

CREDIT SCORING USING FUZZY AHP METHOD: CASE STUDY PT. BATAVIA PROSPERINDO FINANCE TBK

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Abstract:

The rapid technological advances in the automotive industry make the manufacturers and distributors of motor vehicles competing strictly. Purchase on credit is one solution that can help consumers to make purchases of the dream vehicle. This is a good news for lenders to be able to attract more debtors. However, if the lenders do not analyze the prospective borrowers carefully, it will result in a significantly higher Non Performing Loan (NPL) ratio. If this happens, most likely the credit companies will suffer huge losses. To suppress the NPL ratio requires an appropriate method to analyze consumers who apply for credit. One method that can be solve the problem is Credit Scoring. Credit Scoring is an analytical method used by banks in analyzing credit applications proposed by customers. The Credit Scoring method conducted at PT Batavia Prosperindo Finance Tbk still lacks efficiency. To solve this inefficient process, a Credit Scoring model was developed based on the Fuzzy AHP method that aims to assist lenders in making decisions whether or not a customer obtains credit. Credit Scoring based on Fuzzy AHP method is expected to be the right solution for PT Batavia Prosperindo Finance Tbk in making decision. With this Decision Support System Credit Approval, approval process at PT Batavia Prosperindo Finance to be faster than before based on UAT score 92%.

Keywords — Credit Scoring, Credit Analysis, Fuzzy AHP, Ratio Non Performing Loan, PT Batavia Prosperindo Finance Tbk.

I. INTRODUCTION

Technology in the automotive industry, especially four-wheeled vehicles, is currently experiencing rapid progress in terms of innovation. This can be seen from the number of car manufacturers issuing new models every year, maybe even six (6) months. Every new model issued by the car manufacturer has very sophisticated features with different price ranges. A car

is a necessity that can be said as important and not important. It is said to be important if indeed our work or situation requires us to own a car, otherwise it is said to be unimportant if it is purchased only to increase the prestige of the vehicle owner. The number of new models issued makes consumers have a large selection of models, ranging from cheap prices to expensive ones. For those who have established financial conditions, it is certainly not difficult to buy a car that they want

to own. This is different from consumers who only have income that is not too large and want to buy the car they dream of.

In general, people who want to own a car but cannot afford to buy in cash, then another way that can be done is to apply for credit from the leasing. To apply for a loan from the leasing, money is needed for the down payment. The amount of this down payment is determined by the leasing party so that each leasing company has a minimum down payment. Today, business competition in the financing sector is very tight. If there is a finance company that requires consumers to pay a down payment higher than other financing companies, then the company will not get many customers. Not only down payment, credit interest also determines consumers to apply for credit. This intense competition makes financing companies provide low down payments and low interest rates. This condition requires financing companies not to make mistakes in analyzing credit applications submitted by consumers. The term credit comes from the Greek language "credere" which means trust (Herprasetyo, 2012) [1]. According to Chapra (2000)[2], credit must be allocated with the aim of helping to realize social welfare in general. The purpose of the credit agreement according to Kasmir (2002) [3] is to provide benefits to banks, help customers' businesses and help the government. However, if a condition is encountered where the customer is unable to pay part or all of his obligations to the bank as agreed, this condition is called bad credit (Kuncoro and Suhardjono, 2002) [4].

As of November 2017, the amount of credit disbursement that had been realized was 7.47% year on year of Rp 228 trillion. As for the level of non-performing loans (non-performing loans) is still at a relatively maintained level, namely at the level of 3.08% for finance companies.

PT Batavia Prosperindo Finance Tbk, is a finance company that was established in 1994 and obtained a business license from a Finance Agency from the Ministry of Finance of the Republic of Indonesia which includes Financial Leases, Factoring, Credit Cards and Financing Consumer (Consumer Financing) based on the Decree of the Minister of Finance of the Republic of Indonesia No. 90 / KMK.017 / 1995 on February 15, 1995. This company conducts credit scoring for every consumer who requests credit. Credit scoring conducted at PT Batavia Prosperindo Finance Tbk still uses direct survey methods. Direct surveys are the most traditional method of credit scoring analysis and the analysis process takes a long time because in a day, an analyst can only analyze 2-3 credit applicants.

