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Original Research

A Web-Based Credit Financing Eligibility Determination System for Multifinance Companies Using the Fuzzy Tsukamoto Method

Al Ihsan Fauzi Ardilla [a], Achmad Noe'man [b*], Herlawati [c]

[a,b,c] Department of Informatics, Faculty of Computer Science, Universitas Bhayangkara Jakarta Raya, Bekasi, Indonesia

*Corresponding Author: achmad.noeman@dsn.ubharajaya.ac.id

ABSTRACT

The credit eligibility analysis process in a financing company is a crucial stage in minimizing the risk of non-performing loans. However, the assessment process that still relies on the subjective interpretation of credit analysts potentially leads to inconsistencies in decision-making. This issue also occurs at PT Mandiri Utama Finance Bekasi Branch, which has shown a declining trend in financing performance based on the indicators of End Net Receivables (ENR), Total Over Due (TOD), and Net Credit Loss (NCL). This study aims to design and develop a web-based decision support system that can assist in determining credit financing eligibility by applying the Fuzzy Tsukamoto method based on the 5C principles (Character, Capacity, Capital, Collateral, and Condition). The research methods employed include observation, interviews, and literature studies. System development was carried out using the Waterfall model, comprising requirement analysis, system design, implementation, testing, deployment, and maintenance phases. The Fuzzy Tsukamoto method was utilized to process data containing uncertainty through fuzzification, IF-THEN rule-based inference, and defuzzification to generate credit eligibility scores. The expected result of this study is the creation of a web-based decision support system capable of providing credit eligibility recommendations that are more objective, consistent, and structured. Consequently, the developed system can assist credit analysts in the decision-making process and support the company's efforts to minimize the risk of problematic financing.

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1. INTRODUCTION

Financing companies play a vital role in providing financing services to the public; however, they also face the risk of non-performing loans that can adversely affect corporate performance [1, 2]. Therefore, the credit eligibility analysis process becomes a crucial stage in minimizing these risks. PT Mandiri Utama Finance (MUF) Bekasi Branch applies the 5C principles (Character, Capacity, Capital, Collateral, and Condition) as the basis for assessing prospective debtors [3]. Based on the 2024 achievement data of MUF Bekasi Branch in Figure 1.

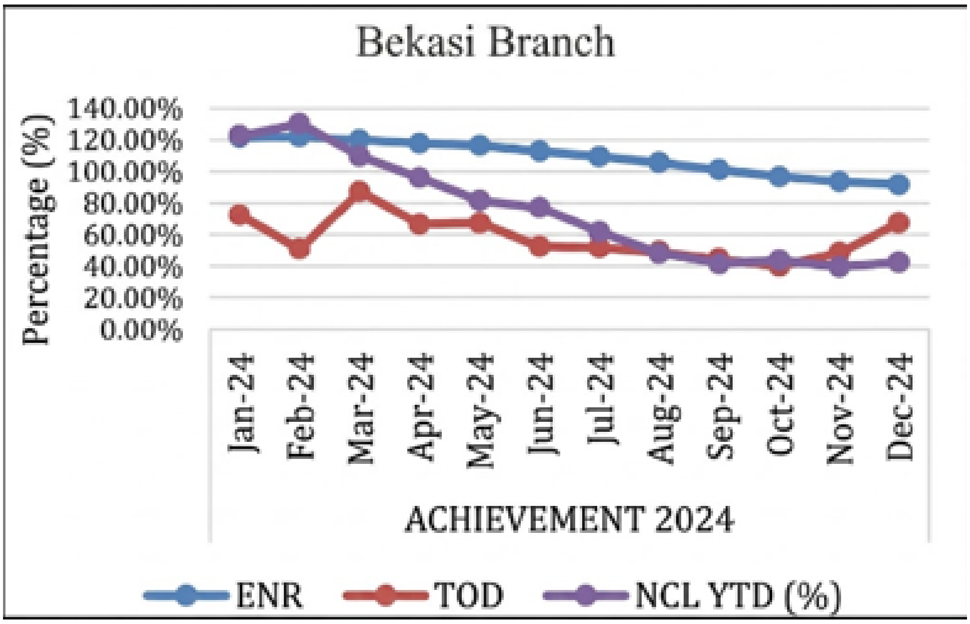

Figure 1. Achievement Data of Mandiri Utama Finance Bekasi (2024)

The End Net Receivables (ENR) value shows a declining trend from approximately 122% in January to 92% in December. Furthermore, the Total Over Due (TOD) and Year-to-Date (YTD) Net Credit Loss (NCL) indicators fluctuated throughout the year, indicating persistent challenges in maintaining financing quality. This condition highlights the urgent need for a system capable of supporting a more objective, consistent, and measurable credit analysis process.

Various studies have developed Decision Support Systems (DSS) for determining credit eligibility using Fuzzy methods. The Fuzzy Tsukamoto method is widely used due to its capability to accommodate uncertainty and linguistic assessments in the decision-making process [4]. Several studies indicate that the application of the Fuzzy Tsukamoto method can enhance the consistency and accuracy of credit recommendations compared to manual processes [5, 6]. Furthermore, the integration of a web-based DSS is considered capable of improving data processing efficiency and accessibility for users in performing credit analysis [7]. Nevertheless, previous studies still have several limitations. Some research only utilized a few credit assessment variables, thereby failing to comprehensively represent the 5C principles. In addition, most of these studies were conducted in the banking sector, which possesses different assessment characteristics compared to financing companies [8]. Another limitation is that few studies have integrated all aspects of the 5C principles into a web-based decision support system using the Fuzzy Tsukamoto method tailored to the operational needs of financing companies [9, 10]. This condition indicates a research gap that warrants further investigation.

