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Smart CRM Application Development Using Artificial Intelligence and Extreme Programming Method

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Abstract: Customer Relationship Management (CRM) is an important strategy for companies to understand customer behavior, increase loyalty, and reduce churn rates. However, the challenge that is often faced is how to manage increasingly complex customer transaction data and turn it into useful information for decision-making. This research aims to develop an artificial intelligence-based smart CRM application by integrating the K-Means algorithm for customer segmentation and XGBoost for retention prediction, as well as using the Extreme Programming (XP) methodology in the development process. The XP methodology was chosen because it is able to provide a fast, adaptive, and user-oriented iterative cycle, so that applications can be developed according to user needs. The results showed that K-Means can group customers into segments that are relevant to marketing strategies, while XGBoost provides retention prediction results with good accuracy. In addition, the application was tested using Blackbox Testing to ensure that the functionality runs according to specifications, as well as the System Usability Scale (SUS) which resulted in an average score of 89 and was included in the excellent usability category. This confirms that the system built is not only technically feasible, but also well received by users. This research contributes to presenting a smart CRM application that combines AI with modern software development methodologies, as well as opening up opportunities for advanced research at a larger data scale and integration with digital marketing systems.

Keywords: Customer Relationship Management, Artificial Intelligence, K-Means, XGBoost, Extreme Programming

INTRODUCTION

Customer Relationship Management (CRM) is an important strategy in maintaining the sustainability of the relationship between the company and the customer. In the digital age, CRM no longer only functions as an interaction recording system, but has evolved into an intelligent analytics tool that helps companies understand consumer behavior patterns more deeply. Customer segmentation and retention prediction are fundamental aspects in CRM because they directly contribute to increased loyalty, reduced churn rates, and optimization of marketing strategies (Awate & Sharma, 2025). However, conventional CRM systems often face limitations in managing complex and large transaction data. Many companies struggle to identify customer groups with similar characteristics or accurately predict retention potential, so marketing strategies are often less targeted and increase customer acquisition costs.

The development of artificial intelligence opens up new opportunities to overcome these limitations. A number of studies show that machine learning algorithms are able to increase the effectiveness of CRM, especially in terms of segmentation and prediction of customer behavior (D et al., 2024; Sharma et al., 2023). K-Means is widely used as a clustering method to group customers based on transaction behavior (Nugroho et al., 2024), while XGBoost has proven to be superior in performing retention predictions due to its ability to process large data with high accuracy and computing efficiency (Putra et al., 2024). However, most research still focuses on algorithmic experiments without integrating the results into a CRM application that is ready for use in a real business context.

Based on the literature review, there are several research gaps that need to be filled. First, previous research has only predominantly evaluated algorithm performance, not yet presenting an integrated CRM application that is ready to be used practically (Lestari et al., 2025). Second, the system development approach is generally still

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minimal using modern software engineering methodologies, so that the quality and sustainability of software are not guaranteed (Melo et al., 2024). Third, user involvement in the smart CRM development cycle is still limited, even though the user experience greatly determines the success of the system (Anders et al., 2024). Fourth, previous performance evaluations emphasized more on algorithm accuracy, without considering aspects of functionality, usability, speed, and user satisfaction (Siro et al., 2024). Fifth, until now there is still not much research that applies the Extreme Programming method in the development of artificial intelligence-based CRM, even though this method is effective in producing adaptive software through rapid iteration, continuous testing, and intensive communication with users (Kalua, 2022).

Therefore, this research contributes by developing an artificial intelligence-based smart CRM application that integrates the K-Means algorithm for customer segmentation and XGBoost for retention prediction. The development process is carried out using the Extreme Programming method to ensure fast iteration, user engagement, and tested software quality. With this approach, the resulting application is not only able to improve the accuracy of customer analysis, but is also relevant to the real needs of the business world and has the potential to be implemented in a sustainable manner.

LITERATURE REVIEW

Research on Customer Relationship Management (CRM) is growing with the integration of artificial intelligence (AI) to increase effectiveness in understanding consumer behavior. AI-based CRM is able to leverage transaction data to analyze customer preferences, provide personalized recommendations, and support long-term retention strategies (Riyaz et al., 2023). Companies that adopt AI-based smart CRM are proving to be more competitive because the system can provide predictive insights rather than relying solely on historical data (Ugbaja et al., 2023).

