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A Cost-Effective Digital Inventory System for Small Enterprises: Leveraging AppSheet with Lean Principles

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Abstract

Small enterprises in Thailand often struggle with inefficient inventory management, particularly in recording serial numbers (S/N) and processing inventory transactions manually. These challenges lead to delays, resource wastage, and increased operational costs. This research aims to develop a cost-effective inventory management system tailored for small enterprises by leveraging App Sheet and Google Sheets, integrated with Lean principles to minimize waste and enhance data accuracy. The proposed system focuses on eliminating redundant processes, improving transaction speed, and reducing errors. Experimental results demonstrate that the implementation of this system reduced S/N recording errors by 85% and decreased inventory management time by 65% compared to traditional methods. Additionally, the system significantly improved data accuracy and operational efficiency. The study suggests further deployment of this solution across small enterprises seeking an affordable yet effective inventory management system to enhance accuracy and streamline operations.

Keywords
Lean Process, Inventory Management, App Sheet, SMEs, Digital Transformation

1. Introduction
Inventory management remains a critical aspect of operational efficiency for businesses of all sizes. However, small and medium-sized enterprises (SMEs) frequently face limitations in adopting advanced inventory management technologies due to budget constraints. Many SMEs still rely on manual record-keeping methods, leading to inefficiencies, data inaccuracy, and increased operational workload. With technological advancements, large enterprises have integrated sophisticated inventory management systems to optimize resource allocation. However, SMEs require more affordable alternatives without compromising efficiency.

A small telecommunications SME in Thailand faced challenges in monitoring and managing inventory, including mobile devices and SIM cards used for network quality testing. The existing inventory management system was manual, relying on physical records and spreadsheets, resulting in frequent errors, delays, and difficulty in tracking equipment. Despite transitioning to Google Sheets for data storage, inefficiencies persisted due to continued reliance on manual data entry.

To address these challenges, this research proposes integrating Lean principles with low-cost digital solutions such as App Sheet and QR scanning. This approach eliminates redundant steps, enhances real-time tracking, and improves overall inventory accuracy. By leveraging existing Google Sheets infrastructure and integrating it with AppSheet, a low-code application development platform, the study aims to develop a cost-efficient and accessible inventory management system for SMEs.

1.1 Objectives

To design and develop a cost-effective inventory management system utilizing App Sheet and Lean principles and analyze the impact of digital transformation on inventory accuracy and SME operational efficiency.

2. Literature Review

Inventory management in small and medium enterprises (SMEs) faces several challenges, including manual data entry errors, slow processing, and lack of real-time stock visibility, leading to operational inefficiencies and higher costs (Lee and Kim 2020) (Olanrewaju et al. 2021). These challenges highlight the need for cost-effective and efficient digital solutions tailored for SMEs to improve accuracy and speed in inventory control.

Low-code/no-code platforms like AppSheet have emerged as suitable tools for SMEs with limited budgets and technical resources. Hu et al. emphasize that successful Lean implementation in SMEs requires easily adoptable tools that rapidly eliminate non-value-adding activities (Hu et al. 2018). Studies by Hassan et al. and Sari and Dewi demonstrate that AppSheet, when combined with tools such as Google Sheets, significantly reduces inventory errors, improves accuracy, and lowers administrative workload—making it an ideal solution for SMEs seeking affordable and rapid digital transformation (Hassan et al. 2023) (Sari and Dewi 2023).

Furthermore, Lean principles integrated with digital systems substantially enhance inventory management performance. Rusli et al. reported that combining Lean with IoT technology in Malaysian automotive SMEs improved raw material tracking accuracy by 88% and reduced waste by 30% (Rusli et al. 2024). This aligns with findings from Hoellthaler et al., who indicated that Digital Lean approaches significantly reduce waste and improve process efficiency in SMEs (Hoellthaler et al. 2018).

Additional research supports the effectiveness of no-code platforms in fostering inclusive digital innovation. Nurharjadmo et al. and Hassani et al. found that these tools reduce development time and costs while increasing adaptability to digital trends, especially in developing economies (Nurharjadmo et al. 2022) (Hassani et al. 2023).

