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DECISION SUPPORT SYSTEM DETERMINES THE PURCHASE OF HOUSE RIGHT USING ANALYTICAL HIERARCHY PROCESS (AHP) AND BORDA METHODS

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ABSTRACT

Increasing population growth also contributes to the increasing need for homes or dwellings as basic human needs. Many ways people do to meet these needs, among others, by buying from someone else, building it yourself or by buying a house in a housing developer. Houses besides being a basic human need, it is also used as an indicator of one's success and as an asset for business development and an increase in the economic value of the owner. Prospective home buyers certainly have criteria that are considered in choosing a house. Many of the existing criteria are often followed by the availability of more than one choice of the house to be able to meet these criteria. Therefore, the writer tries to try to make a Decision Support System in a Home Purchase that will later help prospective home buyers in deciding which house to buy. The decision-making method used in this system is an analytical hierarchy process (AHP) as a form of decision-making model that is suitable for multi-criteria and multi-alternative problems with the main input being human perception. Combined with the Borda method which is one method of group decision making that can combine the results of perceptual analysis (the results of AHP analysis) from several decision makers. it is necessary to have a group decision-making technique (group decision support system). So that the resulting home purchase decision can be accepted by all decision makers (family). From the results of the calculation and voting process, House X was chosen with 9 votes.

Keywords: *Home Purchase, Analytical Hierarchy Process, Borda*

1. INTRODUCTION.

Increasing population growth has led to an increase in the need for homes or dwellings as one of the basic human needs. Various ways people do to meet these needs. The developers or providers of housing compete to complement their housing with various different facilities to meet the needs of the community with a variety of choices and diverse criteria. In determining the choice of the house to be purchased, prospective buyers will not get into trouble if only one home option is available. The problem that arises is if more than one choice of house is available that has a variety of criteria or facilities to be fulfilled. These criteria are for example the location of the house, the location of the house, the shape of the house, the distance of the house to work and school, the availability of supporting facilities such as playgrounds, places of worship, sports venues, shops and so on. Another criterion that is generally also a consideration in making selections on alternative homes is financial criteria. Often financial limitations are the main factor underlying the prospective buyer to make a decision in choosing a house.

Although there are many criteria set by prospective home buyers, housing providers better understand and provide more criteria for criteria that can accommodate the desires of the criteria of prospective buyers. Considering these problems, a decision support system is needed that can be used extensively to facilitate and accelerate a person in making decisions about which house is the most optimal to meet the criteria that have been set. With one of the decision support system methods or techniques commonly used is AHP (Analytical Hierarchy Process).

The next obstacle is the number of decision makers. The process of buying a home must pay attention to the opinions or perceptions of some families who will later occupy the house. For example, father, mother, wife, and child. For this reason, there is a need for a group decision-making method that can unite several perceptions. Borda was chosen as the right method for analyzing several perceptions produced by the AHP method to be combined into one joint decision.

In the writing of this journal is also used a lot of literature as a reference to support the research conducted, such as including the following: Group Decision Support System For Unit Performance Assessment The Company Uses the TOPSIS Method and Borda (Case Study: Perum Jasa Tirta 1 Malang) (Alysha Ghea Arliana, 2018), Design of group decision support systems Topsis and Borda for evaluation of handling activities Road infrastructure (Renny Puspita Sari, 2014), Defining the Borda count in a linguistic decision making context (J.L. Garc´ıa-Lapresta, 2008), Partial justification of the Borda count (Black, 1976), The Borda count and agenda manipulation (Dummett, 1998), Borda’s rule, positional voting and Condorcet’s simple majority principle (P.C. Fishburn, 1976), Borda count versus approval voting: A fuzzy approach (J.L. Garc´ıa-Lapresta, 2002), Does the Borda rule provide more than a ranking? (Marchant, 2000), Multicriteria Decision Making : The Analytic Hierarchy Process (Saaty, 1990), Using the analytic hierarchy process for decision making in engineering applications: some challenges (Evangelos Triantaphyllou, 1995), Application of the Analytical Hierarchy Process (AHP) to Multi-Criteria Analysis for Contractor Selection (Mohammed Balubaid, 2015), Application of the Analytic Hierarchy Process (AHP) in MultiCriteria Analysis of the Selection of Cranes (Doraid Dalalah, 2010), An analytic hierarchy process approach for supplier selection: a case study (Qiang, 2014).

