Solving Inventory Inefficiencies Using SQL

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Executive Summary

This report documents the design and development of a comprehensive inventory analysis dashboard using SQL Server and Power BI for the given dataset. The primary goal was to identify inefficiencies such as stockouts, overstocking, restocking delays, and demand-forecast mismatches using data-driven insights. By building a data warehouse and designing insightful visuals, the project offers actionable recommendations for improved supply chain efficiency.

Problem Statement

UrbanRetailCo operates retail stores across multiple regions and categories. The company faces operational issues including frequent stockouts, overstocking, inaccurate demand forecasts, and erratic restocking. The objective is to create a dynamic BI solution that highlights inefficiencies, reveals operational trends, and guides smarter inventory decisions.

Data Overview

The dataset includes daily transactional data for multiple products, stores, and regions. Key attributes are:

- Transaction Date, StoreID, Region
- ProductID, Category
- Inventory Level, Units Sold, Units Ordered

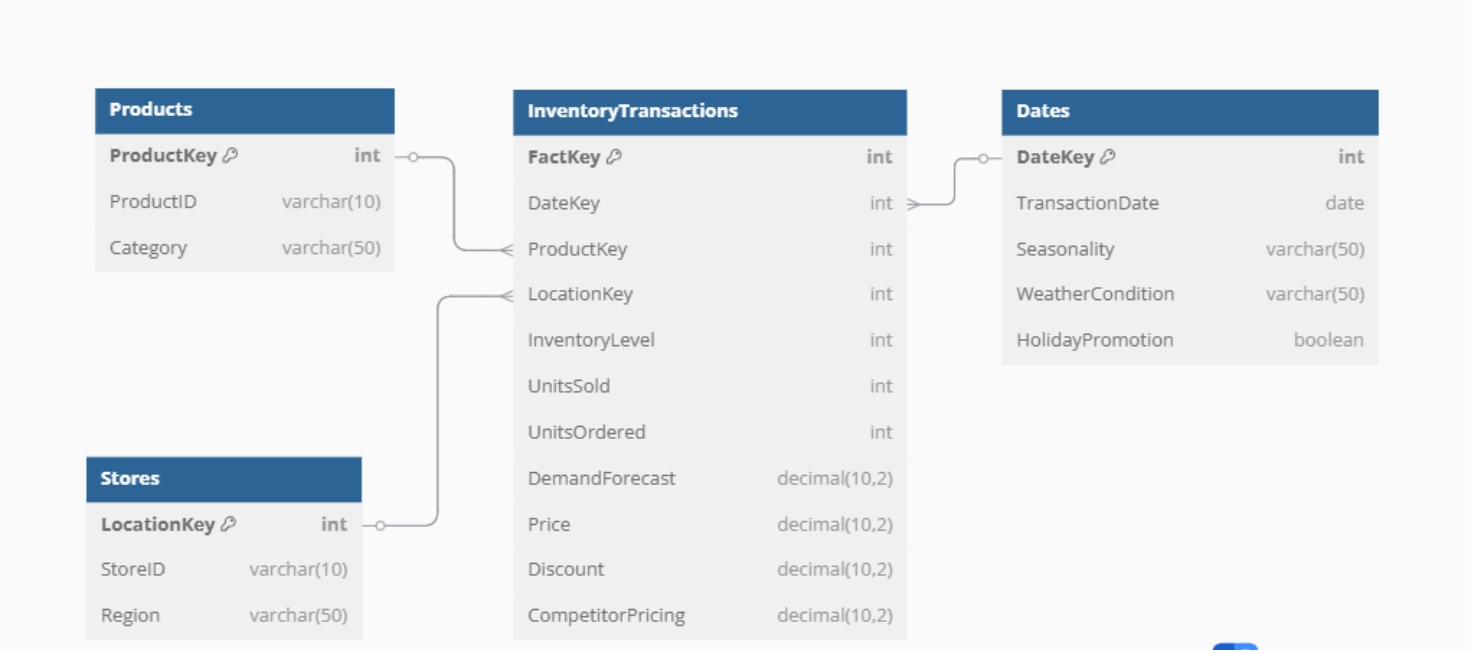
- Demand Forecast, Price, Discount
- Weather Condition, Holiday/Promotion, Seasonality

SQL Server Implementation

Schema Design Overview:

The database is structured using a star schema model consisting of:

- Fact Table:
  - InventoryTransactions: Stores all transactional metrics like inventory level, units sold, units ordered, demand forecast, price, discount, and competitor pricing, linked via foreign keys to dimension tables.
- Dimension Tables:
  - Products: Contains ProductID and Category.
  - Stores: Contains StoreID and Region.
  - Dates: Contains TransactionDate, Seasonality, WeatherCondition, and HolidayPromotion.



