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Web-Based POS System to Support Perfume Sales Transactions Using the Waterfall Model

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ABSTRACT

Many small and medium-sized businesses still rely on manual procedures for recording sales transactions and monitoring inventory, creating challenges related to data accuracy, reporting efficiency, and stock control. At PT. ABC, transaction records and inventory updates are managed manually, which increases the risk of recording errors, delays in obtaining business information, and difficulties in monitoring product availability. Based on these conditions, this study aims to develop and evaluate a web-based Point of Sale (POS) system capable of supporting sales activities, inventory management, and operational reporting in an integrated environment. This research adopts a Research and Development (R&D) approach and applies the Waterfall software development model consisting of requirements analysis, system design, implementation, and testing stages. Data collection was conducted through direct observation, interviews with company stakeholders, and analysis of operational documents. The developed system was implemented using web technologies and evaluated through Black Box Testing to verify functional requirements, as well as User Acceptance Testing (UAT) to measure user acceptance and system suitability for operational activities. The evaluation results indicate that all primary system functions, including user authentication, sales transactions, inventory updates, purchase management, and reporting features, operated according to the specified requirements. Furthermore, the UAT assessment conducted with representatives of system users produced a score of 97.5%, indicating a very high level of acceptance and satisfaction. The findings demonstrate that the developed POS system is capable of improving transaction management, providing real-time inventory information, and supporting more accurate business reporting. This study contributes by providing a practical implementation of a web-based POS solution that integrates operational processes and supports decision-making activities within PT. ABC.

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1. INTRODUCTION

The increasing adoption of information technology has encouraged business organizations to transform conventional operational activities into more integrated digital processes. One of the technologies widely implemented in commercial activities is the Point of Sale (POS) system. POS systems are not only used to record sales transactions but also support inventory control, financial reporting, and business performance monitoring. Previous studies have shown that POS technology can improve transaction efficiency, reduce administrative workload, and provide more accurate operational information for business management[1], [2]. Along with the development of web technology, POS systems have become more flexible because they can be accessed through various devices and locations, enabling businesses to manage operational data in real time [3].

PT. ABC is a company engaged in the perfume retail business that manages both product sales and related services. Despite the increasing need for accurate and timely information, several operational activities within the company are still performed manually. Sales transactions, stock recording, and inventory monitoring are documented using conventional recording methods, creating challenges related to data consistency, transaction traceability, and reporting efficiency. These conditions increase the possibility of recording inaccuracies, difficulties in monitoring stock availability, and delays in obtaining information required for managerial decision-making. Previous research has reported that manual transaction management frequently results in lower data accuracy and less effective inventory monitoring processes, which can negatively affect operational performance [4].

Several studies have investigated the implementation of web-based POS systems in different business sectors. Research conducted at Altari Restaurant demonstrated that a POS system developed using the Waterfall approach improved transaction processing efficiency and reporting accuracy [5]. Similar findings were reported in research conducted at Pandita Coffee and Beauty Hijab Store, where POS implementation contributed to better inventory management and more structured business operations [6]. Furthermore, the study conducted at Andorio Store showed that a web-based POS application could facilitate transaction processing while automatically generating sales and inventory reports [6]. Other studies also reported that POS systems support higher transaction speed, improved data accuracy, and better sales management activities [3].

Although previous studies have demonstrated the benefits of POS implementation in improving business operations, most of them primarily focus on system development and functional validation. Limited attention has been given to evaluating whether the developed system is accepted by end users and capable of supporting operational activities in actual business environments. In addition, the implementation context of perfume retail businesses, which requires integrated transaction management, stock monitoring, purchase management, and profit reporting, remains relatively underexplored in previous studies. Therefore, further investigation is needed to examine not only the technical functionality of a POS system but also its suitability for daily operational use. [6].

