Into the Furniture Woods: Analytical Hierarchy Process Method

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Abstract: ***Sidojaya Furniture is one of the Small and Medium Enterprises that is still developing in improving its business. Related with the lack of information obtained by furniture craftsmen in determining qualified wood, Sidojaya Furniture has problems in determining qualified wood that matches with specified criteria for making furniture quickly and accurately. The objective to be achieved from this study was to create Decision Support System for selecting qualified wood in Sidojaya Furniture using AHP (Analytical Hierarchy Process) Method and using Microsoft Visual Basic programming language that can help provide information about qualified wood for furniture production, so that craftsmen can make decisions quickly to make choice. AHP method is a method of breaking complex/ complicated problem in unstructured situation into component parts. Decision support system for the selection of qualified wood can make it easier for craftsmen to decide on the type and nature of qualified wood and obtain information about the texture, color, direction of fiber, age, durability and growing place of wood to be used. From three alternatives tested, it can be obtained, the decision of qualified wood can be used to make furniture was teak wood with a weight score of 1.389.***

Index Terms*: *Furniture, Qualified Wood, Analytical Hierarchy Process, DSS.

I. INTRODUCTION

1.1 Background

In the era of free competition, especially in the field of furniture today that is growing very rapidly. As said by Chairman of Indonesian Furniture and Handicraft Industry Association (Asmindo) Komda Soleraya, Yanti Rukmana, The development of furniture industry is extremely fast, especially for the American and European markets, the product trend is more directed to furniture industry. Therefore, in the free competition in the field of furniture it is needed to have the best quality, so that the furniture craftsmen must be careful in choosing, selecting and determining qualified wood for furniture manufacturing.

The results [1] explained the decision support system model to determine the quality of wood using AHP method, there were 5 criteria namely Physical Properties of Wood, Mechanical Properties of Wood, Class of Wood, Age of wood and Substance of wood, while for alternatives consist of Teak, Acacia Wood, Mahogany Wood and Trembesi Wood . Then research [2] generated Decision support system for choosing furniture, it can make it easier for consumer to determine the decision to buy furniture and get information about the price, size, quality of wood used, gallery, and furniture manufacturer in Jepara. This decision support system is effective and efficient in the use of time, cost, and energy for users who use it.

The selection process in determining qualified wood at Sidojaya Furniture still faces obstacles in the process of decision making. This is because there is no objective and fast method for determining qualitfied wood. Therefore, in this study the author tried to use one method of DSS (Decission Support System) or what is often referred to as DSS [3][4] by using AHP (Analytical Hierarchy Process) method.

In this study, it used AHP (Analytical Hirearchy Process) method, because the AHP method is a multi-criteria decision making model and optimized into a systematic process so that it makes it easier to make a decision. With the existence of qualified wood for furniture manufacturing on Sidojaya furniture, furniture craftsmen can find qualified wood for furniture manufacturing. Providing appropriate and accurate assessment and in accordance with the criteria in determining qualified wood for furniture manufacturing in Sidojaya Furniture.

1.2. Problem Formulation

Based on background above, it can be formulated the problems to be finished namely :

1. How is the process and determination of qualified wood for making furniture at Sidojaya furniture ?
2. How is the implementation of AHP method in determining qualified wood at Sidojaya furniture ?

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3. How to design and develop decision support system in qualified wood determination at Sidojaya Furniture ?

1.3. Objectives and Benefit of Research

The objectives of this research were :

1. To know process and regulation in qualified wood determination to make furniture at Sidojaya furniture.
2. To know the implementation of Analytical Hierarchy Process method to determine qualified wood to produce furniture at Sidojaya furniture.
3. To know, design and develop decision support system in determining qualified wood to produce furniture at Sidojaya furniture.
4. By the existance of qualified wood determination to produce furniture at Sidojay furniture for every craftsmen can know qualified wood to make furniture.
5. Give right and accurate assesment and in accordance with criteria in determining qualified wood in producing furniture.

II. THEORETICAL BASE

2.1. Analytical Hierarchy Process Method

AHP method [5], [6] is one model for decision making that can help human thinking. Basically AHP is a method that breaks down a complex and unstructured problem into groups, arranges these groups into a hierarchical arrangement, incorporate numerical score instead of human perceptions in carrying out relative comparisons, and finally with a synthesis determined which elements have highest priority. The AHP method uses the perception of people who are favored by Pexpertse, that is, people who really understand the problems raised, feel the consequences of a problem, or who have an interest in the problem[7].

2.2. Decision Support System Charateristics

DSS, according to connotative review, it is a system aimed at higher levels of management, with emphasis on the following characteristics [8], [9] :

a. Focusing on decisions, aimed at top manager and decision maker.

b. Emphasize flexibility, adaptability and fast response.

c. Able to support various decision-making styles and individual managers.

