Exploratory Data Analysis (EDA) for Inventory Optimization at Mint Classics

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2025-01-26

Introduction

This report presents an exploratory data analysis (EDA) conducted to support inventory optimization and the potential closure of a storage facility at Mint Classics. The goal of this analysis is to identify patterns and themes in inventory and sales data that can inform strategic business decisions, ultimately leading to cost savings and improved operational efficiency. The findings and recommendations in this report are based on data from the Mint Classics database, including product, warehouse, and sales information.

Data Sources

The analysis is based on the following tables from the Mint Classics database:

- **products**: Contains product details, including `productCode`, `productName`, `quantityInStock`, and `warehouseCode`.
- **warehouses**: Contains warehouse details, including `warehouseCode`, `warehouseName`, and `warehousePctCap`.
- **orderdetails**: Contains sales data, including `productCode`, `quantityOrdered`, and `priceEach`.

Analysis

Analysis Techniques

The following techniques were used to explore the data and draw insights:

- **Descriptive Statistics**: Summarized warehouse capacity, inventory levels, and revenue to understand the current state of inventory management.
- **Trend Analysis**: Examined seasonality and sales trends to identify patterns in demand.
- **Inventory Turnover Ratio**: Calculated the ratio of sales to inventory to identify slow-moving and fast-moving products.
- **Visualizations**: Created plots to communicate findings effectively.

These techniques were chosen because they provide a clear understanding of inventory performance and help identify actionable insights for optimization.

1. Warehouse Capacity and Inventory

The first step in the analysis was to evaluate the capacity and inventory levels of each warehouse to determine if any facility could be eliminated. The following metrics were used: - **warehousePctCap**: The percentage of warehouse capacity currently utilized. - **estimated_total_capacity**: The total capacity of the warehouse based on current utilization. - **pct_space_available**: The percentage of available space in the warehouse.

```
-- Warehouse Capacity and inventory levels
SELECT
    w.warehouseCode,
```

```
    w.warehouseName,
    w.warehousePctCap,
    COUNT(DISTINCT p.productCode) AS num_product,
    SUM(p.quantityInStock) AS total_inventory,
    ROUND(SUM(p.quantityInStock) / (w.warehousePctCap / 100), 0) AS estimated_total_capacity,
    (100 - w.warehousePctCap) AS pct_space_available
FROM mintclassics.products p
JOIN mintclassics.warehouses w ON p.warehouseCode = w.warehouseCode
GROUP BY w.warehouseCode, w.warehouseName, w.warehousePctCap
ORDER BY estimated_total_capacity;
```

Table 1: 4 records

warehouseCode	warehouseName	warehousePctCap	num_product	total_inventory	estimated_total_capacity	pct_space_available
d	South	75	23	79380	105840	25
a	North	72	25	131688	182900	28
c	West	50	24	124880	249760	50
b	East	67	38	219183	327139	33

```
-- warehouse with the least demanded product lines
SELECT
    p.warehouseCode,
    w.warehouseName,
    p.productLine AS product_line,
    SUM(p.quantityInStock) AS line_quantity
FROM mintclassics.products AS p
JOIN mintclassics.warehouses AS w
ON p.warehouseCode = w.warehouseCode
GROUP BY 1,2,3
ORDER BY SUM(quantityInStock);
```

Table 2: 7 records

warehouseCode	warehouseName	product_line	line_quantity
d	South	Trains	16696
d	South	Ships	26833
d	South	Trucks and Buses	35851
a	North	Planes	62287
a	North	Motorcycles	69401
c	West	Vintage Cars	124880
b	East	Classic Cars	219183

Key Findings: Warehouse South has the lowest total inventory (79,380 units) and the least demanded product lines (Trains, Ships, Trucks and Buses).

Warehouses North, East, and West have sufficient space to accommodate the redistribution of Warehouse South's inventory.