One of the techniques that is widely used in CRM is customer segmentation using a clustering algorithm. K-Means is a popular method because of its ability to efficiently group customers based on transaction patterns and specific characteristics (Anshary et al., 2022). Previous research has shown that the implementation of K-Means helps companies in differentiating loyal, potential, and at-risk customers (Essayem et al., 2022). However, most of this research is still limited to data analysis without realizing an integrated application system.

In addition to segmentation, customer retention prediction or churn prediction is the main focus in modern CRM research. The XGBoost algorithm is known to have high performance for churn classification due to its ability to address data imbalances as well as result in better interpretation of features (Dewi et al., 2024). Research by (Nurhidayat & Dyah Anggraini, 2023) shows that XGBoost is superior to Random Forest and Logistic Regression in predicting customer retention in telecommunications data. Nonetheless, most studies focus only on evaluating the accuracy of the model, without paying attention to the implementation aspects into real applications.

In terms of software engineering, the development methodology also affects the quality of the CRM system produced. Most previous research still uses Waterfall or Agile-Scrum models, which are sometimes less flexible to changing user needs (Zasornova et al., 2022). Extreme Programming (XP) offers advantages with fast iterative cycles, continuous testing, and intensive user engagement so that the software is more adaptive and user-oriented (Taye et al., 2024). However, research that combines XP with AI integration in CRM application development is still rare.

On the other hand, the usability aspect is also important to pay attention to because the success of CRM implementation is not only measured by the accuracy of the model, but also by the ease of users in operating the system. Several studies emphasize the importance of usability testing using scales such as the System Usability Scale (SUS) to ensure application acceptance by users (Haidar et al., 2023; Saputra et al., 2022). Unfortunately, most previous research on AI-based CRM did not explicitly test usability aspects, so there are still research gaps in this area.

Based on the literature review, it can be concluded that there are several research gaps, namely the limited research that integrates K-Means and XGBoost into real CRM applications, the lack of use of XP methodology in the context of AI-based CRM, and the lack of evaluation of system usability. This research is here to close this gap by designing and building a smart CRM application using the XP method, K-Means and XGBoost integration, and evaluating usability through SUS.

METHOD

The methodology of this research is designed to produce artificial intelligence-based smart CRM applications with an Extreme Programming approach. The methodological flow can be seen in Figure 1 below.

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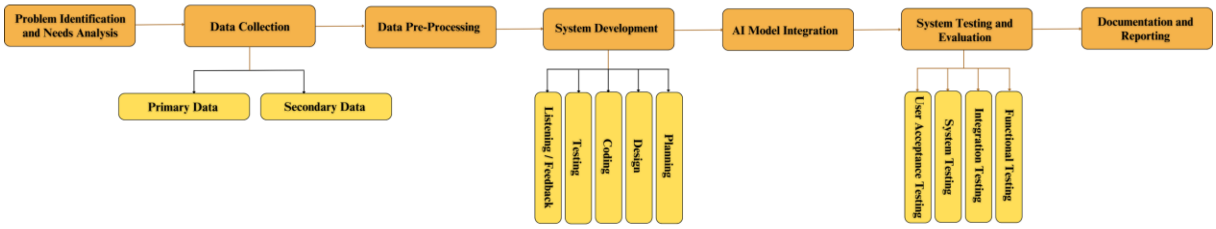

Fig 1. Research Methodology

Based on Figure 1, the methodological stages of this research are systematically arranged starting from the problem identification process to the final stage of documentation and reporting. Each stage is interrelated with each other, thus forming an integrated research workflow between data collection, data processing, system development with an Extreme Programming approach, integration of artificial intelligence models, and testing and evaluation of systems to produce smart CRM applications that suit user needs.

