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SkyStore Web Inventory Management for Aircraft Spare Parts at GMF AeroAsia

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ABSTRACT (10 PT)

PT GMF AeroAsia Tbk uses SAP as the primary material transaction system, but daily inventory activities at the Satellite Store still rely on spreadsheets, creating risks of input errors, duplicated data, delayed reporting, and limited automated shelf-life monitoring. This study developed SkyStore, a web-based inventory information system for aircraft spare-part operations. Data were collected through non-participant observation, directed interviews, and literature study. Development followed Rapid Application Development and was implemented using Laravel and MySQL. SkyStore centralizes incoming and outgoing materials, Return to Warehouse, in-transit tracking, bin mapping, shelf-life control, analytical dashboards, notifications, and role-based user management. Black Box Testing covered 59 functional scenarios across 15 modules, and all scenarios were successful. White Box Testing examined login, incoming, and shelf-life logic with cyclomatic complexities of 3, 5, and 5, respectively; all 13 independent paths produced the expected results. The system therefore supports more structured, traceable, and timely Satellite Store inventory monitoring.

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1. INTRODUCTION

Aircraft Maintenance, Repair, and Overhaul (MRO) operations depend on reliable material availability and accurate information because spare-part readiness directly supports aircraft operational continuity and safety. Digital MRO environments also generate large volumes of operational data that must remain accurate and traceable [1]. In parallel, spare-part availability and procurement risk management are important for preventing operational disruption [2]. Warehouse information systems can improve stock accuracy and material movement control through structured, real-time records [3], [4], while shelf-life control requires prioritization of materials approaching expiration, including the use of FIFO and FEFO principles [5].

Previous studies show that web-based inventory systems can improve recording accuracy, transaction speed, and stock visibility. RAD-based inventory applications have been reported for pharmaceutical inventory and automotive spare parts [6], [7], while other inventory implementations emphasize centralized stock control

and faster access to inventory information [8]–[10]. Dashboard-based stock monitoring can further support rapid interpretation of warehouse conditions [11]. However, the studies reviewed in the thesis mainly address pharmacy, automotive, retail, general warehouse, or manufacturing contexts and do not combine aircraft MRO Satellite Store operations with dashboard analytics, shelf-life notifications, in-transit monitoring, Return to Warehouse, bin mapping, and material traceability in one application.

At PT GMF AeroAsia Tbk, SAP is used as the primary corporate system for recording and tracking material transactions. Nevertheless, operational requirements at the Satellite Store are still supported by spreadsheets because information must be summarized from separate SAP views for daily monitoring. The observed and interviewed users identified risks such as incorrect part numbers, batch numbers, quantities, and storage locations; duplicated or mismatched data; slow reporting; the absence of automated shelf-life notifications; fragmented in-transit monitoring; and the lack of a centralized operational database. Shelf-life checking was also conducted periodically and the resulting reports were maintained in spreadsheets, increasing the effort needed to locate and reconcile information.

This study therefore aims to analyze the existing material-management process, identify operational constraints, develop and implement the Laravel-based SkyStore system with dashboard analytics, shelf-life notifications, and material traceability, and evaluate its main functions and program logic. The research contribution lies in the integrated implementation of these capabilities for aircraft spare-part inventory at a Satellite Store while retaining SAP as the corporate transaction source rather than attempting to replace the complete SAP environment.

2. RESEARCH METHOD

2.1. Research design and data collection

The study used a case-study-oriented system development approach at the Satellite Store of PT GMF AeroAsia Tbk. Requirements were collected through non-participant observation, directed interviews with warehouse personnel and a supervisor, and literature study. Observation focused on receiving, issuing, inter-location movement, data-entry points, stock monitoring, and shelf-life control. Interviews explored operational experience, constraints, information and KPI needs, in-transit handling, and shelf-life management. These techniques are consistent with the observation and interview principles described in the thesis methodology [12].

Inventory analysis used FEFO for materials with controlled expiration dates and FIFO for materials without strict shelf-life control. The research scope was limited to Satellite Store operational recording and monitoring; it did not cover comprehensive inventory audit, procurement, purchase planning, or direct integration with all SAP modules.

2.2. Rapid Application Development process

Rapid Application Development (RAD) was selected because it supports short, iterative development cycles and direct user feedback [13]. In this study, RAD was operationalized into five practical stages: Requirement Planning, User Design, Implementation, Testing, and Maintenance. The stages and their main outputs are summarized in Table 1.