II. LITERATURE REVIEW

A. Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is one method of the Multi Criteria Decision Making (MCDM) developed by Prof. Thomas Lorie Saaty from Wharton Business School in the early

1970s. AHP is an analytical method used to create a problem model that does not have a structure, and can be used to solve quantitative problems and problems that require judgment. In addition, AHP can also be used to solve problems in complex situations. A complex problem can be interpreted as a criterion of many problems (multi criteria), unclear problem structure, uncertainty of opinion from decision makers, decision makers of more than one person, and inaccuracy of available data.

Basically AHP is a general theory of measurement used to find the ratio scale, both from discrete and continuous paired comparisons. These comparisons can be taken from actual or basic scale measures that reflect the strengths of relative feelings and preferences. AHP is also a framework for making decisions effectively on a problem by solving the problem into its parts, arranging these parts or variables in a hierarchical arrangement, giving numerical values to subjective considerations about the importance of each variable and synthesizing these considerations to determine which variables who has the highest priority and acts to influence the outcome of the situation.

The axiomatic foundation of the Analytical Hierarchy Process (AHP) consists of:

- a. Reciprocal Comparison, which means that the paired comparison matrix that is formed must be opposite. For example, if A is k times more important than B then B is 1/k times more important than A.
- b. Homogeneity, which means the similarity in comparison. For example, it is not possible to compare oranges with tennis balls in terms of taste, but more relevant when comparing weight.
- c. Dependence, which means that each level has a link (complete hierarchy) even though there may be an incomplete hierarchy).
- d. Expectation, which means highlighting expectations that are expectations and preferences of decision making. Assessment can be quantitative data or qualitative data.

B. Fuzzy AHP

The use of AHP in the Multi Criteria Decision Making (MCDM) problem is often criticized in relation to the lack of ability of the AHP approach to overcome the factor of inaccuracy experienced by decision makers when it must provide a definite value in the pairwise comparison matrix. Therefore, to overcome the existing AHP weaknesses a method called fuzzy AHP is developed. Fuzzy AHP method is a combination of AHP method with fuzzy approach. In fuzzy AHP method, Triangular Fuzzy Number (TFN) is used. TFN is used to describe linguistic variables with certainty. TFN is symbolized by $M = (l, m, u)$, where $l \leq m \leq u$ and l are the lowest values, m is the middle value and u is the top. The following table shows the TFN used for interest in pairwise comparison matrix (pairwise comparison).

TABLE OF MEMBERSHIP FUNCTIONS FOR FUZZY MEMBERSHIP
(FUZZY MEMBERSHIP FUNCTION)

Definisi	TFN
<i>Absolute</i> (mutlak lebih penting)	(7, 9, 9)
<i>Very strong</i> (sangat penting)	(5, 7, 9)
<i>Fairly strong</i> (lebih penting)	(3, 5, 7)
<i>Weak</i> (sedikit lebih penting)	(1, 3, 5)
<i>Equal</i> (sama penting)	(1, 1, 3)

If we suppose there are 2 TFNs namely $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$, then the Triangular Fuzzy Number arithmetic (TFN) operation is :

$$M_1 + M_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2) \quad (2.10)$$

$$M_1 \otimes M_2 = (l_1 l_2, m_1 m_2, u_1 u_2) \quad (2.11)$$

$$M_1^{-1} = (1/u_1, 1/m_1, 1/l_1) \quad (2.12)$$

III. SYSTEM AND APPLICATION DESIGN

A. Research Method

This research applies information systems development theory using system development methods, analysis and system design with object oriented approaches. Implementation of analysis and design results using Asp.Net based web programming.