1. Problem Identification and Needs Analysis
    a. Process: Literature study, observation, and interviews with potential users (marketing managers, CRM staff, and related stakeholders).
    b. Results: A system requirements specification document, including functional (segmentation, retention prediction, analytics dashboard) and non-functional (system speed, data security, and ease of use) needs.
2. Data Collection
    a. Process: Collect customer transaction data from internal company sources as well as secondary data in the form of literature and related datasets.
    b. Results: Customer dataset consisting of Recency, Frequency, Monetary, product type, and other relevant customer profile variables. This dataset is the main material for further processing.
2. Data Pre-Processing
    a. Process: Perform data cleanup (remove duplicates and fix invalid data), fill in missing values, normalize numerical scales, and encode for categorical variables.
    b. Results: Datasets that are clean, structured, and ready to use by the K-Means and XGBoost algorithms. In addition, *a training set* and *a testing set* were formed for the prediction model testing stage.
3. System Development with Extreme Programming (Kalua, 2022)
    a. Process:
        1. Planning: compiling a backlog of system needs.
        2. Design: creation of database design, software architecture, and user interface design.
        3. Coding: a gradual implementation of the system with *pair programming* and *incremental development*.
        4. Testing: unit testing that is performed each time a feature is added.
        5. Listening/Feedback: improvements based on user feedback.
    b. Results: Prototype of a smart CRM application with basic modules ready to be tested, including user interface and integration with transaction databases.
4. Artificial Intelligence Model Integration
    a. Process:
        1. K-Means: forming customer groups based on transaction patterns.
        2. XGBoost: predicts customer retention or *churn* opportunities .
        3. Integration of AI modules with CRM dashboards.
    b. Results: An artificial intelligence analytics module embedded in a CRM application, generating customer segmentation (e.g.: loyal customers, potential customers, customers at risk of churn) as well as retention predictions to support decision-making.
5. System Testing and Evaluation
    a. Process:
        1. Functional Testing: tests the basic functionality of the application.
        2. Integration Testing: testing the relationships between modules.
        3. System Testing: testing the application as a whole.
    b. Results: A report of test results that includes technical (model accuracy, processing speed) and non-technical (usability, user satisfaction) performance.
6. Documentation and Reporting

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a. Process: Compile technical documentation, evaluation reports, and scientific articles for publication. Results: Complete documentation in the form of system manuals, research reports, and scientific articles explaining the development of artificial intelligence-based smart CRM applications using the Extreme Programming method.

RESULT

This section describes the results of the development of smart CRM applications using artificial intelligence carried out using the Extreme Programming (XP) method. The development process follows an iterative cycle consisting of planning, design, coding, testing, and listening/feedback stages as shown in Figure 2.

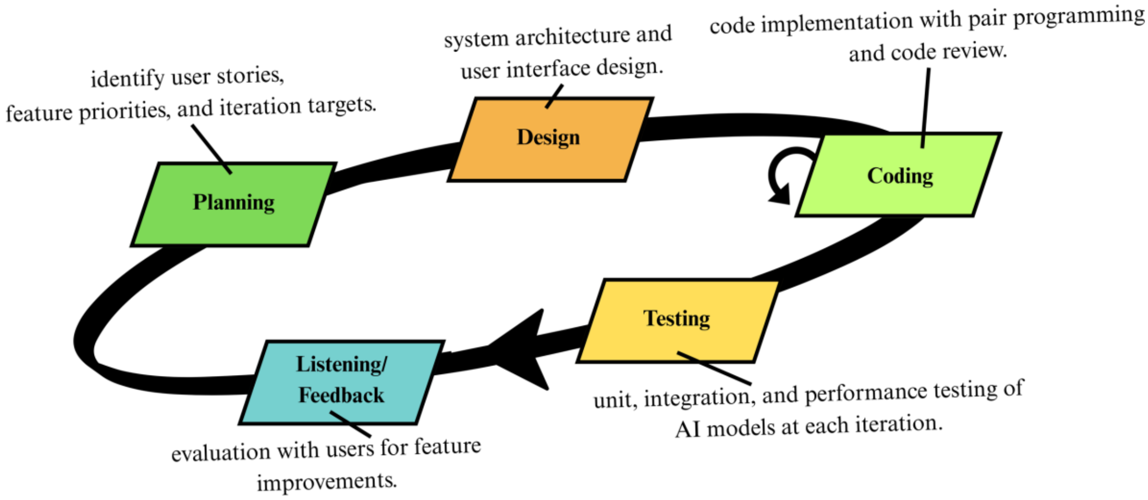

Fig 2. Software development cycle with the Extreme Programming method

Through each XP stage, different but continuous results are obtained. In the planning stage, a list of system needs (user stories), feature priorities, and iteration targets are generated that are adjusted to user input. The design stage produces the design of the system architecture, the design of the transaction database, and the prototype of the user interface. Furthermore, the coding stage results in the implementation of application code with the principles of pair programming and code review so that the quality of the code is better maintained. The testing stage produces unit test reports, integrations, and performance of K-Means and XGBoost algorithms in each iteration. Finally, the listening/feedback stage generates feedback from users that is used to improve features and improve system usability.