Table 1. RAD stages applied in SkyStore development

Stage	Main activities	Primary output
Requirement Planning	Non-participant observation, directed interviews, identification of functional and non-functional needs, and analysis of the existing spreadsheet-supported process.	Actors, requirements, constraints, and operational findings.
User Design	User-involved prototype evaluation; UML modeling using use case, activity, sequence, and class diagrams; ERD and LRS data design.	UI mockups, workflow models, and revised system design.
Implementation	Coding with PHP, Laravel MVC, Filament, and MySQL; creation of modules and database structures.	Functional SkyStore web application.
Testing	Black Box Testing for interface input/output behavior and White Box Testing for internal logic and independent paths.	Functional and logic validation results.
Maintenance	Post-deployment monitoring, anomaly correction, query optimization, and backup preparation.	Operational continuity and data-integrity support.

2.3. System design and implementation environment

SkyStore was implemented with PHP 8.x, HTML, CSS, JavaScript, the Laravel MVC framework, a Filament administration panel, and a MySQL database. Laravel-based web implementations in the thesis literature demonstrate the framework's use for structured web application development [14]–[16]. The system-information and inventory concepts used in the design follow the sources reviewed in the thesis [17], [18]. Core database structures include users, material transactions, shelf-life records, in-transit records, bin locations, notification history, and supporting master data. ERD-based modeling and normalization were used to define

relationships and reduce data redundancy [19]–[21]. The database implementation used MySQL/InnoDB, consistent with the database technologies discussed in the thesis literature [22]–[25].

The functional scope comprised login and role-based access, Incoming, Outgoing, Return to Warehouse (RWS), In-Transit, Shelf Life, Bin Mapping, Dashboard Analytics, Notifications, Users, Roles, Line and Aircraft master data, and import/export functions. Data originating from SAP can be adapted to SkyStore templates for operational monitoring, but direct SAP API synchronization was outside the implemented scope.

2.4. System testing

Black Box Testing evaluated system behavior from the user perspective by comparing expected and actual outputs for valid and invalid inputs. White Box Testing evaluated internal program paths for login authentication, incoming-material validation, and shelf-life calculation. Cyclomatic complexity was calculated with $V(G) = P + 1$, where P is the number of predicate nodes, and each independent path was executed against its expected result.

3. RESULTS AND DISCUSSION

3.1. Existing process and proposed operational response

The analysis of the existing process showed that Satellite Store personnel relied on SAP for transaction data while spreadsheets were used as an operational summary and backup. This created additional reconciliation effort when spreadsheet entries differed from actual material or SAP data, and spreadsheet performance degraded as records accumulated. Shelf-life data were exported from SAP and checked periodically, while in-transit status was also monitored through spreadsheet updates. These conditions motivated a centralized web application that could organize the operational view without replacing corporate SAP transactions.

Table 2. Main operational constraints and SkyStore responses

Observed constraint	SkyStore response
Spreadsheet-based recording risks input errors, duplicate data, and slow reconciliation.	Centralized database, required-field validation, search, filters, and structured transaction modules.
Operational information is fragmented across SAP views and spreadsheets.	Integrated dashboard and module-based operational view for Satellite Store activities.
Shelf-life monitoring and reporting require manual periodic checking.	Remaining-day calculation, status grouping, shelf-life records, system notifications, and notification settings.
In-transit materials lack an integrated operational monitoring view.	In-Transit module with import, status monitoring, overdue filtering, and update functions.
Traceability and storage-location monitoring are limited in spreadsheet workflows.	Incoming, Outgoing, RWS, Bin Mapping, activity history, user roles, and material-location records.

3.2. System implementation

The implemented application provides a single web interface for daily inventory operations. The dashboard presents date-filtered inventory summaries and trend visualizations, while the navigation structure groups logistics operations, reverse logistics, inventory control, master data, and system settings. Incoming and Outgoing modules record material movement; RWS records returned materials; In-Transit supports monitoring of materials that have not yet arrived; Bin Mapping records storage positions; and user/role management restricts access according to responsibilities.