Researchers design a system with knowledge formation using the AHP fuzzy method approach. The use of AHP fuzzy method because the object in this study is a financing service provider company for people who want to buy goods in non-cash and have a credit approval process that has not run optimally so that research needs to be done on the current credit approval process. The research is to measure and improve the quality of prospective customers so that the NPL ratio can be reduced and increase company profits. Credit scoring testing with UAT, the test is needed so that applications developed can meet the quality standards and meet the business needs of BPF companies. The results of this study are expected to use credit scoring models for finance companies.

B. Data Collection Method

Data collection has a function to get the information needed in order to achieve the objectives of a study. To get the data in this study used several methods of data collection, namely :

a. Library Studies

The library study is intended to obtain theoretical data or facts related to research. Literature study can be obtained by studying reference books, journals, literature and other sources that support research.

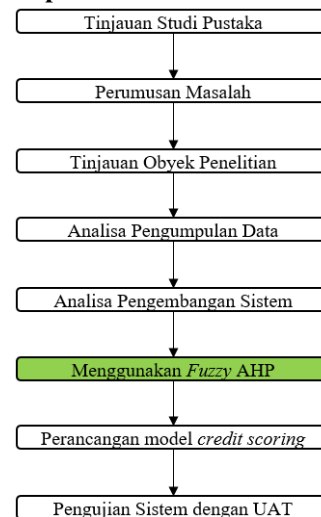
b. Observation

The method of observation or direct observation of the profile of the company and the object of research is done by structured observation by preparing a list of data needs and data sources. In this observation activity is carried out by collecting data through direct observation of phenomena that occur in the research location.

c. Questionnaires

Questionnaires are questions made by researchers to evaluating credit scoring modeling based on the boundaries of the subject matter and the story determined. Questionnaires were distributed to PT BPF marketing

C. Research Steps

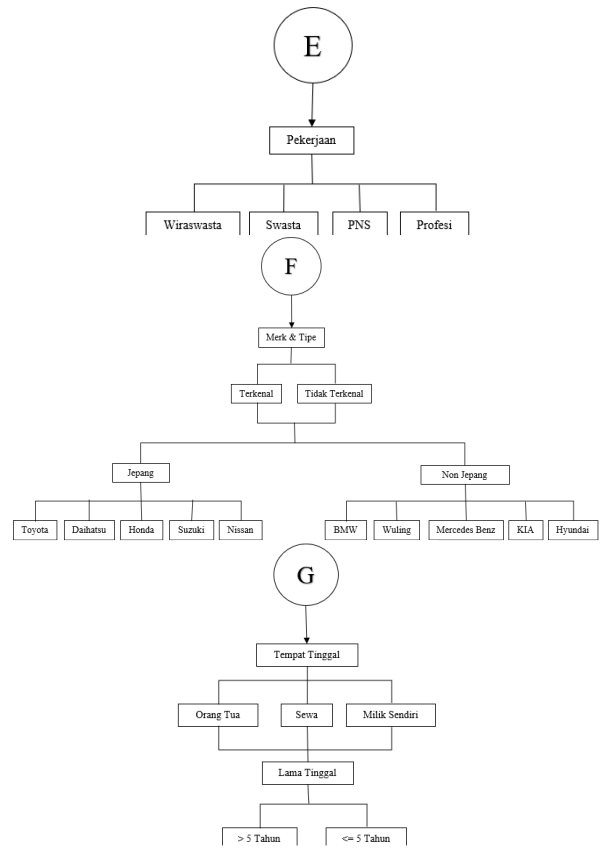
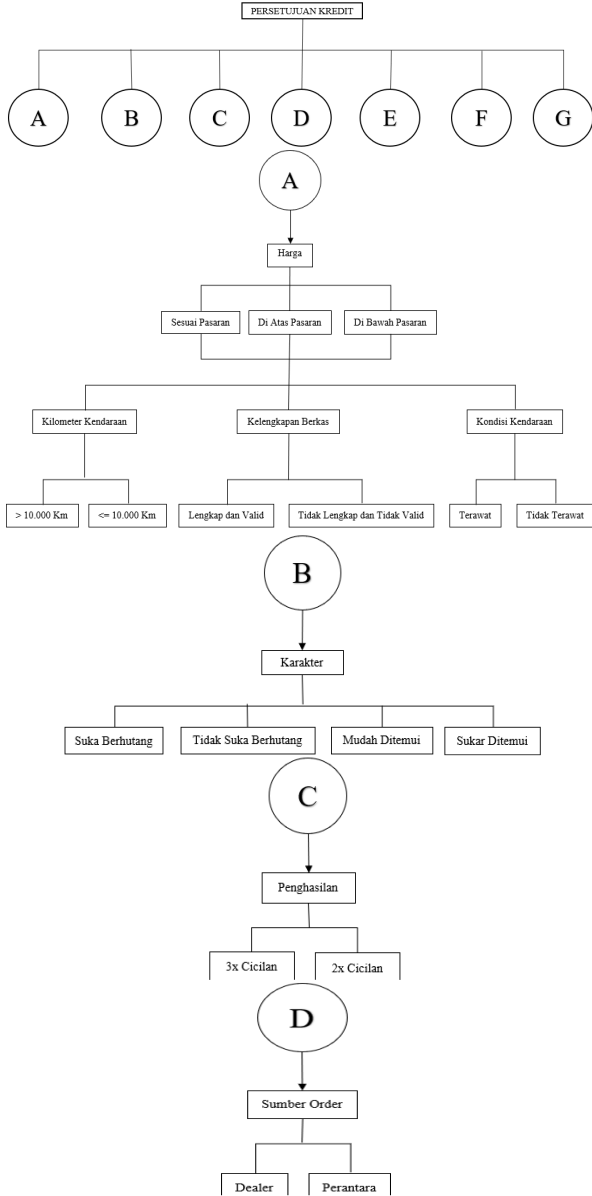


