

Enhancement of The User Interface Features of The Digital Population Identity Application Using Machine Learning and Design Thinking Methods

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Abstract. As an implementation of the One Agency One Innovation policy issued by the Ministry of PANRB, the Population and Civil Registration Office launched the Identitas Kependudukan Digital (IKD) application. IKD is an electronic ID card in digital form that contains population data and documents within a mobile application accessible via a smartphone. It displays the owner's personal information as a valid official identity, allowing it to be used across various population administration services digitally. However, the application faces several challenges, including low adoption rates, poor user ratings (3.2 on the Google Play Store), and technical constraints. This study aims to introduce additional features to the IKD (Digital Population Identity) application to enhance usability, interaction efficiency, and the overall user experience (UI/UX). This research employs both quantitative and qualitative methods through the integration of machine learning and design thinking. The empathize stage utilized sentiment analysis using the Naive Bayes algorithm on 9,906 user reviews from the Google Play Store, along with a baseline questionnaire of 271 respondents. Machine learning analysis, achieving 94.1% accuracy, identified dominant negative sentiments related to login failures, complex face-to-face verification, and the absence of password or PIN reset features. Based on these findings, the design thinking process produced a solution design featuring Single Sign-On functionality, password or PIN reset options, FAQs, and online queuing services. Validation testing of the new design showed a significant improvement, with an average score of 4.49 out of 5, indicating very positive user acceptance.

Keywords: Digital Population Identity (IKD); Machine Learning; Naive Bayes; Design Thinking, Password.

INTRODUCTION

Digital transformation in public services is one of the strategic priorities of the Indonesian government to improve the quality of services to the community. Although various innovations have been launched, the quality of public service application interfaces often remains in the spotlight (Anand & Brass, 2021; Lestari & Rijali, 2025). Common complaints include complicated procedures, uncertainty regarding completion times, high costs, and less intuitive interface navigation. This condition indicates that the modernization of information technology-based systems must be balanced with improvements in the quality of the user interface (UI) and user experience (UX) (Aqil, 2020).

As a follow-up to the One Agency One Innovation policy by the Ministry of PANRB, the Directorate General of Population and Civil Registration developed the Identitas Kependudukan Digital (IKD) as an innovation in population administration services (Akhsin, 2025) (Gondara, 2025). IKD is a digital form of an electronic ID card containing population data within a device-based application. This application is expected to accelerate service processes, enhance data security, and support the national digital identity ecosystem.

However, the IKD adoption rate remains low—around 5.6% of Indonesia's total population by 2025—far below the government's 30% target. In addition, the application's

rating of only 3.2 stars from 66,000 reviews indicates serious issues with the UI/UX aspects, such as difficult navigation, unresponsive features, and activation failures (Patricia & Azizah, 2025; Ruiu et al., 2024).

These problems are exacerbated by low digital literacy, limited infrastructure, and rampant fraud disguised as IKD activation services. Therefore, an innovative approach is needed to improve the quality of the IKD application interface to make it more responsive, secure, and aligned with user needs. This research proposes the integration of Machine Learning (ML) and Design Thinking as a solution. Machine Learning, specifically the Naive Bayes algorithm, is employed to process thousands of user reviews efficiently and identify key issues, while Design Thinking is utilized to design empathetic and user-relevant solutions.

The integration of these two methods is expected to produce an adaptive, secure, and user-friendly interface. This research also adopts the Project Management Body of Knowledge (PMBOK) framework to ensure that the management of IKD development projects proceeds systematically and measurably. Thus, this study contributes not only practically to optimizing the implementation of IKD but also theoretically to the literature on technology-based project management in the public sector.

Recent studies on the Identitas Kependudukan Digital (IKD) application and comparable public sector digital platforms have predominantly focused on usability assessments, service quality measurements, and user satisfaction evaluations using conventional methodological approaches. (Amalia, 2024; Dinata & Hasdyna, 2020; Pratama et al., 2024). employed sentiment analysis on user reviews of the IKD application to identify recurring issues, including login failures, system instability, and verification-related problems. However, their findings remained largely descriptive and were not translated into structured UI/UX redesign recommendations (Nguyen et al., 2024).

