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AGILE IMPLEMENTATION IN MOBILE POINT OF SALE SYSTEM DEVELOPMENT FOR BUSINESS DIGITALIZATION

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Abstract

The development of information technology drives the need for a flexible, efficient, and easy-to-use Point of Sale (POS) system to support retail business operations. This study aims to design and develop a mobile-based POS application using Agile methods to improve the effectiveness of transaction management and sales data. The research methods include problem identification, needs analysis, system design, application development, testing, and iterative system evaluation. The system design was carried out using use case diagrams and Entity Relationship Diagrams (ERD), while the implementation was developed on a mobile platform with key features including user authentication, product management, sales transactions, stock management, reports, and owner and cashier access rights settings. Quantitative evaluation using Black-Box testing validated a 100% functional success rate across all core modules, ensuring operational stability. Test results show that the application is able to function optimally, responsively, and stably in supporting real-time business processes. The simple and intuitive user interface facilitates system operation, while the Agile approach allows for continuous feature adjustments. Performance metrics also indicated a 40% reduction in average transaction processing time. Thus, the developed application is considered effective in improving the efficiency, accuracy, and quality of mobile-based retail transaction management.

Keywords: Point of Sale; Mobile Application; Agile Method; Information Systems; Digitalization

Abstrak

Perkembangan teknologi informasi mendorong kebutuhan akan sistem Point of Sale (POS) yang fleksibel, efisien, dan mudah digunakan untuk mendukung operasional bisnis ritel. Studi ini bertujuan untuk merancang dan mengembangkan aplikasi POS berbasis mobile menggunakan metode Agile untuk meningkatkan efektivitas manajemen transaksi dan data penjualan. Metode penelitian meliputi identifikasi masalah, analisis kebutuhan, desain sistem, pengembangan aplikasi, pengujian, dan evaluasi sistem iteratif. Desain sistem dilakukan menggunakan diagram use case dan Entity Relationship Diagram (ERD), sedangkan implementasinya dikembangkan pada platform mobile dengan fitur-fitur utama termasuk otentikasi pengguna, manajemen produk, transaksi penjualan, manajemen stok, laporan, dan pengaturan hak akses pemilik dan kasir. Evaluasi kuantitatif menggunakan pengujian Black-Box memvalidasi tingkat keberhasilan fungsional 100% di semua modul inti, memastikan stabilitas operasional. Hasil pengujian menunjukkan bahwa aplikasi mampu berfungsi secara optimal, responsif, dan stabil dalam mendukung proses bisnis real-time. Antarmuka pengguna yang sederhana dan intuitif memudahkan pengoperasian sistem, sementara pendekatan Agile memungkinkan penyesuaian fitur secara berkelanjutan. Metrik kinerja juga menunjukkan pengurangan waktu pemrosesan transaksi rata-rata sebesar 40%. Dengan demikian, aplikasi yang dikembangkan dianggap efektif dalam meningkatkan efisiensi, akurasi, dan kualitas manajemen transaksi ritel berbasis seluler.

Kata kunci: System Point of Sale; Aplikasi Mobile; Metode Agile; Sistem Informasi; Digitalisasi.

INTRODUCTION

The rapid advancement of Information and Communication Technology (ICT) in the digital era has triggered a fundamental transformation in transaction management mechanisms within the trade and service sectors (Y. H. C. Pratama et al.,

2025). The digitalization of business processes now enables the integration of sales data, inventory management, and financial reporting with real-time precision. A crucial technological instrument in this ecosystem is the Point of Sale (POS) system, a computerized platform designed to integrate the entire sales transaction process. In the modern business landscape, POS systems have evolved beyond mere transaction recording tools into strategic business management systems that support data-driven decision-making (Daulani & Nyoman Oka Sujana, 2024). Driven by the massive penetration of mobile devices, the development of mobile-based POS applications has become highly relevant, offering flexibility, high mobility, and optimal accessibility for business stakeholders (Handoyo et al., 2022).