Planning

In the *planning* stage, user needs are identified through discussions with marketing staff and CRM managers to understand key issues such as customer segmentation difficulties and retention predictions. From the results of the identification, *user stories* and feature priorities were compiled, with a focus on the development of K-Means-based customer segmentation modules, retention predictions using XGBoost, and interactive analytics dashboards. Each need is then outlined in an iteration backlog that is the basis for planning the development of the system gradually according to the principle of Extreme Programming.

Design

In the design stage, the system design is carried out to describe the flow of interaction between users and applications as well as the design of the interface display. The main result at this stage is a Use Case Diagram that describes system functions such as login, transaction data management, customer segmentation, retention prediction, and report presentation; Activity Diagram that shows the flow of user activity from entering data to obtaining analysis results; and Wireframe which displays the initial design of the smart CRM dashboard interface. These three design artifacts serve as an implementation guide at the coding stage and ensure that the system is in accordance with the user's needs.

In addition to these two main actors, there are also other actors that are not shown in this diagram but have important roles, such as the CRM Analyst who analyzes segmentation and prediction results, the Data Scientist who manages the data and builds the K-Means and XGBoost models, and the System Administrator who is responsible for account setup, security, and system access rights. Next, the design of the system wireframe will be displayed to describe the user interface of the built application.

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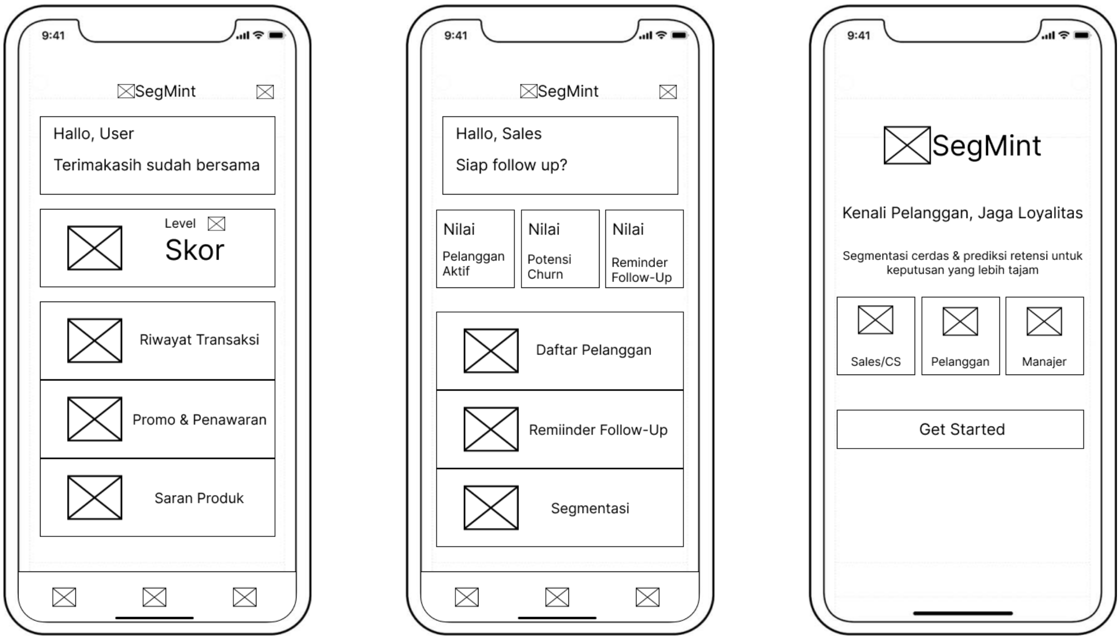

Fig 3. Wireframe Application

Coding

In the coding stage, implementing the core modules of the application iteratively with the principles of pair programming and code review to maintain code quality. The data pipeline is built to perform cleaning, normalization, and encoding before being passed to the K-Means module (RFM segmentation with k-determination through elbow and silhouette) and XGBoost (retention prediction with train/validation split and hyperparameter tuning). The model and its metrics are persisted (registry model) and exposed via a service layer/API integrated into the CRM dashboard for cluster visualization, retention scores, and follow-up recommendations. The implementation follows TDD with unit tests and integration tests, equipped with logging, exception handling, and basic access control to be safe to use in the testing and staging environment before going to production.