Key SQL Insights Extracted

Insight 1: Stockout Risk – Low Inventory vs Demand Forecast
This insight identifies products at risk of stockouts by comparing Inventory

Levels to Demand Forecasts. A threshold of Inventory < 60% of Forecast is used.

Key Findings:

- On 2022-10-28, Product P0079 at Store S001 (North) had 41 units in stock against a demand forecast of 72.48 (Ratio: 0.566).
- Product P0057 at Store S004 (North) had a ratio of 0.576 (Inventory: 51, Forecast: 88.47).
- Product P0133 at Store S003 (South) had a ratio of 0.578 (Inventory: 59, Forecast: 102.11).

Recommendation: Prioritize replenishment for products with low inventory-to-demand ratios. Implement automated alerts for when inventory falls below 60% of forecast.

Insight 2: Inventory Turnover Ratio – Identifying Fast-Moving Products
Turnover ratio is calculated as total units sold divided by average inventory. It indicates how efficiently inventory is being used.

Key Findings:

- Product P0178 (Clothing) has the highest turnover ratio of 2512.68.
- P0046 and P0133 (Clothing) follow with ratios of 2511.72 and 2505.47.
- Clothing dominates the top positions, followed by Groceries and Toys.

Recommendation: Focus restocking and marketing efforts on high-turnover products. Review slow-moving SKUs for potential markdowns or delisting.

Insight 3: Weather Effect on Sales – Analyzing Demand Patterns by Weather Conditions
This analysis examines average units sold across weather conditions for each category.

Key Findings:

- Clothing sales peak during Sunny and Snowy conditions, indicating seasonal demand.

- Electronics remain stable but dip in extreme weather (Snowy/Rainy).
- Furniture and Toys perform better in mild (Sunny/Cloudy) weather.
- Groceries show steady sales regardless of weather.

Recommendation: Adjust inventory planning and promotional campaigns based on seasonal weather forecasts. Stock up on weather-sensitive items in advance.

Insight 4: Promotion/Holiday Impact on Sales – Evaluating Sales Uplift on Event Days
This insight compares average category sales on promotion days (HolidayPromotion = 1) vs non-promotion days.

Key Findings:

- Clothing saw the most significant uplift with an average of 123 units on promotion days.
- Groceries maintained stable sales (~114 on promo days), showing inelastic demand.
- All categories showed slightly improved sales on holidays, validating promotional efforts.

Recommendation: Continue targeted promotions, especially for responsive categories like Clothing and Furniture. Combine with weather-aware marketing for enhanced results.

Insight 5: Reorder Point Estimation – Ensuring Timely Restocking Reorder points are calculated using average daily sales × assumed 2-day lead time.

Key Findings:

- Clothing products require the highest reorder points (often >120 units).
- Groceries also have high reorder needs (~100+ units).
- Toys, Furniture, and Electronics show moderate reorder thresholds.

Recommendation: Implement dynamic, category-wise reorder point systems. Set higher reorder alerts for fast-selling items to avoid stockouts.

Insight 6: Restocking Lag Detection – No Lag Instances Detected
This query was intended to detect when inventory was insufficient to meet sales, but no order was placed.

Key Findings:

- No instances of restocking lag were detected in the dataset.

I**nterpretation:** This may indicate efficient ordering practices or limitations in the dataset's time coverage.

Power BI Dashboard Summary

1. Overall Performance Metrics

Units Sold:
A substantial 11 million units have been sold, indicating healthy sales volume.
Recommendation: Continue current sales strategies but explore upselling to boost revenue per unit.

Turnover Ratio:
At **72.69K,** it suggests relatively high inventory turnover, which is good for liquidity but may indicate understocking risk if not managed.
Recommendation: Set minimum stock levels to avoid stockouts for fast-moving products.

Revenue (Without Discount vs. With Discount):

- **Without Discount: ₹583.37M**
- **With Discount: ₹539.44M**
- Loss of **₹43.93M** due to discounts, which might be necessary for clearance or attracting customers but affects profitability.