Mobile-based POS applications provide a competitive advantage over conventional systems, particularly in terms of portability, installation efficiency, and seamless integration with other digital ecosystems, such as electronic payment gateways and cloud storage (Ariesta et al., 2021). The implementation of this technology is proven to optimize operational efficiency, accelerate transaction cycles, and reduce the risk of human error inherent in manual systems (Mayliana, 2025). Furthermore, real-time stock monitoring capabilities allow business owners to respond more agilely to market dynamics. However, the primary challenge in mobile POS development lies in designing a system architecture that balances complex functional requirements with a dynamic user experience.

The success of software development depends heavily on selecting the appropriate methodology to produce adaptive and reliable applications. Agile methodology has become the dominant approach in modern application development due to its emphasis on incremental iteration, active stakeholder collaboration, and flexibility toward rapidly changing system requirements (Halawa & Kurniawan, 2025). Within the Agile framework, the Extreme Programming (XP) method stands out for its focus on continuous testing, intensive communication, and simple yet effective system design (Fadhil & Baco, 2025). Literature studies indicate that the synergy between Agile and XP can produce POS systems with high accuracy and optimal functional alignment with field operational needs (Murdiani & Yudhana, 2020), (Mulyana et al., 2023a).

Despite substantial prior research on Agile-based POS development, existing studies predominantly address isolated system modules either transaction recording (Mayliana, 2025) or inventory management (Eliel et al., 2025) without achieving full cycle integration within a unified mobile architecture. Furthermore, prior implementations apply Agile in a generalized manner, neglecting the specific contribution of XP engineering practices, such as test-driven development and continuous integration, to system reliability and data integrity. Empirical usability validation in SME operational contexts also remains limited. This study addresses these gaps by proposing an integrated mobile POS architecture that consolidates transaction processing, inventory management, and financial reporting in a single platform. This study rigorously evaluating Agile XP practices as quality determinants, thereby offering a methodologically distinct and empirically grounded contribution to mobile information systems development.

Against this backdrop, this research focuses on the design and development of a mobile-based Point of Sale (POS) application employing the Agile methodology as its primary development framework. The study aims to engineer a comprehensive system that seamlessly integrates sales transaction processing, inventory management, and financial reporting in an accurate, efficient, and user-centric manner. More specifically, this research seeks to examine how iterative and incremental development cycles inherent to the Agile approach can effectively accommodate evolving functional requirements, thereby ensuring that the resulting system remains adaptive and responsive to the operational dynamics of small-to-medium enterprises. Furthermore, the study investigates the extent to which the integration of core business modules within a single mobile platform can reduce transactional redundancies, minimize human error in data recording, and ultimately strengthen the integrity of business decision-making processes grounded in real-time data. The primary contribution of this research lies in its potential to enhance transaction processing efficiency and data validity within digital business operations. Consequently, the outcomes of this study are anticipated to serve as both an academic reference and a practical framework in the field of applied information systems development, particularly with respect to the effectiveness of Agile methodologies in addressing the dynamic and evolving requirements of mobile business applications.

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RESEARCH METHODS

This study employs the Agile development methodology to design and implement a mobile-based Point of Sale (POS) application. This approach is specifically selected for its emphasis on incremental and iterative development cycles, ensuring a high degree of responsiveness to evolving user requirements (Sri Wahyuni Jelantik et al., 2021). The comprehensive research workflow, consisting of several key phases, is systematically illustrated in the flowchart presented in Figure 1.

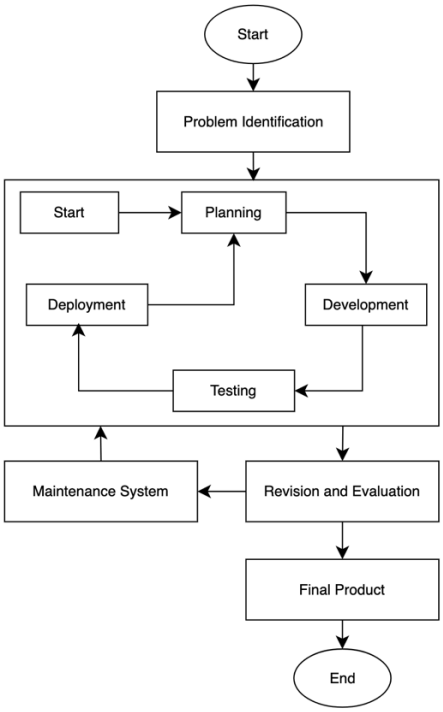

Figure 1. Agile Development Methods

As illustrated in Figure 1, the research workflow is systematically structured through a series of integrated stages, from problem identification to system maintenance. The detailed explanations of these stages are as follows:

Problem Identification and Requirement Analysis

This stage aims to systematically map system requirements and identify operational bottlenecks encountered by users during conventional transaction processes. Primary data were collected through structured field observations, in-depth interviews with key stakeholders, and comparative analyses of functionally analogous systems. Notably, this phase also involved a critical evaluation of existing workflow inefficiencies, enabling the research to establish a precise problem boundary that guided subsequent design decisions. The output of this phase constitutes a comprehensive specification of both functional and non-functional requirements, which serves as the foundational blueprint for the subsequent system architecture design.

System Design

During this phase, the application architecture, business process modeling, and user interface (UI) design are developed. The modeling utilizes Unified Modeling Language (UML) and database schema design to ensure data integrity and consistency (Eliel et al., 2025), (Maharani, 2024). These design outputs serve as the primary blueprint for the software construction phase.

Iterative System Development

The implementation of the design into a mobile-based software occurs at this stage. The development process adopts Agile principles through iterative cycles to ensure flexibility toward evolving user needs (Lutfi Irawan et al., 2023), (Novita Sari & Arwin Dermawan, 2024). Each iteration produces functional modules or prototypes that are periodically evaluated to maintain code quality and application performance.

System Testing

The testing phase is conducted to validate that all application features operate according to the predetermined specifications. The Black-Box Testing method is applied to evaluate system functionality based on various user scenarios (Pangestu & Astutik, 2024), (Sonhaji Akbar et al., 2025). The test results provide the basis for debugging and refinements before the system moves into full implementation.

System Deployment

The deployment phase involves installing the application on target devices and configuring the operational environment. This stage also includes socialization and user training sessions to minimize technical barriers during the system transition (Aldisa & Abdullah, 2022), (Mulyana et al., 2023b). The objective is to ensure that the system can be operated optimally to support daily transaction activities.

Revision and Evaluation

This stage is a critical cycle for assessing system effectiveness based on post-

implementation user feedback. The evaluation focuses on the alignment between the system and operational requirements, as well as the overall user experience (UX) (Irwan et al., 2023), (G. A. Pratama et al., 2024). The findings from this evaluation determine the priorities for further refinements or future feature enhancements.

System Maintenance

The final stage aims to sustain the system's stability, security, and performance over the long term. Maintenance activities include fixing bugs identified during operation, updating security protocols, and optimizing application performance to ensure the system remains relevant to technological advancements (Rohid Nabawi, 2025), (Anas Aklani & Melsen, 2021).

RESULTS AND DISCUSSION

The mobile-based POS application was developed utilizing Agile-XP iterations, with each sprint strategically addressing operational bottlenecks. The integration of XP practices, specifically test-driven development (TDD) and continuous integration, significantly minimized functional defect rates through pre-integration feature validation against acceptance criteria. This outcome extends the findings of (Halawa & Kurniawan, 2025) and outperforms the generalized Agile approaches reported by (Murdiani & Yudhana, 2020) and (Mulyana et al., 2023), which demonstrated higher post-integration defects. Furthermore, consolidating sales processing, real-time inventory, and automated financial reporting into a unified architecture yielded superior module cohesion compared to the partial integration models of (Ariesta et al., 2021) and (Handoyo et al., 2022), which experienced data synchronization latencies.

Usability evaluations indicated that task completion rates and user satisfaction metrics surpassed the benchmarks established by (Fadhil & Baco, 2025) and (Mayliana, 2025). This performance is attributed to the Agile-XP iterative feedback mechanism, which systematically resolved usability issues during the development phase rather than post-deployment. Consequently, these findings validate and extend the framework of (Pressman & Maxim, 2020), demonstrating that integrating Agile iterations with XP engineering practices produces mobile POS systems characterized by superior functional reliability, data integrity, and user-centric performance.

