# SMART EXPIRY TRACKER

*A Report*

*Submitted in partial fulfilment of the Requirements for the completion of*

*COURSE BASED PROJECT*

**BACHELOR OF ENGINEERING**
IN
**INFORMATION TECHNOLOGY**

By

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# ABSTRACT

Smart Expiry Tracker is a C-based supermarket inventory management system designed to efficiently track perishable products and reduce wastage. The system stores product details using a linked list for dynamic inventory handling, employs a hash table for fast searching by Product ID, uses a binary search tree to sort items based on expiry date, and utilizes a min-heap to identify top expiring products and generate dynamic discount recommendations. It supports adding and deleting items, moving expired products to a separate list, checking stock levels, managing donations, exporting data to JSON, and maintaining a detailed activity log. This combination of data structures provides supermarkets with an automated, accurate, and scalable solution for monitoring expiry dates, maintaining stock quality, and improving overall inventory efficiency.

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# 1. INTRODUCTION

## 1.1 OVERVIEW

Smart Expiry Tracker is a supermarket-oriented inventory management application developed using the C programming language and fundamental data structures. The system helps supermarket staff record product details, monitor expiry dates, and take timely actions to prevent losses. By assigning each product a unique Product ID, the tracker allows efficient addition, deletion, expiry checking, restock alerting, discount planning, donation tracking, JSON export, and activity logging

## 1.2 OBJECTIVES

To build an automated expiry management system for supermarket inventory.

- To store and update products efficiently using linked lists.
- To enable fast Product ID–based search using a hash table.
- To generate expiry-sorted data using a binary search tree.
- To identify soon-expiring products through a min-heap.
- To support donation management, restock alerts, JSON export, and activity tracking.

## 1.3 PROBLEM STATEMENT

Supermarkets deal with a large volume of perishable goods, making manual expiry tracking difficult and prone to errors. Expired products cause revenue loss and customer dissatisfaction. Smart Expiry Tracker solves this problem by combining appropriate data structures to automate expiry monitoring, minimize waste, and optimize inventory clearance.

# 2. ALGORITHMS

## 2.1 Linked List – Inventory, Expired List & Donation List

Purpose: Dynamic storage of products where frequent insertions and deletions occur.

Algorithm (Insertion):

1. Create a new node with product fields.
2. Insert at the beginning of the linked list.
3. Update activity log.

## 2.2 Hash Table – Fast Search by Product ID

Purpose: O(1) average-time search for display, deletion, and donation.

Algorithm:

1. Compute index = ProductID % table_size.
2. Insert or search within that bucket.
3. Return node pointer for fast access.

## 2.3 Binary Search Tree – Expiry Sorting

Purpose: Automatically maintain products sorted by expiry date.

Algorithm (BST Insert):

1. Compare expiry date of new product with current node.
2. If earlier, go left; if later, go right.
3. Insert at required position.

## 2.4 Min-Heap – Top Expiring Products & Discounts

Purpose: Identify items closest to expiry.

Algorithm (Heap Insert):

1. Insert expiry value at end of heap.
2. Bubble up until min-heap property is satisfied.

Algorithm (Get Top 10 Expiring):

1. Extract root repeatedly for 10 items.
2. Display items and recommend discounts.

## 2.5 Additional Algorithms

- Date comparison: Convert dd-mm-yyyy to YYYYMMDD for accurate comparisons.
- Restock check: If quantity ≤ threshold, mark for restock.
- JSON export: Traverse linked list and write formatted data to file.
- Activity log append: Record every add/delete/donate/export action.

# 3. EXPERIMENTAL SETUP & IMPLEMENTATION

## 3.1 System Specifications

### 3.1.1 Hardware Requirements

- Laptop/PC with minimum 4 GB RAM
- Intel/AMD processor
- Terminal/console interface

### 3.1.2 Software Requirements

- Operating System: Windows
- Compiler: GCC
- Programming Language: C
- Data Structures: Linked List, Hash Table, BST, Min-Heap
- File Handling for JSON export and logs

### 3.2 Implementation Steps

Step 1: Adding a Product

Read Product ID, name, category, quantity, expiry date. Insert node in linked list. Insert reference in hash table. Insert expiry in BST and min-heap. Log action.