2.3. Procedure in using the Analytical Hirearchy Process Method (AHP)

The procedure in using the AHP method consists of several stages, namely [10][11][12], [13]:

1. Arrange the hierarchy of the problem faced by hierarchical preparation, namely by determining the objectives which are the overall target of the system at the top level. The next level consists of criteria to assess or to consider alternatives and determine alternatives. Each criterion can has sub-criteria below it and each criterion can have the score of each intensity.

2. Determine element priorities with following steps :

a. Make paired comparison. The first step in determining element priority is to make a paired comparison, which is to compare elements in pairs according to the criteria given. For pairwise comparisons, a matrix form is used. The matrix is simple, strong in position that offers a framework for checking consistency, obtaining additional information by making all possible comparisons and analyzing overall sensitivity priority to change considerations. To start the pairwise comparison process, it starts from the top level of the hierarchy to choose criteria, for example C, then from the level below the elements to be compared are taken, for example A1, A2, A3, A4, A5, then the arrangement of elements in a matrix like Table 1.

Table 1. Paired comparison matrix

C	**A1**	**A2**	**A3**
A1	**1**		
A2		**1**	
A3			**1**

a. Filling a paired comparison matrix To fill in a paired comparison matrix, it uses numbers to represent the relative importance of one element to the other in question in the form of a scale from 1 to 9. This scale defines and explains score from 1 to 9 for consideration in the pairwise comparison of elements in each level of hierarchy towards a higher level criteria. If an element is in a matrix and compared to itself, it is given a score of 1. If i is compared with j it gets a certain score, then j compared with i is the reverse. In table 2 provides a definition and explanation of the quantitative scale from 1 to 9 to assess the importance of an element with other elements.

Table 2. Quantitative scale in decision support system

Interest Importance	**Definition**	**Explanation**
1	Both elements are important	Both elements have same influence to purpose
3	One element is a little bit more important than another element	Experience and assesment are a little bit supporting an element than another element.
5	One element is more important than another element	Experience and assesment are very stroing in supporting an element than another element.
7	One element is clerly more absolute than other elements	One strong element is supported and dominant seen in practice
9	One absolute element is more important than another element	Evidence that supports one element to another element has highest affirmation that strenghten.
2,4,6,8	Scores between two near considerations	This score is given if there are two compromises between two choices

The opposite: if activity i gets one number compared to activity j, then it has the opposite score compared.

b. Synthesis Consideration for pairwise comparisons is synthesized to obtain overall priorities with the following steps [14] [15][16]:

- Add scores from each column in matrix
- Divide each score from column with relevant total column to obtain matrix normalization.
- Add scores from each matrix and divide with the number of elements to obtain average score.
- Measuring consistency. In decision maker, it is important to know how well consistency exists, because we do not want decision based on considerations with low consistency. Because with low consistency, consideration will appear as something random and inaccurate. Consistency is important to get valid results in the real world. AHP measures consistency considerations with consistency ratios. Consistency values ratios must be less than 5% for 3x3 matrices, 9% for 4x4 and 10% matrices for larger matrices. If more than the ratio of the boundary, then the value of the matrix comparison is done again. The steps to calculate the consistency ratio score are:
  i. Multiply score of first column with first priority relative element, score of second column with second priority relative element and so on.
  ii. Add every row
  iii. The results of row addition are divided with related relative priority element.
  iv. Divide the results above with existing element, the results are called eigen value (λmax).
  v. Calculate consistency index with formula :
  CI = (λmax-n)/n
  Where CI : *Consistency Index*
  λmax : Eigen Value
  n : The number of elements
  vi. Calculate consistency ratio (CR) with formula :
  CR=CI/RC
  Where : CR : *Consistency ratio*
  CI : *Consistency Index*
  RC : *Random Consistency*

Random matrix with rating scales from 1 to 9 along with the inverse as random consistency (RC). Based on current calculations using 500 samples, if the consideration is to choose randomly from a scale of 1/9, 1/8, ..., 1, 2, ..., 9, the average consistency for different matrices will be obtained as in Table 3.

Table 3. Average consistency score

Matrix Size (n)	Random Consistency (IR)
1	**0,00**
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**

2.4. Microsoft Visual Basic

Visual Basic [17] is derived from the BASIC programming language and offers rapid development of graphical computer software. Some script languages such as Visual Basic for Application (VBA) and Visual Basic Scripting Edition (VBScript), are similar to Visual Basic, but they work differently. Programmers can build applications using components provided by Microsoft Visual Basic. Programs written in Visual Basic also use the Windows API, but require additional external function declarations. Visual Basic is built to create a simple scripting language for graphical user interfaces that are developed in Microsoft Windows operating systems. [18].