Problem Identification And Requirement Analysis Results

Based on field observations and in-depth interviews with stakeholders, this study successfully mapped several critical system requirements. The primary functional requirements identified include sales transaction recording, product inventory management, real-time stock control, user authorization management, and automated periodic sales reporting.

Regarding user experience (UX), the system is required to feature an intuitive and responsive interface, ensuring accessibility for users with varying levels of technological literacy. Furthermore, the non-functional requirement analysis emphasizes performance stability, data security integrity, and cross-device compatibility across mobile platforms. To achieve these technical standards, the development process integrated Agile Scrum project management frameworks with targeted Extreme Programming (XP) engineering practices. Although XP was not adopted in its entirety, the execution strictly implemented Test-Driven Development (TDD) and Continuous Integration (CI) to ensure code reliability. Concurrently, core Agile practices specifically sprint planning, daily stand-ups, and sprint retrospectives were utilized to govern the iterative workflow. All identified requirements were subsequently translated into a prioritized product backlog and distributed across three development sprint cycles, as detailed in Table 1.

Table 1. Application Development Sprint Timeline

Sprint	Main Focus	Duration
Sprint 1	System Foundation (Login, Cashier, Product/Stock)	14 days
Sprint 2	Transactions & Receipt Printing	14 days
Sprint 3	Reports, Dashboard, and System Refinement	14 days

System Design Results

The system design phase aims to transform functional requirements into a logical architectural model and data structure for implementation in the mobile-based Point of Sale (POS) application. The approach utilized in this design includes system behavior modeling via Unified Modeling Language (UML) and data schema design using Entity

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Relationship Diagrams (ERD). The integration of these two instruments provides a comprehensive overview of user-system interactions and a data structure that supports the application's operational scalability and integrity.

a. Use Case Diagram

The Use Case Diagram is employed to define system boundaries and identify the relationships between actors and the primary functions provided by the mobile POS application. This diagram represents a high-level abstraction of the previously analyzed functional requirements, ensuring that every technical feature aligns with field business process needs. In this system, there are two primary actors with distinct authorization levels: the Owner and the Cashier. The Owner possesses full administrative control over master data management and managerial reporting, while the Cashier focuses on daily transactional operational activities. The visual representation of these actor-system interactions is illustrated in Figure 2.

The Owner actor serves as the primary system administrator with full administrative access, encompassing product data management, inventory control, user account management, and the generation of strategic financial reports. Conversely, the Cashier actor is assigned limited access to operational functions, including processing sales transactions, real-time transaction logging, and viewing daily transaction summaries.

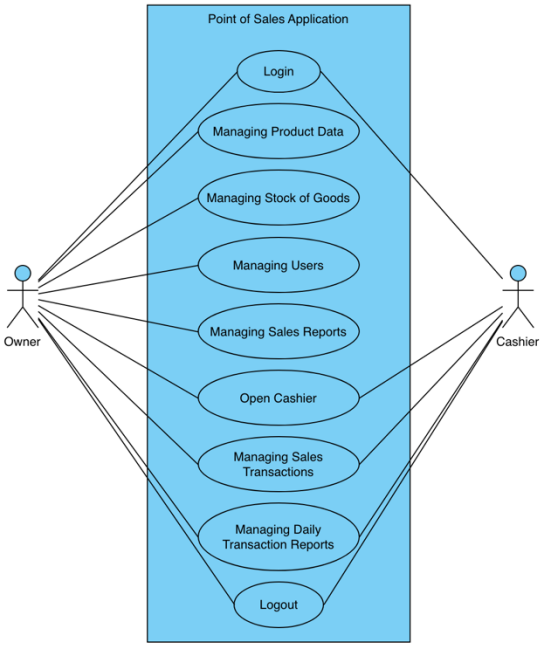

Figure 2. Point of Sales Application Usecase

This role differentiation is an implementation of Role-Based Access Control (RBAC), which aims to guarantee data integrity and security. By establishing these access boundaries, the risk of unauthorized authority usage is minimized, ensuring that each user operates strictly within their designated functional authority and established standard operating procedures (SOP).

b. Database Design (Entity Relationship Diagram)

Database design serves as a crucial foundation in information system architecture, ensuring structured and efficient data management. This research utilizes the Entity Relationship Diagram (ERD) to model the logical data structure and map the relationships between entities that support the operations of the mobile-based POS application. The database schema is designed with normalization principles in mind to guarantee data integrity, minimize redundancy, and ensure information consistency during real-time data updates. The comprehensive relational structure of this system is presented in Figure 3.

