

Implementation of the K-Nearest Neighbor Method in a Web-Based Creditworthiness Decision Support System in Employee Cooperatives

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ABSTRACT

The Republic of Indonesia Employees' Cooperative (KPRI) was established as a legal entity based on the principles of family and people's economy, with a primary mandate to improve the welfare of its members. In its operations, savings and loan units are a crucial service. However, the cooperative's financial sustainability often faces serious challenges in the form of the risk of losses due to bad debts from debtors. This problem indicates that conventional methods for assessing prospective borrowers are often inaccurate and risk subjective, necessitating the need for stronger and more systematic criteria as a basis for decision-making.

This research aims to address these issues by developing a Decision Support System (DSS) for loan eligibility. Through literature review and the collection of historical member transaction data, this research implements the K-Nearest Neighbor (K-NN) algorithm. This method was chosen for its ability to classify new loan eligibility based on similarity patterns (shortest distance) to previous customer data.

The research results show that integrating the K-NN algorithm into the decision support system has a significant positive impact. The system has proven capable of providing classification recommendations that assist cooperative staff in processing loan applications according to predetermined criteria. System testing yielded a feasibility rate of 88%, indicating excellent performance.

Overall, it can be concluded that the implementation of the K-NN method in KPRI loan approval processes makes the selection process more objective, accurate, and time-efficient compared to manual methods. This system is suitable for implementation as a strategic solution to minimize the risk of bad debt and maintain the financial stability of cooperatives.

Keywords: Decision Support System (DSS), K-Nearest Neighbor, Classification, Cooperatives, Loans

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INTRODUCTION

A cooperative is defined as a business entity with legal status and founded on the principle of family, prioritizing the principles of a people's economy. Its primary purpose is to achieve the welfare of its members. Therefore, all profits earned by the cooperative are managed internally to improve operational performance and then distributed to members who actively participate in the cooperative's activities. (Frida, 2023) (Mustofa, 2025)

Many types of cooperatives are established to meet the specific needs of their members, one of which is the Republic of Indonesia Employees Cooperative (KPRI), which is categorized as the primary cooperative for civil servants in Indonesia. The establishment of KPRI aims to enable employees to contribute directly to development according to their respective skills, while at the same time, being able to feel the benefits through improving the welfare of members in particular and the general public in general. (Azisah et al., 2024; Susetyo et al., 2024)

The primary function of a cooperative is to facilitate its members, particularly employees, in obtaining loans with flexible terms and competitive interest rates. To carry out this lending function, the cooperative pools capital from the contributions and savings of all its members. This collected capital is then lent back to members in need. The effective implementation of this function serves as a means to

support and assist in improving the welfare and economic development of each cooperative member. (2023, 2021; Murti et al., 2023)

A fundamental operational process for cooperatives is granting loans to their customers. Borrowers are obligated to repay the principal and interest within a mutually agreed-upon timeframe. However, in practice, this credit granting process often encounters problems due to borrowers' defaults. (Ryan Irwansyah Pasaribu & Kusmilawaty Kusmilawaty, 2024; Silviani & Trisyanto S, 2022)

Problems arising from debtors' payment problems result in bad debts, which directly disrupt cash inflows and outflows. This situation carries the risk of losses for cooperatives. Therefore, the process of determining loan eligibility is a crucial issue that requires a solution, as it has a significant impact on the cooperative's financial status—whether it will record a surplus or a deficit. (Pengetahuan et al., 2023; Simbolon et al., 2023)

To simplify and improve the reliability of the credit granting process, particularly at the Civil Servant Cooperative, a system was developed. This system analyzes creditworthiness using the K-Nearest Neighbor (K-NN) algorithm. The goal is to ensure accurate creditworthiness determination based on supporting parameters, thereby improving the cooperative's overall performance.