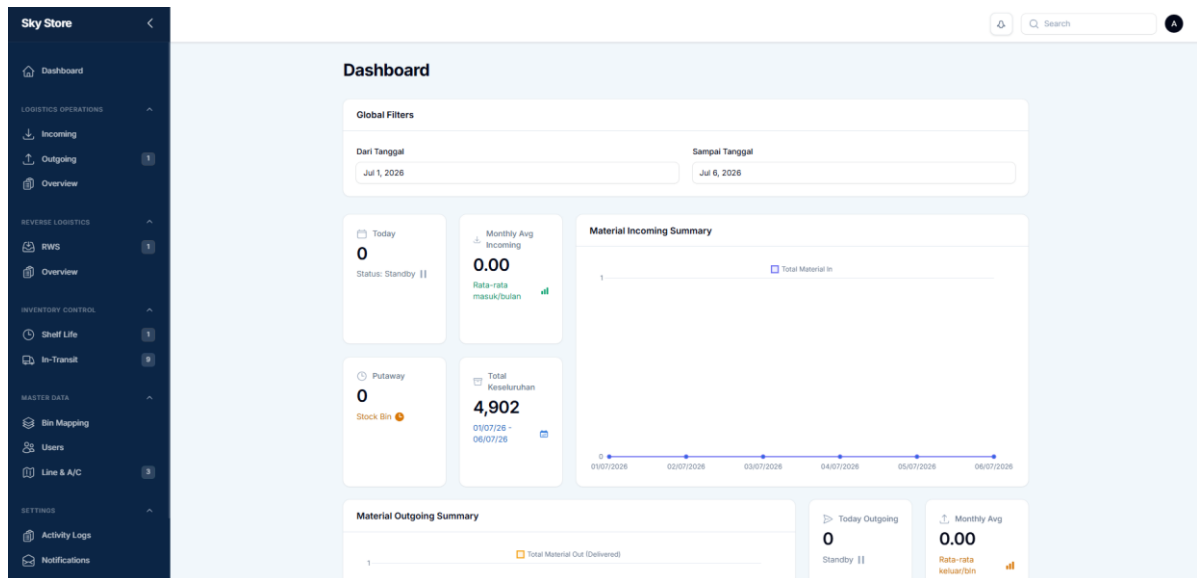


Figure 1. SkyStore dashboard implementation

Shelf-life management stores the date of manufacture (DOM), date of expiry (DOE), quantity, part number, batch, location, and calculated remaining period. The page groups records by operational status and supports import, export, template download, search, and follow-up actions. When expiration conditions are detected, the system updates the status and can generate notification records; the notification module also supports email-related settings and test functions.

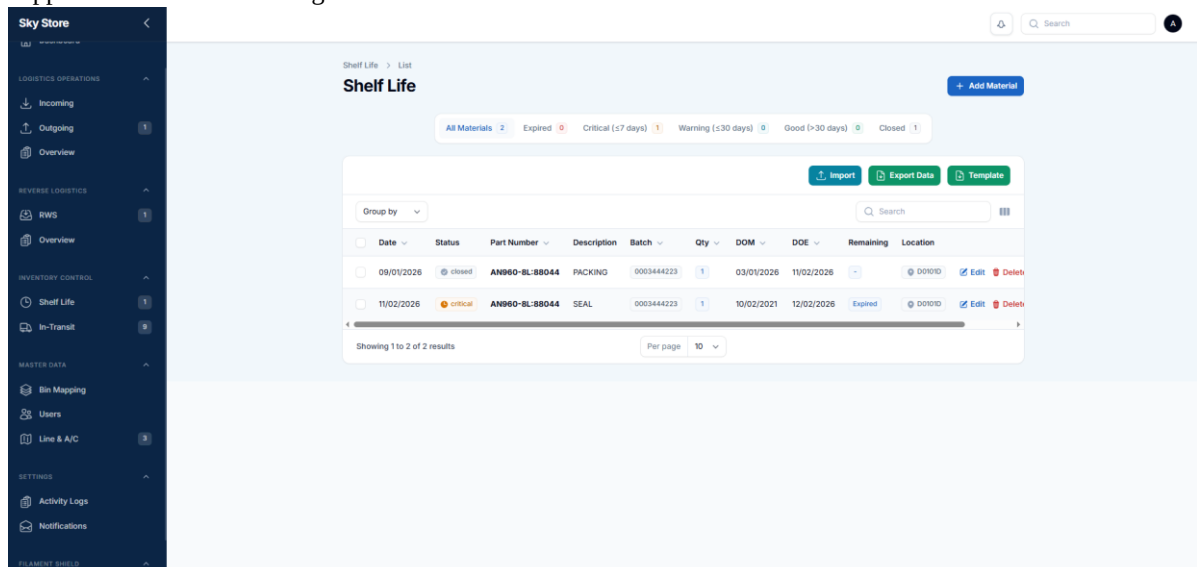


Figure 2. SkyStore shelf-life monitoring page

3.3. Black Box Testing results

Black Box Testing was conducted across 15 functional areas. Counting the individual scenarios listed in the thesis test tables yields 59 scenarios. Every scenario was recorded as successful, including validation failures that were expected to be rejected by the system. Table 3 summarizes the tested modules and outcomes.