2. Revenue by Product Lines

To assess the financial impact of closing Warehouse South, the revenue contribution of each product line was analyzed. This helps identify which product lines are most profitable and which are under performing.

```
-- Revenue by Product Lines
SELECT
    p.productLine,
    SUM(od.quantityOrdered * od.priceEach) AS total_revenue
FROM mintclassics.products p
JOIN mintclassics.orderdetails od ON p.productCode = od.productCode
GROUP BY 1
ORDER BY total_revenue DESC;
```

Table 3: 7 records

productLine	total_revenue
Classic Cars	3853922.5
Vintage Cars	1797559.6
Motorcycles	1121426.1
Trucks and Buses	1024113.6
Planes	954637.5
Ships	663998.3
Trains	188532.9

Key Findings: The product lines stored in Warehouse South (Trains, Ships, Trucks, and Buses) are among the least profitable, contributing minimally to overall revenue.

3. Seasonality by Product Line

Understanding seasonal demand trends is critical for inventory management. The following analysis examines the monthly sales trends for product lines stored in Warehouse South.

```
-- Seasonality by warehouse South Product Line
SELECT
    p.productLine,
    MONTH(o.orderDate) AS order_month,
    SUM(od.quantityOrdered) AS total_units_sold
FROM mintclassics.orders o
JOIN mintclassics.orderdetails od ON o.orderNumber = od.orderNumber
JOIN mintclassics.products p ON od.productCode = p.productCode
WHERE p.productLine IN ('Trains', 'Ships', 'Trucks and Buses')
GROUP BY p.productLine, order_month
ORDER BY p.productLine, order_month;
```

Table 4: Displaying records 1 - 10

productLine	order_month	total_units_sold
Ships	1	652
Ships	2	722
Ships	3	866
Ships	4	399
Ships	5	641
Ships	6	646
Ships	7	267
Ships	8	629
Ships	9	520

3

productLine	order_month	total_units_sold
Ships	10	957

Visualization: Seasonality Plot

- Key Findings:

The product lines in Warehouse South exhibit clear seasonal trends, with certain months showing significantly higher sales. This information can be used to time the closure of Warehouse South during a low-demand period, minimizing disruption.

4. Inventory vs. Sales Analysis

To identify inventory imbalances, the analysis compared inventory levels with sales figures. This helps determine which products are overstocked or understocked.

```sql
-- Inventory Vs Sales analysis - Top Surplus
SELECT
    w.warehouseCode,
    p.productName,
    p.quantityInStock,
    SUM(od.quantityOrdered) AS total_units_sold,
    (p.quantityInStock - SUM(od.quantityOrdered)) AS inventory_surplus_deficit
FROM mintclassics.products AS p
JOIN mintclassics.orderdetails AS od
ON p.productCode = od.productCode
JOIN mintclassics.warehouses AS w
ON p.warehouseCode = w.warehouseCode
GROUP BY 1,2,3
ORDER BY inventory_surplus_deficit DESC;
```

Table 5: Displaying records 1 - 10

warehouseCode	productName	quantityInStock	total_units_sold	inventory_surplus_deficit
a	2002 Suzuki XREO	9997	1028	8969
b	1995 Honda Civic	9772	917	8855
a	America West Airlines B757-200	9653	984	8669
b	2002 Chevy Corvette	9446	894	8552
c	1932 Model A Ford J-Coupe	9354	957	8397
a	1982 Ducati 996 R	9241	906	8335
b	1976 Ford Gran Torino	9127	915	8212
b	1968 Dodge Charger	9123	925	8198
c	1912 Ford Model T Delivery Wagon	9173	991	8182
b	1965 Aston Martin DB5	9042	914	8128

```sql
-- Inventory Vs Sales analysis - Top Deficit
SELECT
    w.warehouseCode,
    p.productName,
    p.quantityInStock,
    SUM(od.quantityOrdered) AS total_units_sold,
```

```
    (p.quantityInStock - SUM(od.quantityOrdered)) AS inventory_surplus_deficit
FROM mintclassics.products AS p
JOIN mintclassics.orderdetails AS od
ON p.productCode = od.productCode
JOIN mintclassics.warehouses AS w
ON p.warehouseCode = w.warehouseCode
GROUP BY 1,2,3
ORDER BY inventory_surplus_deficit;
```

