Web-Based Perishable Inventory Optimization for Waste and Financial Loss Reduction in Quick Commerce

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***Abstract*—Quick-commerce platforms, such as Blinkit, have changed the way customers purchase groceries, dairy products, bakery items, fresh food, and other daily-use products by providing fast delivery through local and dark stores. However, managing perishable products is a major challenge because these products have a limited shelf life and their demand can change from day to day. Existing stock prediction methods can predict the expected daily demand of products; however, the predicted quantity does not guarantee that the products will actually be sold. When actual sales are lower than expected, some products may remain unsold and can become near-expiry, resulting in product wastage and financial loss. Therefore, there is a need for a system that can identify unsold or near-expiry stock and provide suitable corrective actions.**

This study proposes a web-based support system for managing unsold and near-expiry perishable products in quick-commerce stores. The proposed system uses product quantity, sales history, expiry date, price, predicted demand, and actual end-of-day sales to identify products that remain unsold or are approaching expiry. After identifying such products, the system provides suitable recommendations based on the condition of the inventory. For example, products that are still within a safe selling period can continue under normal sales, while products that are closer to expiry can be offered with an appropriate discount to encourage customers to purchase them before expiry. The system can also recommend other corrective inventory actions when required, helping store operators make timely decisions instead of allowing products to remain unsold until they expire. The main purpose of the proposed system is to reduce the loss that occurs when the predicted product demand is not achieved and the stock remains unsold. By identifying unsold and near-expiry products at the end of the day and providing appropriate actions, such as discounting, the system aims to reduce product wastage and financial losses. It can also improve the utilization of available inventory and support better decision-making for quick-commerce store operators. The effectiveness of the proposed approach can be evaluated using historical or simulated inventory data based on measures such as unsold stock reduction, waste reduction, revenue, and stock utilization. This approach provides a practical support system for handling unsold and near-expiry perishable products in quick-commerce stores.

***Index Terms*—Quick Commerce, Perishable Products, Inventory Management, Dynamic Discounting, Stock Redistribution, Food Waste Reduction**

I. INTRODUCTION

Quick commerce has emerged as an important development in the e-commerce sector, enabling customers to purchase groceries, food items, and other frequently required products with very short delivery times. To support rapid order fulfilment, quick-commerce businesses generally maintain inventories through geographically distributed stores, dark stores, and local fulfilment centers. Although this model provides convenience and faster service to customers, it also creates challenges in managing products with limited shelf lives. Perishable products, such as fruits, vegetables, dairy products, bakery items, and other fresh goods, can quickly lose their value when they remain unsold. Therefore, effective inventory management is important for maintaining product availability while reducing wastage and financial losses.

The management of perishable inventory is more complex than that of non-perishable products because the value and usability of a product decrease as its

expiration date approaches. Quick-commerce businesses may use stock or demand prediction methods to estimate the quantity of products that may be sold in a day. However, a prediction does not guarantee that the predicted quantity will be sold. Changes in customer demand, product preferences, store-level conditions, and other factors can cause actual sales to be lower than predicted. As a result, some inventory may remain unsold at the end of the day and may later become near-expiry stock. If such products are not identified and handled in a timely manner, they can result in product wastage and financial loss.

Existing inventory management systems provide useful functions such as stock tracking, order management, and inventory updates. Demand prediction methods can also help businesses estimate expected product sales. However, predicting demand alone does not solve the problem of unsold or near-expiry inventory. A system is required to evaluate the actual end-of-day sales outcomes and identify products for which the anticipated quantities were not sold. Such products may require timely corrective actions depending on their remaining quantity and shelf life. This creates a research gap in developing a practical system that moves beyond demand prediction and provides appropriate actions for unsold or near-expiry products.

The main objective of this research is to design and implement a web-based support system that uses demand prediction and actual end-of-day sales information to assist in managing perishable inventory. The proposed system maintains product and inventory information, monitors sales and expiry dates, and identifies products that remain unsold or are approaching expiry. Based on the condition of the remaining stock, the system can recommend suitable actions, such as continuing normal sales, applying an appropriate expiry-based discount, or taking other corrective inventory actions. The purpose of these recommendations is to encourage the timely sale of products before they become waste.

The primary contribution of this research is a web-based decision-support approach that combines demand prediction with actual sales-based inventory monitoring and corrective action. Instead of relying only on predicted demand, the proposed system uses the actual end-of-day sales outcome to identify whether products remain unsold and require attention. By providing timely recommendations, such as discounting for suitable near-expiry products, the system aims to reduce unsold inventory, minimize product wastage and financial losses, and improve the utilization of perishable stock in quick-commerce operations. This approach provides a practical solution for handling the difference between expected product demand and actual sales, while supporting better inventory-related decisions.

