



Development of Point of Sale System Using FIFO Method at Toko Inti Peraga Mandiri Pekanbaru

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ABSTRACT

The existing web-based Point of Sale (POS) system of Toko Inti Peraga Mandiri Pekanbaru was not equipped with a stock management mechanism that prioritizes the order of incoming goods. This study aims to develop the existing POS system by applying the First In First Out (FIFO) method to the stock management module, designing a mechanism for recording entry dates and determining stock issuance priority, and testing user acceptance of the developed feature. The development was carried out using the Waterfall model, designed through UML, and implemented using the Laravel Framework, MySQL database, and Tailwind CSS. The FIFO method was applied administratively through batch recording in the database along with an algorithm for determining stock issuance priority, whose correctness was proven inductively and verified through numerical simulation and actual data. Black Box Testing on 12 functional scenarios resulted in entirely valid outcomes, while preliminary user feedback involving the admin/cashier and the store owner produced a feasibility percentage of 95%, categorized as Highly Feasible. This result is a preliminary test with limited generalizability and cannot be generalized. The developed FIFO-based stock management feature is well accepted and helps Toko Inti Peraga Mandiri Pekanbaru manage stock rotation more systematically without altering the existing transaction and reporting modules. Research limitations and future development suggestions are explicitly discussed.

Keywords: FIFO; batch management; inventory rotation; Point of Sale; stock management

1. INTRODUCTION

The development of information technology has driven retail businesses to transition toward web-based Point of Sale (POS) systems to accelerate transaction recording and stock management. POS systems have become the backbone of modern retail operations, enabling real-time integration among sales transactions, inventory management, and financial reporting. Toko Inti Peraga Mandiri Pekanbaru, a retailer of educational aids and laboratory equipment, already operates a web-based POS system developed by Amir et al. [3] using the Waterfall model and UML design. The system covers sales transactions, item data management, and stock monitoring. However, it currently records stock as a single accumulative value without considering the arrival date per batch. Consequently, there is no available mechanism to ensure that inventory entering first is prioritized to leave first. This condition potentially leads to the accumulation of old items, deterioration of plastic components, and reduced product relevance due to curriculum changes.

Theoretically, inventory management is a component of supply chain operations that balances holding costs, stockout risks, and service quality. In operations literature, there are several methods for inventory valuation and issuance: FIFO (First-In, First-Out), LIFO (Last-In, First-Out), and average. FIFO assumes that items entering earlier are issued earlier; LIFO assumes that the newest items are issued earlier; whereas average calculates the weighted mean cost. For products with a specific shelf life, risk of quality degradation, or rapid obsolescence, FIFO is highly relevant because it promotes

physical rotation and minimizes the accumulation of legacy inventory. PSAK 14 also recognizes FIFO as a permissible inventory valuation method. Thus, FIFO is not merely a stock reduction algorithm, but an accounting and operational practice that impacts reporting accuracy and internal control.

Previous studies have implemented FIFO within inventory information systems. Tanjung and Ikhwan [8] applied FIFO to bakery inventory, while Gani et al. [9] applied it to Toko Grosir Ceria. However, these studies focused on building new or standalone applications rather than adding a FIFO feature to a pre-existing operational POS system. Integrating FIFO into an active POS system is significantly more challenging than building a new system from scratch because it must maintain data compatibility, transaction consistency, and the store's operational continuity, [11]. The research gap lies in the integration of FIFO into a running POS system, particularly regarding: (1) batch recording from existing purchase data, (2) determining issuance priority without modifying the core transaction module, (3) verifying warehouse FIFO compliance, and (4) formally proving algorithmic correctness.

The novelty of this study extends beyond a standard case study. The contributions offered include an administrative FIFO integration pattern for active POS systems, a batch priority algorithm with inductive invariant proofs, and a QR Batch verification mechanism to bridge system compliance with staff physical compliance. The objectives of this research are to: (1) enhance the existing POS system of Toko Inti Peraga Mandiri Pekanbaru by applying the FIFO method for more structured stock management; (2) design a mechanism for recording purchase dates and determining stock issuance priority based on entry order; and (3) evaluate the user acceptance rate toward the developed features.