Step 2: Deleting a Product

Search with hash table (O(1)). Remove from linked list, BST, and heap. Log deletion.

Step 3: Moving Expired Items

Compare expiry date with current date. Move expired items to Expired List. Log each move.

Step 4: Restock Alerts

Traverse inventory. If quantity < threshold → print restock alert.

Step 5: Dynamic Discount Recommendations

Extract top expiring items from min-heap. Apply discounts based on days left.

Step 6: Donation Feature

Search item using hash table. Move to donation list and donation history. Log donation.

Step 7: Export to JSON

Traverse linked list. Write product details to JSON file. Confirm successful export.

Step 8: Activity Log

Maintain log entries for all operations. Display log on request.

# 4. PROPOSED SOLUTION

## 4.1 Pseudocode

```
STRUCT Product:
    id, name, category
    quantity
    expiry_date
    next

LinkedList inventory, expiredList, donationList
HashTable table
BST expiryTree
MinHeap expiryHeap
LogList logList

FUNCTION addItem():
    read details
    create node
    insertLinkedList(inventory, node)
    hashInsert(table, id, node)
    bstInsert(expiryTree, node)
    heapInsert(expiryHeap, node)
    log("Added item")

FUNCTION deleteItem(id):
    node = hashSearch(table, id)
    deleteLinkedList(inventory, node)
    hashDelete(table, id)
    bstDelete(expiryTree, node)
    heapMarkDeleted(node)
    log("Deleted item")

FUNCTION moveExpired():
    today = getToday()
    for each node in inventory:
```

```
        if node.expiry < today:
            deleteItem(node.id)
            insertLinkedList(expiredList, node)
            log("Expired item moved")

FUNCTION donate(id):
    node = hashSearch(table, id)
    deleteItem(id)
    insertLinkedList(donationList, node)
    log("Donated item")

FUNCTION generateTopExpiring():
    for i = 1 to 10:
        item = heapExtractMin(expiryHeap)
        print(item)

FUNCTION restockCheck():
    for each node in inventory:
        if node.quantity <= threshold:
            print("Restock Alert:", node.name)

FUNCTION exportJSON():
    traverse inventory:
        write JSON format
    log("Exported inventory")
```