Studies by de Souza et al. and Rusli et al. further confirm that integrating IoT and Lean tools in smart warehouse management reduces excess inventory by up to 65% and improves overall supply chain efficiency (de Souza et al. 2021), (Rusli et al. 2024). This enables SMEs to respond faster and more effectively to customer demands.

In summary, applying a cost-effective digital inventory management system such as AppSheet, combined with Lean principles, offers SMEs a clear pathway to reduce errors, cut costs, and improve stock management efficiency. This approach addresses the demand for easy-to-use yet high-impact inventory solutions tailored to small enterprises (Hu et al. 2018) (Lee and Kim 2020) (Rusli et al. 2024) (Hassan et al. 2023).

3. Methods

3.1 Analysis of Traditional Equipment Issuance and Return System

This study analyzes the traditional equipment issuance and return system, identifying inefficiencies and bottlenecks. The research involves data collection through observations and user feedback to map the complete process from request initiation to final equipment return. Key issues recorded include delays in processing time, data entry errors, and redundancy in workflows.

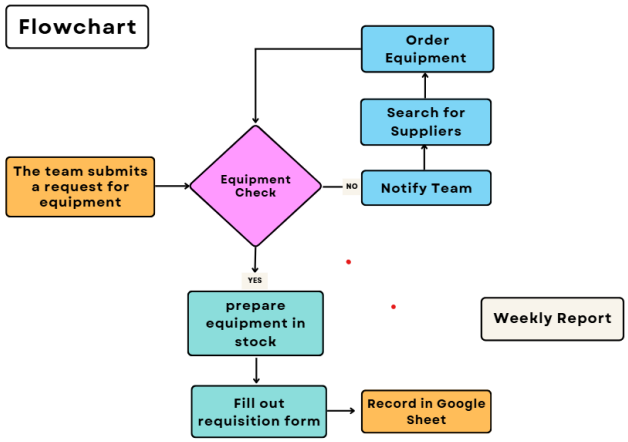

Figure 1. Traditional Equipment Requisition and Issuance Process

Figure 1 illustrates the traditional process of issuing and returning equipment, which the organization utilized before developing its inventory management application. The traditional workflow proceeds as follows:
Request Submission

- The field team notifies the warehouse staff when equipment needs to be issued or returned.

Equipment Unavailable (No Path)

- If the requested equipment is not found in stock, the warehouse staff informs the requesting team or department and initiates the procurement of additional items.
- The inventory records are then updated to reflect the new equipment status.

Equipment Available (Yes Path)

- Stock Verification: Warehouse staff verifies equipment stock by checking both the Google Sheets database and the physical inventory to ensure accuracy. If the requested quantity is confirmed to be adequate, the team is informed that they can pick up the equipment.
- Manual Data Entry: The requesting team must fill out the equipment issuance details. Issuing multiple items can be time-consuming, especially with urgency, increasing the risk of data entry errors—particularly for lengthy serial numbers (S/N).
- System Updates and Reporting: Warehouse staff manually records the information into Google Sheets based on the paper forms. Any inaccuracies on the forms can propagate errors in the system. At the end of each week, the data is compiled into a summary report for submission to management.

3.2 Analysis of Issues Encountered

Based on the study and subsequent analysis of the current process, interviews were conducted with key stakeholders—including staff responsible for equipment issuance and return, team members, and managers—to gather insights on the organization's existing equipment issuance-return procedures, operational constraints, and user expectations. These findings serve as a foundation for designing the new system. The major issues identified are summarized below:

3.2.1 Lengthy Issuance Process

- The issuance workflow relies on traditional methods such as paper-based forms or updating information through Google Sheets, leading to operational delays.
- Inaccurate or incomplete equipment records necessitate additional time for retrospective verification.
- There is no efficient tracking system to monitor the status of issued equipment.

3.2.2 Errors in Recording Serial Numbers (S/N)

- Team members frequently make mistakes when entering S/Ns, adversely affecting equipment traceability.
- The lack of an automated validation system increases the likelihood of incorrect data entry.
- Retrieving historical records can be challenging if incorrect S/Ns have been recorded.

3.2.3 Lack of Real-Time Inventory Tracking

- Inventory managers cannot accurately determine current stock levels.
- No automated alerts exist for low stock (below reorder levels), leading to shortages of critical items.
- Generating inventory reports is time-consuming as data must be gathered from multiple sources.