METHOD

Research Design

1. **Research Design** This research was designed using a systems development approach with the Waterfall model. This model was chosen to ensure a structured and systematic system workflow. The research stages include: (Fachri et al., 2024; Supiyandi et al., 2022)

Research Design (Waterfall Model)

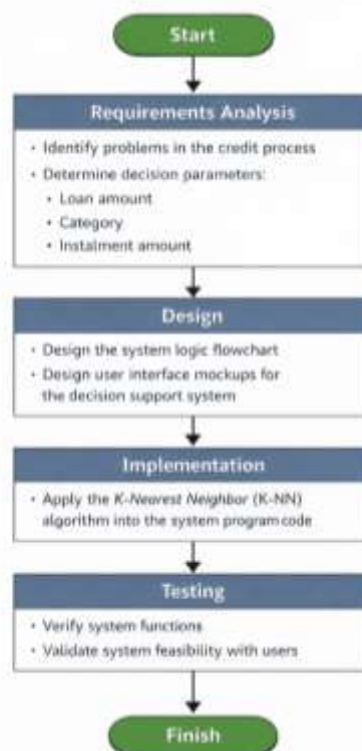


Figure 1. Waterfall Development Model

- a) Needs Analysis:** Identifying problems in the current credit process and determining decision parameters (loan amount, class, and installment amount).
- b) Design:** Designing the system logic flow using a flowchart and designing a user interface (mock-up) for the decision support system.
- c) Implementation:** Implementing the K-Nearest Neighbor classification algorithm into the system's program code.
- d) Testing:** Verifying system functionality and validating its feasibility with users.

2. Research Population and Sample

- a) **Population:** The population in this study is all members of the Republic of Indonesia Employees Cooperative "Tirto Kencono Langgeng", which consists of Civil Servants (PNS) within the Public Works Department and registered honorary workers.(Candra Susanto et al., 2024)
- b) **Sample:** The sample used is historical data from customers applying for loans. This data includes specific attributes such as loan amount, loan classification, and repayment period, which will be used as a dataset (training and testing data) in the algorithm's calculations.(Mushofa et al., 2024)

3. Data Collection Techniques and Instruments

Data collection is carried out through two main techniques:

- a) **Observation and Interviews:** Researchers conducted direct observations and systematic recording at the study location, as well as conducting direct interviews with cooperative treasurers and employees to understand the ongoing creditworthiness analysis procedures.(Ardiansyah et al., 2023)
- b) **Literature Study:** Researchers collect references from libraries, journals, and articles related to Data Mining theory and the application of the K-Nearest Neighbor method to support the theoretical basis for system design.(Mochamad, 2023)

4. Data Analysis Tools

- a) **Analysis Method:** The main analysis tool used is the K-Nearest Neighbor (K-NN) algorithm. This method is used to classify the creditworthiness of new customers based on the similarity of distance to existing customer data (samples).(Setiawan, 2022; Sinaga et al., 2022)
- b) **System Testing:** Software quality analysis is carried out using the Black Box Testing method to test feature functionality (such as login, data input, and calculations).(Abdillah et al., 2023; Maspupah, 2024)
- c) **Feasibility Test:** The validity of user acceptance is measured using a Likert-scale questionnaire, involving respondents from academic circles (Lecturers/Heads of Study Programs) and system users (Cooperative Admins). The test results are interpreted into a feasibility percentage (Very Feasible, Feasible, Fairly Feasible, or Less Feasible).(Informatika, 2022; Sufandi et al., 2022)

5. Research Model

This research model focuses on a decision support system using K-NN logic. The process begins by determining the input parameters, namely the loan amount, employee class, and installment amount. Next, the system calculates the proximity between the new customer data and the sample data using the Euclidean Distance formula. The resulting distance values are then sorted from smallest to smallest to determine the nearest neighbor. Based on the majority category of the nearest neighbor, the system will conclude a loan eligibility recommendation.(Gaol & Halim, 2025; Hasibuan, 2025)

FINDING AND DISCUSSION

Project Results

- a) **Dashboard Page**

This homepage displays the initial display after successfully logging into the system. Users will see the same homepage. The homepage appears as follows.



Figure 2. Dashboard Page

b) Admin Data Page

This page contains admin data, where the admin can add, edit and delete existing data, and the display is as follows.

