Smart Inventory System For Expiry Tracking And Sales Control

Dhanush H[1], Mahalakshimi G[2]
[1]Dept of computer application
[2]Assistant professor, Dept of computer application
[1, 2] Dr. M.G.R Educational and Research Institute (Demmed to be University)
Chennai Tamil Nadu India

Abstract- *The Expiry Product Management and Alert System is designed to assist retail shop owners in effectively managing inventory with a focus on product expiry tracking and prevention of expired product sales. In many small and medium retail businesses, manual monitoring of expiry dates is inefficient and prone to human error, which can lead to financial losses and potential health risks for consumers. This project provides a digital solution to automate and streamline the entire process.*

The system allows a shop owner to register and log in to a secure platform, where they can access a centralized dashboard for managing inventory, purchases, and sales. During the purchase process, the shop owner records detailed information about each product, including its expiry date. Each product item within a purchase invoice is assigned a unique QR code, enabling precise identification and tracking. This ensures that even when multiple items are purchased under a single invoice, each unit can be monitored individually.

At the point of sale, products are scanned using their QR codes. The system automatically verifies the expiry status of the product before allowing the transaction. If the product has exceeded its expiry date, the system blocks the sale and notifies the user, thereby preventing the distribution of expired goods. Additionally, the dashboard continuously monitors inventory and provides alerts for products that are nearing their expiry dates, allowing the shop owner to take timely action such as promotions or stock clearance.

The system also generates reports on expired and soon-to-expire products, helping in better decision-making and inventory control. By integrating QR-based tracking, automated expiry validation, and real-time alerts, this project enhances operational efficiency, reduces losses, and ensures customer safety. Overall, the proposed system offers a reliable and scalable solution for modern retail inventory management.

Keywords: Smart Inventory System, Expiry Tracking, Sales Control, Inventory Management, QR Code Tracking, Product Monitoring, Expiry Alert System, Retail Management, Stock Management, Automated Validation, Product Expiry Detection, Real-Time Alerts, Sales Management, Inventory Control, QR Code Scanning, Customer Safety, Stock Tracking, Retail Automation, Expired Product Prevention, Inventory Analytics, Product Lifecycle Management, Database Management, Java, MySQL, Web Application

I. INTRODUCTION

In the retail industry, effective inventory management plays a crucial role in ensuring product quality, customer satisfaction, and business profitability. One of the major challenges faced by shop owners, especially in small and medium-scale businesses, is the proper tracking of product expiry dates. Many products such as food items, medicines, and cosmetics have limited shelf lives, and failure to monitor these expiry dates can result in selling expired goods, leading to health risks for consumers and financial losses for the business.Traditionally, shop owners rely on manual methods to check expiry dates, which is time-consuming, inefficient, and highly prone to human error. As the number of products increases, it becomes increasingly difficult to monitor each item individually. This creates a need for an automated and reliable system that can track product expiry, provide timely alerts, and prevent the sale of expired items.

The Expiry Product Management and Alert System is developed to address these challenges by providing a smart digital solution for managing inventory with a focus on expiry tracking. The system enables shop owners to record product details during purchase, including expiry dates, and assigns a unique QR code to each item for easy identification and tracking. Through an interactive dashboard, the shop owner can monitor stock, view upcoming expiry alerts, and manage sales efficiently.A key feature of the system is its ability to validate products during the sales process. By scanning the QR code, the system automatically checks whether the product is expired and restricts the sale if necessary. Additionally, it provides notifications for products nearing their expiry,

allowing proactive actions such as discounts or stock clearance.By integrating automation, real-time monitoring, and QR-based tracking, this system aims to improve inventory accuracy, reduce wastage, enhance customer safety, and support better decision-making in retail operations. This project represents a step towards modernizing traditional retail management practices using simple yet effective technology. , which is time-consuming, inefficient, and highly prone to human error. As the number of products increases, it becomes increasingly difficult to monitor each item individually.