This research is organized as follows, chapter 1 introduction, chapter 2 shows material and methodology, chapter 3 shows the results of data and discussion, chapter 4 conclusion.

2. MATERIAL/METHODOLOGY.

2.1. Decision Support System (SPK).

Decision support system (SPK) is a system that is able to provide problem solving and communication skills to problems with semi-structured and unstructured conditions (Dewanto J., 2007). This system is used to help decision making in semi-structured situations and unstructured situations, where no one knows exactly how decisions should be made (Turban, 2005). SPK is a computer-based information system that provides interactive information support for managers and business practitioners during the decision-making process (O’Brien, 2006). SPK is a computer-based information system that combines models and data to solve problems and some structural problems with broad user involvement (Turban, 2006). SP is designed to help managers solve certain problems (McLeod, 2008). From the various definitions, it can be concluded that a decision support system is a tool or method that supports making a decision which is a system that is able to provide problem solving capabilities with semi-structured and unstructured conditions.

2.2. AHP (Analytical Hierarchy Process).

Analytic Hierarchy Process (AHP) is a method of decision making using pairwise comparisons of each criterion. This theory was first introduced by Thomas Saaty. Cases that often use this method usually have multilevel criteria, there are sub-criteria of each criterion or just some criteria (Saaty, 2008). AHP can also track inconsistencies in the judgment and preferences of assessors (Saaty, 1991), so leaders are able to assess the quality of their staff's knowledge and the stability of the solutions produced. AHP compiles feelings and intuition and logic in a structured design for decision making (Oei, 2012). In solving problems with AHP, the initial stage in applying this method is to construct the structure of the objectives, criteria, sub-criteria, and alternatives to decision making. After that, determine the weights of the paired comparisons of each criterion. the last calculation of the calculation by pairwise comparison (Kurniawati, 2011) and (Malik, Al-Khatani and Naushad, 2013).

Table 2. Scale pairwise comparison

Intensity of interest	Information	Eksplanation
1	Both elements are equally important	Two elements have a influence as big as the goal
3	One element is a little more important than the other elements	Experience and judgment favor a single element compared to other elements
5	One element is more important than the other elements	Experience and assessment strongly support one element compared to other elements
7	One element is clearly more important than other elements	One strong element is supported and dominant seen in practice
9	One element is absolutely important than other elements	Evidence that supports one element against another element has the highest degree of affirmation that might strengthen
2,4,6,8	The values between two consideration values are close together	This value is given if there are two compromises between the two choices
the opposite	If for activity i get one number compared with activity j, then j has the opposite value compared to i	

2.3. Borda.

Borda is a group decision support method that is done by multiplying the reference value by the weight of the ranking (Klamler, 2004). Borda determines the winner who has the most points. Borda gives a certain number of points for each candidate according to the ranking set by each decision maker (Zarghami, 2011). Winners will be determined by the number of points collected or obtained from each candidate (Wu, 2011).

The steps for calculating with the Borda method include:

1. Every decision maker gives a n-1 value for the first choice alternative, n-2 value for the second choice alternative, and 0 for the last choice alternative.
2. The alternative with the highest total value is the winner.
3. For example: there are 3 alternatives with 9 voters 2 - 1 - 0

4 situations where X> Y> Z,

X: 4x2 + 3x0 + 2x0 = 8 votes

3 circum stances where Y> Z> X,

Y: 4x1 + 3x2 + 2x1 = 12 votes

2 conditions where Z> Y> X,

Z: 4x0 + 3x1 + 2x2 = 7 votes

Remarks: rank 1 is given a value of 2, rank 2 is given a value of 1, and rank 3 is given a value of 0. Where n = 3.

The result is Y as the winner.