This study also strictly adheres to research ethics. The data utilized in this research was obtained with written permission from the owner of Toko Inti Peraga Mandiri Pekanbaru. All data presented in this article has been anonymized and contains no confidential store information. Furthermore, the data is exclusively used for the analytical purposes of this study and will not be shared with third parties.

2. RESEARCH METHODS

This study employed a Research and Development (R&D) approach using a case study strategy at Pelalawan Pet Shop. The software development model used was Waterfall, selected because its systematic and sequential stages facilitate planning, development, and quality control at each phase of system development [4]. The stages of the Waterfall method used in this study are as follows:

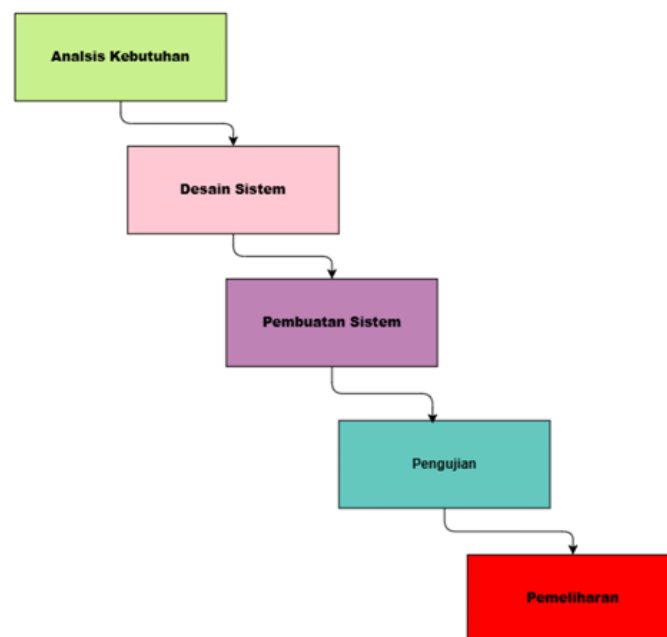


Figure 1. Waterfall Method

1. Requirements Analysis. Data were collected through observation and interviews at Pelalawan Pet Shop to obtain information about the current inventory management process, required data types, workflows, and existing constraints. The results of this requirements analysis served as the basis for system design to ensure that it met user needs.
2. System Design. System design included database design for inventory data storage, user interface (UI/UX) design using Laravel and Blade Template, and the use of technologies such as PHP and Laravel. The system workflow was also designed to facilitate digital inventory management by the Admin.
3. System Development. The system was coded using Visual Studio Code and the Laravel framework based on the completed system design. This stage included developing features for data entry, editing, deletion, and searching.
4. Testing. After the features had been developed, the system was tested to ensure that they functioned properly and according to their intended purposes, and that the system operated stably without errors before use.
5. Maintenance. System maintenance involved fixing any errors or bugs and making improvements and further developments to add features in the future, so that the application could continue to support the smooth operation of Pelalawan Pet Shop.

The research object was the inventory management business process at Pelalawan Pet Shop, including item, category, attribute, and supplier data, as well as incoming and outgoing stock transactions. System users were grouped into three actors: the Owner, who has full authority over reports and access control; the Admin, who manages master data and transactions; and the Staff, who records daily transactions.

Data analysis during the testing stage was conducted in three ways. First, Black Box Testing was used to verify system outputs against the inputs provided for each module without examining the program code structure. Second, User Acceptance Testing (UAT) was conducted with six users using a five-point Likert-scale questionnaire consisting of 12 statements grouped into several system-acceptance variables. The percentage was calculated using the formula $P = (S / \text{Ideal Score}) \times 100\%$, where P is the percentage, S is the total score of respondents' answers, and the Ideal Score is the maximum score multiplied by the sample size. Third, usability was evaluated using Nielsen's 10 Usability Heuristics to assess the ease of use of the system interface in terms of information clarity and user support [9]. A complete summary of the three testing results is presented in the Results and Discussion section.