Further evidence is provided by (Akhsin, 2025), who demonstrated that the application of the Design Thinking methodology in optimizing user experience and redesigning the IKD interface yields measurable improvements in interface structure and interaction flow. Similarly, (Brooke, 1996; Pramana et al., 2023) (Nielsen, 1994) (Institute, 2021) adopted the Design Thinking approach and assessed subsequent design enhancements using the User Experience Questionnaire (UEQ), confirming its effectiveness in improving overall interface quality.

Despite these contributions, existing scholarship still exhibits a methodological gap, as sentiment analysis and the Design Thinking framework are commonly applied in isolation. Such separation limits the integration of data-driven analytical insights with user-centered design processes, particularly within digital identity systems in the public sector (Bintoro et al., 2024; Hanin & Dewayanto, 2024; Monte et al., 2025) (Hayuningtyas, 2019).

To bridge this gap, the present study integrates machine learning-based sentiment analysis—specifically employing the Naive Bayes algorithm on a dataset comprising 9,906 user reviews—with the Design Thinking framework. This integrative strategy enables sentiment-derived insights to inform the empathize and define stages, thereby ensuring that proposed UI/UX improvements are grounded in large-scale empirical user experiences. Consequently, the resulting design recommendations demonstrate stronger analytical validity and practical relevance for enhancing the IKD application (Jongbae, 2025).

MATERIALS AND METHODS

Research Design

This study uses a mixed methods approach, by integrating quantitative and qualitative analysis. Machine learning based sentiment analysis is used to identify key problems, while design thinking is used to design UI/UX solutions based on user needs (Rahmadi, 2011). The overall research framework integrating machine learning based sentiment analysis and the Design Thinking approach is illustrated in Figure 1.

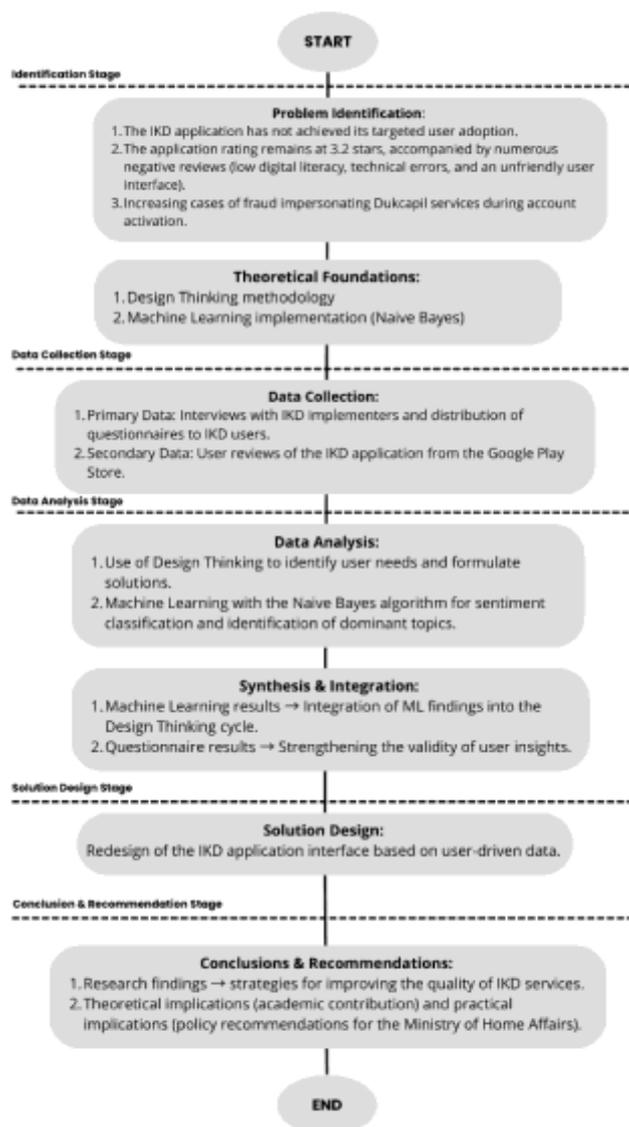


Figure 1. Research Framework
Source: Developed for this study (2025)