Based on these issues, this study proposes the development of a web-based decision support system by applying the Fuzzy Tsukamoto method and comprehensively integrating the 5C principles into the credit eligibility assessment process at PT Mandiri Utama Finance Bekasi Branch. The novelty of this research lies in the application of an assessment model that adapts to the credit analysis practices of financing companies, thereby generating more objective and consistent recommendations. This study aims to design and build a system capable of assisting credit analysts in determining credit eligibility more effectively, structurally, and accurately to support financing risk management.

2. RESEARCH METHODS

This study employs a system development research approach to build a web-based credit eligibility Decision Support System (DSS) at PT Mandiri Utama Finance Bekasi Branch. The research framework initiates with the identification of problems in the credit analysis process, followed by data collection and system requirements gathering, the design of the Fuzzy Tsukamoto model based on the 5C principles (Character, Capacity, Capital, Collateral, and Condition) [3], web-based system development, and concludes with system testing. The software development process was carried out using the Waterfall model, comprising the phases of requirement analysis, system design, implementation, testing, and maintenance.

2.1. Proposed Method

The Fuzzy Tsukamoto method was used to determine the credit eligibility level of prospective debtors, with the systematic steps of the process illustrated in Figure 2.

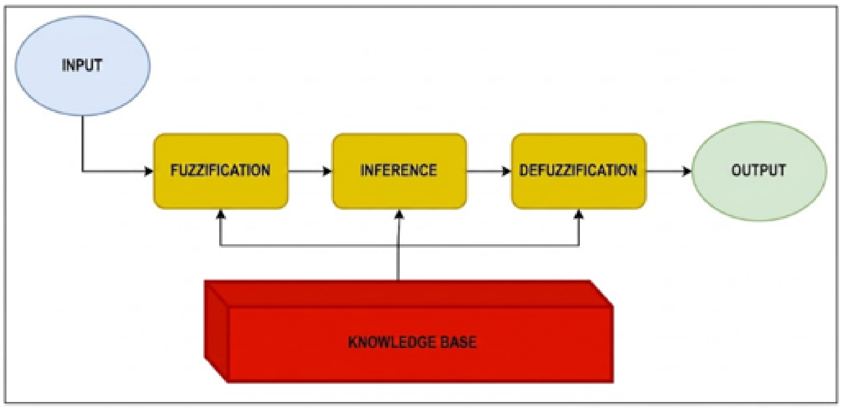

Figure 2. Phases of the Fuzzy Method

The calculation process consists of three stages: fuzzification, inference, and defuzzification. In the inference stage, IF–THEN rules were applied to generate the α-predicate value for each rule [11, 12]. The final credit eligibility value was calculated using the weighted average method, as shown in Equation (1):

$$Z = \frac{\sum \alpha_i \cdot z_i}{\sum \alpha_i} \tag{1}$$

Information:

- Z = The final output value obtained from the defuzzification process.
- α_i = The fire strength (degree of truth) of the i-th rule.
- z_i = The crisp output value of the i-th rule.
- $\sum \alpha_i \cdot z_i$ = The sum of the product of the fire strength and the output value for each rule.
- $\sum \alpha_i$ = The sum of the fire strengths from all active rules.

The obtained output value is utilized as the basis for credit eligibility recommendations.

2.2. Variables and Calculation Simulation

In the developed system, the Fuzzy Tsukamoto method is applied to five input variables and two output variables. The detailed assessment criteria for these variables are presented in Table 1.

Table 1. Assessment Variables

Variable	Description
Character	The debtor's integrity and credit compliance history (e.g., SLIK OJK).
Capacity	The ability to repay the loan based on cash flow.
Capital	Net worth and financial structure to assess financial resilience.
Collateral	Assets pledged as a safeguard against default risk.
Condition	External factors (economy, industry, business) that affect repayment capacity.

The classification of fuzzy sets for all variables is located within the domain values of each variable's respective membership degree. The variable classifications for this system are presented in Table 2 and Table 3.

Table 2. Fuzzy Set Classification

Type	Variable	Fuzzy Set	Domain
Input	Character (c_1)	S1 (Slik Type 1)	Excellent, Very Good, Good (1)
		S2 (Slik Type 2)	Medium, Bad 1 (2)
		S3 (Slik Type 3)	Bad 2, Worst (3)
	Capacity (c_2)	Unfeasible	$x \leq 50$
		Feasible	$50 \leq x \leq 90$
		Highly Feasible	$x \geq 70$
	Capital (c_3)	Unfeasible	$x \leq 50$
		Feasible	$50 \leq x \leq 90$
		Highly Feasible	$x \geq 70$

Table 3. Continued Fuzzy Set Classification

Type	Variable	Fuzzy Set	Domain
Input	Collateral (c_4)	Unfeasible	$x \leq 50$
		Feasible	$50 \leq x \leq 90$
		Highly Feasible	$x \geq 70$
	Condition (c_5)	Unfeasible	$x \leq 50$
		Feasible	$50 \leq x \leq 90$
		Highly Feasible	$x \geq 70$
Output	Credit Eligibility	Unfeasible	$z < 70$
		Feasible	$z \geq 70$

2.3. Fuzzification Process

Based on interviews conducted with stakeholders at PT Mandiri Utama Finance Bekasi, the input and output variables were determined.