II. LITERATURE REVIEW / RELATED WORK

Perishable inventory management has been widely studied because products with limited shelf lives require different inventory policies compared to non-perishable products. Bakker, Riezebos, and Teunter reviewed inventory systems involving deterioration and discussed factors such as shelf-life characteristics, demand behavior, price discounts, shortages, and multi-location inventory structures [3]. Karaesmen, Scheller-Wolf, and Deniz also examined perishable and ageing inventory and highlighted the importance of considering product ageing in supply-chain decisions [4]. These studies establish that inventory decisions for perishable products should consider not only the available quantity but also the remaining shelf life and demand conditions.

A. Perishable Inventory Management

Traditional inventory management systems generally focus on maintaining sufficient stock to satisfy expected demand. However, for perishable products, excess inventory can become a direct source of loss because the value of a product decreases as it approaches its expiry date. Therefore, maintaining an appropriate inventory level is more challenging for products with limited shelf lives. The remaining shelf life, inventory quantity, and demand conditions need to be considered when making inventory decisions.

Previous studies have developed mathematical models for deteriorating inventories and examined different combinations of demand patterns, replenishment policies, shortages, and pricing decisions [3], [4]. These approaches provide an important theoretical foundation for managing perishable inventories. However, the expected or predicted demand does not always represent the quantity that will be sold. When actual sales are lower than expected, some products may remain unsold and continue to approach their

expiration date. This creates a need for the timely identification of unsold inventory and appropriate corrective actions.

B. Dynamic Pricing of Perishable Products

Dynamic pricing refers to changing the selling price according to changing market or inventory conditions. Elmaghraby and Keskinocak presented a broad review of dynamic pricing in the presence of inventory considerations and described how demand information and pricing technologies can support pricing decisions [6]. For perishable products, dynamic pricing can be particularly useful when the remaining shelf life is short. Avramidis and den Boer studied dynamic pricing for perishable inventory under demand uncertainty and finite price choices [7]. Other research has examined data-driven pricing strategies for reducing food waste in retail environments [8]. These studies indicate that pricing can be used as an inventory-management mechanism rather than only as a marketing activity.

Research has also considered the relationship between dynamic pricing and reducing food waste. Sanders investigated the effect of dynamic pricing on grocery retail food waste using empirical data and reported that pricing decisions can influence both waste and retailer outcomes [10].

These findings support the use of discounting as a possible corrective action for products that remain unsold and are approaching expiration. In the proposed system, discounting is considered an action to encourage the timely sale of products and reduce the possibility of expiry-related waste.

C. Food Waste Reduction in Retail

Food waste in retail environments is influenced by several operational factors, including demand uncertainty, ordering decisions, inventory policies, sales performance, and product shelf life. Colombo de Moraes et al. reviewed the causes and reduction practices associated with retail food waste and emphasized the need for systematic approaches to waste reduction [11]. Huang et al. examined retailers' business practices for food-waste management and discussed the role of retailers in reducing waste throughout the supply chain [12].

A more recent review by Akkas et al. classified analytical and modelling approaches for food waste prevention in grocery store operations. The study identified areas such as assortment planning, replenishment, and dynamic pricing as important approaches for reducing food waste but also highlighted that these decisions are not always integrated [9].

These studies demonstrate that reducing food waste requires timely and appropriate inventory decisions. However, a predicted demand quantity alone cannot confirm whether the expected products have actually been sold. When actual end-of-day sales are lower than expected, the remaining stock must be identified and evaluated, particularly when its expiry date is approaching. This study addresses this situation by using actual sales information to identify unsold products and provide suitable corrective actions.

D. Inventory Redistribution

Discounting is not always the most appropriate solution when a product remains unsold or approaches its expiry date. If another store has sufficient demand for the same product, transferring the surplus inventory can provide better use of the available stock. Estrada-Moreno et al. studied the redistribution of perishable food inventories among supermarket locations and formulated the problem of transferring products from stores with excess stock to stores with unsatisfied demand [5].

The proposed system adopts this principle at a simplified level of operation. When unsold or surplus inventory is identified, the system can consider the inventory requirements or demand conditions of other stores. If suitable conditions are met, stock redistribution can be recommended as an alternative corrective action. Thus, the proposed system can support more than one possible action, depending on the inventory condition.