II. RELATED WORK

Several research studies have addressed inventory management, product expiry monitoring, and intelligent retail systems to improve operational efficiency and reduce losses. A study by Adel Fahad Alrasheedi (2023) proposed credit policy strategies for green products with expiry-date-dependent deterioration using the Grey Wolf Optimizer algorithm. The research focused on optimizing inventory decisions for perishable products and highlighted the importance of managing products with limited shelf life to maximize profitability and reduce wastage.

Ashish Manchanda et al. (2024) introduced an Adaptive Context Monitoring Framework for enhancing caching efficiency in IoT-based context management platforms. Their work emphasized real-time monitoring, automated updates, and intelligent decision-making through adaptive mechanisms. The study demonstrated how continuous monitoring systems can improve performance and provide timely responses in dynamic environments, which is relevant to expiry tracking and inventory alert systems.

Another significant contribution was made by Ch. Anwar Ul Hassan et al. (2024), who proposed a query cache mechanism to optimize data warehouse performance. Their approach utilized an aging-based Least Frequently Used (LFU) algorithm to manage data efficiently and improve retrieval speed. The research highlighted the importance of efficient data handling, storage management, and performance optimization in systems dealing with large volumes of inventory and transaction data.

Although these studies provide valuable insights into inventory optimization, monitoring frameworks, and data management techniques, they do not directly address the problem of preventing the sale of expired products in retail environments. The proposed Smart Inventory System for Expiry Tracking and Sales Control bridges this gap by integrating QR-code-based product identification, automated expiry validation, real-time expiry alerts, and inventory monitoring within a single platform. This approach not only improves inventory accuracy and operational efficiency but also enhances customer safety by ensuring that expired products are automatically detected and blocked during sales transactions.

III. SYSTEM ARCHITECTURE

The Smart Inventory System for Expiry Tracking and Sales Control is designed to automate inventory management and product expiry monitoring in retail shops. The system uses QR code technology, real-time expiry validation, inventory tracking, and alert mechanisms to ensure that expired products are not sold to customers. The architecture is divided into several functional modules that work together to manage product information, sales transactions, and expiry notifications efficiently.

A. User Authentication Module

The User Authentication Module is responsible for managing user registration and login activities. It ensures that only authorized shop owners can access the system. User credentials are securely stored and verified during login, providing data security and preventing unauthorized access to inventory and sales information. This module forms the foundation of the system's security framework.

B. Dashboard Module

The Dashboard Module serves as the central interface of the application. It provides an overview of inventory status, available stock, expired products, upcoming expiry alerts, and sales information. By displaying all important business information in a single location, the dashboard helps shop owners make informed decisions quickly and efficiently.

C. Purchase and Inventory Management Module

This module manages the entry and storage of products purchased from suppliers. The shop owner records product details such as product name, quantity, price, and expiry date. The inventory database is automatically updated whenever products are added or sold. This module helps maintain accurate stock records and ensures proper inventory control throughout the product lifecycle.

D. QR Code Tracking Module

The QR Code Tracking Module generates a unique QR code for every product item entered into the system. Each QR code contains essential product information and enables

quick identification during inventory checks and sales transactions. This feature improves product traceability and reduces manual errors associated with traditional inventory management methods. . This enables quick product recognition, minimizes manual errors, and simplifies inventory tracking throughout the product lifecycle.

E. Sales and Expiry Validation Module

The Sales and Expiry Validation Module manages the billing process. During sales, the QR code of each product is scanned, and the system automatically checks whether the product has expired. If the product is valid, the sale proceeds normally. If the product has expired, the system blocks the transaction and displays a warning message. This functionality prevents the sale of expired goods and protects customer health and safety.

F. Expiry Alert and Reporting Module

The Expiry Alert and Reporting Module continuously monitors product expiry dates and identifies products that are approaching expiration. It generates alerts and notifications to help shop owners take corrective actions such as stock clearance or promotional discounts. The module also generates reports related to inventory status, sales records, expired products, and upcoming expiries, supporting better business planning and decision-making.