Explanation :

1. The researcher conducts a literature review conducted by searching several journals as reference material in accordance with the research topic,
2. Then the researcher formulates the existing problem and is adjusted to the reference of the previous problem which is suitable for research,
3. Researchers carry out a review of research objects by finding out the organizational structure of the company, the information system used, the number of employees to analyze the company's business needs,
4. Then the researcher observes directly to the place of research object and literature review from various sources.
5. Data analysis describes several diagrams to explain some of the relationships between users and the system,
6. The system development model uses prototyping models and knowledge formation using fuzzy AHP, In making the prototype, the researcher designed the database structure according to the needs using a

diagram illustrating the design of the credit scoring model interface. In the testing phase, researchers used the prototype specification testing using the UAT method.

D. Credit Approval Hierarchy



Explanation :

1. Price
Price is a benchmark of the value of a motor vehicle that will be traded. The price intended in this criterion is not the nominal price, but the suitability of the price to be traded at the market price of the motorized vehicle. This price criterion is also related to the condition of the motorized vehicle that will be traded.
2. Character
Characters are personal traits, character traits, traits, ways of life, family circumstances, hobbies and social conditions of credit applicants.
3. Income
The income that is used as a criterion in making this decision is the amount of income received by the credit applicant in 1 month. The income earned by the credit applicant will be faced with the installments to be charged later, whether the income from the credit applicant is able to pay the credit installments or not.
4. Source of Order
The source of the order is who brings the credit applicant to the credit provider.
5. Employment

Employment is the activity of a credit applicant who can make money or income.

6. Merk And Type

Merk And Type is a brand of motorized vehicle that will be traded. Brands and types intended in this criterion are not the actual brands and types, but the level of popularity of the brands and types of motor vehicles.

7. Residence

Residence is the place where the credit applicant lives.