2.3.1. Input Variables

In determining credit eligibility at PT Mandiri Utama Finance Bekasi, the five input variables are fuzzified into linguistic variables. The variables Capacity (c_2), Capital (c_3), Collateral (c_4), and Condition (c_5) utilize three numerical fuzzy sets: Unfeasible uses a left-shoulder linear membership function, Feasible uses a triangular membership function, and Highly Feasible uses a right-shoulder linear membership function. Meanwhile, the Character variable (c_1) is fuzzified discretely based on SLIK history into sets S_1 (Excellent, Very Good, Good = 1), S_2 (Medium, Bad 1 = 2), and S_3 (Bad 2, Worst = 3). The representations of these membership functions are illustrated in Figure 3.

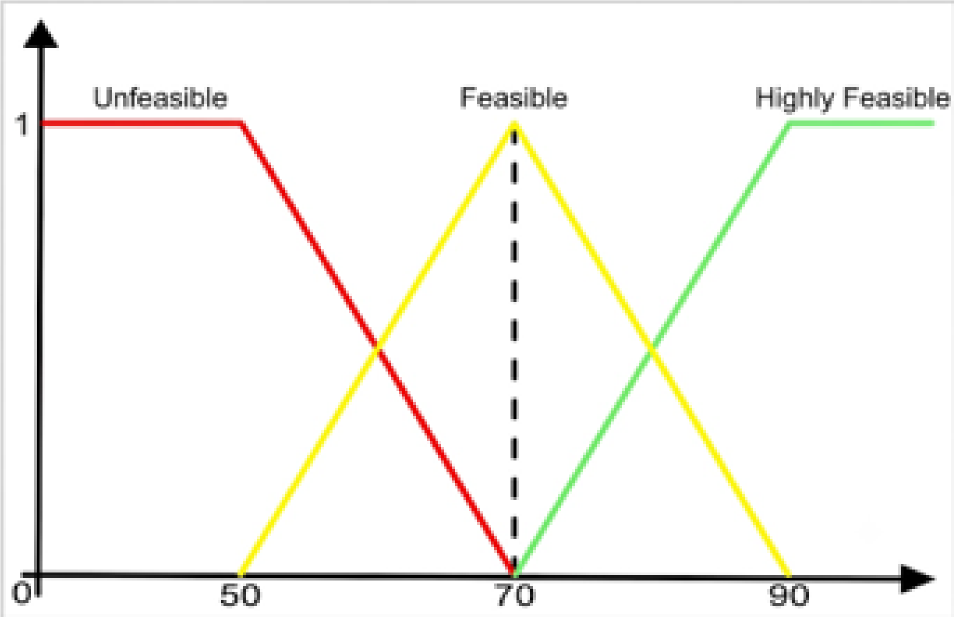

Figure 3. Membership Function Curve Representation for Input Variables

The Fuzzification of the sets is defined as follows:

$$\mu_{S1}(c_1) = \begin{cases} 1, & \text{if } c_1 \in \{\text{Excellent, Very Good, Good}\} \\ 0, & \text{otherwise} \end{cases} \tag{2}$$

$$\mu_{S2}(c_1) = \begin{cases} 1, & \text{if } c_1 \in \{\text{Medium, Bad 1}\} \\ 0, & \text{otherwise} \end{cases} \tag{3}$$

$$\mu_{S3}(c_1) = \begin{cases} 1, & \text{if } c_1 \in \{\text{Bad 2, Worst}\} \\ 0, & \text{otherwise} \end{cases} \tag{4}$$

$$\text{Unfeasible}(x) = \begin{cases} 1, & x \leq 50 \\ \frac{70-x}{70-50}, & 50 \leq x \leq 70 \\ 0, & x \geq 70 \end{cases} \tag{5}$$

$$\text{Feasible}(x) = \begin{cases} 0, & x \leq 50 \text{ or } x \geq 90 \\ \frac{x-50}{70-50}, & 50 \leq x \leq 70 \\ \frac{90-x}{90-70}, & 70 \leq x \leq 90 \end{cases} \tag{6}$$

$$\text{Highly Feasible}(x) = \begin{cases} 0, & x \leq 50 \\ \frac{x-50}{70-50}, & 50 \leq x \leq 70 \\ 1, & x \geq 70 \end{cases} \tag{7}$$

2.3.2. Output Variables

The assessment output variables for this system consist of Feasible and Unfeasible. The corresponding membership functions are illustrated in Figure 4.

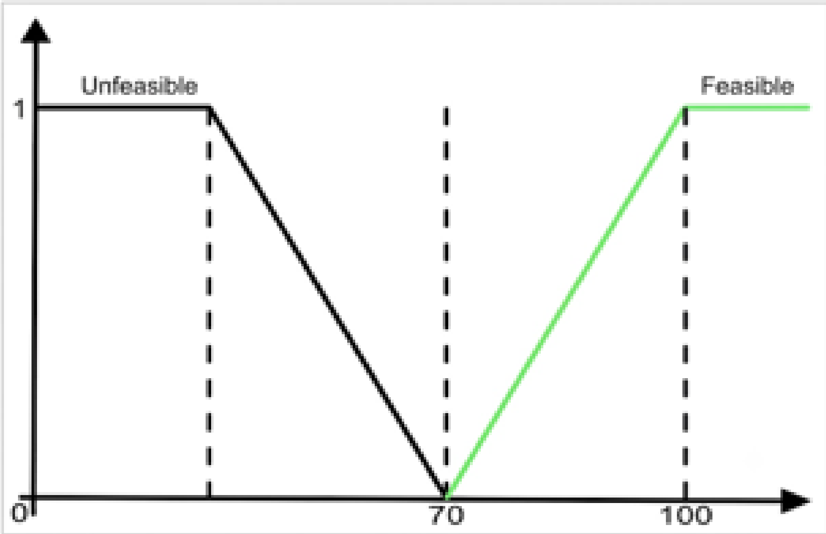

Figure 4. Membership Function Curve Representation for the Output Variable

The fuzzification of the sets is defined as follows:

$$\text{Unfeasible}(z) = \begin{cases} 1, & z \leq 0 \\ \frac{70-z}{70}, & 0 \leq z \leq 70 \\ 0, & z \geq 70 \end{cases} \tag{8}$$

$$\text{Feasible}(z) = \begin{cases} 0, & z \leq 70 \\ \frac{z-70}{30}, & 70 \leq z \leq 100 \\ 1, & z \geq 100 \end{cases} \tag{9}$$

2.4. Knowledge Base Formation

Rule formation for decision-making is conducted by considering the weight of each variable. This process serves to determine a fuzzy output value from the fuzzy inputs [13, 14]. Theoretically, the possible combination of rules that can be generated amounts to 243 rules. However, based on consultations with credit analysts at PT Mandiri Utama Finance, this study utilizes a set of representative rules deemed capable of reflecting the credit decision-making process, thereby reducing system complexity without compromising assessment accuracy. The representative rule set used for this decision-making process is presented in Table 4 and Table 5.

Table 4. Knowledge Base (Rules)

Rule	IF	Input					THEN	Output
		Character	Capacity	Capital	Collateral	Condition		
R1	IF	S1	Highly Feasible	Highly Feasible	Highly Feasible	Highly Feasible	THEN	Feasible
R2	IF	S1	Highly Feasible	Highly Feasible	Highly Feasible	Feasible	THEN	Feasible
R3	IF	S1	Highly Feasible	Highly Feasible	Feasible	Highly Feasible	THEN	Feasible
R4	IF	S1	Highly Feasible	Feasible	Highly Feasible	Highly Feasible	THEN	Feasible
R5	IF	S1	Feasible	Highly Feasible	Highly Feasible	Highly Feasible	THEN	Feasible
R6	IF	S1	Unfeasible	Highly Feasible	Highly Feasible	Highly Feasible	THEN	Unfeasible

Table 5. Knowledge Base (Rules) (Continued)

Rule	IF	Input					THEN	Output
		Character	Capacity	Capital	Collateral	Condition		
R7	IF	S1	Feasible	Unfeasible	Highly Feasible	Highly Feasible	THEN	Unfeasible
R8	IF	S1	Feasible	Feasible	Unfeasible	Highly Feasible	THEN	Unfeasible
R9	IF	S1	Feasible	Feasible	Highly Feasible	Unfeasible	THEN	Unfeasible
R10	IF	S2	Unfeasible	Feasible	Feasible	Feasible	THEN	Unfeasible

2.5. Manual Calculation Simulation

In performing the Fuzzy Tsukamoto calculation, the value of each variable for every prospective debtor at PT Mandiri Utama Finance has been predetermined.

Calculation Example: A prospective debtor named Aziz applies for a motorcycle loan with a debtor profile consisting of c_1 with a SLIK status of S_1, c_2 with a value of 80, c_3 with a value of 75, c_4 with a value of 85, and c_5 with a value of 60.

Fuzzification Process:

1. Fuzzification of Character (c_1): Since the SLIK type input is 1, then: $\mu_{S1}(x) = 1$, $\mu_{S2}(x) = 0$, $\mu_{S3}(x) = 0$.
2. Fuzzification of Capacity (c_2): Since 80 falls between 50 and 90, then: $\mu_{\text{Feasible}}(80) = \frac{90-80}{90-70} = \frac{10}{20} = 0.5$. Furthermore, $\mu_{\text{Highly Feasible}}(80) = 1$, since $80 \geq 70$.
3. Fuzzification of Capital (c_3): Since 75 falls between 50 and 90, then: $\mu_{\text{Feasible}}(75) = \frac{90-75}{90-70} = \frac{15}{20} = 0.75$. Furthermore, $\mu_{\text{Highly Feasible}}(75) = 1$, since $75 \geq 70$.
4. Fuzzification of Collateral (c_4): Since 85 falls between 50 and 90, then: $\mu_{\text{Feasible}}(85) = \frac{90-85}{90-70} = \frac{5}{20} = 0.25$. Furthermore, $\mu_{\text{Highly Feasible}}(85) = 1$, since $85 \geq 70$.
5. Fuzzification of Condition (c_5): Since 60 falls between 50 and 90, then: $\mu_{\text{Feasible}}(60) = \frac{60-50}{70-50} = \frac{10}{20} = 0.5$. Furthermore, $\mu_{\text{Highly Feasible}}(60) = \frac{60-50}{70-50} = \frac{10}{20} = 0.5$.