## 4.2 Screenshots

```
Starting Smart Expiry Tracker ...
Loaded inventory from disk.

=== Smart Expiry Tracker Menu ===
1. View Inventory
2. Add Item by Scan/Product DB
3. Delete Item
4. Move expired items to Expired List
5. View Expired List
6. Restock Check
7. Dynamic Discount Recommendations
8. Top Expiring Items (Heap)
9. Export Inventory to JSON
10. View Activity Log
11. Generate Full Report
12. Save & Exit
13. Donate an Item
14. View Donation History
0. Exit without Saving
Enter choice:
```

```
Enter choice: 1
--------------------------------------------------------------------------------
ID      NAME            CATEGORY     QTY    EXPIRY       PRICE    SUPPLIER
--------------------------------------------------------------------------------
101     Milk            Dairy        10     2025-11-20   45.50    DairyFarm
102     Bread           Bakery       10     2025-11-25   25.00    BakeryHouse
103     Cheese          Dairy        10     2026-01-15   120.00   CheeseCo
104     Eggs            Poultry      10     2025-12-05   60.00    EggFarm
106     Butter          Dairy        10     2025-12-10   80.00    DairyFarm
107     Chocolate       Snacks       10     2026-01-20   50.00    SweetCo
108     Apple           Fruits       10     2025-11-28   10.00    FruitFarm
109     Orange Juice    Beverages    10     2025-12-15   60.00    JuiceCo
110     Cereal          Grains       10     2026-02-10   120.00   CerealCo
111     Tomato          Vegetables   10     2025-11-22   5.00     VegFarm
112     Potato          Vegetables   10     2025-12-05   2.50     VegFarm
113     Carrot          Vegetables   10     2025-12-01   4.00     VegFarm
114     Paneer          Dairy        10     2025-12-12   90.00    DairyFarm
115     Chicken         Meat         10     2025-11-20   200.00   MeatCo
116     Fish            Seafood      10     2025-11-21   250.00   SeafoodCo
117     Rice            Grains       10     2026-03-10   50.00    GrainFarm
118     Pasta           Grains       10     2026-01-30   60.00    PastaCo
119     Snacks          Snacks       10     2025-12-25   40.00    SnackCo
120     Juice Box       Beverages    10     2025-11-27   20.00    JuiceCo
```

```
Enter choice: 2
Enter Product ID (barcode): 121
Enter Product Name: Maggie
Enter Expiry (YYYY-MM-DD): 2026-01-10
Enter Price: 30
Enter Supplier: Nestle
Enter Category: Packed Food
Enter Quantity: 20
Item added: Maggie  [Expiry: 2026-01-10]
```

```
=== Smart Expiry Tracker Menu ===
1. View Inventory
2. Add Item by Scan/Product DB
3. Delete Item
4. Move expired items to Expired List
5. View Expired List
6. Restock Check
7. Dynamic Discount Recommendations
8. Top Expiring Items (Heap)
9. Export Inventory to JSON
10. View Activity Log
11. Generate Full Report
12. Save & Exit
13. Donate an Item
14. View Donation History
0. Exit without Saving
Enter choice: 3
Enter Item ID to delete: 121
Item deleted successfully: Maggie
```

```
=== Smart Expiry Tracker Menu ===
1. View Inventory
2. Add Item by Scan/Product DB
3. Delete Item
4. Move expired items to Expired List
5. View Expired List
6. Restock Check
7. Dynamic Discount Recommendations
8. Top Expiring Items (Heap)
9. Export Inventory to JSON
10. View Activity Log
11. Generate Full Report
12. Save & Exit
13. Donate an Item
14. View Donation History
0. Exit without Saving
Enter choice: 4
Product moved to expired list: Milk
Product moved to expired list: Bread
Product moved to expired list: Tomato
Product moved to expired list: Chicken
Product moved to expired list: Fish

Expired Item Tally: 5 items moved.
```

```
Enter choice: 6
Enter restock threshold: 23

=== Restock Alerts (Threshold: 23) ===
Restock alert: Cheese (ID: 103) quantity is 10. Contact supplier: CheeseCo
Restock alert: Eggs (ID: 104) quantity is 10. Contact supplier: EggFarm
Restock alert: Butter (ID: 106) quantity is 10. Contact supplier: DairyFarm
Restock alert: Chocolate (ID: 107) quantity is 10. Contact supplier: SweetCo
Restock alert: Apple (ID: 108) quantity is 10. Contact supplier: FruitFarm
Restock alert: Orange Juice (ID: 109) quantity is 10. Contact supplier: JuiceCo
Restock alert: Cereal (ID: 110) quantity is 10. Contact supplier: CerealCo
Restock alert: Potato (ID: 112) quantity is 10. Contact supplier: VegFarm
Restock alert: Carrot (ID: 113) quantity is 10. Contact supplier: VegFarm
Restock alert: Paneer (ID: 114) quantity is 10. Contact supplier: DairyFarm