This study addresses PT. ABC's operational challenges by designing, implementing, and evaluating a web-based POS system that integrates sales transactions, inventory monitoring, purchasing, and profit reporting into a single platform. Its main contribution lies in providing a tailored implementation model that enables real-time transaction processing and automatic stock updates. The novelty stems from unifying full-cycle sales and inventory control with comprehensive technical (Black Box) and user acceptance (UAT) validations, ultimately enhancing operational efficiency and supporting data-driven decision-making.

2. RESEARCH METHOD

2.1 Research and Development (R&D)

The study adopts an R&D approach to produce a usable software artifact and evaluate its performance. The development process itself follows the Waterfall SDLC to ensure a structured progression from requirements to testing. The R&D method is a systematic process that combines needs analysis and product testing to create useful innovations [7]. In this study, the product developed is a web-based Point of Sale (POS) system for PT. ABC, and its functionality in overcoming existing transaction recording and stock management problems is tested. The realization of the R&D approach in this study will begin with an initial research phase to identify and analyze user needs and problems at PT. ABC. The results of this analysis phase will then form the basis for the development stage, where the POS information system will be designed and built systematically following the Waterfall model. The end result of this R&D realization is a functional POS system product, which will then be tested with black-box and User Acceptance Test (UAT).

This research can be applied because it produces a final product in the form of ready-to-use software. System requirements were explored directly through interviews and observation of operational activities in the field. Thus, the designed system is able to provide relevant solutions to real problems faced by the company.

This research uses the Waterfall system development model. This model was chosen because of its linear and systematic nature, which is suitable for clearly defined requirements. The first step was to analyze the existing manual processes at PT ABC. This analysis became the basis for designing a new, more efficient and structured solution.

According to [7], research and development (R&D) can be categorized as longitudinal research. This is because the process involves continuous stages, starting from the identification of needs to the evaluation of the final product. System development in this research applies the Waterfall model. This model goes through the phases of needs analysis, design, implementation, testing, and evaluation in sequence.

2.2 Research Procedure

The research was conducted through a sequence of interconnected activities beginning with problem identification and ending with system evaluation. Each stage was designed to ensure that the developed solution addressed the operational challenges encountered by PT. ABC. The overall research procedure is illustrated in Figure 1

Figure 1. Research Stages

As presented in Figure 1, the research process started with the submission of the research topic and preliminary investigation of operational activities at PT. ABC. Observations and interviews were conducted to identify problems related to transaction recording and inventory management.

Initial findings were analyzed to define the research problem and objectives, followed by system design using UML diagrams and UI prototypes. The system was then implemented using web technologies and evaluated via Black Box Testing and User Acceptance Testing (UAT) for functionality and user approval. The study concluded with documentation and publication preparation.

2.3 System Point of Sale (POS)

Point of Sale (POS) systems have evolved from simple transaction recording tools into integrated business management platforms. Modern POS applications support various operational activities, including sales processing, inventory monitoring, customer management, and financial reporting [8].

The implementation of POS technology enables businesses to improve transaction accuracy, accelerate service delivery, and provide access to operational information in real time. By integrating multiple business functions into a single platform, organizations can reduce manual administrative activities and improve the quality of decision-making processes [9], [6], [10].

In this research, the POS system serves as the primary solution for managing sales transactions, monitoring inventory movements, recording purchase activities, and generating profit reports within PT. ABC.

2.4 Waterfall Method

The Waterfall model was selected as the software development methodology because it provides a systematic and sequential framework for transforming user requirements into a functional information system. The model emphasizes clear documentation and structured progression between development stages, making it suitable for projects with well-defined requirements [11], [12]. Figure 2. illustrates the Waterfall software development model used in this study. The model was selected because it provides a systematic approach for transforming user requirements into a functional information system through a series of sequential development stages.