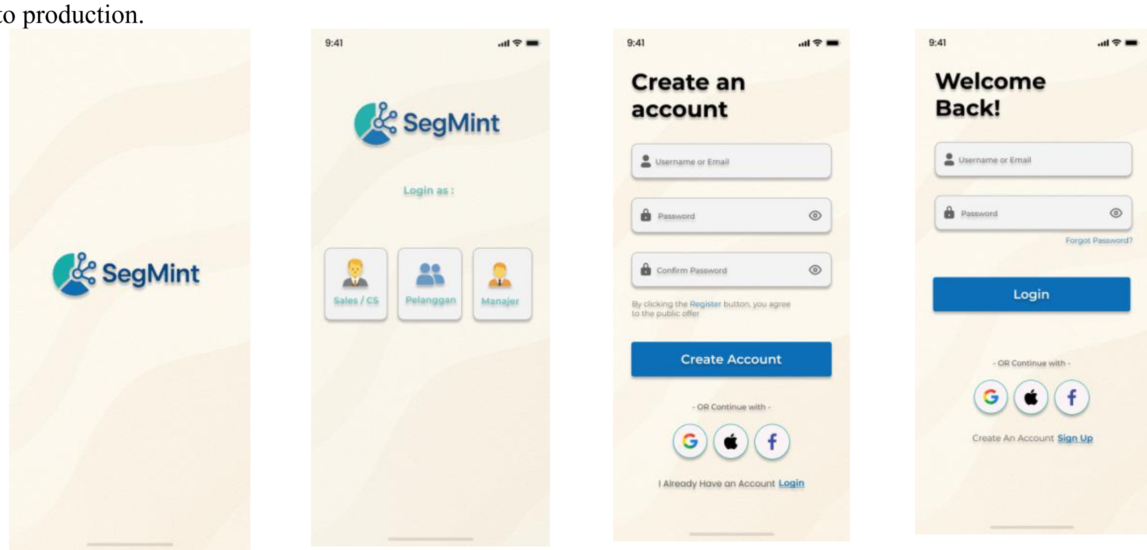

Fig 4. Pre-Login Page View

Figure 4 shows when the SegMint app is opened, the splash screen contains the initialization of important components (version check, API connection, session status) before the user enters the role selection. The selection of Sales/CS, Customer, or Manager roles determines the scope of access (RBAC) and post-login landing pages: Sales/CS is directed to the follow-up and segmentation module (read/write limited), Manager to the KPI dashboard and retention insights (read/approve), while Customer to the profile and interaction history (read-only + consent).

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In Create Account, registration validates unique emails, password strengths, and privacy policy approvals; Verification tokens are sent via email/OTP. Login supports both local and OAuth credentials (Google/Apple/Facebook); The process results in JWT/refresh tokens that are stored securely (secure storage) and accompanied by device binding and login anomaly detection. The Forgot Password feature runs a time-limited link-based reset flow. After successful authentication, the app loads the role profile, active feature flag, and user preferences, and then prefetches the initial data (e.g., segmentation briefs, follow-up queues, or KPI cards). As such, this set of pre-logins is not just a display, but an access control gateway that sets up the context of operations, security, and user experience according to their role before entering SegMint's core features.