2. RESEARCH METHODS

2.1 Research Design

This study utilizes a system development approach (Research and Development) with the Waterfall model serving as the software development lifecycle. The Waterfall model was selected because integrating a new feature into a pre-existing operational system demands a highly structured framework that maintains consistency with previous POS development efforts. The research workflow follows these phases: requirement analysis, design, implementation, testing, and maintenance [13].

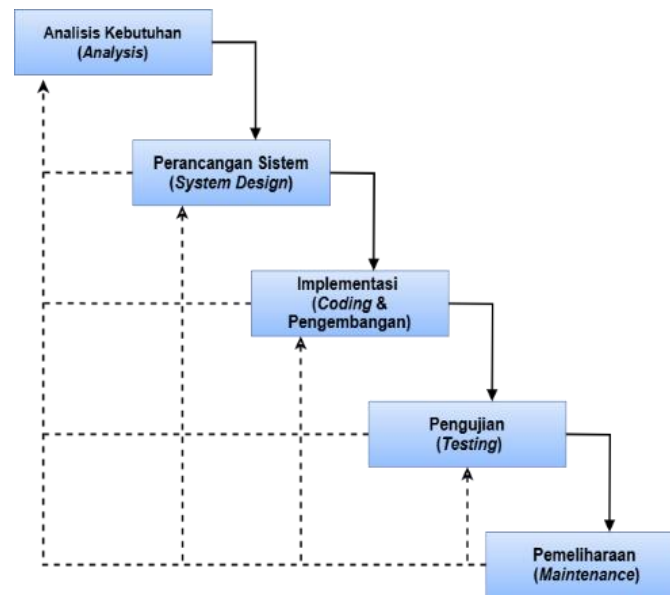


Figure 1. Waterfall Method

2.2 Data Collection

Data was collected through interviews with the owner and administrators/cashiers, direct observation of procurement and sales processes, and documentation of item, stock, and purchase data stored within the POS system. The objects of this research comprise the item data, stock records, and purchase entries at Toko Inti Peraga Mandiri Pekanbaru. The volume of analyzed products spans 15 distinct item types, encompassing a total of 45 purchase transactions and 120 sales transactions recorded over the January–June 2026 period.

2.3 System Development

The system was enhanced using the Laravel framework with a Model-View-Controller (MVC) architecture [14], a MySQL database [15], and Tailwind CSS [16]. The FIFO module itself was implemented within the FIFOService component. Development was executed using a Lenovo Ideapad Slim 3 laptop equipped with an Intel Core i5-1135G7 processor, 8 GB of RAM, Windows 11 Pro operating system, MySQL, and Visual Studio Code as the primary IDE.

2.4 FIFO Algorithm and Invariant Proof

Let there be a set of batches $B=\{b_1, b_2, \dots, b_n\}$ where each batch b_i possesses an entry date t_i and a remaining quantity $s_i \geq 0$, sorted such that $t_1 \leq t_2 \leq \dots \leq t_n$. Given a sales demand of D units. If D exceeds the aggregate remaining quantity of all batches, the transaction is rejected without altering s_i . Otherwise, for $i=1, 2, \dots, n$, let $a_i = \min(s_i, D)$, then apply the updates $s_i \leftarrow s_i - a_i$ dan $D \leftarrow D - a_i$. The process continues iteratively if and only if $D > 0$.

$$a_i = \min(s_i, D); \quad s_i \leftarrow s_i - a_i; \quad D \leftarrow D - a_i \quad (1)$$

Inductive Invariant Proof. Proposition P: batches with earlier entry dates are always fully depleted before any subsequent batches with newer entry dates undergo deduction.

Induction Basis: for $i=1$, the algorithm sets $a_1 = \min(s_1, D)$. if $D \geq s_1$, then s_1 becomes 0 and the algorithm proceeds to $i=2$; if $D < s_1$, the subsequent batches remain unaffected. Thus, P holds true for the first batch.

Inductive Step: Assume P holds true up to the k -th batch. The algorithm will only process the $(k+1)$ -th batch if $D > 0$ after evaluating the k -th batch, which mathematically implies that $s_k = 0$. Consequently,

the k -th batch must be completely exhausted before the $(k+1)$ -th batch is reduced. Therefore, P holds true for the $(k+1)$ -th batch.