E. Pairing matrix and conversion to Fuzzy AHP

Persetujuan Kredit	Harga	Merk & Tipe	Karakter	Tempat Tinggal	Pekerjaan	Penghasilan	Sumber Order
Harga	1.00	3.00	5.00	1.00	3.00	0.20	3.00
Merk & Tipe	0.33	1.00	3.00	0.33	3.00	0.20	3.00
Karakter	0.20	0.33	1.00	5.00	5.00	0.20	1.00
Tempat Tinggal	1.00	3.00	0.20	1.00	0.20	0.20	3.00
Pekerjaan	0.33	0.33	0.20	5.00	1.00	0.20	3.00
Penghasilan	5.00	5.00	5.00	5.00	5.00	1.00	3.00
Sumber Order	0.33	0.33	1.00	0.33	0.33	0.33	1.00

From the paired matrix for all criteria, it will be converted into fuzzy numbers and look for the defuzification value of these criteria. The first process is to convert paired matrices into fuzzy numbers according to the membership function table of fuzzy membership functions. The results look like the table below :

Persetujuan Kredit	Harga			Merk & Tipe			Karakter			Tempat Tinggal			Pekerjaan			Penghasilan			Sumber Order			
	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper	Lower	Middle	Upper	
Harga	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Merk & Tipe	0.20	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Karakter	0.14	0.20	0.33	0.20	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tempat Tinggal	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Pekerjaan	0.20	0.33	1.00	0.20	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Penghasilan	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Sumber Order	0.20	0.33	1.00	0.20	0.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

After being converted into fuzzy numbers, the next step is to determine the level of importance by calculating the geometric average in each row, namely by taking n from the multiplication of the values in the cell contained in the matrix row (n is the number of criteria / alternative).

Importance Level of Price =

$$l_{\text{harga}} = \sqrt[7]{(7 \times 1 \times 1 \times 3 \times 1 \times 1 \times 0.14 \times 1)} = 0.8834$$

$$m_{\text{harga}} = \sqrt[7]{(7 \times 1 \times 3 \times 5 \times 1 \times 3 \times 0.20 \times 3)} = 1.6013$$

$$u_{\text{harga}} = \sqrt[7]{(7 \times 3 \times 5 \times 7 \times 3 \times 5 \times 0.33 \times 5)} = 3.0748$$

Importance Level of Merk and Type =

$$l_{\text{Merk & Tipe}} = \sqrt[7]{(7 \times 0.20 \times 1 \times 1 \times 0.20 \times 1 \times 0.14 \times 1)} = 0.4768$$

$$m_{\text{Merk & Tipe}} = \sqrt[7]{(7 \times 0.33 \times 1 \times 3 \times 0.33 \times 3 \times 0.20 \times 3)} = 0.9270$$

$$u_{\text{Merk & Tipe}} = \sqrt[7]{(7 \times 1 \times 3 \times 5 \times 1 \times 5 \times 0.33 \times 5)} = 1.9904$$

Importance Level of Character =

$$l_{\text{Karakter}} = \sqrt[7]{(7 \times 0.14 \times 0.20 \times 1 \times 3 \times 3 \times 0.14 \times 1)} = 0.6202$$

$$m_{\text{Karakter}} = \sqrt[7]{(7 \times 0.20 \times 0.33 \times 1 \times 5 \times 5 \times 0.20 \times 1)} = 0.8535$$

$$u_{\text{Karakter}} = \sqrt[7]{(7 \times 0.33 \times 1 \times 3 \times 7 \times 7 \times 0.33 \times 3)} = 1.7386$$

Importance Level of Residence =

$$l_{\text{Tempat tinggal}} = \sqrt[7]{(7 \times 1 \times 1 \times 0.14 \times 1 \times 0.14 \times 0.14 \times 1)} = 0.4306$$

$$m_{\text{Tempat tinggal}} = \sqrt[7]{(7 \times 1 \times 3 \times 0.20 \times 1 \times 0.20 \times 0.20 \times 3)} = 0.6867$$

$$u_{\text{Tempat tinggal}} = \sqrt[7]{(7 \times 3 \times 5 \times 0.33 \times 3 \times 0.33 \times 0.33 \times 5)} = 1.3480$$

Importance Level of Employment =

$$l_{\text{Pekerjaan}} = \sqrt[7]{(7 \times 0.2 \times 0.2 \times 0.14 \times 3 \times 1 \times 0.14 \times 1)} = 0.4212$$

$$m_{\text{Pekerjaan}} = \sqrt[7]{(7 \times 0.33 \times 0.33 \times 0.2 \times 5 \times 1 \times 0.2 \times 3)} = 0.6772$$

$$u_{\text{Pekerjaan}} = \sqrt[7]{(7 \times 1 \times 1 \times 0.33 \times 7 \times 3 \times 0.33 \times 5)} = 1.4164$$