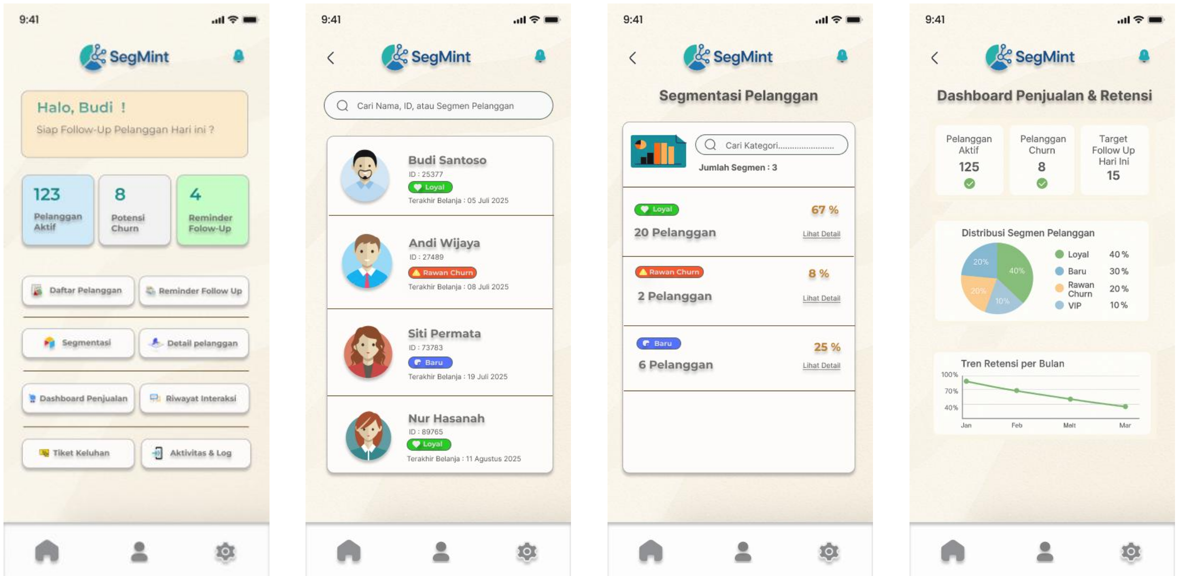

Fig 5. Sales Page Display

Figure 7 shows the SegMint application interface in the Sales/Customer Service role. On the main page, the system greets users personally and displays a quick summary of the number of active subscribers, potential churns, and follow-up reminders that need to be done that day. From the main menu, Sales can access various core features such as customer lists, follow-up reminders, customer segmentation, customer details, sales dashboards, interaction history, complaint tickets, to activities and logs.

The customer list display shows customer identity information, segmentation status (loyal, churn-prone, new, VIP), and the last date of the transaction. The search feature allows Sales to find customers by name, ID, or segment category. In the segmentation menu, the system summarizes the distribution of customers into groups according to the results of K-Means analysis, such as loyal customers, prone to churn, and new customers. Sales can see more details to understand the composition of each segment and follow-up opportunities.

The sales and retention dashboard shows key indicators (KPIs) such as the number of active customers, churn customers, follow-up targets, distribution of customer segments in the form of charts, and retention trends per month. This view helps Sales/CS understand customer conditions in real-time and prioritize interactions with customers at risk of churn.

Overall, the Sales page is designed to support day-to-day operational work more effectively by leveraging segmentation analysis and artificial intelligence-based retention predictions.

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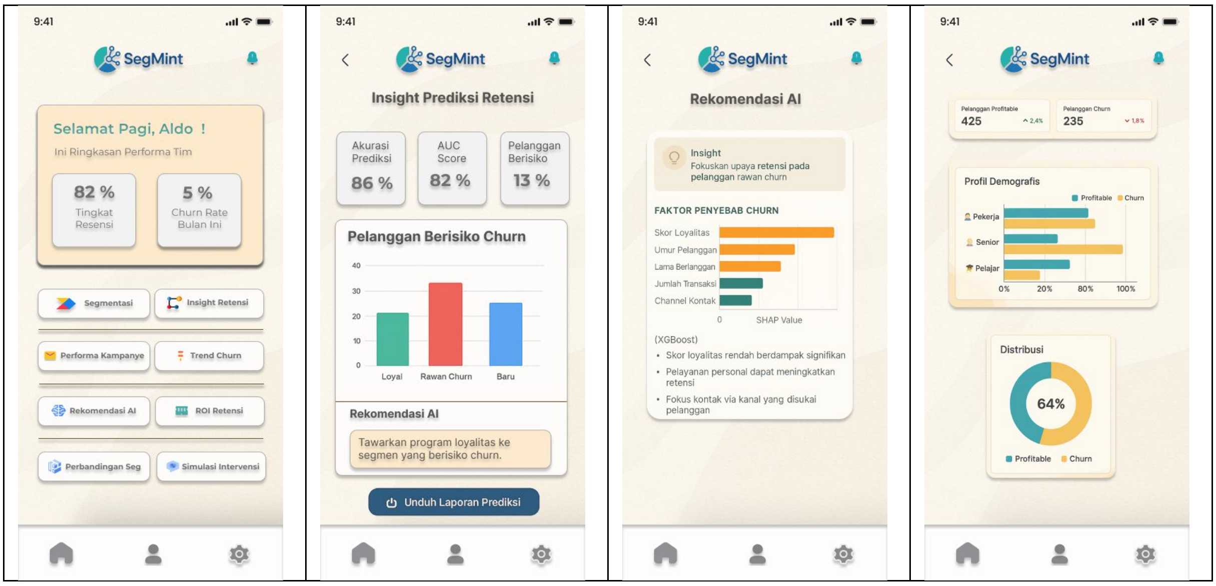