E. Technology-Supported Perishable Inventory Decisions

Technology has made it easier to collect and manage inventory, sales, pricing, and expiry information at frequent intervals. Research on RFID-supported perishable inventory management has explored the use of automatic product-age information together with dynamic pricing to improve inventory decisions [13]. Artificial-intelligence-based approaches have also been investigated for pricing fresh produce according to product quality and customer behavior [14].

The proposed project does not depend on specialized RFID or sensor hardware requirements. Instead, it uses a web-based architecture in which product, sales, price, expiry, predicted demand, and inventory information can be digitally maintained. The system uses this information to identify unsold or near-expiry products and provide suitable, action-oriented recommendations. This provides a comparatively simple and accessible approach for demonstrating decision support for perishable inventory management in quick commerce operations.

F. Research Gap

The reviewed studies show that perishable inventory management, demand prediction, dynamic pricing, and food waste reduction are important research areas. However, predicting daily product demand does not mean that the predicted quantity will be sold. This can leave some products unsold and cause them to become near-expiry.

The research gap addressed by this work can be summarized as follows:

1. Predicted demand may differ from actual sales.
2. Unsold products at the end of the day may not be identified.
3. Near-expiry products need timely actions, such as discounts.
4. A web-based system can help identify these products and suggest suitable actions to reduce waste and financial losses.

TABLE I. COMPARISON OF RELATED APPROACHES

Approach	Main Focus	Major Strength	Limitation	Relevant to This Work
Perishable inventory models	Inventory and product deterioration	Considers product ageing and shelf life	Often focuses mainly on mathematical inventory decisions	—
Dynamic pricing models	Price adjustment for perishable products	Helps improve the sale of products approaching expiry	May not consider actual end-of-day sales or other corrective actions	—
Food-waste studies	Reduction of food waste	Identifies major causes and methods of reducing waste	Different waste-reduction decisions may remain separate	—
Redistribution models	Store-to-store stock movement	Uses surplus stock to satisfy demand at another store	May not integrate expiry-based discounting	—
Demand prediction approaches	Daily product demand prediction	Helps estimate expected product sales	Predicted demand does not guarantee actual sales	—
AI pricing approaches	Demand/quality-based pricing	Supports data-driven pricing decisions	May require larger and more detailed datasets	—
Proposed system	Demand + actual sales + expiry + corrective actions	Identifies unsold/near-expiry products and recommends suitable actions through a web platform	Large-scale validation requires real operational data	✓

III. PROPOSED METHODOLOGY / SYSTEM DESIGN

A. System Overview

The proposed system is a web-based system designed to help quick-commerce stores manage perishable products. The main purpose of the system is to identify products that are not sold as expected and may become near-expiry and then suggest a suitable action to avoid wastage and financial loss.

The system stores basic product and inventory details, such as product name, store, available quantity, selling price, expiry date, sales history, predicted demand, and actual sales. The predicted demand shows how much of a product is expected to be sold during the day. At the end of the day, the system checks the actual

quantity sold and identifies products where some stock is still unsold.

After identifying unsold stock, the system checks its remaining quantity and expiry date. Based on these details, it provides a suitable recommendation to the store operator.

The main recommendations are:

1. Normal Sale – the product has sufficient shelf life and does not require immediate action.
2. Dynamic Discount: The product is unsold or sold less than expected and is close to expiry. A discount is suggested to encourage customers to purchase it.
3. Other corrective action: If the remaining stock requires another solution, the system can suggest a suitable action, such as stock redistribution.

B. System Architecture

The proposed architecture comprises four main layers:

TABLE II. SYSTEM ARCHITECTURE LAYERS

Layer	Technology	Function
User Interface Layer	HTML, CSS, JavaScript, Bootstrap, React.js	Provides dashboard and interactive interface
Application Layer	Java, Spring Boot	Handles user requests, processes inventory and sales data, and manages the application logic
Decision Layer	Java/Spring Boot, Demand Prediction, Sales and Expiry Rules	Compares predicted demand with actual end-of-day sales, identifies unsold or near-expiry products, and recommends actions such as discounts or other corrective actions
Database Layer	MySQL	Stores product, inventory, sales, expiry, pricing, and recommendation data

C. Product Monitoring

The system maintains important information about each product to monitor its stock, sales, and expiry status. The following details are maintained:

- Product ID
- Product name
- Category
- Store ID
- Available quantity
- Selling price
- Expiry date
- Sales history
- Predicted demand
- Actual quantity sold

The predicted demand represents the expected quantity of the product that may be sold during the day. At the end of the day, the system records the actual quantity sold and checks whether some stock is still remaining. The unsold quantity is calculated as follows:

Unsold Quantity = Available Quantity − Actual Quantity Sold

The system additionally verifies the number of days remaining until the product reaches its expiration date:

Remaining Shelf Life = Expiry Date − Current Date

Using the unsold quantity and remaining shelf life, the system identifies products that require attention. If a product remains unsold and is close to expiry, the system can recommend an appropriate action, such as applying a discount, to help sell the product before it expires.