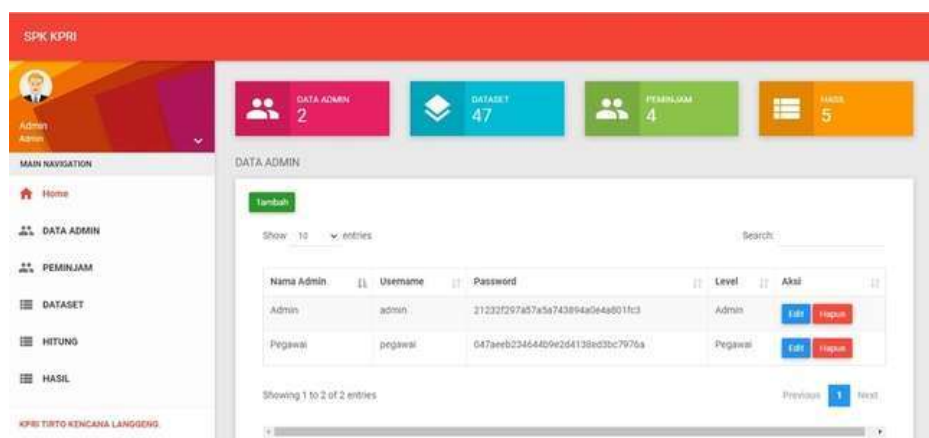


Figure 3. Admin Data Page

c) Borrower Data Page

The borrower data page contains various information about the borrower's criteria. Admins can view the information, add, delete, and edit data. The criteria page displays as follows.

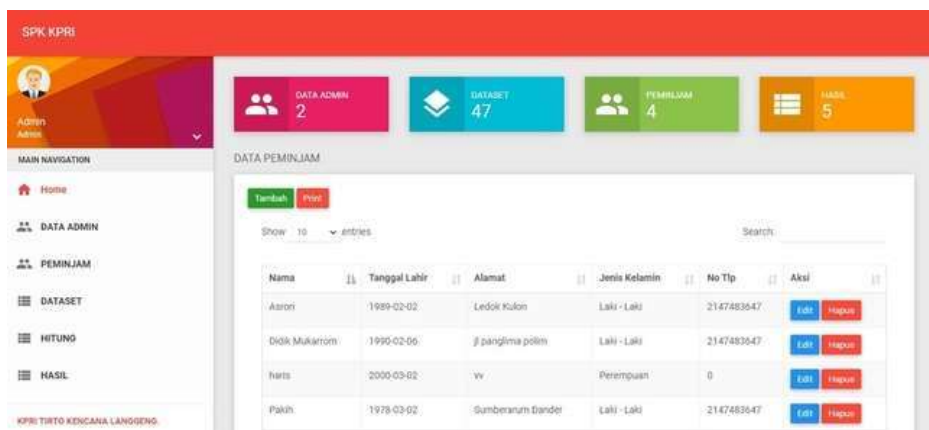


Figure 4. Borrower Data Page View

d) Dataset Page

The dataset page contains sample data from previously existing cases that will be used as a reference for future decisions. Admins can view the dataset and add new case data. The criteria page displays as

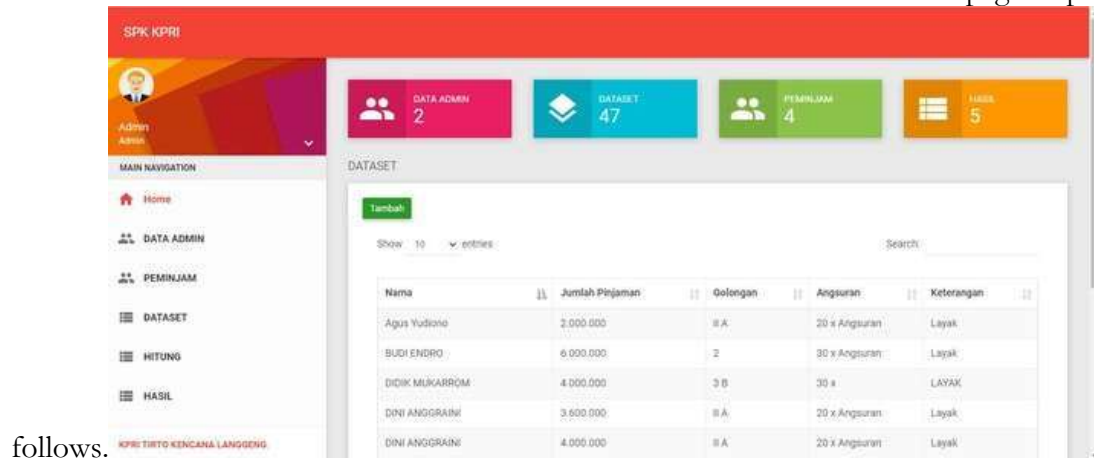


Figure 5. Dataset Page View

e) Calculation Page

On this page, the admin can add a score in the form of a weighted criteria based on predetermined aspects and the number of closest neighbors. This determines whether the borrower is eligible for a loan.