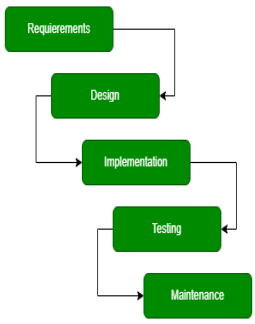

Figure 2. Stages of the Waterfall Method [12]

Figure 2 shows the stages of system development according to [11], The Waterfall method is a software development approach that focuses on sequential stages, starting from planning, analysis, design, implementation, to maintenance [13]. However, in this study, the maintenance stage was not carried out because the main focus was on ensuring that the system functions ran properly. The description of each stage in the Waterfall model is as follows:

1. Requirements At this stage, user needs are collected and analyzed in detail. This analysis includes an in-depth understanding of existing business processes and determining the requirements for the new system [14]. In this phase, data is collected systematically through direct observation, interviews with owners, and literature studies. The goal is to formulate a detailed list of system requirements, both functional and non-functional.

2. Design The design stage involves creating a comprehensive system design, including system architecture, database design, and user interface [14]. After conducting an initial analysis, the technical design stage continued with the creation of a system architecture using Unified Modeling Language (UML), which included use case diagrams, activity diagrams, and sequence diagrams, which the author created on web draw io. The database was implemented using MySQL, while the user interface was designed using Figma. This design was structured to clearly illustrate how the system would operate before the implementation stage began.
3. Implementation At this stage, programmers begin writing code for the system based on the design that has been created. Development involves coding, unit testing, and module integration [14]. After the design was approved, the implementation phase began with the process of coding the system using the PHP 8.4 programming language, utilizing the Laravel 12 framework. In developing the user interface, the Filament 4.0 library was used to build the user interface, as well as Livewire to create dynamic interactions on the POS system that can automatically update the display. In addition, backend management includes setting access based on user roles in the database. At this stage, the author used a MySQL database with Laragon software for the local laptop server. Each module and function was developed systematically in accordance with the design that had been prepared previously. The result of this phase was a software system that was ready for further testing.
4. Testing The developed system is thoroughly tested to find and fix errors. Testing includes functional testing, system testing, and user acceptance testing [14]. After the system was built, testing was conducted to ensure that all functions worked according to user requirements. This testing process used the black-box testing method, where evaluation focused on system inputs and outputs without considering the internal structure of the program code. The focus of testing at this stage included validation of the system's main functions, reliability of responses to various input scenarios, and accuracy of the results produced. In addition, a User Acceptance Test (UAT) is conducted, involving end users through questionnaires to measure satisfaction levels, ease of use, and the suitability of the system for daily operational needs.
5. Maintenance Ensures software performance over time [12]. After the system is used by users, there may be a need for adjustments, bug fixes, or feature enhancements. The maintenance phase aims to ensure that the system remains relevant and reliable in the long term. However, in this study, maintenance was not carried out because the project focused on developing the system to the initial testing stage.

This framework is widely applied to projects with firmly established initial requirements, as it guarantees highly organized documentation and a highly manageable development lifecycle.[15]

2.5 Website

Websites are one of the most important components in accessing information in today's era. With their ability to connect users to various information on the internet, websites are portals that can be accessed via the internet anytime, anywhere [12]. In the development of Information Technology, especially web-based Information Technology, it can provide convenience and support for various fields of work related to easier access, distance, and time flexibility [16].An online site serves as a web-based medium that empowers users to acquire knowledge and digital offerings effortlessly using multiple connected gadgets [17]. In the process of designing the Point of Sale system, the author used the PHP programming language version 8.4. PHP (Hypertext Preprocessor) is a language used to convert lines of program code into machine code that can be understood and added by the server-side computer to HTML[6]. The Laravel framework is a mainstay for web application developers. The Laravel framework ensures efficient development and effectiveness in data management [18]. The author uses the MySQL database, which is a database management system (DBMS) capable of receiving and sending data at high speeds. MySQL also supports simultaneous use by multiple users and uses standard SQL (Structured Query Language) commands [19]. In the realm of web development, MySQL remains a heavily utilized relational database architecture[20] .The prominent role of web technologies in crafting present-day information architectures stems from their capacity to simplify user access, expedite data flow, and unify digital commercial activities [21]. As long as there is internet connectivity, leveraging websites for information management ensures that data can be retrieved effortlessly, regardless of the user's whereabouts or chosen hardware.[22]