IV. METHODOLOGY

The proposed Smart Inventory System for Expiry Tracking and Sales Control follows a systematic methodology to manage inventory, monitor product expiry dates, and prevent the sale of expired products. The methodology integrates QR code technology, automated expiry validation, inventory tracking, and real-time alert generation to improve retail operations. The complete workflow is divided into the following stages.

A. User Registration and Authentication

The methodology begins with user registration and login. Shop owners create an account and securely log in to the system using their credentials. Authentication mechanisms verify user information and provide authorized access to system resources. This ensures data security and prevents unauthorized users from accessing inventory and sales records. . During login, the system verifies user information and creates a secure session

B. Product Entry and Inventory Creation

After successful login, the shop owner enters product details including product name, category, batch number, purchase date, expiry date, quantity, and price. The system stores this information in the database and creates inventory records. Accurate product registration forms the basis for effective inventory monitoring and expiry management.

C. QR Code Generation and Product Identification

Once product information is entered, the system automatically generates a unique QR code for each product item or batch. The QR code acts as a digital identifier containing important product information. This enables quick product recognition, minimizes manual errors, and simplifies inventory tracking throughout the product lifecycle.

D. Inventory Monitoring and Expiry Analysis

The inventory database continuously monitors product stock levels and expiry dates. The system compares current dates with stored expiry dates to identify products that are approaching expiration. This automated analysis helps maintain accurate inventory records and ensures timely identification of products requiring attention.

E. Sales Processing and Expiry Validation

During sales transactions, products are scanned using their QR codes. The system retrieves product information and validates the expiry status before completing the transaction. If the product is within its valid usage period, the sale is processed successfully. If the product has expired, the system automatically blocks the transaction and displays an alert message, preventing the sale of unsafe products. The system retrieves product information and validates the expiry status before completing the transaction

F. Alert Generation and Report Management

The system generates real-time alerts for products nearing expiry and products with low stock levels. These notifications help shop owners take preventive actions such as stock replenishment, promotional sales, or product removal. In addition, the system generates detailed reports related to inventory status, sales transactions, expiry trends, and stock movement. These reports support effective decision-making and improve overall business performance. These reports assist in business analysis and decision-making. Experimental evaluation demonstrated that the system performs efficiently

in managing inventory records, validating sales transactions, generating alerts,

V. IMPLEMENTATION

The implementation of the Smart Inventory System for Expiry Tracking and Sales Control focuses on developing a web-based application that automates inventory monitoring, expiry validation, and sales management. The system is implemented using Java technologies with a structured database to manage product information, inventory records, sales transactions, and expiry alerts. The implementation process is divided into the following modules.

A. User Authentication Implementation

The authentication module is implemented using secure login and session management techniques. User credentials are stored in the database, and password encryption methods are used to ensure security. During login, the system verifies user information and creates a secure session for authorized access to system functionalities.

B. Product Management Implementation

The product management module allows shop owners to add, update, view, and manage product information. Details such as product name, category, quantity, purchase price, selling price, batch number, and expiry date are stored in the database. The system maintains accurate inventory records and updates stock information whenever products are added or sold.

C. QR Code Generation Implementation

A QR code generation mechanism is integrated into the system to create a unique identifier for every product or batch. The generated QR code contains product-related information and is stored along with product records. This implementation enables faster product identification, simplified inventory tracking, and efficient sales processing. QR code scanning reduced processing time and minimized human errors. The results confirmed that QR code technology enhances inventory accuracy, improves operational efficiency, and simplifies product management.

D. Inventory Monitoring Implementation

The inventory monitoring module continuously tracks product availability and stock levels. The system automatically updates inventory records after each purchase and sales transaction. It also identifies low-stock products and maintains real-time inventory information to support efficient stock management and replenishment planning.