3.2.4 Manual Updates in Google Sheets

- Manual data entry causes delays and increases the risk of errors.
- There is no mechanism to prevent duplicate entries or accidental deletions.
- Accessing the system requires a stable internet connection, which may not always be reliable.

3.2.5 Risk of Damaged or Lost Documentation

- Paper-based records are prone to damage or loss.
- There is no backup or retrieval system for historical data, making it difficult to validate past records.
- Searching for historical data is cumbersome, hindering both auditing processes and overall management (Figure 2).

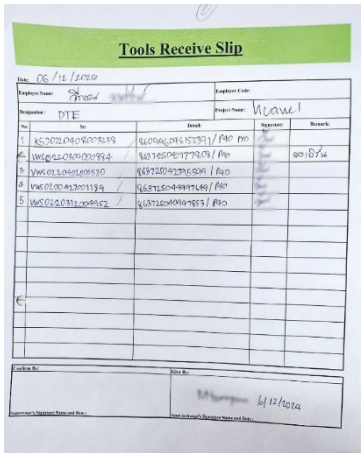

Figure 2. Traditional Equipment Requisition and Dispensing Documentation

3.3 System Design and Development Using Google App Sheet

In response to the challenges identified in the traditional equipment issuance and return process, the system has been enhanced by employing Google App Sheet. This approach facilitates the design and development of a new digitalized workflow model that is both modern and accurate, ultimately creating a more efficient inventory management solution. The improvement process is divided into 4 key steps, as follows in Figure 3:

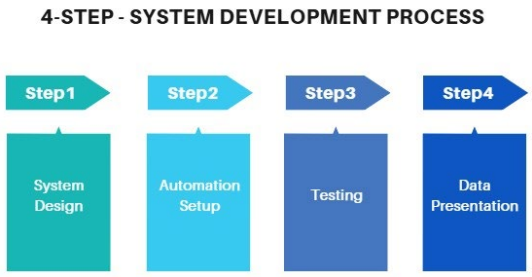

Figure 3. The Step of Design App - Google App Sheet

Step 1: System Design
To address inefficiencies in the traditional inventory request and return process, a modernized digital system was developed using Google App Sheet. The system was designed with the following key components:
Google App Sheet Configuration: A structured setup of Google App Sheet was implemented, requiring all team members to install the App Sheet mobile application for easy system access.

Google Sheets Integration: The existing database structure in Google Sheets was optimized for seamless synchronization with App Sheet.

QR Code Implementation: A QR code scanning system was integrated to record serial numbers (S/N) efficiently, minimizing manual data entry errors.

Core System Features:
Automated Inventory Request and Return: The system provides a user-friendly interface that allows users to fill out digital forms with dropdown menus and selection buttons. Digital signatures are incorporated for authentication (Figure 4).