2.6 Testing System

Black-box testing evaluates software functionality from the end-user's perspective without inspecting the underlying code or internal structure. It focuses on ensuring features perform as intended, identifying bugs for correction, and confirming that the application meets user expectations and usability standards [18]. The black box method is frequently used to test multiple aspects of software, including functionality, performance, and security [23] .The application of behavioral testing reveals how functional verification not only ensures all capabilities meet client requirements but also preserves the accuracy of processed records [24]. By utilizing this method, developers can verify that all functionalities meet the established user demands and the structural guidelines set forth in the initial blueprints [24]. Another test that uses User Acceptance Test (UAT) is a system testing process carried out by end users, where the results are in the form of an acceptance document for the developed system and an agreement that the system meets user needs [19]. In UAT, this questionnaire is used to collect feedback from users regarding their experience in using the developed system. The data

obtained plays an important role in supporting further development and improving the quality of the system. The UAT score is calculated using the following formula:

UAT Score = ((Number of Answers x Answer Weight) / Number of Respondents) x 100% ... (1)

This percentage result is used to assess the level of user acceptance of the developed system[4].

2.7 Development Environment

The system was built using PHP 8.2 and Laravel 12, with MySQL 8.4 for database management and Laragon as the local development environment. Coding was executed in PhpStorm IDE on an Intel Core i5 laptop with 8 GB RAM and 512 GB SSD, providing optimal performance during implementation and testing.

3. RESULTS AND DISCUSSION

3.1 Use-Case Diagram

Figure 3.1 presents the use-case diagram of the proposed POS system. The diagram is intended to describe the interactions between system users and the functionalities provided by the application.

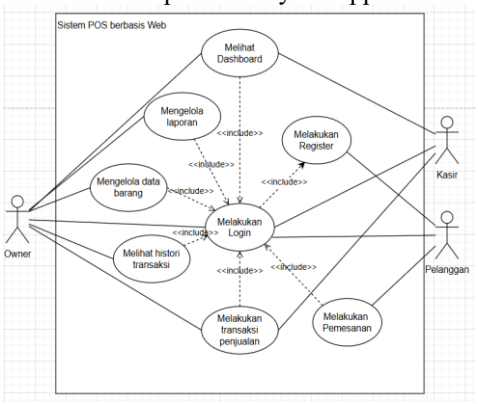

Figure 3 Use-case Diagram System Pos

The use-case diagram presented in Figure 3 illustrates the interaction between the main actors and the developed POS system. Three primary actors were identified, namely the owner, cashier, and customer. The separation of responsibilities among these actors enables the implementation of role-based access control, ensuring that each user can only access functionalities relevant to their operational duties.

The use-case design reflects PT. ABC's operational workflow across sales, inventory, and reporting. By unifying these processes, the system minimizes manual entry, improves data accessibility, and establishes a clear framework for security controls and transaction traceability.

3.2 System Implementation and Output

Figure 5 displays the dashboard interface that functions as the central information panel of the application.The dashboard provides users with an overview of operational data, including transaction summaries, inventory information, and other business indicators relevant to daily activities

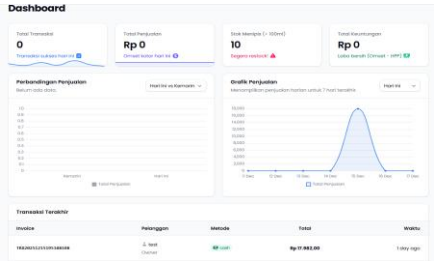

Figure 5. Dashboard Page

The Dashboard acts as a central hub for real-time monitoring, displaying key metrics like daily transactions, turnover, low-stock alerts, and total profit via summary cards. It features sales comparison and weekly performance charts, along with a table of recent transactions detailing payment amounts, methods, and timestamps to support fast operational overview.