Since both the basis and inductive step are proven, P is verified for all batches. This mathematical proof also consistently applies when D exceeds the total stock: the transaction is immediately rejected and no_si is modified.

2.5 QR Batch Verification

The QR Batch code is generated during the purchase phase and affixed to the physical batch packaging. The QR code contains the `batch_id`, `product_id`, `entry_date`, and an HMAC cryptographic signature. When verification mode is active, the cashier scans the QR code. The system validates the signature, verifies the batch matching, and deducts the inventory directly from the physically scanned batch. If the scanned batch is not the immediate FIFO priority, the system still deducts the stock from that specific batch but flags the transaction as "Non-FIFO Compliant" and mandates the cashier to submit a reason for the deviation. This mechanism successfully bridges system compliance with the physical operational compliance of the staff. Incorporating QR codes into inventory tracking systems has been proven to enhance recording accuracy and accelerate validation workflows [17].

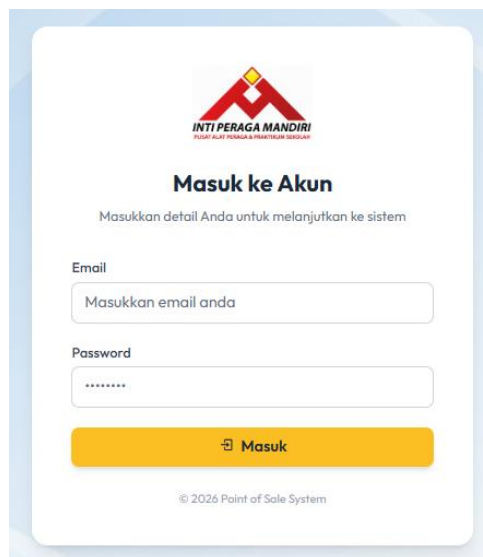
2.6 Testing

Black Box Testing is deployed to evaluate 12 functional scenarios, including batch formation, FIFO-based sales transactions, QR Batch verification, transaction cancellations, and stock consistency. User acceptance evaluation is carried out via questionnaires structured around a 1–5 Likert scale containing 10 operational statements. The questionnaire instrument underwent expert judgment evaluation by the advisory lecturer to guarantee content validity. The limited sample size of respondents is explicitly acknowledged as a constraint of this study.

3. RESULTS AND DISCUSSION

3.1 FIFO Module Implementation

The FIFO stock management module was integrated into the existing POS system without changing its transaction and reporting modules. The module records purchases as batches, displays recommended issuing priorities, provides QR Batch verification, and presents batch stock reports that can be filtered and downloaded in PDF/Excel formats. The system login page is shown in Figure 2. This page serves as the main gateway for users (Admin, Cashier, and Owner) to access the system according to their respective access rights.



INTI PERAGA MANDIRI
POS ALAT PERAGA & PRAMATIUM BERKUALITAS

Masuk ke Akun

Masukkan detail Anda untuk melanjutkan ke sistem

Email

Masukkan email anda

Password

Masuk

© 2026 Point of Sale System

Figure 2. POS System Login Page

The main dashboard page is shown in Figure 3. It displays a summary of important information, such as total sales, item stock, and minimum-stock notifications.