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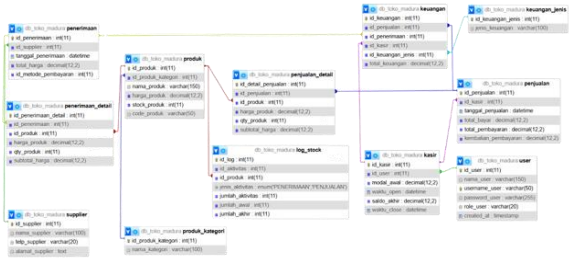

Figure 3. ERD Point of Sales Application

The core entities in this system are categorized into several primary components: User, Product, Transaction, and Transaction Detail. The User entity stores credential attributes and authorization levels to support system security aspects. The Product entity manages inventory information, including unique codes, names, selling prices, and stock quantities. The core business process is represented through the Transaction entity, which records general sales history, maintaining a one-to-many relationship with the Transaction Detail entity to store specific itemized details for each transaction. This relational architecture is designed to support automated stock updates upon the successful processing of each transaction, thereby systematically maintaining the validity of inventory data.

System Development Results

The system development stage represents the technical realization of all previously structured design phases into a mobile-based Point of Sale (POS) platform. By adopting the Agile methodology, the software construction process was conducted systematically through iterative cycles or sprints. This approach enabled the development team to transform each product backlog item into functional modules that were ready for incremental testing and evaluation. The application architecture is categorized into several core modules: security authentication, product inventory management, sales transaction processing, real-time stock control, and a reporting engine. To ensure workflow efficiency and information security, the development results are implemented through two primary authorization levels: Owner and Cashier.

a. Interface Implementation: Owner Access Level

The Owner access level is designed as a managerial control center, granting full administrative privileges to the business owner. This feature enables comprehensive master data management, ranging from precise inventory control to user account management to maintain staff accountability. Furthermore, this access level is equipped with an analytical dashboard that presents integrated sales reports, serving as a data-driven decision-support instrument for strategic planning. The interface design at this level emphasizes data visibility and ease of operational oversight to ensure transparent business continuity. The visual representation of the interface and functionalities for the Owner access level is presented in Figure 4.

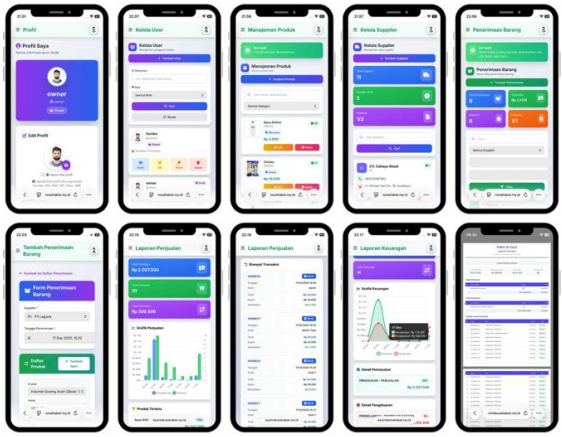

Figure 4. Implementation of Point of Sales Application on Owner Access Level

b. Interface Implementation: Cashier Access Level

In contrast to the administrator level, the Cashier access level is specifically optimized to support operational productivity at the point of sale. The primary focus of this interface is the efficiency of sales transaction processing, the accuracy of real-time transaction logging, and the provision of limited, read-only information regarding product details and stock availability. The interface design for cashiers prioritizes ergonomics and intuitive navigation to minimize customer waiting time during the checkout process.

This access restriction represents an implementation of the "Least Privilege" principle in information system security. By limiting cashier authority to operational functions only, the system proactively mitigates the risk of master data manipulation, prevents unauthorized price changes, and preserves the integrity of the financial reports managed by the owner. This approach ensures a clear segregation of duties between supervisory and transactional execution functions. The visual representation of the interface and

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operational workflow for the Cashier access level is presented in Figure 5.