Inference Process: The AND operator is utilized to obtain the minimum value from the membership degree of each input variable. This minimum value is used as the α-predicate value for each rule:

$$\alpha_i = \min\left(\mu(c_1), \mu(c_2), \mu(c_3), \mu(c_4), \mu(c_5)\right) \tag{10}$$

1. Rule 1, R1: IF Character = S_1 AND Capacity = Feasible AND Capital = Feasible AND Collateral = Feasible AND Condition = Feasible THEN Assessment = Feasible

$$\alpha_1 = \min(1; 0.5; 0.75; 0.25; 0.5) = 0.25$$

Since the rule output is Feasible:

$$\mu_{\text{Feasible}}(z) = \frac{z-70}{100-70} \implies 0.25 = \frac{z_1-70}{30} \implies z_1 = 70 + (0.25 \times 30) = 77.5$$

2. Rule 2, R2: IF Character = S_1 AND Capacity = Feasible AND Capital = Highly Feasible AND Collateral = Feasible AND Condition = Feasible THEN Assessment = Feasible

$$\alpha_2 = \min(1; 0.5; 1; 0.25; 0.5) = 0.25$$

Since the rule output is Feasible:

$$\mu_{\text{Feasible}}(z) = \frac{z-70}{100-70} \implies 0.25 = \frac{z_2-70}{30} \implies z_2 = 70 + (0.25 \times 30) = 77.5$$

3. Rule 3, R3: IF Character = S_1 AND Capacity = Feasible AND Capital = Feasible AND Collateral = Highly Feasible AND Condition = Feasible THEN Assessment = Feasible

$$\alpha_3 = \min(1; 0.5; 0.75; 1; 0.5) = 0.5$$

Since the rule output is Feasible:

$$\mu_{\text{Feasible}}(z) = \frac{z-70}{100-70} \implies 0.5 = \frac{z_3-70}{30} \implies z_3 = 70 + (0.5 \times 30) = 85$$

4. Rule 4, R4: IF Character = S_1 AND Capacity = Feasible AND Capital = Highly Feasible AND Collateral

= Highly Feasible AND Condition = Highly Feasible THEN Assessment = Feasible

$$\alpha_4 = \min(1; 0.5; 1; 1; 0.5) = 0.5$$

Since the rule output is Feasible:

$$\mu_{\text{Feasible}}(z) = \frac{z - 70}{100 - 70} \implies 0.5 = \frac{z_4 - 70}{30} \implies z_4 = 70 + (0.5 \times 30) = 85$$

Defuzzification Process: The defuzzification equation for the Fuzzy Tsukamoto method is defined as:

$$Z = \frac{\sum \alpha_i \cdot z_i}{\sum \alpha_i} \tag{11}$$

Therefore:

$$Z = \frac{(0.25 \times 77.5) + (0.25 \times 77.5) + (0.5 \times 85) + (0.5 \times 85)}{0.25 + 0.25 + 0.5 + 0.5} = \frac{19.375 + 19.375 + 42.5 + 42.5}{1.5} = \frac{123.75}{1.5} = 82.50$$

Based on the inference process, four active rules were obtained with α-predicate values of 0.25 and 0.50. The calculation of the z-value for each rule yielded values of 77.5 and 85. Subsequently, the defuzzification process was performed using the weighted average method, resulting in a final credit eligibility score of 82.50. Since this value falls within the range of 70–100, the prospective debtor, Aziz, is declared feasible.

3. RESULTS AND DISCUSSION

The purpose of this interface is to facilitate user inputs and display outputs generated by the application [15,16]. The system features a main interface consisting of a Login Menu, a Monitoring Dashboard, an Input Data Analysis Menu, and a Results Menu [17–20].

3.1. Login Menu

Access to the system begins with a login process using the user's NIK and password as identity verification. The login page functions as the main gateway and the first layer of security to ensure that only authorized personnel can carry out the credit eligibility assessment process. The interface design of the login page is shown in Figure 5.

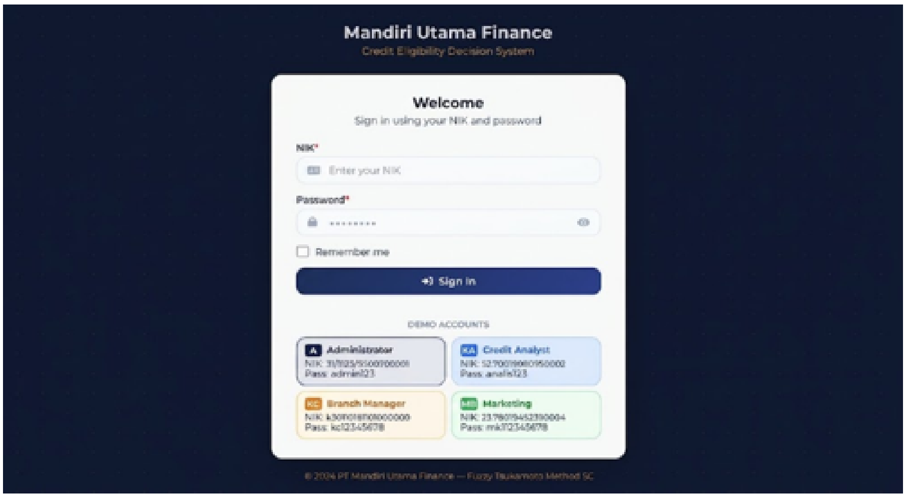

Figure 5. Login Page

As shown in Figure 5, the login page displays a welcome message ("Welcome") together with two mandatory input fields, namely NIK and password, a "remember me" option, and a "In" (Login) button. At the bottom of the page, a demo account panel is provided presenting the four user roles, Administrator, Head of Audit, Branch Head, and Marketing, each accompanied by an example NIK and its corresponding role, enabling users to recognize the access rights of each role before entering the system. Through this role-based login mechanism, the system ensures separation of duties and authority: Marketing inputs the application data, the Branch Head performs verification and approval, the Head of Audit oversees the process, and the Administrator manages the system configuration, thereby maintaining the security, confidentiality, and accountability of the credit eligibility assessment data.