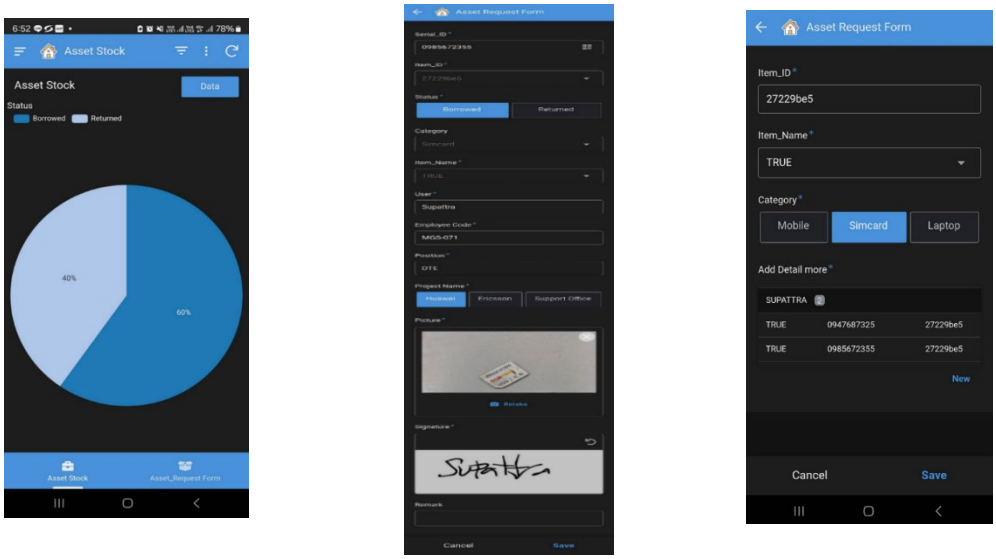

Figure 4. User Interface - App Sheet

- Real-time Inventory Tracking: Automated updates occur when items are added or removed, providing a dashboard view of current inventory status and usage trends.
- Reduction of Manual Data Entry: The integration of Google App Sheet and Google Sheets minimizes manual data input, enhancing reliability and reducing workload.

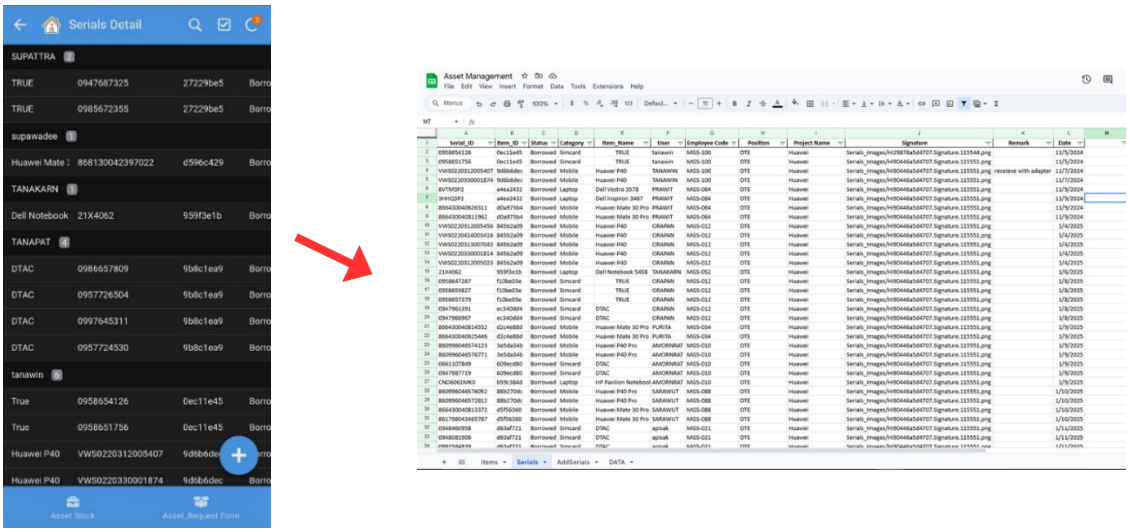

Figure 5. App Sheet Link to Google Sheet

- Data Backup and Security: All data is securely stored in the cloud with controlled access permissions to prevent unauthorized viewing (Figure 5).

Step 2: Automation Configuration

To enhance operational efficiency, the system incorporated Automation Workflow using Google Sheets and App Sheet:

Automated Email Notifications: Alerts are sent upon item requests, returns, or updates, ensuring real-time communication among stakeholders.

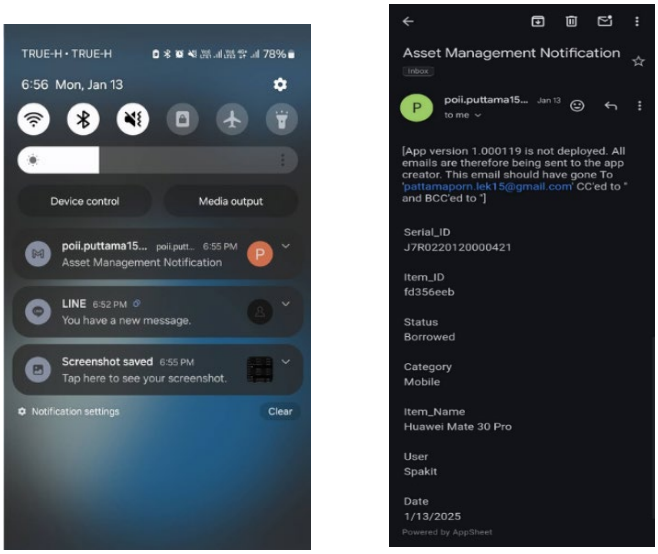

Figure 6. Automated Email Notification Feature

Automated PDF Generation: Inventory request and return forms are auto-generated as PDFs and stored in Google Drive for easy access (Figure 6).