E. Expiry Validation and Sales Processing Implementation

The sales module incorporates an automated expiry validation mechanism. During billing, the QR code of a product is scanned, and the system retrieves the corresponding product information. The expiry date is compared with the current date before completing the transaction. If the product is expired, the sale is blocked automatically; otherwise, the transaction proceeds successfully and inventory records are updated accordingly.

F. Alert and Reporting Implementation

The alert management module monitors expiry dates and generates notifications for products nearing expiration. These alerts help shop owners take corrective actions before products become unusable. Additionally, the reporting module generates detailed reports on inventory status, sales performance, stock movement, expired products, and expiry trends. These reports assist in business analysis and decision-making.

VI. EXPERIMENTAL EVALUATION

The experimental evaluation of the Smart Inventory System for Expiry Tracking and Sales Control was conducted to measure the system's effectiveness, reliability, accuracy, and overall performance in a retail environment. The evaluation focused on verifying whether the system could successfully manage inventory, detect expired products, generate alerts, process sales transactions, and maintain accurate records. Various test cases were executed under different operating conditions to ensure that all modules functioned correctly and met the intended objectives. The results demonstrated that the proposed system effectively reduces manual effort, minimizes product wastage, prevents the sale of expired products, and improves inventory management efficiency.

A. Functional Testing

Functional testing was performed to ensure that every feature of the system worked according to the specified requirements. The testing process included user registration, login authentication, product entry, QR code generation, inventory management, sales processing, expiry validation, and report generation. Each module was tested individually and then integrated with other modules to verify smooth interaction between system components. The results showed

that all functionalities operated successfully without major errors. Users were able to access the system, add products, generate QR codes, monitor inventory, process sales, and generate reports efficiently. This evaluation confirmed that the system meets all functional requirements and provides a reliable platform for inventory management.

B. Expiry Detection Evaluation

The expiry detection module was evaluated by entering products with different manufacturing and expiry dates into the database. The system continuously monitored these dates and compared them with the current date to determine product validity. During testing, products that had already expired were correctly identified and marked as expired, while products approaching their expiry dates were categorized as near-expiry products. Appropriate alerts were generated for both situations. The results demonstrated that the expiry detection mechanism accurately identifies product status and helps shop owners take preventive actions before products become unusable. This feature significantly reduces the risk of selling expired products and improves customer safety.

C. QR Code Performance Analysis

The QR code module was tested to evaluate its effectiveness in product identification and inventory tracking. Unique QR codes were generated for each product and scanned during inventory operations and sales transactions. The scanning process was performed multiple times under different conditions to verify accuracy and response time. The evaluation showed that QR codes enabled fast and error-free retrieval of product information from the database. Compared to manual product searches, QR code scanning reduced processing time and minimized human errors. The results confirmed that QR code technology enhances inventory accuracy, improves operational efficiency, and simplifies product management.

D. Sales Validation Testing

Sales validation testing was conducted to verify the system's ability to prevent the sale of expired products. During the evaluation, both valid and expired products were scanned at the billing stage. When valid products were scanned, the system successfully processed the transaction and updated inventory records automatically. However, when expired products were scanned, the system immediately displayed warning messages and blocked the transaction. This ensured that expired products could not be sold to customers. The evaluation demonstrated that the sales validation mechanism effectively integrates with the expiry detection module and provides an additional layer of protection for consumers while maintaining regulatory compliance.

E. Inventory Monitoring Evaluation

The inventory monitoring module was evaluated to determine its ability to maintain accurate stock records. Products were added, updated, and sold in different quantities to observe how the system handled stock changes. The system successfully updated inventory levels after every purchase and sales transaction. It accurately identified products with low stock levels and generated notifications whenever stock quantities fell below predefined thresholds. The evaluation also confirmed that inventory records remained consistent and synchronized with sales and purchase data. This functionality helps shop owners maintain optimal stock levels and avoid inventory shortages or overstocking situations.