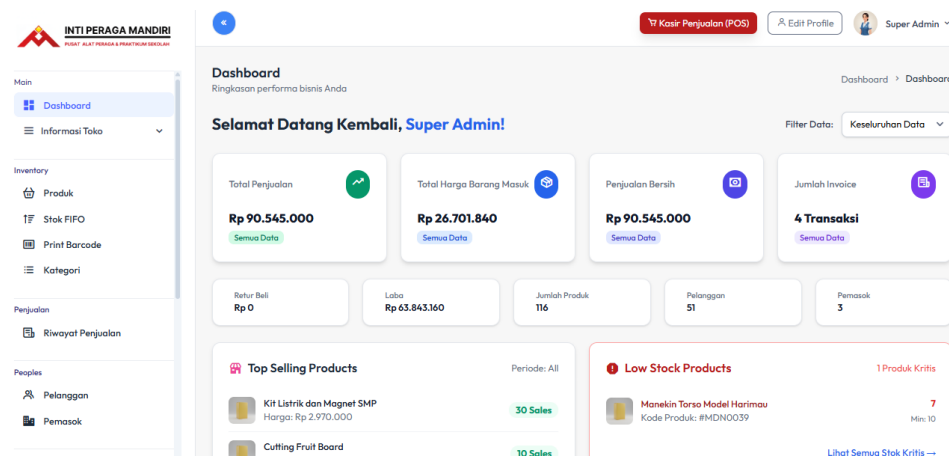
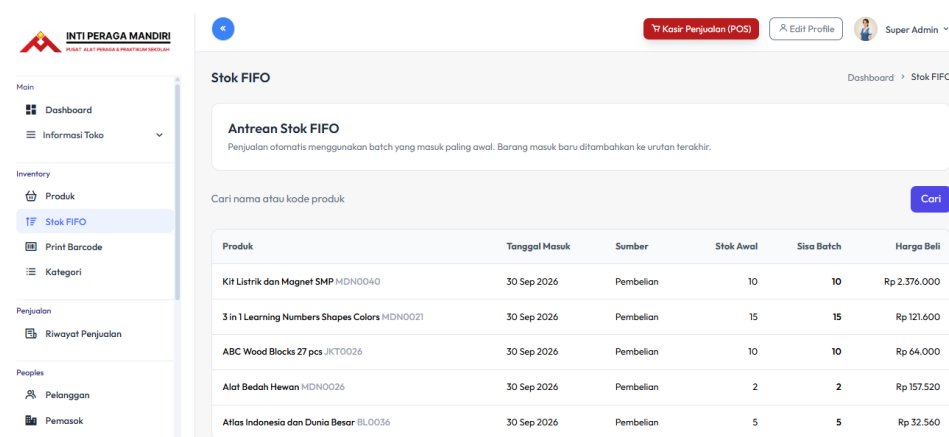


Figure 3. POS System Dashboard Page

The FIFO implementation page is shown in Figure 4. This page displays a list of item batches, including entry dates, remaining stock, and recommended issuing priorities based on FIFO.



Stok FIFO

Antrean Stok FIFO
Penjualan otomatis menggunakan batch yang masuk paling awal. Barang masuk baru ditambahkan ke urutan terakhir.

Cari nama atau kode produk **Cari**

Produk	Tanggal Masuk	Sumber	Stok Awal	Sisa Batch	Harga Beli
Kit Listrik dan Magnet SMP MDN0040	30 Sep 2026	Pembelian	10	10	Rp 2.376.000
3 in 1 Learning Numbers Shapes Colors MDN0021	30 Sep 2026	Pembelian	15	15	Rp 121.600
ABC Wood Blocks 27 pcs JKT0026	30 Sep 2026	Pembelian	10	10	Rp 64.000
Alat Bedah Hewan MDN0026	30 Sep 2026	Pembelian	2	2	Rp 157.520
Afilas Indonesia dan Dunia Besar BLO036	30 Sep 2026	Pembelian	5	5	Rp 32.560

3.2 Algorithm Verification

The inductive proof shows that a batch with an earlier entry date is always depleted before a newer batch is reduced. A numerical simulation using the Veterinary Surgical Instruments product is presented in Table 1. Batch 1 (22-03-2026, initial remaining quantity of 21) was fully depleted by issuing 21 units; Batch 2 (30-07-2026, initial remaining quantity of 22) was then reduced by 9 units, leaving 13 units.