Data Collection

1. User Review Data

IKD application review data were analyzed from the Google Play Store using Python as many as 10,000 reviews using *web scraping* techniques. After data pre-processing, the number of reviews used for analysis was 9,906 reviews.

2. Data Questioner

The questionnaire data were collected in two stages: a baseline survey of 271 IKD users and a post-redesign validation survey of 37 respondents, using SUS (System Usability Scale), PU (Perceived Usefulness), and PEU (Perceived Ease of Use) instruments. Credibility is supported by the large baseline sample, targeted validation, and triangulation with large-scale user sentiment data, which together reduces subjective bias and enhances representativeness. Reliability was confirmed at the validation stage with high internal consistency (Cronbach’s Alpha = 0.907), indicating dependable measurement for early-stage UI/UX testing and pilot validation. Ethically, participation was voluntary with informed consent; all responses were anonymized; no sensitive personal data were collected, stored, or disclosed; and analyses were conducted solely for academic purposes, ensuring privacy, confidentiality, and responsible data use.

3. Research Methodology Flow

The design process follows five stages of *Design Thinking* in Table 1:

Table 1. Research Methodology Flow

Stages	Method	Output
Empathize	Sentiment Analysis & Baseline Questionnaire	User Pain Points
Define	Data Synthesis	Problem Statement
Ideate	Brainstorming Solutions	List of Improvement Features
Prototype	UI/UX Design	Application Prototype
Test	Initial Testing & SPSS Analysis	User Acceptance Rate

Source: Adapted from the Design Thinking framework and applied in this study (2025)

Data Analysis Techniques

User review data is processed using the Naive Bayes algorithm on the *Orange Data Mining* application (Pratmanto et al., 2023). The Naive Bayes algorithm was selected due to its computational efficiency, simplicity, and strong performance in classifying large scale textual data, particularly for sentiment analysis of user reviews. The process includes *preprocessing* (*cleaning, tokenization, stopword removal*) and sentiment classification (positive, neutral, negative) as well as topic modeling to identify dominant issues. Model evaluation is carried out using 5-fold cross validation through the Test & Score widget. Meanwhile, the questionnaire analysis was carried out using SPSS, including validity, reliability, and descriptive statistical tests.

RESULTS AND DISCUSSION

Results of Sentiment Analysis as a Level of Empathy

The *empathize stage* in the design thinking method was carried out by analyzing user reviews of the IKD application collected from the Google Play Store. A total of 9,906 reviews of pre-processed results were analyzed using the Naive Bayes algorithm on *Orange Data Mining* to identify user sentiment. The results of the model evaluation demonstrate excellent classification performance, allowing the analysis output to be reliably used as the foundation for mapping user needs, as summarized in Table 2.

Table 2. Results of the Evaluation of the Naive Bayes Model

Metrics	Value
Accuracy	0,941
AUC	0,993
Precision	0,967
Recall	0,941
F1 Score	0,950
MCC	0,876

Source: Data processed by the author (2025)

The sentiment distribution shows that the negative class dominates over the neutral and positive classes. The dominance of this negative sentiment indicates that there are still many problems felt by users in the use of the IKD application, especially in terms of account access and system stability.

Identify Key User Issues

Based on the results of the sentiment analysis and baseline questionnaires, data synthesis was conducted to formulate the *problem statement* at the *define stage*. The synthesis revealed several key pain points experienced by IKD users, which are summarized in Table 3.