Elimination of Redundant Tasks: The system removes the need for duplicate entries in messaging applications such as Line, reducing administrative workload.

Step 3: System Testing
The system underwent rigorous testing to validate its effectiveness:
Pilot Testing: Employees tested the system under both old and new inventory processes.
Data Collection and Analysis: Key metrics such as processing time, record accuracy, and inventory consistency were evaluated.
User Satisfaction Survey: Users provided feedback on system usability, speed, redundancy reduction, and encountered issues.

Step 4: Data Presentation with Looker Studio
For efficient reporting, Google Looker Studio was used to present weekly inventory updates:
Dashboard Development: Real-time inventory status and updates were presented in an interactive dashboard for management review.
Direct Google Sheets Integration: Ensures real-time data updates without the need for additional software.
Key Insights: Displays current inventory levels, weekly/monthly usage trends, frequently used item categories, and historical usage statistics (Figure 7).

Figure 7. Dashboard by looker studio

4. Data Collection

Data were collected from interviews, observations, trial use of the system, and user feedback over a three-month period (November–January). These data were then analyzed to evaluate the performance of the newly developed system. The data collection process involved the following:

1. System Trial Data
   Actual usage data from 25 staff members were recorded over a three-month span. The information collected included the accuracy of recorded Serial Numbers (S/N) and the time required for data entry through the application.
2. User Feedback
   Staff members completed a satisfaction survey regarding the use of Google AppSheet. Their comments and satisfaction levels concerning the lean-based improvements to the equipment issuance and return process were also documented.
3. Comparative Analysis
   Data were gathered before and after implementing the new system. Key metrics included the total time from the start to the end of the equipment issuance and return process, the frequency of data entry errors—particularly errors involving S/N—and overall user satisfaction with the new system.

5. Results and Discussion

After three months of data collection (November–January) through interviews, observations, system trials, and user feedback, the newly developed App Sheet-based system was found to significantly resolve the existing issues and enhance the efficiency of the equipment issuance process.

5.1 Process Improvement Comparison

The implementation of the new equipment issuance system has resulted in significant improvements in both process efficiency and performance metrics when compared to the traditional method. The primary areas of improvement include communication, accuracy, processing time, and data accessibility. As summarized in Table 1, the new system consolidates the original eight-step process into five streamlined steps. This transformation is achieved by automating key operations such as request submission, inventory checking, and reporting. These changes lead to a 37.5% reduction in process steps and a 65% decrease in processing time. In addition to process improvement, system performance was evaluated based on several operational criteria, as presented in Table 2. The results indicate substantial enhancement in operational time, error rate, user satisfaction, and overall system capabilities.

Table 1. Comparative outcomes of process improvements: Old vs. new equipment issuance system

Process Step	Traditional System	New App Sheet System	Improvement
Request Submission	Manual notification to warehouse	Digital request via app	Streamlined communication
Stock Verification	Manual check in Google Sheets and physical inventory	Automated real-time inventory display	Instant verification
Equipment Issuance Documentation	Paper forms with manual S/N entry	QR code scanning for S/N capture	Eliminated manual entry errors
System Update	Manual entry into Google Sheets	Automatic synchronization	Real-time data accuracy
Reporting	Manual compilation of weekly reports	Automated dashboards via Looker Studio	Instant access to analytics
Total Steps	8 steps	5 steps	37.5% reduction in process steps
Total Time	15-20 minutes	5-7 minutes	65% reduction in processing time