Importance Level of Income =

$$l_{\text{Penghasilan}} = \sqrt[7]{(7 \times 3 \times 3 \times 3 \times 3 \times 3 \times 1 \times 1)} = 2.1918$$

$$m_{\text{Penghasilan}} = \sqrt[7]{(7 \times 5 \times 5 \times 5 \times 5 \times 5 \times 1 \times 3)} = 3.6934$$

$$u_{\text{Penghasilan}} = \sqrt[7]{(7 \times 7 \times 7 \times 7 \times 7 \times 7 \times 3 \times 5)} = 5.9109$$

Importance Level of Source of Order =

$$l_{\text{Sumber Order}} = \sqrt[7]{(7 \times 0.2 \times 0.2 \times 1 \times 0.2 \times 0.2 \times 0.2 \times 1)} = 0.3168$$

$$m_{\text{Sumber Order}} = \sqrt[7]{(7 \times 0.33 \times 0.33 \times 1 \times 0.33 \times 0.33 \times 0.33 \times 1)} = 0.4530$$

$$u_{\text{Sumber Order}} = \sqrt[7]{(7 \times 1 \times 1 \times 3 \times 1 \times 1 \times 1 \times 3)} = 1.3687$$

Persetujuan Kredit	Lower	Middle	Upper
Harga	0.8834	1.6013	3.0748
Merk & Tipe	0.4768	0.9270	1.9904
Karakter	0.6202	0.8535	1.7386
Tempat Tinggal	0.4306	0.6867	1.3480
Pekerjaan	0.4212	0.6772	1.4164
Penghasilan	2.1918	3.6934	5.9109
Sumber Order	0.3168	0.4530	1.3687

SUM 5.3407 8.8921 16.8478

After obtaining the level of importance for each criterion, the next step is normalization. Before normalizing, vertically add the lower value (l), middle value (m) and the value of (u) all levels of importance of the criteria. After summing up the next step is to divide between the bottom value and the sum of the top values, then divide the middle value by the number of the middle values, then divide the top value by the bottom value.

Normalize of Price = $(0.8834/16.8478, 1.6013/8.8921, 3.0748/5.3407) = (0.052, 0.1801, 0.576)$

Normalize of Merk And Type = $(0.4768/16.8478, 0.9270/8.8921, 1.9904/5.3407) = (0.028, 0.1042, 0.373)$

Normalize of Character = $(0.6202/16.8478, 0.8535/8.8921, 1.7386/5.3407) = (0.037, 0.093, 0.326)$

Normalize of Residence = $(0.4306/16.8478, 0.6867/8.8921, 1.3480/5.3407) = (0.026, 0.0772, 0.252)$

Normalize of Employment = $(0.4212/16.8478, 0.6772/8.8921, 1.4164/5.3407) = (0.025, 0.0762, 0.265)$

Normalize of Income = $(2.1918 /16.8478, 3.6934 /8.8921, 5.9109 /5.3407) = (0.13, 0.4154, 1.107)$

Normalize of Source of Order = $(0.3168/16.8478, 0.4530/8.8921, 1.3687/5.3407) = (0.019, 0.0509, 0.256)$

After normalizing, the next step is to change the fuzzy number into real value (crisp). The formula used is as follows: where α is the degree of optimism (0 - 1). In this study, researchers used an optimism degree of 0.5

Defuzification Price criteria = $0.5 * (0.5 * 0.576 + 0.1801 + (1 - 0.5) * 0.052) = 0.2471$.

Defuzification Merk And Type criteria = $0.5 * (0.5 * 0.373 + 0.1042 + (1 - 0.5) * 0.028) = 0.1524$.