Fig 6. Page Manager View

Figure 6 shows the SegMint application interface for Manager roles that focus on artificial intelligence-based strategic decision-making. On the main page, the system directly provides a summary of team performance in the form of retention rates and monthly churn rates, along with quick access menus to important features such as segmentation, retention insights, campaign performance, churn trends, AI recommendations, retention ROI, segment comparisons, and intervention simulations. The retention prediction insights view shows model performance metrics such as accuracy, AUC score, and percentage of customers at risk of churn, visualized in the segment distribution graph. The system also provides AI-based recommendations by displaying the main factors causing churn through the interpretation of the XGBoost model, such as loyalty score, customer life, subscription length, number of transactions, and communication channel preferences. These insights help managers design loyalty strategies or interventions that are more targeted. In addition, this page comes with a demographic analysis that compares customer profiles by worker, senior, and student categories, as well as the distribution between profitable and churn customers, so that managers can understand the customer's condition thoroughly. Beyond the manager's role, this system also involves other actors who have complementary roles, such as CRM Analysts who deepen data analysis, Sales or Customer Service who execute direct follow-ups to customers, Data Scientists who build and optimize K-Means and XGBoost models, and System Administrators that manages the security and access of the user. With the involvement of these various actors, the manager page serves as a strategic control center that connects analytical insights with real business decisions.

Testing

In the *testing* stage, testing is carried out with two main approaches, namely Blackbox Testing and System Usability Scale (SUS). Blackbox Testing is used to test the main functions of the application without looking at the program code, but only based on input and *output*. Through this test, every core feature such as login, account registration, customer segmentation, retention prediction, campaign management, and data export is checked to ensure that the system responds according to the user's needs and predetermined specifications. The focus of the test is on the validation of the correctness of functions, business flows, and integrations between modules.

Table 1. Blackbox Testing

ID	Feature	Test Case	Precondition	Expected Output	Status
TC-01	Authentication	Login with valid credentials	username=valid, password=valid	Redirect to dashboard; session created	Success
TC-02	Authentication	Login with invalid password	username=valid, password=wrong	Error message shown; stay on login page	Success

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TC-21	Notifications	Overstock alert	stock >= max level	Overstock notification displayed	Success
…..	…..	…..	…..	…..	…..
TC-23	Reports	Export without permission	user lacks role	Access denied message	Success

Meanwhile, the System Usability Scale (SUS) test was carried out to assess the usability aspect of the application from the user's perspective. In this case, respondents consisting of Sales/CS, Managers, and CRM Analysts were asked to try the application and then fill out a SUS questionnaire containing 10 statements related to ease of use, consistency of appearance, interaction efficiency, and overall satisfaction. The resulting SUS score is an indicator of how well an application is received by the end user. With the combination of Blackbox Testing and SUS, testing not only guarantees the accuracy of the application's functionality, but also ensures a comfortable user experience that meets real needs.