III. RESEARCH METHOD

3.1. Data Analysis

The purpose of system analysis in the development of decision support system application is to get all the needs of users and systems, which includes inputs and outputs that must be provided by the system, as well as information needed by users. The process will be an input for the overall system design process for determining qualified wood for furniture manufacturing. Sidojaya Furniture UKM owner does not have certain standards in determining qualified wood for furniture manufacturing. The Sidojaya furniture UKM owner assigned score and weights for each criterion. The score and weights stated in the order of priority criteria. The system only provided the results information in the form of the sequential data criteria then the HR team with the help of an application program determine the qualified wood. To help furniture craftsmen determine qualified wood for furniture manufacturing using the Analytical Hirearchy Process Method.

3.2. Data Input Process

The process of input data was divided into several parts and all data input were carried out by the owner of Sidojaya Furniture who had a user name and password in accordance with the access right. The inputted data among others :

1. Texture data input
2. Color data input
3. Fiber direction data
4. Age data input Change formed matrix Pairwise Comparison
5. Resilience data input

6. Growing place data input

3.3. AHP Calculation

Assign problem, criteria and sub criteria

a. Criteria :

C1 : Texture
C2 : colour
C3 : fiber direction
C4 : age
C5 : resilience
C6 : growing place

b. **Sub Criteria :**

Table 4. Sub Criteria

Sub Criteria		Score
Texture	Tenuous pore	1
	Medium pore	2
	Solid pore	3
Colour	Light	1
	Medium	2
	Dark	3
Fiber direction	Circular	1
	Cohesive	2
	Straight	3
Age	Young	1
	Medium	2
	Old	3
Resilience	Hot	1
	Water	2
	Termite	3
Growing Place	Humid	1
	Fertile	2
	Pebble	3

Table 5. P*airwise Comparison* matrix

C	C1	C2	C3	C4	C5	C6
C1	1	3	5	2	4	2
C2	1/3	1	1/3	1/5	1/5	½
C3	1/5	3	1	1/5	1/5	1/5
C4	½	5	5	1	1/3	1/3
C5	¼	5	5	3	1	1/3
C6	½	2	7	3	3	1

Table 6. In decimal form

C	C1	C2	C3	C4	C5	C6
C1	1,000	3,000	5,000	2,000	4,000	2,000
C2	0,333	1,000	0,333	0,200	0,200	0,500
C3	0,200	3,000	1,000	0,200	0,200	0,200
C4	0,500	5,000	5,000	1,000	0,333	0,333
C5	0,250	5,000	5,000	3,000	1,000	0,333
C6	0,500	2,000	7,000	3,00	3,00	1,00
				0	0	0
Number of Column	**2,783**	**19,000**	**23,333**	**9,200**	**8,733**	**4,366**

Table 7. Divide elements in each column with the number of related columns

C	CI	C2	C3	C4	C5	C6
C1	0,369	0,158	0,215	0,128	0,458	0,458
C2	0,120	0,053	0,014	0,022	0,023	0,115
C3	0,072	0,158	0,042	0,022	0,023	0,046
C4	0,180	0,264	0,215	0,109	0,039	0,077
C5	0,090	0,264	0,215	0,326	0,115	0,077
C6	0,180	0,106	0,300	0,326	0,344	0,230

Calculate normalized *Eigen Vector* by : adding every row then divided with the number of criteria

C	C1	C2	C3	C4	C5	C6	Jumlah Baris	Eigen vector normalisasi
C1	0,369	0,158	0,215	0,128	0,458	0,458	1,777	0,297
C2	0,120	0,053	0,014	0,022	0,023	0,115	0,470	0,794
C3	0,072	0,158	0,042	0,022	0,023	0,046	0,364	0,061
C4	0,180	0,264	0,215	0,109	0,039	0,077	0,884	0,148
C5	0,090	0,264	0,215	0,326	0,115	0,077	1,088	0,182
C6ccc6	0,180	0,106	0,300	0,326	0,344	0,230	1,486	0,248

Table 8. Calculate paired comparison between subcriteria element of texture

Texture	PP	PS	PR	The number of rows	Normalized eigen vector
PP	0,632	0,667	0,571	1,870	0,623
PS	0,286	0,222	0,211	0,718	0,239
PR	0,158	0,111	0,412	0,412	0,137

Table 9. Calculate paired comparison between subcriteria element of colour

Colour	GL	SD	TR	The number of rows	Normalized eigen vector
GL	0,632	0,667	0,571	1,870	0,623
SD	0,286	0,222	0,211	0,718	0,239