Restock alert: Rice (ID: 117) quantity is 10. Contact supplier: GrainFarm
Restock alert: Pasta (ID: 118) quantity is 10. Contact supplier: PastaCo
Restock alert: Snacks (ID: 119) quantity is 10. Contact supplier: SnackCo
Restock alert: Juice Box (ID: 120) quantity is 10. Contact supplier: JuiceCo
```

```
Enter choice: 8

=== Top 10 Items Expiring Soonest ===
ID      NAME            CATEGORY     QTY    EXPIRY       DAYS LEFT
------------------------------------------------------------------
120     Juice Box       Beverages    10     2025-11-27   0
113     Carrot          Vegetables   10     2025-12-01   4
108     Apple           Fruits       10     2025-11-28   1
104     Eggs            Poultry      10     2025-12-05   8
114     Paneer          Dairy        10     2025-12-12   15
109     Orange Juice    Beverages    10     2025-12-15   18
106     Butter          Dairy        10     2025-12-10   13
107     Chocolate       Snacks       10     2026-01-20   54
112     Potato          Vegetables   10     2025-12-05   8
103     Cheese          Dairy        10     2026-01-15   49
```

```
=== Recent Activity Log ===
[2025-11-19 17:42:35] ADD | Item ID: 131 | Coffee
[2025-11-19 17:42:41] EXPIRED | Item ID: 131 | Coffee
[2025-11-19 17:42:41] EXPIRED | Item ID: 105 | Yogurt
[2025-11-19 17:54:08] ADD | Item ID: 121 | Maggie
[2025-11-19 18:03:18] DONATE | Item ID: 101 | Milk
[2025-11-19 18:16:25] DONATE | Item ID: 101 | Milk
[2025-11-19 18:28:01] AUTO_DONATE | Item ID: 101 | Milk
[2025-11-19 18:28:01] AUTO_DONATE | Item ID: 111 | Tomato
[2025-11-19 18:28:02] AUTO_DONATE | Item ID: 115 | Chicken
[2025-11-19 18:28:02] AUTO_DONATE | Item ID: 116 | Fish
[2025-11-19 18:32:11] AUTO_DONATE | Item ID: 101 | Milk
[2025-11-19 18:32:11] AUTO_DONATE | Item ID: 111 | Tomato
[2025-11-19 18:32:11] AUTO_DONATE | Item ID: 115 | Chicken
[2025-11-19 18:32:11] AUTO_DONATE | Item ID: 116 | Fish
[2025-11-19 18:48:39] AUTO_DONATE | Item ID: 101 | Milk
[2025-11-19 18:48:40] AUTO_DONATE | Item ID: 111 | Tomato
[2025-11-19 18:48:40] AUTO_DONATE | Item ID: 115 | Chicken
[2025-11-19 18:48:40] AUTO_DONATE | Item ID: 116 | Fish
[2025-11-19 18:49:16] ADD | Item ID: 121 | Maggie
[2025-11-27 16:24:11] ADD | Item ID: 121 | Maggie
```

```
Enter choice: 11
Generating full report...

==================================
      FULL INVENTORY REPORT
==================================

Inventory Summary:
  Total Items: 14
  Total Value: ₹7665.00
  Expired: 0
  Expiring in 7 days: 3
  Expiring in 30 days: 6

Top 5 soonest-to-expire items (preview):

=== Top 5 Items Expiring Soonest ===
ID      NAME            CATEGORY     QTY    EXPIRY       DAYS LEFT
------------------------------------------------------------------
120     Juice Box       Beverages    10     2025-11-27   0
113     Carrot          Vegetables   10     2025-12-01   4
108     Apple           Fruits       10     2025-11-28   1
104     Eggs            Poultry      10     2025-12-05   8
114     Paneer          Dairy        10     2025-12-12   15

=== Expired Category Analysis (This Month) ===
Most expired category: 'Seafood' [1 items]
==================================
```

```
==== Donation History ====

Item: Fish (ID: 116)
Donor: AUTO_DONATION
Contact: SYSTEM
Quantity: 10
Date: 2025-11-19

Item: Chicken (ID: 115)
Donor: AUTO_DONATION
Contact: SYSTEM
Quantity: 10
Date: 2025-11-19

Item: Tomato (ID: 111)
Donor: AUTO_DONATION
Contact: SYSTEM
Quantity: 10
Date: 2025-11-19

Item: Milk (ID: 101)
Donor: AUTO_DONATION
Contact: SYSTEM
Quantity: 10
Date: 2025-11-19
```

# 5. FUTURE SCOPE

- Integration with actual barcode scanners.
- Real-time expiry alerts on staff mobile devices.
- Dashboard for store managers with analytics and graphs.
- Integration with billing system for automatic discount updates.
- Cloud-based inventory system for multi-branch supermarkets.
- AI-based expiry prediction and smart restocking.

# 6. LEARNING NEW THINGS

- Applied multiple data structures together in a practical supermarket system.
- Learned how Linked Lists support dynamic inventory management.
- Implemented Hash Tables for instant product search.
- Understood BST-based natural sorting by expiry date.
- Used Min-Heap to prioritize soon-expiring items.
- Practiced file handling for JSON export and logs.
- Strengthened problem-solving and modular C programming skills.