Figure 6 shows the Purchase Order module implemented to manage procurement activities within the company. This feature allows users to record product purchase requests, monitor procurement status, and maintain documentation related to inventory replenishment.

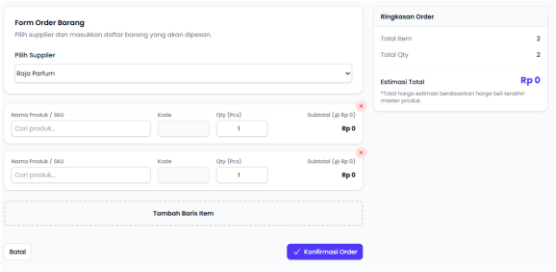

Figure 6. Purchase Order Page

The page in Figure 7 is used to create purchase requests for goods from suppliers. Users select a supplier, then add order items by entering the name of the item, item code, and quantity to be ordered. The system displays a summary of the total number of items and total quantity on the side. Additional information is provided to explain the process after the order is confirmed.

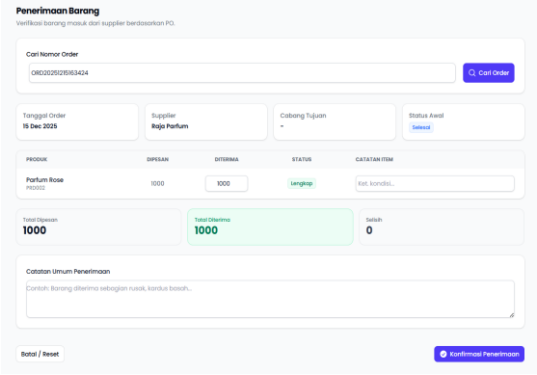

Figure 7. Receive Order Page

This page is used to verify and confirm receipt of goods from suppliers. Users enter the order number to display the details of the order that must be received. Once the order data appears, the system displays a list of items along with the quantity ordered and a column for filling in the quantity received. On the side is an order summary that includes the order date, supplier, and current status. The system also calculates the difference between the quantity ordered and the quantity received if there is a discrepancy. Before completing the process, users can add notes regarding the condition of the goods. This page helps ensure that goods receipt is recorded accurately and in accordance with business processes.

Figure 8 presents the profit reporting feature developed to provide information regarding business performance. The report is generated based on transaction data and inventory records stored within the system, enabling users to evaluate revenue, costs, and overall profitability.

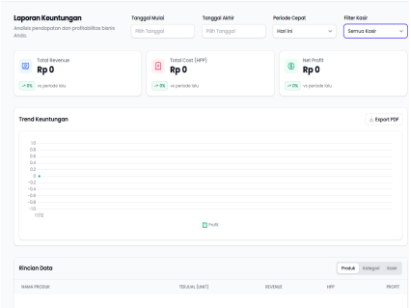

Figure 8. Profit ReportPage

This page summarizes sales performance across user-selected date ranges, report frequencies, and cashiers. Key metrics—total revenue, costs, and profits—are displayed in summary cards alongside a profit trend graph for visual tracking. A detailed table breaks down product-level metrics, with an option to export reports to PDF, directly supporting strategic decision-making. Figure 9 shows the product management interface used to maintain product information within the system. Through this module, users can add, update, and monitor product data, including stock availability and pricing information.

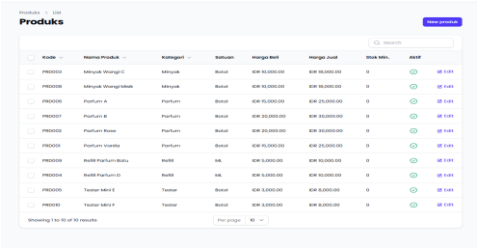

Figure 9. Master Product Page

This page displays all product data available in the system. The information is presented in a table format to facilitate the search and management process. Each row contains the product code, product name, category, unit, purchase price, selling price, minimum stock, and product activity status. A search feature is provided to speed up the process of finding specific products. On the right side of each row is an Edit button for making changes to the data. This display is designed so that users can monitor and update product data efficiently and maintain consistency of information in store operations.