  Recommendation: Use targeted or time-limited offers instead of blanket discounts to preserve margins.

Forecast Accuracy: 0.87 (87%) – quite high, indicating reliable demand prediction models.
Recommendation: Keep refining the model by adding seasonal and regional demand patterns.

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2. Inventory Analysis

A. Inventory by Category (Donut Chart)

Clothing holds the highest inventory level (38.9%), suggesting a potential overstocking situation.
Electronics (25.1%) and Furniture (19.4%) are the next highest.
Toys and Groceries combined are only **~17%,** possibly understocked or fast-moving.
Recommendation: Reduce clothing stock gradually and increase stock for high-demand, low-stock items like groceries if needed.

B. Inventory Distribution Curve

Most categories peak between 100-200 units, with Clothing dominating the volume. This may highlight inefficiencies in stocking beyond actual sales demand.
Recommendation: Match stock to actual demand, especially for clothing, using past sales data**.**

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3. Turnover Ratio Trends (Quarterly)

Clothing consistently shows a high turnover, increasing over quarters.
Furniture and Electronics show moderate turnover, with slight upward trends—good, but optimization potential remains.
Groceries and Toys are flat or declining, suggesting slow-moving stock or ineffective promotion in these segments.
Recommendation: Focus on promotions and discounts for Toys and Groceries, and review product relevance**.**

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4. Sales Performance

A. Year-on-Year Comparison (Bar Chart)

Sales across Clothing, Electronics, Furniture are stable or slightly increasing from 2022 to 2023, indicating resilient demand.
Recommendation: Maintain momentum and run customer loyalty programs to sustain demand**.**

B. Sales by Product Category

Clothing is the top-selling category, followed by Electronics and Furniture.
Toys and Groceries show poor performance in sales despite holding inventory, especially groceries, indicating potential deadstock.
Recommendation: Reduce variety or bundle deadstock items to push them off shelves.

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5. Geographic/Location Insights

Sales distribution is even across 20 locations (each at ~5%). This uniformity is uncommon and could suggest:

- Either standardized stocking strategy, or
- **Lack of location-specific optimization—**opportunity to tailor strategy per region.

  Recommendation: Analyze sales per location and customize inventory and promotions regionally.

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6. Seasonal Impact (Tree Map)

Winter > Summer > Autumn > Spring in terms of units sold.
Actionable Insight: Align stocking and marketing campaigns heavily toward Autumn and Winter, possibly with earlier procurement planning.
Spring has the lowest sales, ideal for discount campaigns or bundling to clear

inventory.
Recommendation: Start seasonal campaigns early, and plan clearance sales in Spring.

Conclusion
The SQL-driven inventory analysis for UrbanRetailCo revealed key operational patterns and inefficiencies:

1. **Stockout Risk:** Several products, particularly in the Clothing category, consistently had inventory levels below 60% of their forecasted demand. These stockouts point to inadequate replenishment cycles and the need for improved forecasting and restocking triggers.

2. **High Inventory Turnover:** Clothing items exhibited extremely high turnover ratios (e.g., P0178 with 2512.68), indicating rapid sales and efficient inventory flow. This reaffirms the demand strength of apparel and underscores the need for priority restocking and focus on these fast-movers.

3. **Weather Influence:** Sales patterns varied significantly with weather. Clothing performed best in Sunny and Snowy conditions, while Electronics dipped in extreme weather. Groceries remained stable regardless of conditions. This highlights the importance of weather-aligned stocking strategies.

4. **Promotion Impact:** Promotional and holiday events led to a clear uplift in sales, especially for Clothing and Groceries. The data validates that promotional campaigns are effective and should be expanded, particularly for weather-sensitive or fast-moving categories.

5. **Reorder Point Strategy:** Based on 2-day lead time assumptions, reorder points for high-demand categories like Clothing and Groceries need to be significantly higher (120+ units), supporting proactive inventory management.

6. **Restocking Lags:** No instances were found where inventory was lower than demand and no restocking occurred, suggesting current ordering

practices are timely. However, this could also be a limitation of the dataset’s time window.

In summary, UrbanRetailCo should implement dynamic reorder point systems, align stocking with weather and promotional calendars, and continuously monitor turnover rates to avoid both stockouts and overstocking. The insights support data-driven, category-specific strategies to optimize inventory flow, improve customer satisfaction, and enhance profitability.