Table 3. Summary of Black Box Testing

Module	Representative functions tested	Scenarios	Result
Login	Valid/invalid credentials; required fields	3	All successful
Dashboard	Display, summary data, date filter	3	All successful
Incoming	Add, validation, search/filter, status update	6	All successful
Outgoing	Display, deliver, bulk deliver, date filter	4	All successful
Return to Warehouse	Add, required fields, condition update, set to bin	4	All successful
Shelf Life	Add, date/quantity validation, status, expired process	5	All successful
In-Transit	Add, required fields, overdue filter, view/edit	4	All successful

Bin Location	Add, duplicate validation, status, search	4	All successful
Notifications	Settings, email validation, days-before validation, test email	4	All successful
Users	Add, duplicate email, edit, assign role	4	All successful
Roles	Display, add, name validation, permission update	4	All successful
Line and A/C	Add, duplicate aircraft, status filter, bulk status	4	All successful
Import Data	Template download, valid import, incomplete-data rejection	3	All successful
Export Data	Incoming, Outgoing, RWS, Shelf Life, In-Transit exports	5	All successful
Logout	Logout and protected access after logout	2	All successful
Total		59	59/59 successful

3.4. White Box Testing results

White Box Testing focused on three processes with important branches. Login produced a cyclomatic complexity of 3, while Incoming and Shelf Life each produced a complexity of 5. The corresponding 13 independent paths were executed and all produced the expected outcome. For shelf-life logic, the tested paths included required-field validation, DOE validity, expired status, critical status when approaching DOE, and active status when the remaining period was still safe.

Table 4. Summary of White Box Testing

Module	V(G)	Independent paths	Outcome
Login	3	3	All paths successful
Incoming	5	5	All paths successful
Shelf Life	5	5	All paths successful
Total	-	13	13/13 paths successful

3.5. Discussion

The implementation results are consistent with the prior inventory-system studies reviewed in the thesis, which show that web-based systems can reduce dependence on manual records and improve access to stock information [6]–[10]. SkyStore extends this pattern to the aircraft MRO Satellite Store context by integrating operational modules that were previously split between SAP views and spreadsheets. Compared with the dashboard-focused study in [11], SkyStore combines visualization with transaction recording, in-transit monitoring, bin mapping, and shelf-life control rather than providing dashboard monitoring alone.

The most distinctive operational element is the shelf-life workflow. The system not only stores expiration-related data but also calculates and classifies remaining shelf life, supports notifications, and preserves records for follow-up. This directly addresses the thesis finding that material shelf life was previously checked periodically and reported through spreadsheets. The integration of Incoming, Outgoing, RWS, In-Transit, Bin Mapping, and role-based access further supports traceability within the operational application.

The test results demonstrate conformance to the specified functional scenarios and selected internal program paths, but the evaluation scope remains the one defined in the thesis. Comprehensive inventory audit, procurement and purchase planning, predictive demand analysis, handheld/mobile operation, and direct SAP API integration were not part of the implemented system. Consequently, the findings support the correctness of the tested functions and logic rather than claiming complete replacement of enterprise logistics systems or long-term operational performance beyond the study scope.

4. CONCLUSION

SkyStore was successfully developed as a Laravel- and MySQL-based web application to support aircraft spare-part inventory management at the Satellite Store of PT GMF AeroAsia Tbk using the RAD approach. The system centralizes Incoming, Outgoing, Return to Warehouse, In-Transit, Bin Mapping, Shelf Life, Dashboard Analytics, Notifications, and user/role management. The implemented shelf-life feature supports monitoring of materials approaching or exceeding expiry, while the dashboard provides summarized inventory information for operational monitoring. Across 59 Black Box scenarios, all tested functions were successful; White Box Testing also confirmed the expected behavior of all 13 independent paths for login, incoming, and shelf-life logic. Further development identified in the thesis includes direct SAP integration through an API, mobile or handheld-scanner support, notification delivery through instant-messaging platforms such as WhatsApp or Telegram, additional specialized roles for the RWS process, and predictive analysis based on historical inventory data.

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