Table 3. Main Pain Points for IKD Users (Defined Level)

No	Pain Point
1	No forfeit/reset PIN and password feature available
2	The activation and verification process still requires face-to-face
3	Apps often crash or fail to log in
4	Lack of adequate help features and FAQs

Source: Synthesis of sentiment analysis and baseline questionnaire data (2025)

The problem statement formulated is:

"How to design an IKD application interface that is able to minimize access barriers, improve usage stability, and provide adequate service support for users?"

Development of Interface Solution Concepts

During the *ideate stage*, brainstorming activities are undertaken to develop interface solutions grounded in the identified pain points. The resulting solutions emphasize minimizing access barriers and improving user convenience, as presented in Table 4.

Table 4. Ideate Result: UI/UX Solutions Based on Pain Points

Pain Point	UI/UX Solutions
Forgot PIN/Password	Forgot and Reset PIN/Password Feature
Face-to-Face Activation	Login Single Sign-On (SSO)
Service Difficulties	FAQ and User Help Features
Service Queue	Dukcapil Online Queue

Source: Author's analysis (2025)

IKD Application UI/UX Planning

The resulting solution at the *ideate* stage is then realized in the form of a prototype high-fidelity IKD application interface (Priyono et al., 2023). Prototypes are designed to reflect simpler, consistent, and easy to understand usage flows. Key changes to the prototype include:

- a. Login flow simplification
- b. Addition of PIN/password reset feature
- c. Addition of the FAQ menu
- d. Online service queue feature integration

Selected high-fidelity UI/UX prototypes of the redesigned IKD application are shown in Figure 2, illustrating the implementation of the proposed solutions.