Defuzification Character criteria = $0.5 * (0.5 * 0.326 + 0.096 + (1 - 0.5) * 0.037) = 0.1386$.

Defuzification Residence criteria = $0.5 * (0.5 * 0.252 + 0.0772 + (1 - 0.5) * 0.026) = 0.1081$.

Defuzification Employment criteria = $0.5 * (0.5 * 0.265 + 0.0762 + (1 - 0.5) * 0.025) = 0.1106$.

Defuzification Income criteria = $0.5 * (0.5 * 1.107 + 0.4154 + (1 - 0.5) * 0.13) = 0.5169$.

Defuzification Source of Order criteria = $0.5 * (0.5 * 0.256 + 0.0509 + (1 - 0.5) * 0.019) = 0.0942$.

Persetujuan Kredit	Lower	Middle	Upper	Defuzifikasi
Harga	0.052	0.1801	0.576	0.2471
Merk & Tipe	0.028	0.1042	0.373	0.1524
Karakter	0.037	0.096	0.326	0.1386
Tempat Tinggal	0.026	0.0772	0.252	0.1081
Pekerjaan	0.025	0.0762	0.265	0.1106
Penghasilan	0.13	0.4154	1.107	0.5169
Sumber Order	0.019	0.0509	0.256	0.0942

IV. RESULT AND DISCUSSION

A. System Testing

Following are the results of system testing using Alpha and Beta testing.

1) Alpha Testing:

Alpha testing conducted for 1 type of user, namely an approver of 2 (two) respondents. The following is the result of the alpha test recapitulation :

TABLE RESULT OF ALPHA TESTING APPROVER USER

No	Kebutuhan Pengguna	Jumlah Responden	Tanggapan Responden		Kesimpulan
			Diterima	Ditolak	
1	Melakukan Login	2	2		Setuju
2	Melakukan Analisa Kredit	2	2		Setuju

Based on these results, the respondent's overall respondent stated that the prototype could be accepted and approved the results of the test.

2) Beta Testing :

The results of the respondents' answers as many as 40 respondents in beta testing are explained in the table below:

TABLE OF RESPONDENTS ANSWER

Kriteria Jawaban	Bobot	Pertanyaan								Total
		1	2	3	4	5	6	7	8	
SS	5	2	2	2	3	5	5	3	4	26
S	4	3	3	2	2				2	12
RR	3			1					1	2
TS	2									0
STS	1									0
Jumlah Responden		5	5	5	5	5	5	5	5	40
Skor Aktual		22	22	21	23	25	23	23	23	184
Skor Ideal		25	25	25	25	25	25	25	25	200

$$\begin{aligned} \%Skor \text{ Aktual} &= \frac{\text{Skor aktual}}{\text{Skor Ideal}} \times 100 \% \\ &= \frac{184}{200} \times 100 \% \\ &= 92\% \end{aligned}$$

The conclusion from the results of beta testing shows that respondents provide good criteria for the quality of the prototype. This is indicated by the results of the percentage score of respondents' responses of 92%.

These results indicate that the non-functionality needs from the prototype that was made was fulfilled and the respondent agreed that the prototype able to make the credit approval process more efficient. The results of this conclusion indicate that the first hypothesis in this study has been proven.

V. CONCLUSION

Based on the description in the previous chapters, it can be concluded that this study which discusses about building a support system for credit scoring-based motor vehicle loan approval decisions with AHP fuzzy method, is as follows:

1. The construction of a prototype support system for motor vehicle loan approval decisions has succeeded in making the motor vehicle loan approval process more efficient than before.
2. From the Questionnaire Results and has been changed to fuzzy numbers it can be seen that the most influential variable in credit approval is the income from the prospective customer. This can be seen from the results of defuzification that is equal to 0.5827.
3. User acceptance test (UAT) is conducted with 2 (two) types of testing, namely alpha test and beta test. From the results of the alpha test, the results obtained that the prototype built meets the functional needs of the user. The beta test results indicate that nonfunctional needs can be met by the user and the user agrees that the prototype can help the approver in decision making where the test results are obtained with a percentage of 92%.

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