2.4. Research Methodology.

To solve problems in the observed research, steps are needed and determined to describe the approach and model of the problem. The steps taken are:

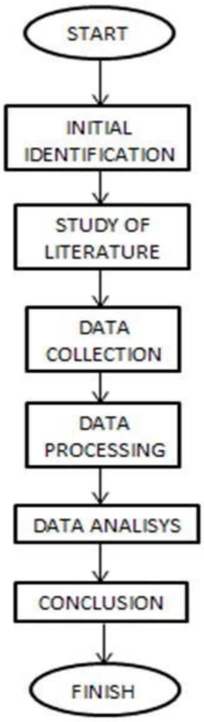

Fig. 1 Research Methodology Flowchart.

Target: the purpose of this study is to produce a decision support system by combining the results of the calculation of different perceptions of each prospective family home buyer so that the resulting home purchase can be accepted by all decision makers (family).

Steps: the steps of this study are step 1 Determine the main criteria of a house, step 2 calculates and ranks or the order of values of existing home alternatives, step 3 combines the results of the ranking and perception of each family member. with the Borda method, step 4 Makes a decision based on the biggest results of the calculation, step 5 provides suggestions for improvement and conclusions.

Decision support systems are made using the AHP method, where the hierarchy used for the benefit of this decision support system can be seen in Figure 2.

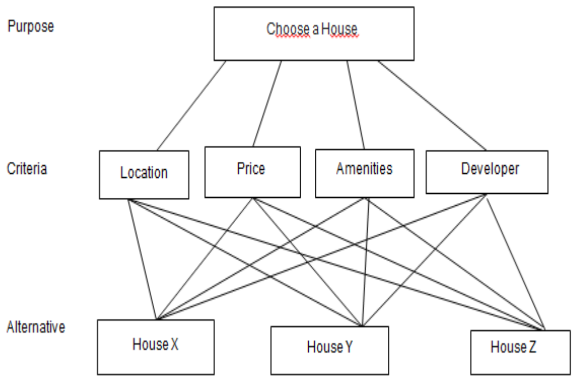

Fig. 2 The Hierarchy of Objectives of the House Purchasing Process

In this study, three examples of alternative home pieces will be used, namely Rumah X, Rumah Y, and Rumah Z. Each alternative home will be assessed based on 4 main criteria, namely Location, Price, Facilities, and Developer. Where these criteria will be filled with perceptions of prospective home buyers. After the criteria are filled in, the next step will be to do calculations based on the calculation steps in the AHP method. The result of the calculation is in the form of rank or sequence of values from existing home alternatives.

Every family member of a prospective buyer has their own perceptions. Therefore, the results of calculations produced based on the perceptions of each family member can vary. There are those who favor Rumah X, Rumah Y, and there are also those who favor Rumah Z. Each house has its own rating in each family member. To combine some of the results of these calculations, it is necessary to use a group decision-making model namely Borda so that the results of calculations from each family member can be put together into a joint decision.

3. RESULTS AND DISCUSSION.

This study will simulate a method of selecting houses to be purchased using the AHP Decision Support System and Borda. It is assumed there is a prospective home buyer who will determine the choice of a house that he bought. To determine which house to buy, a prospective home buyer will have the criteria to be considered. For example, location, price, facilities, and developers. And every alternative home certainly has different criteria data. The following in Table 3.1 will show the criteria data from the existing home alternatives.

Table 1.. Data criteria for existing home alternatives

Criteria	House X	House Y	House Z
Location	City center	Suburbs	Countryside
Price	1 billion	500 million	250 million
Amenities	Electricity, PAM Water, and Parks	Electricity, PAM Water, and Parks	Electricity, Well Water, and Gardens
Developer	PT. Mitra Mandiri	PT. Segara Mas	PT. Bangkit Jaya

For example, of the four criteria, prospective home buyers assume:

- Location is more important than price
- Prices are more important than facilities, and
- Facilities are more important than developers

Then the pairwise comparison matrix for the criteria that can be made looks like in Table 3.2.