Figure 6. New Case Data Input View

f) Results Page

This results page contains the results of calculations by calculating the Euclidean distance between objects, ranking and nearest neighbor values using the K-NN method.

Jumlah Pinjaman	Golongan	Angsuran	Jarak	Keterangan
4000	3	30 x	3	LAYAK
4000	0	10 x Angsuran	7.14143	TIDAK LAYAK
4000	0	10 x Angsuran	7.14143	LAYAK
5000	0	20 x Angsuran	7.07107	Layak
5000	0	20 x	7.07107	LAYAK
5000	0	20 x Angsuran	7.07107	Tidak Layak
5500	0	20 x Angsuran	7.08872	TIDAK LAYAK
6000	2	30 x Angsuran	4.3589	Layak

Figure 7. Euclidean Distance Display

The student with the highest score is selected as the most qualified within the available quota. The calculation page displays as follows.

Jumlah Pinjaman	Golongan	Angsuran	Jarak	Keterangan
2500	0	5 x Angsuran	7.5	Layak
3000	0	20 x Angsuran	7.34847	LAYAK
4000	3	30 x	3	LAYAK
4000	0	10 x Angsuran	7.14143	TIDAK LAYAK
4000	0	10 x Angsuran	7.14143	LAYAK
5000	0	20 x Angsuran	7.07107	Layak

Figure 8. Calculation Results Display

Discussion

a) Project Testing Results

Black Box testing focuses on verifying the system's overall functionality without examining the internal code structure. The testing focuses on various vital components, from secure access to the login page and master data management (such as admin data, borrower data, and datasets), to logical validation of key calculation features. Validators involved in this testing ensure each test scenario represents actual user needs.

Based on a series of test scenarios, all features demonstrated valid status. From the CRUD (Create, Read, Update, Delete) functions for admin and borrower data to the output of the calculation process, everything ran according to design specifications. No functional errors or bugs were found that hampered the system's workflow.

Implicitly, "valid" results for these calculation and data management features indicate that the system is ready to support decision-making. The accuracy of the calculation functions ensures that the recommendations or analysis results provided to the Admin are reliable. Thus, the system is not only technically functional but also effectively assists users in managing borrower data and determining evaluation results objectively and efficiently.

b) Method Test Results

Based on the system design outlined in Chapter III, the next stage is testing the method using the K-Nearest Neighbor (K-NN) algorithm. This testing aims to measure the system's accuracy in determining the creditworthiness of KPRI employees. This process includes calculating Euclidean distances, ranking the closest distances, and determining the final classification results.

c) Manual Calculation of K-Nearest Neighbor Algorithm

This sub-chapter conducts a manual simulation to verify the logic of the K-Nearest Neighbor algorithm. This process calculates the Euclidean distance between new case data (credit applicants) and available historical sample data from KPRI employees. The analysis is conducted by reviewing relevant literature to determine appropriate credit parameters.

d) Parameter Determination and Data Transformation

The algorithm implementation begins by defining the determining attributes: Loan Amount, Class, and Installment Amount. Each attribute from the sample data (old case) and test data (new case) is converted into a numerical weight value for mathematical calculation.

The following sample data is used as the knowledge base:

Table 1. Sample Data

No	Borrower name	Loan Amount	Group	Installment amount	Keterangan
1.	Agus Yudiono	2.000.000	II A	30 x installments	Worthy
2.	Budi Endro p.	6.000.000	II A	30 x installments	Worthy
3.	Didik Mukarom	5000000	III B	30 x installments	Worthy
4.	Dini Anggraini	3600000	II A	30 x installments	Worthy
5.	Dini Anggraini	4.000.000	II A	30 x installments	Worthy
6.	Dja'is	2000000	II B	30 x installments	Worthy
7.	Djoko Eko S	7500000	HONORARY	30 x installments	not feasible
8.	Enieke Suci	6.000.000	III C	30 x installments	Worthy
9.	Erwin meidy p,st	6000000	IV A	30 x installments	Worthy
10.	H. Moesir	5000000	IV B	30 x installments	Worthy
11.	Hadi suprono	18500000	HONORARY	30 x installments	not feasible
12.	Hari kristanto	6.000.000	III B	20 x installments	Worthy
13.	Hendro suhartono	1500000	IV B	20 x installments	Worthy
14.	Hidayat	7.000.000	III B	20 x installments	Worthy
15.	Ike ratna m.	5.000.000	II D	30 x installments	not feasible
16.	Ike ratna s	6000000	III B	20 x installments	Worthy
17.	Kasdam	5000000	II A	30 x installments	not feasible
18.	Marlan	15000000	III B	30 x installments	Worthy
19.	Mastur	3000000	IV B	30 x installments	Worthy