3.2. Monitoring Dashboard

After a successful login, the system directs the user to the main dashboard page, which functions as the initial control panel. This page presents an aggregated summary of the credit eligibility assessments that have been conducted and provides quick access to the main features of the system. The dashboard interface is shown in Figure 6.

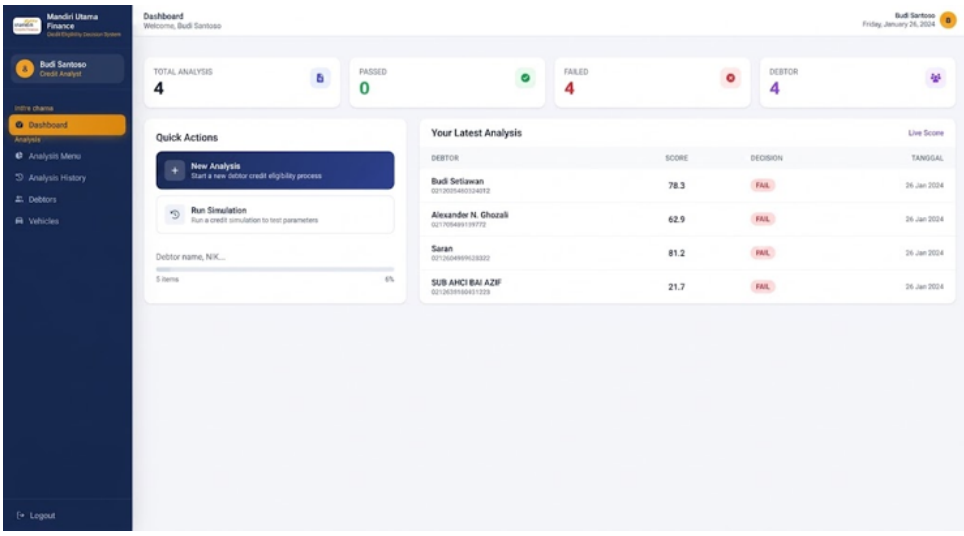

Figure 6. Monitoring Dashboard Page

As shown in Figure 6, the dashboard consists of four main components: (1) a left navigation sidebar containing the Dashboard, Analysis Menu, Analysis History, Debtors, and Vehicles menus, together with the user identity (Budi Santoso – Credit Analyst) and a Logout button; (2) four summary cards displaying the total number of analyses, passed applications, failed applications, and registered debtors; (3) a Quick Actions panel containing the New Analysis and Run Simulation buttons along with a debtor search field based on name or NIK; and (4) a Your Latest Analysis table presenting debtor names, credit scores, decisions (Pass/Fail), and analysis dates. In the illustrated example, the system records four analyses with zero passed and four registered debtors, so all decisions in the latest analysis table are shown as Fail. This presentation enables the credit analyst to read the overall portfolio status rapidly, identify applications that do not meet the criteria, and proceed directly to the analysis or simulation process, thereby supporting faster and more data-driven decision-making.

3.3. Input Data Analysis Menu

After the officer selects the New Analysis menu from the dashboard, the system displays the credit eligibility assessment page based on the 5C method. This page serves as the main workspace for the credit analyst to enter debtor candidate data and define the assessment parameters for the Character, Capacity, Capital, Collateral, and Condition components. The interface of the New Analysis page is shown in Figure 7.

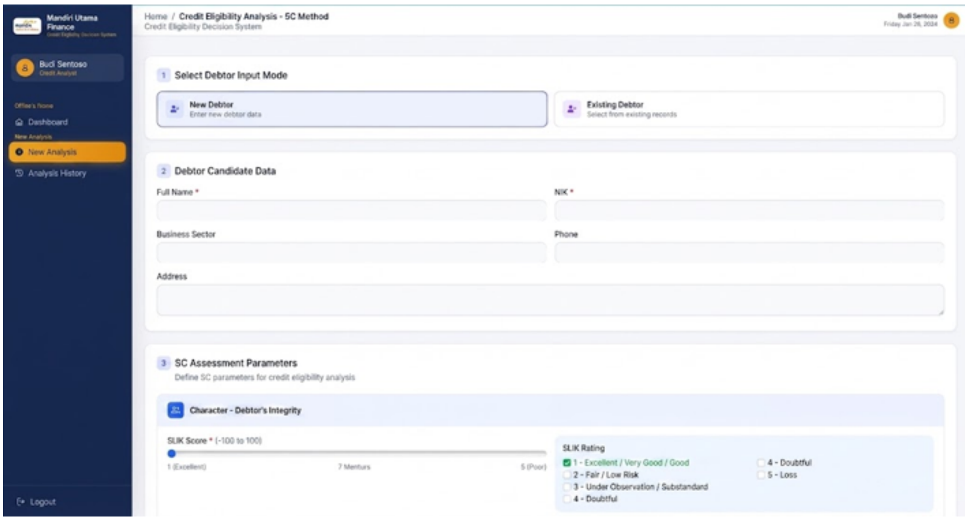

Figure 7. Credit Eligibility Assessment Page – 5C Method

As shown in Figure 7, the analysis page is organized into three main sections. The first section, Select Debtor Input Mode, offers two options: New Debtor for entering new debtor data and Existing Debtor for selecting from previously saved records. The second section, Debtor Candidate Data, contains input fields for full name, NIK, business sector, phone number, and address, with full name and NIK as mandatory fields. The third section, 5C Assessment Parameters, begins with the Character – Debtors Integrity component, which is measured through an SLIK Score slider on a 1–100 scale together with an SLIK Rating consisting of five categories, namely Excellent/Very Good/Good, Fair/Low Risk, Under Observation/Satisfactory, Doubtful, and Loss. This structure ensures that the assessment proceeds systematically in accordance with the 5C principles, so that every aspect of the debtors eligibility is measured with clear parameters before the system calculates the final score and credit decision.