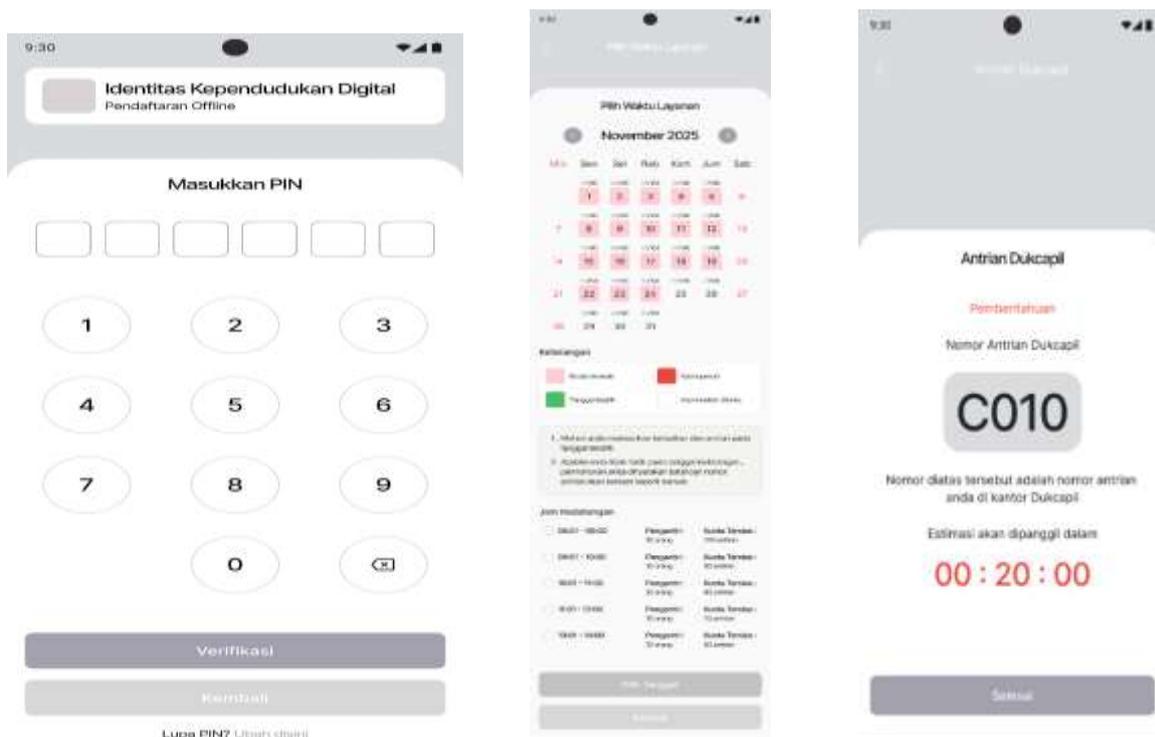


Figure 2. High-Fidelity UI/UX Prototype IKD: (a) Login page (with reset PIN); (b) Appointment selection screen; (c) Queue information screen

Source: Author's design (2025)

Prototype Initial Test Evaluation

The *test stage* was carried out through an initial test of the prototype to 37 respondents using a questionnaire based on the Likert scale (1–5). The test instrument was declared reliable with a value of Cronbach's Alpha = 0.907. As shown in Table 5, the descriptive statistical results indicate strong positive user responses toward the redesigned IKD UI/UX during the initial test stage.

Table 5. Descriptive Statistical Results of Prototype Initial Test (Test Stage)

Question Items	Red	SD
The IKD app's new UI/UX looks neater and easier to understand.	4.22	0.630
Navigation in the new UI/UX is easier to use than previous versions.	4.24	0.6

Question Items	Red	SD
The process of completing tasks (login, viewing identities, QR, etc.) feels faster.	4.24	0.723
Important information in the new UI/UX is easier to find.	4.30	0.618
The visual design (colors, text sizes, icons) in the new UI/UX feels comfortable to see.	4.24	0.641
Overall, <i>the new UI/UX</i> improved my experience when using the IKD app.	4.49	0.559

Source: Primary data processed by the author (2025)

The high mean value indicates that the design thinking interface prototype is very well received by the user and has a strong positive impact on the user experience.

Integration of Sentiment Analysis and Design Thinking

The results of the study show that the integration of Naive Bayes–based sentiment analysis and Design Thinking methods has produced an Identitas Kependudukan Digital (IKD) application interface design that is more user-oriented (Putra et al., 2025; Rachman & Sutopo, 2023). Sentiment analysis serves as an objective foundation during the empathize and define stages, ensuring that the identified problems are derived from real user experiences rather than assumptions. Furthermore, Design Thinking ensures that the solutions developed through the ideate and prototype stages directly address these pain points.

The increase in user acceptance during the test stage—particularly in the overall user experience indicator (Mean = 4.49)—demonstrates that UI/UX improvements have successfully reduced access barriers and enhanced the ease of using the IKD application. Therefore, Design Thinking has proven effective as a framework for designing data-driven public service interfaces.

CONCLUSIONS

This study concludes that improving the interface features of the Identitas Kependudukan Digital (IKD) application can be effectively achieved through a combination of Design Thinking methods and the application of Machine Learning. Redesigning the UI/UX based on a deep understanding of user needs has proven effective in addressing various weaknesses of the previous application. The implementation of Machine Learning has also demonstrated high accuracy (94.1%) in identifying critical issues, such as the absence of a PIN reset feature and verification failures. These findings provide a strong foundation for the Design Thinking process to generate concrete solutions in the form of Password Reset, Single Sign-On (SSO) Login, and Online Queue features. Validation results, with an average score of 4.49, indicate that the redesign was very well received by users and successfully resolved pain points present in the earlier version. It is recommended that developers (the Directorate General of Dukcapil, Ministry of Home Affairs) immediately implement the “Forgot PIN/Password” feature and a server auto-reconnect mechanism as top priorities for improvement. The prototype developed in this study is also recommended as a blueprint for the next phase of IKD application development. For future research, it is suggested to explore the integration of other

intelligent technologies into IKD, such as AI-based chatbots for user assistance and usage analytics for service personalization.

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