As testing material, one new case data was used with the following details:

Table 2. New Case Data

ID Number	Loan Amount	Group	Amount	Installments
K028	Rp 5.000.000	IV A	20 x installments	

Before calculating the distance, the data is converted based on the following weighting criteria:

Table 3. Loan Amount Attribute Weight Value

No Criteria	Criterion Value
1 1 - 3 Juta	5
2 4 - 10 Juta	4
3 11 - 15 Juta	3
4 16 - 20 Juta	2
5 > 20 Juta	1

Table 4. Group Criteria

No Criteria	Criterion Value
1 IV A - IV D	5
2 III A - III D	4
3 II A - II D	3
4 I A	2
5 Honorary	1

Table 5. Installment Amount Criteria

No Criteria	Criterion Value
1 < 5 installments	5
2 > 5 installments	4
3 10 installments	3
4 20 installments	2
5 30 installments	1

2. Euclidean Distance Calculation

The core process of this algorithm is to calculate the difference in weight values between new and old cases. The formula used is Euclidean Distance. The researchers set the nearest neighbor constant value at **K=5**.

The following is a simulation of calculating the distance between new case data (ID K028) and one of the sample data (for example, data in the name of Agus Yudiono):

a) **Loan Amount Attribute:**

- o New Case (5 Million) = Weight 4 (*a*)
- o Old Case (2 Million) = Weight 5 (*A*)

b) **Class Attributes:**

- o New Case (IV A) = Weight 5 (*b*)
- o Old Case (II A) = Weight 3 (*B*)

c) **Installment Amount Attribute:**

- o New Case (20x) = Weight 2 (*c*)
- o New Case (20x) = Weight 2 (*C*)

The distance calculation is as follows:

$$\text{Distance} = (a - A)^2 + (b - B)^2 + (c - C)^2$$

$$\text{Distance} = (4 - 5)^2 + (5 - 3)^2 + (2 - 2)^2$$

$$\text{Distance} = (-1)^2 + (2)^2 + (0)^2$$

$$\text{Distance} = 1 + 4 + 0$$

$$\text{Distance} = \sqrt{5}$$

$$\text{Distance} = 2,236067977$$

Note: The above calculations are repeated for all available sample data.

3. Ranking and Classification Results

Once the Euclidean distance values are obtained for all data, the next step is to sort the data from smallest to largest distance (ascending). A smaller distance indicates a higher degree of similarity between new loan applicants and historical data.

Based on the ranking table above, the system takes the top 5 (five) data as the nearest neighbors (Nearest Neighbors) according to the value of $K = 5$. A summary of the top 5 data can be seen in the following table:

Table 6. Recapitulation of 5 Nearest Neighbors ($K=5$)

Rank	Borrower Name	Euclidean distance	Information
1	Djoko Eko S	1	WORTHY
2	Dini A	1,414	WORTHY
3	Erwin Meidy P, ST	1,414	WORTHY
4	H. Moesir	1,414	WORTHY
5	Hadi Suprono	1,414	WORTHY

4. Conclusion of Results

Based on the summary table above, it can be seen that the five nearest neighbors (Rank 1 to 5) have a "FEATURED" status. In accordance with the majority voting mechanism in the K-Nearest Neighbor algorithm, because the dominance (even the entirety) of the nearest data indicates a feasible status, the system concludes that the credit application with ID Number K028 is classified as FAIR for a loan.

CONCLUSIONS

Conclusion

Based on the research and testing described above, it can be concluded that the implementation of the K-Nearest Neighbor method in the KPRI customer loan decision support system has proven effective. This system is able to operate objectively, accurately, and quickly, with a feasibility test result of 88%. Furthermore, blackbox testing showed a valid status, confirming that the developed system is highly feasible for implementation to assist the decision-making process of cooperative management.

Recommendations

The authors acknowledge that this research still has certain limitations. Therefore, it is recommended that future research expand this system beyond its current scale to a more complex program. This development should include broader functionality and additional features to improve the system's accuracy and usability in the future.

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