Table 6: Displaying records 1 - 10

warehouseCode	productName	quantityInStock	total_units_sold	inventory_surplus_deficit
a	1960 BSA Gold Star DBD34	15	1015	-1000
b	1968 Ford Mustang	68	933	-865
a	1997 BMW F650 ST	178	1014	-836
c	1928 Ford Phaeton Deluxe	136	972	-836
d	Pont Yacht	414	958	-544
a	F/A 18 Hornet 1/72	551	1047	-496
a	2002 Yamaha YZR M1	600	992	-392
c	1928 Mercedes-Benz SSK	548	880	-332
c	1911 Ford Town Car	540	832	-292
d	1996 Peterbilt 379 Stake Bed with Outrigger	814	988	-174

Key Findings:

- Overstocked Products: Several products have a significant surplus (e.g., over 2,000 units), indicating excess inventory that could be reduced.

- Understocked Products: Some products have a deficit, suggesting a need to increase stock levels to meet demand.

5. Revenue Analysis by Product

To identify the most and least profitable products, the revenue generated by each product was calculated. This analysis helps prioritize high-performing products and identify underperforming ones that may need to be discontinued or promoted.

Top 10 Revenue-Generating Products   The following query identifies the top 10 products by revenue:

```
-- revenue per item top 10
SELECT
    p.productName,
    p.quantityInStock,
    od.priceEach,
    SUM(od.quantityOrdered * od.priceEach) AS total_revenue
FROM mintclassics.products AS p
JOIN mintclassics.orderdetails AS od
ON p.productCode = od.productCode
GROUP BY p.productName, p.quantityInStock, od.priceEach
ORDER BY total_revenue DESC;
```

productName	quantityInStock	priceEach	total_revenue
1917 Grand Touring Sedan	2724	153.00	29835.00
1968 Ford Mustang	68	184.84	29389.56
1969 Corvair Monza	6906	145.04	29008.00
2001 Ferrari Enzo	3619	176.63	27907.54
1952 Alpine Renault 1300	7305	205.73	26744.90
2001 Ferrari Enzo	3619	193.25	25122.50
1969 Ford Falcon	1049	169.56	24755.76
1992 Ferrari 360 Spider red	8347	137.17	24004.75
1957 Corvette Convertible	1249	120.53	23864.94
ATA: B757-300	7106	98.48	23339.76

```sql
-- revenue per item bottom 10
SELECT
    p.productName,
    p.quantityInStock,
    od.priceEach,
    SUM(od.quantityOrdered * od.priceEach) AS total_revenue
FROM mintclassics.products AS p
JOIN mintclassics.orderdetails AS od
ON p.productCode = od.productCode
GROUP BY p.productName, p.quantityInStock, od.priceEach
ORDER BY total_revenue;
```

Table 8: Displaying records 1 - 10

productName	quantityInStock	priceEach	total_revenue
1932 Alfa Romeo 8C2300 Spider Sport	6553	91.11	546.66
1954 Greyhound Scenicruiser	2874	50.32	553.52
1936 Mercedes Benz 500k Roadster	2081	41.03	615.45
1932 Model A Ford J-Coupe	9354	104.25	625.50
1982 Lamborghini Diablo	7723	32.47	649.40
1939 Chevrolet Deluxe Coupe	7332	29.21	671.83
1958 Chevy Corvette Limited Edition	2542	33.95	679.00
1939 Chevrolet Deluxe Coupe	7332	29.54	679.42
1982 Lamborghini Diablo	7723	34.36	687.20
1939 Chevrolet Deluxe Coupe	7332	33.19	730.18

Key Findings:

- The top 10 products contribute significantly to Mint Classics' revenue. These products should be prioritized for inventory management and marketing efforts to maximize profitability.