Table 2. Pairwise comparison matrix for criteria

	Location	Price	Amenities	Developer
Location	1	3	5	7
Price	1/3	1	3	5
Amenities	1/5	1/3	1	3
Developer	1/7	1/5	1/3	1

After getting the paired comparison matrix for the criteria, the following calculations are carried out:

1. Add the values of each column on the matrix.
2. Divide each value from the column with the total column in question to obtain the normalization of the matrix.
3. Add the values of each row and divide by the number of elements (matrix order) to get the average value.
4. After doing the previous calculation, a normalized matrix will be obtained as shown in Table 3.

Table 3. Normalized matrix

	Location	Price	Amenities	Developer	line average
Location	0,59659091	0,66176471	0,53571429	0,4375	0,55789248
Price	0,19886364	0,22058824	0,32142857	0,3125	0,26334511
Amenities	0,11931818	0,07352941	0,10714286	0,1875	0,12187261
Developer	0,08522727	0,04411765	0,03571429	0,0625	0,0568898

The results of line averages are also called relative priorities. In making decisions, it is important to know how well consistency exists because we do not want decisions based on considerations with low consistency. The things done in this step are (Kusrini, 2007):

1. Multiply each value in the first column with the relative priority of the first element, the value in the second column with the relative priority of the second element, and so on.
2. Add up each row.
3. The results of the sum of rows divided by the relative priority elements concerned.
4. Add the quotient above, then divide the number of elements, the result is called λ max.
5. Calculate Consistency Index (CI) with the formula:

CI = (λ max-n) / (n-1),

where **n** = number of elements (matrix order)

6. Calculate Consistency Ratio (CR) with the formula:

CR = CI / IR

Where **CR** = Consistency Ratio

CI = Consistency Index

IR = Index Random Consistency

7. Check the consistency of hierarchies. If the value is more than 10%, then the assessment of data judgment must be corrected. But if the

Consistency Ratio (CR) is less or equal to 0.1, then the calculation results can be stated correctly.

List of Index Random Consistency (IR) can be seen in Table 4.

Table 4. List of Index Random Consistency (IR)

Size (order) matrix	IR value
1,2	0 , 00
3	0 , 58
4	0 , 90
5	1 , 12
6	1 , 24
7	1 , 32
8	1 , 41
9	1 , 45
10	1 , 49
11	1 , 51
12	1 , 48
13	1 , 56
14	1 , 57
15	1 , 59

After calculating the Consistency Ratio (CR), a CR is **0.04387617 (eligible)**.

The next step we are working on is to create an alternative paired comparison matrix for location criteria. If prospective home buyers assume that the location of house X is better than house Y and the location of house Y is better than house Z, then the alternative paired comparison matrix for location criteria will appear as in Table 5.

Table 5. Alternative pairing matrix for location criteria

Alternative	House x	House y	House z
House X	1	3	5
House Y	0,333333	1	3
House Z	0,2	0,33333333	1

From the matrix in Table 7, we get a relative priority for **home X = 0.633346**, for **house Y = 0.260498**, and for **house Z = 0.106156**. With **Consistency Ratio = 0.033375 (eligible)**.

After we create an alternative paired comparison matrix for location criteria, then we create an alternative paired comparison matrix for the price criteria. If prospective home buyers assume that Z house prices are better than house Y and house price Y is better than house X, then the alternative paired comparison matrix for price criteria will appear as in Table 6.

Table 6. Alternative pairing comparison matrix for price criteria

Alternative	House X	House Y	House Z
House X	1	0,33333333	0 , 2
House Y	3	1	0,333333333
House Z	5	3	1

From the matrix in Table 5, we get a relative priority for **houses X = 0.106156**, for **houses Y = 0.260498**, and for **houses Z = 0.633346**. With **Consistency Ratio = 0.033375 (eligible)**.

After we create an alternative paired comparison matrix for price criteria, then we create an alternative paired comparison matrix for the facility criteria. If prospective home buyers assume that house X facilities are better than house Z and Z house facilities are better than house Y, then the alternative paired comparison matrix for facility criteria will appear as in Table 7.