D. Expiry Risk Classification

The system classifies products based on their remaining shelf life and sales conditions. This helps to identify which products need attention.

- Low Risk: The product has sufficient shelf life and is selling normally.
- Medium Risk: The product has a limited shelf life or its actual sales are lower than expected.
- High Risk: The product has very little shelf life remaining, and a significant quantity is still unsold.

The risk level can be adjusted based on product category, expiry period, and business requirements. This helps the system decide which products require corrective action first.

E. Sales and Demand Analysis

The system uses previous sales data to estimate the expected demand for a product. The projected demand provides an estimate of the quantity of the product that

may be sold throughout the day. However, the predicted quantity may not always be sold because actual customer demand can vary.
At the end of the day, the system records the actual quantity sold and compares it with the predicted demand. For example, if the predicted demand is 20 units but only 12 units are sold, the remaining stock is considered for further checking.

The difference between the available stock and actual sales can be calculated as follows:
Unsold Quantity = Available Quantity − Actual Quantity Sold
The system then checks the expiry date of the remaining stocks.
If the unsold quantity is high and the product is close to expiring, the system marks the product for corrective action, such as applying a discount. This helps stores take action on unsold products before they become waste.

F. Dynamic Discount Recommendation
When a product remains unsold at the end of the day and is getting close to its expiry date, the system can recommend a discount to help increase its chances of being sold before its expiry.

The discount recommendation is based on factors such as
Discount Level = f(Remaining Shelf Life, Unsold Quantity, Sales Condition)
Products with more remaining shelf life may receive a smaller discount, whereas products that are closer to expiry and have more unsold stock may receive a higher discount. The actual discount percentage can be set using predefined rules and can be adjusted according to the product category and business requirements.

G. Inter-Store Stock Redistribution
Discounting may not always be the best option for unsold stocks. If another store has a requirement for the same product, the available stock can be moved to that store before it reaches its expiry. For example:

Store A: 30 units available and low sales Store B: 5 units available and higher demand
If Store B requires additional stock and the product can be transferred before expiry, the system can recommend transferring a suitable quantity from Store A to Store B.
This helps to use the remaining stock more effectively and can reduce the need for discounting or product disposal.

H. Decision Algorithm
The proposed decision process is as follows:
1. Retrieve the product, predicted demand, inventory, sales, and expiry information.
2. The actual quantity sold at the end of the day is recorded.
3. Compare predicted demand with actual sales.
4. Identify the quantity of stock that remains unsold in the future.
5. Check the remaining shelf life of unsold stock.
6. If the product has a sufficient shelf life, normal sales will continue.
7. If the product is close to expiry, recommend a suitable discount to the customer.
8. If another store requires the product, stock redistribution should be considered.
9. The recommended action is stored.
10. The recommendation is displayed on the dashboard.

I. Pseudocode
FOR each product DO
Get the predicted demand, actual quantity sold, available stock, and expiry date. The remaining shelf life was calculated.
Calculate unsold quantity as: Available Stock − Actual Quantity Sold.

IF unsold quantity <= 0 THEN Recommendation = "Normal Sale"
ELSE IF remaining shelf life is sufficient THEN Recommendation = "Normal Sale"
ELSE IF another store has demand THEN Recommendation = "Stock Transfer"
ELSE

Recommendation = "Dynamic Discount" END IF
The recommendation is saved and displayed on the dashboard. END FOR

J. Database Design
The MySQL database can contain tables such as

TABLE III. PRODUCT TABLE

Field	Description
product_id	Unique product identifier
product_name	Name of product
category	Product category
price	Current selling price
expiry_date	Product expiry date

TABLE IV. INVENTORY TABLE

Field	Description
inventory_id	Inventory record ID
product_id	Related product
store_id	Store location
quantity	Available quantity
updated_at	Last update time

TABLE V. SALES TABLE

Field	Description
sale_id	Sales record ID
product_id	Product sold
store_id	Selling store
quantity_sold	Units sold
sale_date	Date of sale

IV. IMPLEMENTATION

A. Technology Stack

The proposed web application uses multiple technologies for the different system components.