Figure 10 illustrates the main transaction interface of the developed Point of Sale system. This module enables cashiers to process customer purchases, calculate transaction totals, manage payment activities, and generate transaction records automatically.

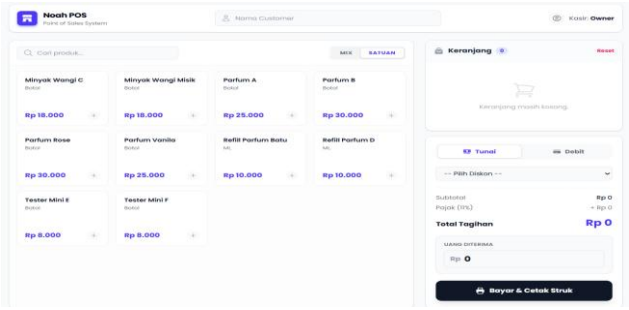

Figure 10. Point of Sale Page

The POS module streamlines checkout by unifying product selection, quantity, discounts, and payments into one interface, reducing manual calculation errors. Completed transactions automatically update inventory in real time, eliminating manual stock reconciliation and resolving key inventory tracking issues.

3.3 Black Box Testing

Table 1 presents the Black Box Testing results for the developed POS system. The table is included to verify whether each functional module operates according to the predefined system requirements.

Table 1 Black Box Testing Login Page

No	Testing Activity	Expected Result	Test Result	Conclusion
1	Enter the correct email, password, and CAPTCHA code, then click the Login button.	The system validates the account and directs the user to the Dashboard page and menu according to their Role.	Correct	Success
2	Enter the correct email but incorrect password, then click the Login button	The system denies access and displays the error message "Incorrect email or password"	Correct	Success
3	Enter the correct email and password, but the CAPTCHA code is incorrect	The system denies access and displays the message "Incorrect Captcha Code"	Correct	Success
4	Leave all input fields blank, then click the Login button	The system displays a warning that the data cannot be empty	Correct	Success

The information in Table 3.1 can be interpreted by comparing the expected results with the actual system outputs obtained during testing. A “Pass” status indicates that the functionality performed as intended and satisfied the corresponding requirement. The results demonstrate that all tested modules successfully executed their designated operations.

Table 3 Black Box Testing Point of Sale Page

No	Testing Activity	Expected Result	Test Result	Conclusion
1	Selecting products from the catalog	Products are added to the shopping cart with the correct prices	Correct	Success
2	Increasing the quantity (qty) of items in the cart	The system automatically recalculates the subtotal and total price	Correct	Success
3	Attempt to add items exceeding available stock	The system displays an “Insufficient Stock” error message and prevents the addition	Correct	Success
4	Entering the payment amount and processing the transaction	The system saves the transaction, calculates the change, reduces the stock, and displays the receipt send email option	Correct	Success
5	Performing a transaction and selecting the discount option from the dropdown menu	The total price is reduced according to the discount amount/percentage	Correct	Success
6	Pressing the “Print Receipt” button after a successful transaction	The system generates a receipt ready to be sent digitally via email to the customer	Correct	Success

Table 5 Black Box Testing Transaction Details, Reports Page

No	Testing Activity	Expected Result	Test Result	Conclusion
1	Open the Transaction History menu and select an Invoice ID.	The system displays a transaction details popup (Item, Price, Time).	Correct	Success
2	Select a date range in the Report menu	The system displays Revenue, Cost, and Profit data only for the selected period	Correct	Success
3	Click the “Export PDF” button on the report page	The system downloads the report file in the selected format	Correct	Success

Black Box Testing verified that all core modules operate error-free, proving that the business logic meets specifications and that real-time transaction-inventory synchronization functions correctly.