3.4. Analysis Results Menu

After the assessment process is completed, all analysis results are recorded on the Analysis History page, which allows the officer to review the list of debtor candidates that have been assessed. This page also provides search and filtering facilities to facilitate monitoring of credit application statuses over time. The interface of the Analysis History page is shown in Figure 8.

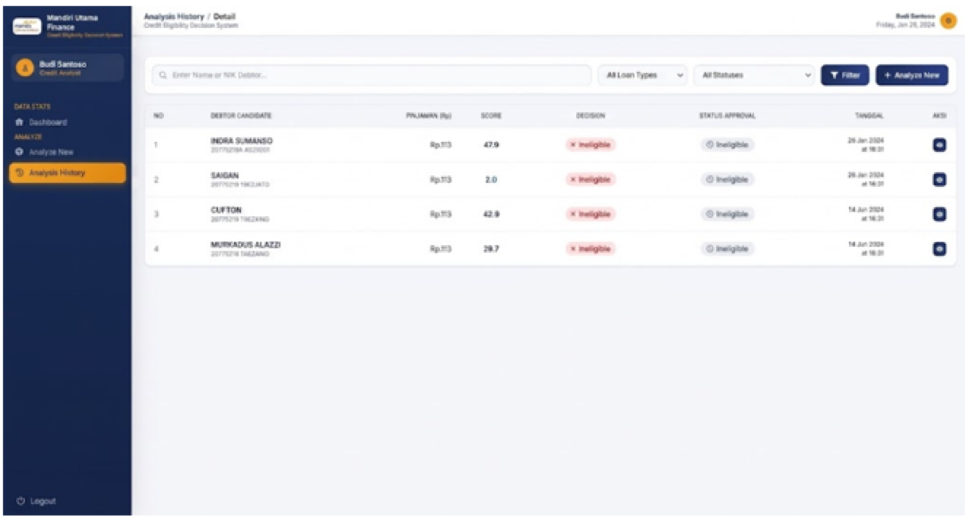

Figure 8. Analysis History Page of the Credit Eligibility Decision System

As shown in Figure 8, the Analysis History page consists of a search field based on debtor name or NIK, loan type and analysis status filter dropdowns, Filter and Analyze New buttons, and a result table containing columns for number, debtor candidate (name and NIK), loan amount (Rp), credit score, decision, approval status, analysis date, and detail action. In the illustrated example, four debtor candidates, Indra Sumanso, Saigan, Cufton, and Murkadus Alazzi—record scores ranging from 2.0 to 47.9, all with an Ineligible decision and Ineligible approval status, indicating that none of the applications has met the systems minimum eligibility threshold. Through this page, the officer can trace analysis results chronologically, filter applications by loan type and status, and open the details of each analysis, thereby supporting transparency and traceability in the credit decision-making process.

3.5. System Testing

System testing was conducted in two phases to verify both the functional reliability and the educational effectiveness of the decision support system. The initial phase involved black-box testing, as summarized in the scenario-based verification, to ensure that all modules, including login, dashboard visualization, parameter input, and report generation, operated according to the predefined data flow and entity relationships. Simulated debtor data were inputted into the system to observe whether the outputs matched the expected behaviors, such as the correct calculation of eligibility scores on the dashboard. All core functionalities successfully passed the verification, confirming that the prototype's internal logic and relational database structure were consistent, traceable, and free of critical processing errors.

Following the functional verification, a User Acceptance Test (UAT) was conducted to evaluate the system's usability and suitability for credit analysis. Testing involved 10 respondents from PT Mandiri Utama Finance Bekasi Branch, comprising 1 Branch Head, 1 Head of Audit, 4 Credit Analysts, and 4 Marketing officers. Each respondent executed assigned test scenarios and completed a usability questionnaire based on a five-point Likert scale.

The evaluation yielded an overall average acceptance score of 88.5%, categorized as "Very Good," indicating that the system is highly acceptable and ready for operational deployment. The credit analysts particularly appreciated the structured workflow that connected 5C parameters with automated Tsukamoto inference. Meanwhile, the Branch Head and Head of Audit noted that the role-based access and history recapitulation modules effectively supported portfolio monitoring in a controlled environment.

3.6. Discussion

System testing was conducted to verify the functional reliability of the web-based decision support system and the accuracy of the Fuzzy Tsukamoto method implementation at PT Mandiri Utama Finance Bekasi Branch. The testing process comprised three main activities: black-box testing of the system interfaces, calculation accuracy verification, and user acceptance testing. Black-box testing was performed to ensure that all modules operated according to the predefined system requirements without inspecting the internal code. All core functionalities successfully passed this phase, confirming that the role-based access for the Administrator, Head of Audit, Branch Head, and Marketing operated securely and that the data flow from input to the final credit eligibility decision was consistent. Following the functional verification, the accuracy of the Fuzzy Tsukamoto calculation was verified by comparing the system-generated outputs with manual calculations across multiple prospective debtor profiles, including the worked example of the debtor Aziz.