Table 2. System Usability Scale (SUS) Testing

Respond	1	2	3	4	5	6	7	8	9	10	Sum	Value (Total × 2.5)
R1	5	2	5	2	4	2	5	2	5	1	35	87,5
R2	5	1	5	2	5	2	5	1	5	2	35	87,5
R3	5	2	5	2	5	2	4	2	5	2	35	87,5
R4	5	1	5	1	5	1	5	1	5	1	37	92,5
R5	4	2	5	2	5	2	5	2	5	1	35	87,5
R6	5	1	5	2	4	1	5	1	5	1	36	90,0
R7	5	1	5	1	5	1	5	1	5	1	37	92,5
R8	5	1	5	1	5	2	5	1	5	2	36	90,0
R9	4	2	4	2	5	2	5	2	5	2	34	85,0
R10	5	1	5	1	5	1	5	1	5	1	37	92,5
R11	5	2	5	2	5	2	5	2	5	1	36	90,0
Total number of scores												**979,5**
Average score												**89**

The results of the *System Usability Scale (SUS)* test shown in Table 2 resulted in an average score of 89. The value falls under the category of Excellent Usability, which means that the smart CRM application developed is very easy to use, consistent, and provides a positive experience for users. This high score indicates that the interface, workflow, and key features in the application are tailored to the needs of users of various roles, such as Sales/Customer Service, Manager, and CRM Analyst. Thus, it can be concluded that the application is not only technically feasible based on *the Blackbox Testing* test, but also well received in terms of user convenience and satisfaction, so that it is ready for wider implementation in real operational contexts.

DISCUSSIONS

The results show that the smart CRM application developed using the Extreme Programming (XP) method is capable of effectively integrating K-Means for customer segmentation and XGBoost for retention prediction. Segmentation successfully groups customers into relevant categories, while retention prediction produces good accuracy and supports strategic decision-making. Usability testing with the System Usability Scale (SUS) yielded an average score of 89, categorized as excellent usability, indicating that the application is easy to use and suitable for the needs of various user roles. Compared with previous studies, this research provides a more practical contribution. For instance, Sharma et al. (2023) and Nurhidayat & Anggraini (2023) focused only on evaluating algorithmic accuracy such as Logistic Regression, Random Forest, or XGBoost in isolation. In contrast, this study not only evaluates the performance of K-Means and XGBoost but also integrates them into a fully functional CRM system validated through both technical testing (Blackbox) and usability testing (SUS score = 89). This dual evaluation highlights the system's readiness for real-world adoption, an aspect rarely discussed in prior literature.

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Another important aspect to consider is data security and privacy. Since CRM directly involves sensitive data such as customer identities and transaction histories, the application must comply with security standards. In this prototype, basic measures such as role-based access control (RBAC), password encryption, and token-based authentication have been applied. However, further development should incorporate stronger mechanisms, including end-to-end encryption, anomaly detection for suspicious logins, and compliance with international data protection regulations (such as GDPR) as well as Indonesia's PDP Law. These measures are essential to ensure regulatory compliance and build user trust. Despite the promising results, this study is limited by the relatively small dataset size and the modest number of usability testing respondents (11 users), which restricts the generalizability of the findings. Therefore, future research should expand the dataset across multiple sectors (retail, banking, telecommunications) and involve a larger and more diverse pool of respondents to increase statistical robustness. In addition, comparative statistical significance testing among models (e.g., XGBoost vs. Random Forest or Deep Learning methods) should be conducted to provide stronger empirical evidence of relative performance. In conclusion, the main contribution of this study lies in presenting a ready-to-use AI-based CRM system, rather than merely an algorithmic study. The integration of the XP method, K-Means, and XGBoost, combined with technical evaluation and usability testing, demonstrates the system's readiness for real-world implementation while opening avenues for further research on dataset expansion, enhanced data security, and comparative model analysis.

CONCLUSION

This research successfully developed an artificial intelligence-based smart CRM application by integrating K-Means algorithms for customer segmentation and XGBoost for retention prediction, as well as applying the Extreme Programming methodology in the development process. The test results show that the application is able to effectively segment customers, provide retention predictions with good accuracy, and obtain a System Usability Scale (SUS) score of 89 which is included in the category of excellent usability. This confirms that the system built is not only technically feasible, but also well received by users. Thus, this study contributes in the form of a ready-to-use smart CRM application, while showing that the XP approach is effective in producing adaptive and user-oriented software.

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