Frontend:
HTML5: Used to define the structure and content of web pages.
CSS3: Used for layout, styling, spacing, typography, and visual presentations.
JavaScript: Used to implement client-side interaction, calculations, button operations, and dynamic dashboard behavior.
Bootstrap: Used to create responsive interface components and maintain usability across different screen sizes.
React.js: Used for developing reusable and dynamic user interface components.

Backend:
Java: Used for application logic, data processing, and decision-making.
Spring Boot: Used to develop backend services, handle requests, process inventory and sales data, and implement system rules.

Database:
MySQL: Used to store product, store, inventory, sales, expiry, predicted demand, and actual sales information.

Development Tools:
VS Code/Eclipse or Spring Tool Suite: Used for application development and testing. Git/GitHub: Used for source code management and version control.

B. Major System Modules

1. Authentication Module: Provides controlled access to the system and management dashboards.
2. Product Management Module: This module allows users to add, update, view, and manage product information.
3. Inventory Management Module: Displays available stock and store-wise inventory information.
4. Expiry Monitoring Module: Tracks expiry dates and identifies products that are approaching expiration.
5. Sales Analysis Module: Records actual end-of-day sales and compares them with the predicted demand to identify unsold stock.
6. Dynamic Discount Module: Suggests suitable discounts for unsold products that are close to expiry.
7. Stock Redistribution Module: Identifies surplus stock and checks whether another store requires the same product.
8. Decision Support Module: Uses inventory, sales, demand, and expiry information to suggest appropriate actions.
9. Dashboard Module: Displays the inventory status, unsold products, near-expiry products, and recommended actions in one place.

V. RESULTS AND DISCUSSION

The proposed system can be evaluated using historical or simulated inventory and sales data. The main purpose of the evaluation is to check whether the system can identify unsold or near-expiry products and provide a suitable action before the products become

waste. The evaluation can also show whether the recommended actions help improve the use of available inventory. The major evaluation measures are:

A. Waste Reduction

This measures the extent to which the amount of products reaching expiry without being sold is reduced.

Waste Reduction (%) = ((Baseline Waste − Proposed Waste) / Baseline Waste) × 100

B. Revenue Recovery

This measures the revenue received from products that might otherwise remain unsold or expired.

Recovered Revenue = Revenue from Discounted Sales + Revenue from Other Utilized Stock

C. Stock Utilization

This measures the amount of available stock successfully sold or otherwise used.

Stock Utilization (%) = (Units Sold or Utilized / Units Available) × 100

D. Unsold Stock

This measures the quantity of products that remain unsold at the end of the day.

Unsold Quantity = Available Quantity − Actual Quantity Sold

This measure is important for the proposed research because actual end-of-day sales data are used to identify products that remain unsold.

E. Recommendation Performance

The recommendations can be evaluated by checking whether the system provides a suitable action for the condition of each product. The test data can contain predefined expected actions, and the system's recommendations can be compared with them. This can help evaluate whether the system correctly identifies products that require normal sales, discounting, or other corrective actions.

VI. CONCLUSION AND FUTURE SCOPE

This study presents a web-based support system for managing unsold and near-expiry perishable products in quick-commerce stores. The system uses React.js, Java Spring Boot, and MySQL to provide a full-stack solution for managing product and inventory information. It considers predicted demand, actual end-of-day sales, available stock, and expiry dates when identifying products that require attention.

The main issue addressed by this research is that predicted demand does not always match actual sales. A product may be expected to sell a certain quantity; however, actual sales may be lower, leaving some stock unsold. If this stock is not handled in time, it may become near-expiry and eventually result in product waste and financial loss. The proposed system helps identify this situation and provides a suitable action based on the condition of the remaining stock.

The system can recommend normal sales when no immediate action is required and can suggest discounts for suitable near-expiry products. Stock redistribution can also be considered when another store requires the same product. These recommendations provide store operators with a simple way to decide what should be done with unsold stock instead of allowing it to remain until expiry.

The current system is based mainly on predefined rules and data available in the system. Therefore, its performance can be affected by incorrect or incomplete sales and inventory information. More testing with actual quick commerce data is required to understand how well the system performs in different stores and product categories. In the future, machine learning can be used to improve demand prediction using larger amounts of historical sales data. Discount recommendations can also be improved so that the system can suggest a suitable discount based on the remaining shelf life, unsold quantity, and sales pattern. Real-time inventory updates, automatic notifications, and a mobile application can also be added to make the system more useful for store managers.

Overall, the proposed system provides a simple and practical way to handle products that remain unsold after the expected demand is not met. By identifying such products and suggesting actions such as discounts or redistribution, the system can help reduce product waste and financial losses in quick-commerce stores.

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