Table 1. Numerical Simulation of Batch Issuing Priority for Veterinary Surgical Instruments

Batch Code	Entry Date	Initial Remaining	Quantity Issued	Final Remaining
Batch 1	22-03-2026	21	21	0
Batch 2	30-07-2026	22	9	13

3.3 Hasil Black Box Testing

Table 2. Scenarios and Black Box Testing Results

No.	Test Scenario	Result	Description
1	Record a new purchase for Veterinary Surgical Instruments with a valid entry date and quantity	Valid	The system creates a new batch with a unique code; the remaining quantity equals the purchase quantity
2	Record a purchase with an empty/zero quantity	Valid	The system rejects the entry and displays a validation message
3	Record two purchases with different entry dates for the same product	Valid	The system creates two separate batches, both of which appear in the batch list
4	Sell 10 units when Batch 1 has 21 units remaining and Batch 2 has 22 units remaining	Valid	The system issues 10 units from Batch 1; Batch 1 has 11 units remaining
5	Sell an additional 15 units after the previous transaction	Valid	The system depletes 11 units from Batch 1, then issues 4 units from Batch 2; Batch 2 has 18 units remaining
6	Sell more than the total remaining quantity of both batches (e.g., 50 units)	Valid	The system rejects the transaction and displays an insufficient-stock message
7	Print a receipt/invoice after a successful transaction	Valid	The system displays details of the batches used and the quantities issued
8	Enable QR Batch verification and scan QR Batch 1 (the highest FIFO priority)	Valid	The system deducts stock from Batch 1 and marks the transaction as FIFO-compliant
9	Scan QR Batch 2 while Batch 1 still has remaining stock	Valid	The system still deducts stock from Batch 2 but marks the transaction as non-compliant with FIFO
10	Save a non-FIFO-compliant transaction without entering a reason	Valid	The system rejects the entry and requests a reason for the deviation
11	Cancel a transaction that deducted stock from one batch	Valid	The system returns the quantity to the original batch
12	Cancel a transaction that deducted stock from two batches	Valid	The system returns the quantities to their respective batches; the total remaining stock stays consistent

All 12 scenarios were declared **valid**. From a practical standpoint, the cashier receives recommendations on which batch should be sold, the physical stock in the warehouse can be verified via the QR code, and transaction cancellations do not compromise stock consistency.

3.4 Preliminary User Acceptance Evaluation

he initial evaluation involved the admin/cashier and the store owner. The system achieved a total score of 95 out of a maximum of 100, or 95% (Highly Feasible). The highest scores were observed in the user interface design, login process, purchase recording, batch formation, sales transactions, and QR verification. Conversely, the lowest score was recorded for the batch stock report. Notably, these findings represent limited preliminary user feedback rather than a formal, statistically validated User Acceptance Test (UAT).

Table 3. Summary of Preliminary User Acceptance Evaluation

Aspect	Score	Category
Ease of use	96	Highly Feasible
FIFO feature suitability	95	Highly Feasible
Overall feasibility	95%	Highly Feasible

3.5 Discussion

The results demonstrate that FIFO can be integrated into an operational POS system without disrupting existing transaction and reporting functionalities. This addresses the research gap left by Tanjung and Ikhwan [8] as well as Gani et al., who focused on building entirely new systems from scratch. The advantages of this approach include batch history traceability, QR verification, and documented FIFO compliance. However, the implementation of FIFO remains administrative; physical compliance still relies heavily on store staff. Although the system detects non-compliance and mandates a reason for the deviation, it cannot physically enforce correct stock retrieval.

Comparison with Prior Studies. Compared to the study by Sumarlin, which applied FIFO to an inventory accounting information system, this research introduces a QR Batch verification mechanism that enables physical verification of FIFO compliance. Furthermore, while Hamidy and Yasin [19] implemented FIFO within a pharmacy information system, their work did not incorporate formal algorithmic proofs as presented in this study.

4 CONCLUSION

Based on the development and testing results conducted, it can be concluded that the First-In, First-Out (FIFO) method was successfully integrated into the running POS system of Toko Inti Peraga Mandiri Pekanbaru by adding a batch-based stock management module without modifying the pre-existing transaction and reporting modules. The mechanism for recording product purchase dates and prioritizing stock issuance based on the order of entry has been designed and proven correct inductively. This correctness is reinforced through numerical simulations, actual data verification, and Black Box Testing across 12 functional scenarios, all of which were declared valid. Preliminary user feedback involving the admin/cashier and the store owner yielded a feasibility score of 95%, falling into the "Highly Feasible" category. This indicates that the FIFO-based stock management features are well-received and align with the store's operational requirements. Consequently, all research objectives have been successfully achieved.

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