TR	0,158	0,111	0,412	0,412	0,137
LB	0,158	0,111	0,412	0,412	0,137

Wood name	Texture	Colour	Fiber direction	age	resilience	Growing place	Results
Teak	2	2	2	3	3	3	1,389
dadap	1	1	3	2	2	2	0,645
Cempaka (shorea)	3	2	3	3	3	3	0,463

Table 10. Calculate paired comparison between subcriteria element of fiber direction

Fiber direction	LR	BP	ML	The number of rows	Normalized eigen vector
LR	0,632	0,667	0,571	1,870	0,623
BP	0,286	0,222	0,211	0,718	0,239
ML	0,158	0,111	0,412	0,412	0,137

Table 11. Calculate paired comparison between subcriteria element of age

Age	TU	SD	MD	The number of rows	Normalized eigen vector
TU	0,632	0,667	0,571	1,870	0,623
SD	0,286	0,222	0,211	0,718	0,239
MD	0,158	0,111	0,412	0,412	0,137

Table 12. Calculate paired comparison between subcriteria element of resilience

Resilience	RY	AI	PN	The number of rows	Normalized eigen vector
RY	0,632	0,667	0,571	1,870	0,623
AI	0,286	0,222	0,211	0,718	0,239
PN	0,158	0,111	0,412	0,412	0,137

Table 13. Calculate paired comparison between subcriteria element of growing place

Growing place	KR	SB	LB	The number of rows	Normalized eigen vector
KR	0,632	0,667	0,571	1,870	0,623
SB	0,286	0,222	0,211	0,718	0,239

After receiving the input score of a paired comparison, the system will calculate the AHP criteria and sub criteria to get priority weight score in each criteria. The example output generated is shown in table2 below:

Table 14. The score of sub criteria element priority assesment

From the above assessment, it can be obtained that the decision on quality wood that can be used to make furniture is teak wood with a weight score of 1,389.

3.4. Program Implementation

The application of a decision support system to determine quality wood for furniture manufacturing in Sidojaya Furniture using Microsoft Visual Basic applications had several forms, among others :

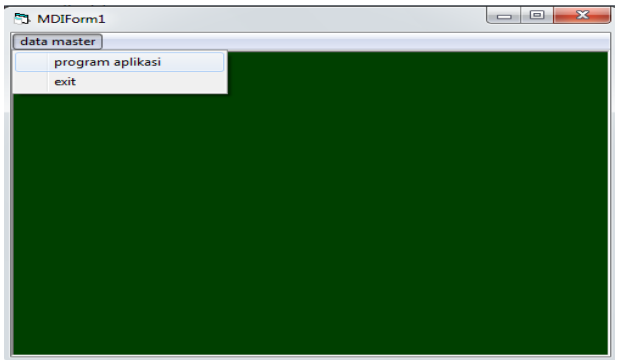

Figure 1. Main menu form

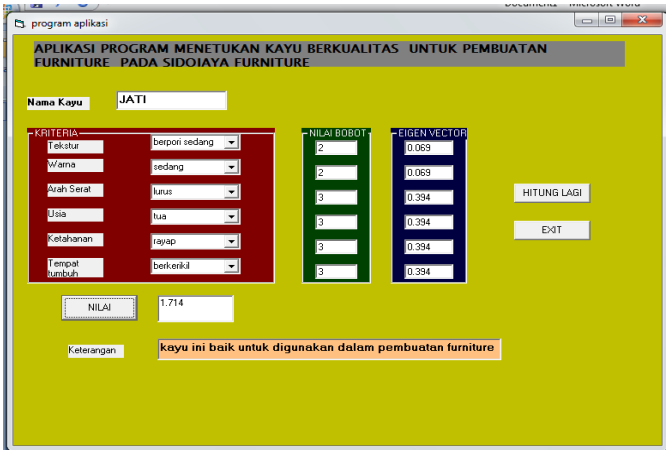

Figure 2. Program application

IV. CONCLUSION

Based on the results of research from the design and construction of decision support system applications in determining qualified wood for furniture production using AHP method (Analytical Hirearchy Process) then conclusions can be drawn are as follows:

1. Application of decision support system for determining qualified wood for furniture

production can help furniture craftsmen in making decision for determining qualified wood in Sidojaya Furniture.

2. The use of the AHP (Analytical Hierarchy Process) method on the application of the support system for determining qualified wood for furniture production will have different results, because it uses priority score or weights determined by furniture craftsmen who need quality wood into the system.
3. The more alternatives (types of wood) and the use of criteria that are more specific, the system will produce more accurate score from the wood selection process.
4. Application of decision support systems for determining qualified wood to simplify and accelerate furniture craftsmen for determining qualified wood for furniture production.

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