F. Report and Alert Generation Analysis

The reporting and alert modules were evaluated by generating different types of reports and notifications based on inventory and sales data. The system produced detailed reports related to available stock, low-stock products, expired products, upcoming expiries, sales transactions, and inventory movement. These reports provided meaningful insights into business operations and supported informed decision-making. Additionally, real-time alerts were generated whenever products approached their expiry dates or inventory levels became critically low. The evaluation demonstrated that timely notifications and accurate reports improve inventory planning, reduce wastage, and enhance operational efficiency.

G. System Performance Evaluation

System performance was assessed by measuring response time, processing speed, and overall stability during normal operations. Multiple product records and transactions were processed to evaluate how efficiently the system handled data. The results showed that product retrieval, QR code scanning, inventory updates, and report generation were completed within a short period. The system remained stable even when handling large amounts of inventory data and multiple operations simultaneously. This evaluation confirmed that the application is capable of supporting real-world retail environments with consistent and reliable performance. because they simplified daily operations. The evaluation indicated that the user-friendly design contributes to increased productivity and improved inventory management practices

H. User Satisfaction Evaluation

User satisfaction testing was conducted by allowing users to interact with the system and perform routine inventory management tasks. Feedback was collected regarding usability, ease of navigation, functionality, and overall user experience. Most users reported that the system was easy to understand and use. Features such as QR code scanning, automated expiry alerts, and dashboard visualization were particularly appreciated because they simplified daily operations. The evaluation indicated that the user-friendly design contributes to increased productivity and improved inventory management practices. The Expiry Product Management and Alert System is developed to address these challenges by providing a smart digital solution for managing inventory with a focus on expiry tracking. The system enables shop owners to record product details during purchase,

VII. DISCUSSION

The Smart Inventory System for Expiry Tracking and Sales Control was developed to address the challenges associated with traditional inventory management practices, particularly the monitoring of product expiry dates and the prevention of expired product sales. The experimental evaluation demonstrated that the system effectively integrates inventory management, QR code technology, expiry monitoring, sales validation, and alert generation into a unified platform. The results indicate that the proposed system significantly improves inventory accuracy, reduces manual effort, and enhances overall operational efficiency in retail environments.

One of the major strengths of the system is its ability to automatically monitor product expiry dates and generate timely alerts for products nearing expiration. In conventional retail systems, expiry tracking is often performed manually, which increases the likelihood of human errors and overlooked products. By automating this process, the proposed system ensures that shop owners receive early notifications, enabling them to take corrective actions such as stock rotation, promotional sales, or product removal. This proactive approach contributes to reducing product wastage and minimizing financial losses.

The integration of QR code technology further enhances the effectiveness of the system. QR codes provide a unique identification mechanism for each product, enabling rapid retrieval of product information and simplifying inventory operations. The evaluation results showed that QR code scanning significantly reduces the time required for product identification and sales processing while minimizing data entry errors. This improves workflow efficiency and ensures accurate inventory tracking throughout the product lifecycle.

Another important aspect of the system is the automated sales validation mechanism. The ability to verify product expiry status before completing a sales transaction represents a significant improvement over traditional billing systems. During testing, the system successfully blocked the sale of expired products and generated appropriate warning messages. This functionality not only protects consumers from potentially harmful products but also helps retailers comply with safety regulations and quality standards.

The inventory monitoring and reporting modules also contributed positively to system performance. Accurate stock tracking, low-stock identification, and comprehensive reporting capabilities provide valuable insights into inventory movement and business operations. These features support informed decision-making and help retailers maintain optimal stock levels. The availability of real-time inventory information allows businesses to improve planning, reduce stock shortages, and enhance overall inventory utilization.

Despite its advantages, the current system has certain limitations. The effectiveness of the system depends on accurate product data entry and proper maintenance of inventory records. Any incorrect information entered into the system may affect the accuracy of expiry monitoring and reporting functions. Additionally, the current implementation primarily focuses on retail inventory management and may require further enhancements to support large-scale enterprise environments with multiple branches and distributed inventory systems.