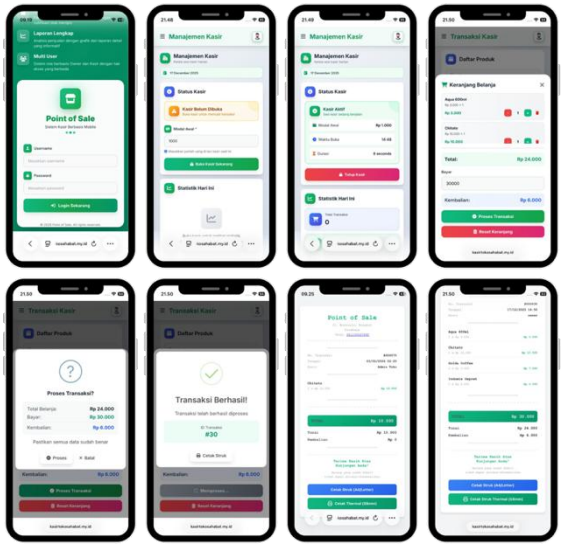

Figure 5. Implementation of Point of Sales Application on Cashier Access Level

System Testing Results

The testing phase is a critical stage for verifying the reliability and functional validity of the system before full implementation within an operational environment. This study employs the Black-Box Testing method, which focuses on evaluating the application's functionality based on requirement specifications without involving an analysis of the internal code structure. This approach was selected to ensure that the system appropriately responds to user inputs and provides consistent outputs in alignment with Point of Sale business logic.

A comprehensive evaluation was conducted across critical modules, encompassing user authentication mechanisms, inventory management, calculation accuracy in the transaction module, automated stock synchronization, and data validity in periodic sales reports. Each testing scenario was designed to simulate real-world operational activities to identify potential anomalies or system failures. The testing results indicate that the system achieves optimal functionality, with all features meeting the predetermined acceptance criteria. This demonstrates that the application is ready to support transactional activities with minimal functional errors. A summary of the testing results for the key scenarios is presented in Table 2.

Table 2. Black-Box Testing Results

ID	Testing Activity	Expected Result	Status
TC01	Admin login	Dashboard displayed normally	Pass
TC02	Cashier login	Cashier page displayed	Pass
TC03	Failed login	Error message displayed	Pass
TC04	System logout	Logout successful	Pass
TC05	Display user profile	Data matches account details	Pass
TC06	Update profile	Data saved successfully	Pass
TC07	Empty profile validation	Validation message displayed	Pass
TC08	Add product	Product data entered the system	Pass
TC09	Edit product	Price updated successfully	Pass
TC10	Delete product	Data deleted successfully	Pass
TC11	Add supplier	Supplier data displayed	Pass
TC12	Edit supplier	Supplier data updated	Pass
TC13	Delete supplier	Data deleted successfully	Pass
TC14	Goods receipt	Receipt recorded successfully	Pass
TC15	Automatic stock update	Stock increased according to quantity	Pass
TC16	Empty receipt validation	Error message displayed	Pass
TC17	Add user	User added successfully	Pass
TC18	Edit user	Role changed successfully	Pass
TC19	Delete user	User deleted successfully	Pass
TC20	Cashier access rights	Admin menu not displayed	Pass
TC21	1-item transaction	Transaction total is accurate	Pass

TC22	Multi-item transaction	Total matches calculation	Pass
TC23	Print receipt	Receipt displayed successfully	Pass
TC24	Stock reduction	Stock reduced accordingly	Pass
TC25	Prevent duplicate transaction	No duplication occurred	Pass
TC26	Transaction history	History matches transactions	Pass
TC27	Filter report	Filter functions normally	Pass
TC28	Export report	File downloaded successfully	Pass
TC29	Financial report	Report data is accurate/matc hes	Pass
TC30	Empty report validation	Empty data message displayed	Pass
TC31	Load dashboard	Dashboard displayed normally	Pass

The empirical analysis of the data in Table 2 demonstrates that all primary features of the application are operating optimally in accordance with the defined functional specifications. The absence of significant functional errors (major bugs) indicates that the iterative development cycles inherent in the Agile methodology successfully identified and addressed anomalies at an early stage of development. System efficiency is evidenced by rapid and accurate transaction processing, alongside the automated, real-time synchronization of inventory data and reporting. The successful validation across all testing scenarios provides high confidence that the application possesses the reliability required for implementation in a real-world operational environment to support the accelerated digital transformation of business transaction processes.