These findings are consistent with previous studies conducted [5] [7], which reported that web-based POS systems developed using structured software development approaches were able to support business operations effectively through reliable transaction and inventory management features. Similar outcomes were also reported [6], who found that automated transaction recording and reporting features significantly improved operational efficiency.

Compared with manual recording practices previously implemented at PT. ABC, the developed system provides a more controlled transaction workflow, minimizes the risk of recording errors, and improves accessibility to operational information. Therefore, the Black Box Testing results indicate that the proposed system is functionally suitable for operational deployment.

3.4 User Acceptance Testing

User Acceptance Testing (UAT) was conducted with two respondents, namely the Owner and Cashier of PT. ABC, who are direct users of the system. The testing instrument was a questionnaire with a Likert scale of 1–5, covering aspects of ease of use, feature reliability, and system interface display.

The following are the results of the questionnaire, presented in a table containing a list of questions and their answers. Commonly used scale (Likert scale):

1. Strongly Agree (SA) = 5
2. Agree (A) = 4
3. Neutral (N) = 3
4. Disagree (D) = 2
5. Strongly Disagree (SD) = 1

Table 3.7 summarizes the results of the User Acceptance Testing (UAT) conducted with system users. The objective of this evaluation is to measure the level of user acceptance toward the developed application.

Table 3.7 User Acceptance Testing

No	Questionnaire Statement	SS(5)	S (4)	N (3)	TS (2)	STS (1)	Total Score
1	The system display (Dashboard & POS) is easy to understand and user-friendly.	1	1	0	0	0	9
2	The system simplifies the transaction recording process compared to manual methods.	2	0	0	0	0	10
3	The product and stock search features work accurately.	1	1	0	0	0	9
4	Profit reports and transaction history are easy to access and understand.	2	0	0	0	0	10
5	The system runs stably and does not experience errors when used.	2	0	0	0	0	10
6	Login security (CAPTCHA & Password) provides a sense of security.	2	0	0	0	0	10
7	The receipt printing feature helps provide proof of transaction to customers.	2	0	0	0	0	10
8	Overall, this system helps store operations.	2	0	0	0	0	10
	Total Calculation						78

Based on the results of the table, it is used for feasibility calculations based on the percentages in Chapter II.
Calculation Analysis:

1. Number of Questions: 8 Questions
2. Number of Respondents: 2 x 8 x 5 = 80
3. Total Answers x Answer Weight: 78

UAT Score = 78 / 80 x 100% = 97.5%

The UAT achieved a 97.5% acceptance score, demonstrating high satisfaction among users who found the system easy to use, stable, and superior to manual methods. Core features—including automated stock updates, transaction history, profit reporting, and access control—successfully met operational needs and boosted efficiency.

The findings support previous research conducted [19] , which emphasized the importance of UAT in measuring the suitability of information systems from the end-user perspective. Unlike functional testing, which focuses on technical correctness, UAT provides evidence regarding user satisfaction and practical usability in real-world environments.

The score confirms the system's technical and operational viability. Integrating sales, inventory, and reporting into one platform streamlines data access and accelerates decision-making, ultimately boosting PT. ABC's operational effectiveness.

4. CONCLUSION

The web-based POS system developed using the Waterfall model successfully automates and integrates PT. ABC's sales, inventory management, and financial reporting in real time. Rigorous testing confirmed its technical and operational viability, with black-box testing showing no major functional errors and User Acceptance Testing (UAT) achieving a high satisfaction score of 97.5%. Overall, the system enhances efficiency, minimizes manual errors, and provides accurate data to support business decision-making. To build on these results, PT. ABC is advised to conduct routine maintenance, while future developments can integrate advanced algorithms and evaluate long-term usability using a larger sample size and frameworks like the System Usability Scale (SUS).

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