Table 7. Alternative pairing matrix for facility criteria

Alternative	House X	House Y	House Z
House X	1	5	3
House Y	0,2	1	0,333333333
House Z	0,333333	3	1

From the matrix in Table 7, we get a relative priority for **home X = 0.633346**, for **houses Y = 0.106156**, and for **houses Z = 0.260498**. With **Consistency Ratio = 0.033375 (eligible)**.

After we create an alternative paired comparison matrix for facility criteria, then we create an alternative paired comparison matrix for developer criteria. If prospective home buyers assume that home developer Y is better than home

X and home developer X is better than home Z, then the alternative paired comparison matrix for developer criteria will appear as in Table 8.

Table 8. Alternative pairing matrix for developer criteria

Alternative	House X	House Y	House Z
House X	1	0,33333333	3
House Y	3	1	5
House Z	0,333333	0,2	1

From the matrix in Table 3.8, we get a relative priority for **home X = 0.260498**, for **house Y = 0.633346**, and for **house Z = 0.106156**. With **Consistency Ratio = 0.033375 (eligible)**.

The last step we do is make the final matrix determine the optimal weight. Data on the final matrix determining the optimal weight comes from relative priority data in the pairwise comparison matrix for alternative paired criteria and comparison matrices for location, price, facilities, and developer criteria. The results of the final matrix determining the optimal weight are shown in Table 9.

Table 9. The final matrix determines the optimal weight

Final calculation	Location 0,5578925	Price 0,263345	Amenities 0,1218726	Developer 0,05689	Weight
House X	0,6333457	0,106156	0,6333457	0,260498	0,473302
House Y	0,260498	0,260498	0,1061563	0,633346	0,262899
House Z	0,1061563	0,633346	0,260498	0,106156	0,263799
OPTIMAL / MAXIMUM BLOB					**0,473302**

Weight on House X was obtained from (0.5578925 x 0.6333457) + (0.263345 x 0.106156) + (0.1218726 x 0.6333457) + (0.05689 x 0.260498) = 0.473302. For weights in homes Y and Z, can be searched in the same way / similar to the one at home X.

From the final matrix to determine the optimal weight, we obtain the optimal/maximum weight at House X with a weight value = 0.473302. Therefore, the house that is recommended to be chosen/purchased based on the perception that has been entered is House X.

This result is only the result of the calculation of perceptions entered by one of the prospective family home buyers. What about the results of the calculation of perceptions from other family members? With the AHP method, each family member can calculate perceptions. Where the results of the calculation in the form of a sequence or ranking of the existing alternative home. And to combine the results of the calculation of the overall ranking of the house from every perception of family members, we can use methods of decision making in borda groups. The technique used by borders to combine the results of the calculation of house rank by voting.

For example, in a home purchase, there are 3 alternative houses and 6 voters/decision makers. Where the results of calculating the ranking of houses with borders can be seen in Table 10.

Table 10. The results of calculating the ranking of houses with borda

Rating calculations	Rank 1 (value 2)	Rating 2 (value 1)	Rating 3 (value 0)	Vote
Husband	X	Z	Y	X : 1x2 + 1x1 + 2x2 + 2x1 = 2+1+4+2 = 9 votes
Wife	Z	X	Y	Y : 1x0 + 1x0 + 2x1 + 2x2 = 0+0+2+4 = 6 votes
Children (2 people)	X	Y	Z	Z : 1x1 + 1x2 + 2x0 + 2x0 = 1+2+0+0 = 3 votes
Father and mother	Y	X	Z	From the results of the voting, House X was chosen

4. CONCLUSION.

Based on the research that has been done, the following conclusions are taken:

1. Decision Support Systems using the AHP method can be applied to cases of home purchases.
2. Decision Support Systems with the AHP method can solve multi-criteria and multi-alternative problems.

3. The Decision Support System using the AHP method can generate suggestions on home purchases based on perceptions entered by prospective home buyers.
4. To combine the results of the calculation of perceptions that are different from each family member of a prospective home buyer, it can be used methods of decision making in borda groups.
5. From the results of the calculation and voting process, House X was chosen with 9 votes.

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