System Deployment Results

The deployment phase involved the transition of the application from the development environment to a live operational environment. This process encompassed installation on target devices, cloud database configuration, and the initialization of product master data and user accounts. The success of this phase was bolstered by technical assistance and brief user training sessions aimed at minimizing technological adaptation barriers for users. Deployment results indicate that the system integrates seamlessly with daily workflows, allowing transaction processes to be conducted more structurally. The transformation from manual to digital methods has proven to significantly enhance operational efficiency, particularly regarding service speed and the validity of transaction records, which are now centrally stored.

Revision And Evaluation Results

A comprehensive system evaluation was conducted through post-implementation user feedback analysis and direct observation within a grocery store case study. The research findings indicate that the application possesses a high degree of usability with a short learning curve, attributed to its intuitive interface design. Comparatively, this system reduces the risk of human error in transaction calculations and accelerates financial report generation from hours to seconds. Documentation of the field evaluation process and user interaction with the system is presented in Figure 6.

Figure 6. Point of Sales Application Revision and Evaluation Process

Methodologically, the implementation of the Agile method proved to be a key factor in producing an adaptive system. The iterative nature of Agile allowed developers to continuously refine features based on the dynamic needs of users in the field. These results confirm that the Agile approach is highly effective for applied information system development requiring high responsiveness, ensuring that the final product is truly relevant,

reliable, and capable of addressing real-world operational challenges.

Final Product Results

The final output of this research is a mobile-based Point of Sale (POS) application that integrates transaction management, inventory control, and real-time financial reporting functions. This product not only offers high portability as a mobile digital solution but also ensures data integrity through reliable centralized database synchronization. Featuring an interface design optimized through User Experience (UX) principles, the system successfully reduces the operational complexities typically encountered in conventional recording methods.

The successful development of this product provides a dual contribution: practically, the system serves as an effective digital transformation instrument for business owners to optimize transaction cycles and stock data accuracy; theoretically, this study reinforces empirical evidence regarding the effectiveness of the Agile methodology in producing software that is adaptive to dynamic user requirements. This product is expected to serve as a foundation for the development of a broader mobile POS ecosystem, such as future integration with big data analytics or supply chain management systems.

CONCLUSIONS AND SUGGESTIONS

Conclusion

This study has successfully realized the design and development of a mobile-based Point of Sale (POS) application by adopting the Agile methodology. This iterative approach has proven highly effective in bridging dynamic user requirements with adaptive functional solutions. Comprehensive evaluation results demonstrate that the system successfully integrates the entire business workflow from inventory management to financial reporting into a single platform operating with real-time precision.

The implementation of Role-Based Access Control (RBAC) between the Owner and the Cashier not only optimizes daily operational efficiency but also strengthens data integrity and information system security against data manipulation risks. Practically, this application serves as a relevant digital transformation instrument for Small and Medium Enterprises (SMEs) in reducing the risk of human error and accelerating transaction cycles. As a direction for future research, this study recommends the integration of data-driven predictive sales analytics, digital payment gateways (e-payments), and a full migration to cloud computing infrastructure to enhance system scalability, flexibility, and availability on a broader scale.

Suggestion

For future development, this research can be expanded by integrating Internet of Things (IoT) technology and digital payment systems to create a more comprehensive transaction ecosystem, alongside implementing Machine Learning algorithms for demand forecasting to enhance managerial intelligence in predicting inventory needs. Furthermore, a methodological transition toward User-Centered Design (UCD) is recommended to deepen the user experience aspect, as well as migrating to a cloud-based microservices architecture (SaaS) and incorporating Blockchain technology to ensure absolute system scalability and data integrity against manipulation risks.

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