Table 2. Comparative criteria and outcomes: Old vs. new system

Criteria	Traditional System	App Sheet System	Improvement
Operational Time	15–20 minutes per transaction	5–7 minutes per transaction	65% reduction
S/N Recording Accuracy	8–10 errors per month	1–2 errors per month	80% reduction in errors
User Satisfaction (5-point scale)	Average score of 2.8	Average score of 4.2	50% improvement
Equipment Status Tracking	10–15 minutes to locate	1–2 minutes to locate	85% reduction in search time
Report Generation	1 working day	5–10 minutes	95% reduction in reporting time
Operational Costs	Paper-based documentation	Paperless operations	Significant cost reduction
Data Accessibility	Office hours, on-site only	24/7 mobile access	Improved accessibility
Data Analysis Capabilities	Limited historical analysis	Real-time dashboards	Enhanced decision-making

5.3 Discussion of Results

The implementation of the App Sheet-based inventory management system demonstrated significant improvements across all measured metrics:

1. Operational Efficiency

The reduction in processing time from 15-20 minutes to 5-7 minutes represents a 65% improvement in operational efficiency. This time saving directly translates to increased productivity, allowing staff to focus on more value-adding activities rather than administrative tasks.

2. Data Accuracy

The 80% reduction in S/N recording errors (from 8-10 monthly errors to just 1-2) demonstrates the effectiveness of the QR code scanning feature. This improvement directly addresses one of the most critical issues in the traditional system—inaccurate equipment tracking due to manual entry errors.

3. User Experience and Adoption

The improvement in user satisfaction scores from 2.8 to 4.2 (on a 5-point scale) indicates strong user acceptance of the new system. This positive reception is crucial for successful implementation and sustained usage of the digital solution.

4. Resource Optimization

The system significantly reduced the resources required for inventory management:

- 85% reduction in equipment tracking time
- 95% reduction in report generation time
- Elimination of paper documentation
- Reduced storage requirements for physical records

5. Decision Support Capabilities

The integration with Looker Studio for real-time dashboard reporting enhanced management's ability to make informed decisions based on current inventory status and usage trends. This capability was entirely absent in the traditional system.

6. Lean Process Implementation

The application of Lean principles is evident in the elimination of waste throughout the inventory management process:

- Elimination of redundant steps (process waste)
- Reduction in waiting time (time waste)
- Elimination of paper documentation (material waste)
- Improvement in data accuracy (defect waste)
- Automation of repetitive tasks (human resource waste)

5.4 Limitations

While the developed inventory system shows strong results, it also has certain limitations. First, the system relies heavily on a stable internet connection, which may hinder usability in remote or low-connectivity areas. Second, the current version supports only a single language, limiting its accessibility among diverse user groups. Third, the system has not been tested in integration with enterprise-grade ERP platforms, so its scalability in more complex environments remains uncertain.

6. Conclusion

This study demonstrates how App Sheet can serve as an effective inventory management solution for small and medium-sized enterprises (SMEs), addressing the inefficiencies of traditional manual systems. The newly developed system increases data accuracy, enables real-time inventory tracking, and streamlines operational workflows, all while reducing human errors and minimizing delays.

The research successfully met its objectives by:

- Reducing Serial Number (S/N) Errors by 80% through QR code scanning implementation.
- Shortening the Equipment Issuance and Return Process by 65%, significantly improving operational efficiency.
- Providing Real-time Inventory Tracking that reduced equipment search time by 85%.
- Automating Report Generation resulting in a 95% reduction in reporting time.
- Raising User Satisfaction from an average score of 2.8 to 4.2 on a 5-point scale, reflecting the system's overall effectiveness.

This study offers practical guidance on integrating a no-code platform like AppSheet into SME operations, illustrating how digital transformation can enhance operational performance without requiring advanced technical expertise. The findings support Lean principles in inventory management by presenting a cost-effective, adaptable framework that SMEs can implement to optimize their equipment-tracking processes. The demonstrated success of this implementation suggests that similar approaches could be widely adopted by SMEs across various industries to improve their inventory management practices without significant financial investment.

6.1 Future Work

Future research should explore integrating the proposed system with IoT-based sensors to enable automatic detection of stock movement. Expanding the system's language support can improve inclusivity and user accessibility. Additionally, testing the integration of this system with cloud-based ERP platforms would be beneficial for extending its application to medium-sized enterprises. Enhancements in predictive analytics and dashboard customization using AI could also be considered for better decision support.

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