- The bottom 10 products generate minimal revenue and may not be worth retaining in the inventory. These products should be evaluated for discontinuation or promotional campaigns to clear out excess stock.

```sql
-- Slow-moving or non-moving items
SELECT
    p.productCode,
    p.productName,
```

```
    p.quantityInStock,
    IFNULL(SUM(od.quantityOrdered), 0) AS total_units_sold,
    (p.quantityInStock - IFNULL(SUM(od.quantityOrdered), 0)) AS inventory_not_sold
FROM products p
LEFT JOIN orderdetails od ON p.productCode = od.productCode
GROUP BY p.productCode, p.productName, p.quantityInStock
HAVING total_units_sold = 0 OR total_units_sold < 100
ORDER BY inventory_not_sold DESC;
```

Table 9: 1 records

productCode	productName	quantityInStock	total_units_sold	inventory_not_sold
S18_3233	1985 Toyota Supra	7733	0	7733

The product code S18_3233 named 1985 Toyota Supra has quantity of 7733 but sold 0 units, thus having an inventory of 7733 not sold.

4. Inventory Turnover Ratio

I calculated the inventory turnover ratio to identify fast-moving and slow-moving products.

```
-- Inventory turnover ratio
SELECT
    p.productCode,
    p.productName,
    p.quantityInStock,
    SUM(od.quantityOrdered) AS total_units_sold,
    (SUM(od.quantityOrdered) / p.quantityInStock) AS inventory_turnover_ratio
FROM products p
JOIN orderdetails od ON p.productCode = od.productCode
GROUP BY p.productCode, p.productName, p.quantityInStock
ORDER BY inventory_turnover_ratio ASC;
```

Table 10: Displaying records 1 - 10

productCode	productName	quantityInStock	total_units_sold	inventory_turnover_ratio
S18_1984	1995 Honda Civic	9772	917	0.0938
S24_3432	2002 Chevy Corvette	9446	894	0.0946
S32_2206	1982 Ducati 996 R	9241	906	0.0980
S18_3482	1976 Ford Gran Torino	9127	915	0.1003
S18_1589	1965 Aston Martin DB5	9042	914	0.1011
S12_3380	1968 Dodge Charger	9123	925	0.1014
S700_2466	America West Airlines B757-200	9653	984	0.1019
S18_2325	1932 Model A Ford J-Coupe	9354	957	0.1023
S12_2823	2002 Suzuki XREO	9997	1028	0.1028
S18_2870	1999 Indy 500 Monte Carlo SS	8164	855	0.1047

Key Findings: Products with low turnover ratios are candidates for discontinuation, while high-turnover products should be prioritized for restocking.

Recommendations

Based on the analysis, the following recommendations are proposed:

1. **Close Warehouse South and Redistribute Its Inventory**:
   - Warehouse South houses low-revenue, low-demand product lines and has significant slow-moving inventory.
   - Redistribute its inventory to Warehouses North, East, and West, which have sufficient available space.
   - Time the closure during a low-demand period to minimize disruption.
2. **Optimize Inventory Levels Based on Sales Trends**:
   - Reduce overstocked inventory through promotions or supplier returns.
   - Increase stock for high-demand products to avoid stockouts.
   - Discontinue unprofitable, slow-moving items to free up space and reduce holding costs.

Conclusion

- **Warehouse South**: The analysis shows that Warehouse South houses low-revenue, low-demand product lines and has significant slow-moving inventory. Closing this warehouse and redistributing its inventory is feasible and will lead to cost savings.
- **Inventory Optimization**: Significant inventory imbalances were identified, with some products overstocked and others understocked. Adjusting inventory levels based on sales trends will improve efficiency and customer satisfaction.
- **Product Performance**: The top 10 revenue-generating products should be prioritized, while the bottom 10 should be evaluated for discontinuation or promotions.

Next Steps

1. **Redistribute Inventory**: Develop a detailed plan for redistributing Warehouse South's inventory to other warehouses.
2. **Liquidate Slow-Moving Items**: Launch promotions or discounts to clear out slow-moving inventory.
3. **Monitor Performance**: Continuously monitor inventory levels and sales trends to ensure optimal stock levels.
4. **Explore Advanced Analytics**: Use forecasting models to predict future demand and optimize inventory further.