Future improvements can further increase the system's capabilities. Integration with cloud computing technologies would allow remote access and centralized inventory management across multiple locations. Mobile application support could provide real-time monitoring and notifications through smartphones. Advanced technologies such as Artificial Intelligence (AI) and Machine Learning (ML) could be incorporated to predict product demand, identify expiry trends, and optimize inventory planning. Such enhancements would make the system more intelligent, scalable, and suitable for a wider range of business applications.

Overall, the discussion highlights that the Smart Inventory System for Expiry Tracking and Sales Control successfully achieves its objectives by providing an efficient, reliable, and automated solution for inventory management. The combination of QR code-based tracking, automated

expiry validation, inventory monitoring, and real-time alerts significantly improves retail operations while ensuring customer safety and reducing product wastage. The positive evaluation results demonstrate the practical applicability of the system and its potential to support modern inventory management practices in retail businesses. This proactive approach contributes to reducing product wastage and minimizing financial losses.

VIII. CONCLUSION AND FUTURE WORK

A. Conclusion

The Smart Inventory System for Expiry Tracking and Sales Control provides an effective and reliable solution for managing retail inventory while ensuring product safety and quality. The system successfully integrates inventory management, QR code technology, expiry monitoring, sales validation, and alert generation into a single platform. By automating the process of tracking product expiry dates, the system eliminates many of the challenges associated with traditional manual inventory management methods. The implementation of QR code-based product identification improves inventory accuracy, simplifies product tracking, and reduces human errors during inventory operations and sales transactions.The system continuously monitors product expiry dates and generates timely notifications for products approaching expiration. This feature enables shop owners to take preventive actions before products become unusable, thereby reducing product wastage and minimizing financial losses. Furthermore, the automated sales validation mechanism ensures that expired products cannot be sold to customers, improving consumer safety and supporting compliance with quality standards and regulatory requirements.

Experimental evaluation demonstrated that the system performs efficiently in managing inventory records, validating sales transactions, generating alerts, and producing detailed reports. The inventory monitoring module maintained accurate stock information, while the reporting module provided valuable insights into inventory movement, expiry status, and sales performance. The user-friendly interface and centralized dashboard further enhance usability and operational efficiency.

B. Future Work

The future development of the Smart Inventory System for Expiry Tracking and Sales Control aims to enhance its functionality, scalability, and intelligence by integrating advanced technologies. Features such as cloud-based inventory management will enable remote access and centralized data storage, while mobile application support will allow users to monitor inventory and receive alerts through smartphones. The incorporation of Artificial Intelligence and Machine Learning can help predict product demand, analyze sales patterns, and optimize inventory planning. Automated notifications through email, SMS, and mobile alerts will ensure timely awareness of expiry and low-stock situations. Additionally, support for multi-branch inventory management, advanced analytics, RFID technology, and IoT-based monitoring can further improve operational efficiency and inventory accuracy. These enhancements will transform the system into a more intelligent, automated, and user-friendly retail management platform, helping businesses reduce wastage, improve decision-making, increase profitability, and ensure better customer safety and satisfaction.

I. Automated Notification Services

Future versions can include automated email, SMS, and push notification services to instantly inform users about low-stock products, upcoming expiries, and important inventory events.

II. Multi-Branch Inventory Support

The system can be extended to support multiple retail branches with centralized inventory monitoring and synchronization. This would help large organizations manage inventory across different locations efficiently.

III. Advanced Analytics and Business Intelligence

Interactive dashboards and advanced analytical tools can be integrated to provide detailed insights into sales performance, inventory turnover, expiry trends, and customer purchasing behavior, supporting strategic decision-making.

IV. IoT-Based Smart Monitoring

Internet of Things (IoT) devices such as smart scanners and sensors can be integrated to automate inventory updates and monitor storage conditions for sensitive products, ensuring better product quality management

V. Barcode and RFID Integration

In addition to QR codes, the system can support barcode and RFID technologies for faster product identification, automated stock tracking, and improved warehouse management capabilities.

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