The comparison yielded identical crisp output values and eligibility decisions, proving that the fuzzification, inference using the representative knowledge base, and defuzzification processes were correctly programmed and free of computational errors. Finally, a User Acceptance Test was conducted involving 10 respondents from PT Mandiri Utama Finance Bekasi Branch, consisting of 1 Branch Head, 1 Head of Audit, 4 Credit Analysts, and 4 Marketing officers. The respondents evaluated the system using a five-point Likert scale questionnaire covering aspects of functional suitability, ease of use, decision accuracy, and interface design. The evaluation yielded an overall average acceptance score of 88.5%, categorized as very good. The credit analysts particularly appreciated the system's ability to automatically process the 5C variables and generate objective recommendations, which significantly reduced the time required for manual assessments. Meanwhile, the Branch Head and Head of Audit noted that the analysis history and dashboard summaries provided better transparency and traceability for monitoring financing portfolio risks. Minor suggestions for future iterations included integrating the system directly with the national SLIK OJK database to automate the Character variable input and optimizing the interface for mobile devices used by field marketing officers.

The primary finding of this study is that the integration of the Fuzzy Tsukamoto method with the 5C principles into a web-based decision support system successfully provides objective, structured, and consistent credit eligibility recommendations for multifinance companies.

The declining trend in End Net Receivables and the fluctuating Net Credit Loss at PT Mandiri Utama Finance Bekasi Branch highlight the limitations of relying solely on the subjective interpretation of credit analysts. By translating linguistic assessments and uncertain financial data into precise crisp values through fuzzification, rule-based inference, and defuzzification, the developed system mitigates human bias and ensures that every prospective debtor is evaluated against the same standardized criteria. This computational consistency directly addresses the operational need to minimize the risk of non-performing loans and problematic financing. Compared to previous studies that applied fuzzy logic for credit or loan eligibility, this research offers a more comprehensive and context-specific approach. For instance, studies utilizing fuzzy methods in savings and loan cooperatives or for residential and vehicle financing often rely on a limited number of variables and do not fully capture the complex risk profiles inherent in multifinance operations. Similarly, research applying the Fuzzy Tsukamoto method for mortgage eligibility demonstrates the method's general effectiveness in handling uncertainty, but lacks the structural integration of the complete 5C framework required by formal financing institutions. Furthermore, while some studies have explored credit risk mitigation and non-performing loan prevention using statistical or machine learning approaches like Naïve Bayes in banking and rural credit institutions, these models often function as black boxes that do not provide transparent, rule-based reasoning that credit analysts can easily interpret or justify to management. The proposed system bridges this gap by utilizing a transparent knowledge base of IF–THEN rules derived directly from expert consultations at PT Mandiri Utama Finance, allowing decision-makers to trace exactly how specific 5C parameters influenced the final eligibility score. The web-based architecture of the system further enhances its practical value by centralizing data management and improving accessibility across different organizational roles. The role-based dashboard and analysis history modules enable the Branch Head and Head of Audit to monitor the overall financing portfolio, track the approval status of applications, and identify potential bottlenecks in the credit processing workflow. However, the current implementation still relies on manual input for the Character variable, specifically the SLIK OJK history. Future development should focus on integrating the system with external financial databases via Application Programming Interfaces to automate data retrieval, thereby reducing manual entry errors and further accelerating the analysis process. Additionally, expanding the knowledge base by training the rule set on larger historical datasets could refine the system's predictive accuracy, ultimately providing a more robust tool for financing risk management in multifinance companies.

4. CONCLUSION

This study successfully designed, developed, and verified a web-based Credit Financing Eligibility Determination System utilizing the Fuzzy Tsukamoto method based on the 5C principles for PT Mandiri Utama Finance Bekasi Branch. By integrating Character, Capacity, Capital, Collateral, and Condition into a structured computational model, the system effectively addresses the inconsistencies and subjectivity inherent in traditional manual credit assessments. The mathematical model was verified through precise calculation simulations, yielding consistent crisp eligibility scores. System testing through Black-Box Testing confirmed that all functional modules operated seamlessly, while User Acceptance Testing (UAT) with company stakeholders yielded an average acceptance score of 88.5%, demonstrating high usability and decision-support value. Consequently, the developed system provides a structured, objective, and transparent decision-support tool that assists credit analysts, improves processing efficiency, and supports corporate risk management in minimizing non-performing financing. Future research should explore direct API integration with SLIK OJK to automate Character data ingestion and expand the rule base using machine learning techniques to further enhance predictive precision.

DECLARATIONS

Author Contributions:
Al Ihsan Fauzi Ardilla: Conceptualization, Methodology, Software, Writing – Original Draft.
Achmad Noe'man: Supervision, Validation, Writing – Review & Editing.
Herlawati: Supervision, Methodology, Writing – Review & Editing.

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The data that support the findings of this study are available from the corresponding author upon reasonable

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AI Use Statement:
During the preparation of this manuscript, the authors used AI tools (such as Gemini and ChatGPT) solely for language refinement, readability improvement, and general programming assistance for the web-based prototype (including code suggestions and debugging). All scientific content, system design, data simulations, interpretations, and conclusions were developed, verified, and validated by the authors. Following the use of these tools, the authors carefully reviewed and edited the manuscript and assume full responsibility for the content of the published article.

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