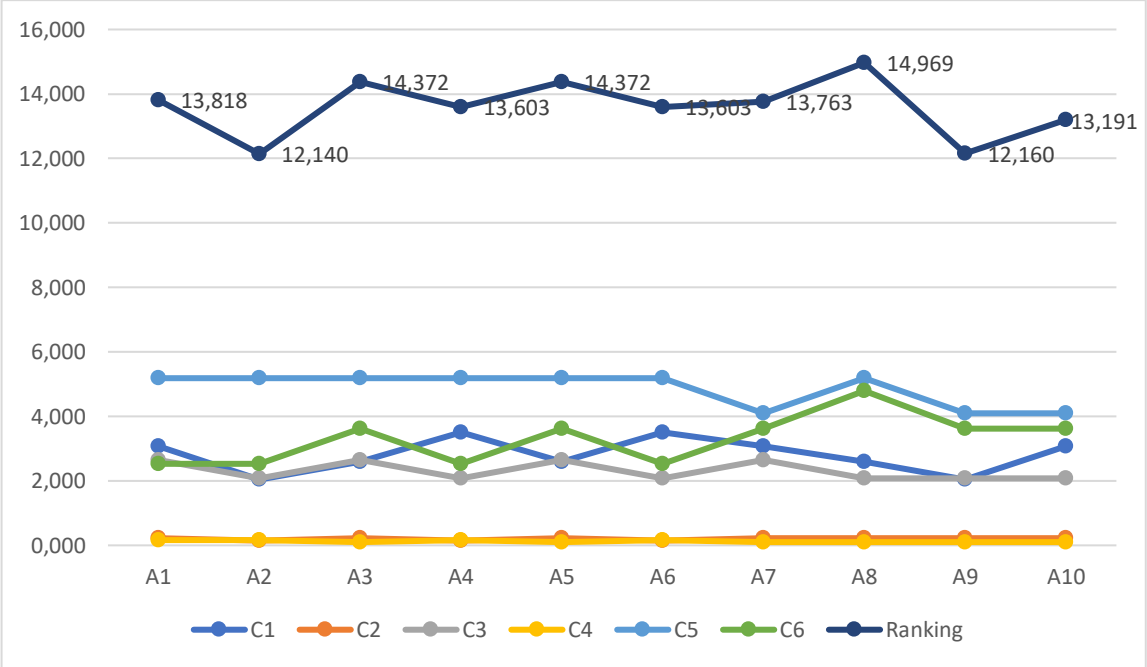

Figure 3. Diagram of Bank Election Ranking Results for KPR

4. CONCLUSION

The results of the research are carried out by combining two decision-making methods, namely the analytical hierarchy process method and the weighted product method in solving financial problems of public housing loans taken by customers by comparing 10 (ten) alternative banks with 6 (six) criteria. The most effective decision is obtained, namely BTN as a bank that is eligible to finance KPR with the highest preference weight of 14,969. However, it does not mean that other banks are not feasible. Only after comparing using 6 (six) criteria with 2 (two) methods, it can be concluded that BTN gets the highest preference weight. The author's suggestion for future research is to use a different method by optimizing the method used and comparing the results with this study, and then calculate the level of accuracy of the results of this study with real data in the field.

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