

Solving Inventory Inefficiencies Using Advanced SQL Analytics

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Project Objective

The goal of this project is to build an end-to-end inventory management analytics pipeline using structured SQL queries and interactive Tableau dashboards. This system enables businesses to identify stock imbalances, evaluate product demand cycles, and optimize stocking strategies.

Data Infrastructure

A normalized relational schema was designed with the following key components:

- **stores:** Store IDs and associated regions
- **products:** Product IDs with categories
- **inventory_transactions:** Daily transactional records including units sold, demand forecast, pricing, promotions, and seasonal data

Relationships:

- Foreign keys link `inventory_transactions` to both `stores` and `products`
- Composite primary key: `(date, store_id, product_id)` ensures no duplicate daily entries

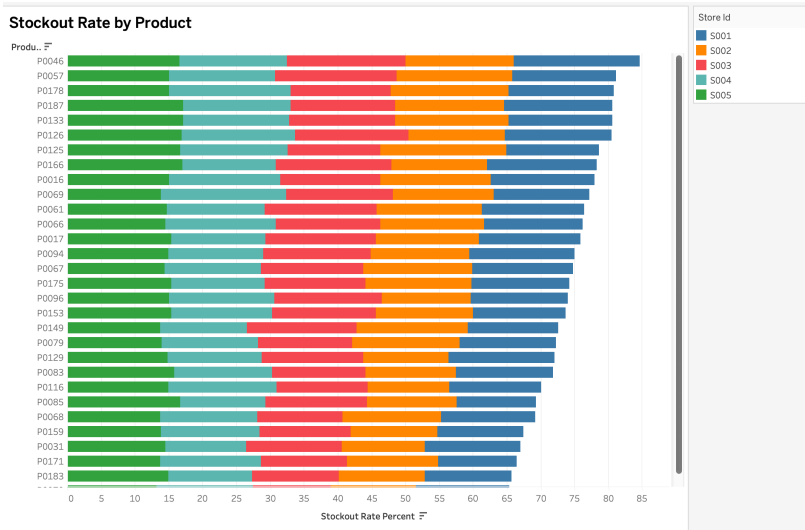
Indexes were added to optimize query performance:

- `product_id`, `store_id`, `date`, and combined fields for faster filtering

Key Performance Indicators (KPIs)

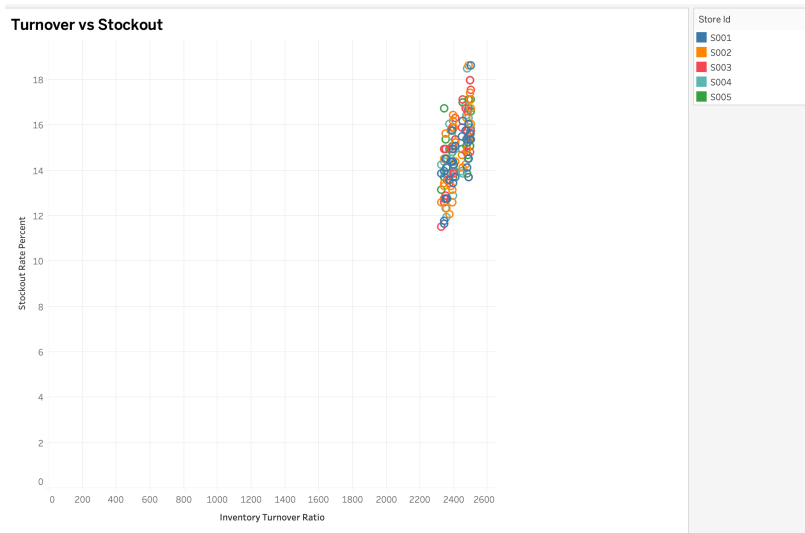
1. Stockout Rate (%):

- Products like P0046, P0057 showed high stockout rates
- Indicates frequent missed sales due to insufficient stock



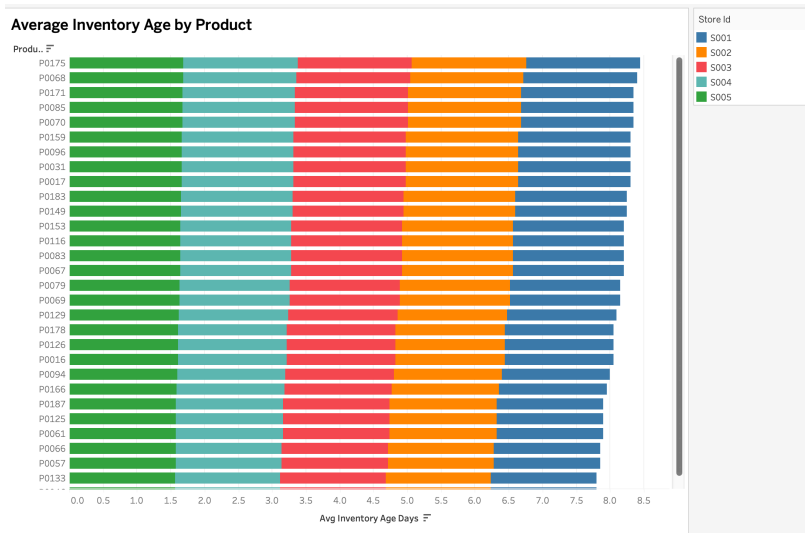
2. Inventory Turnover Ratio:

- Higher ratio = faster product movement
- Used for identifying slow-moving SKUs



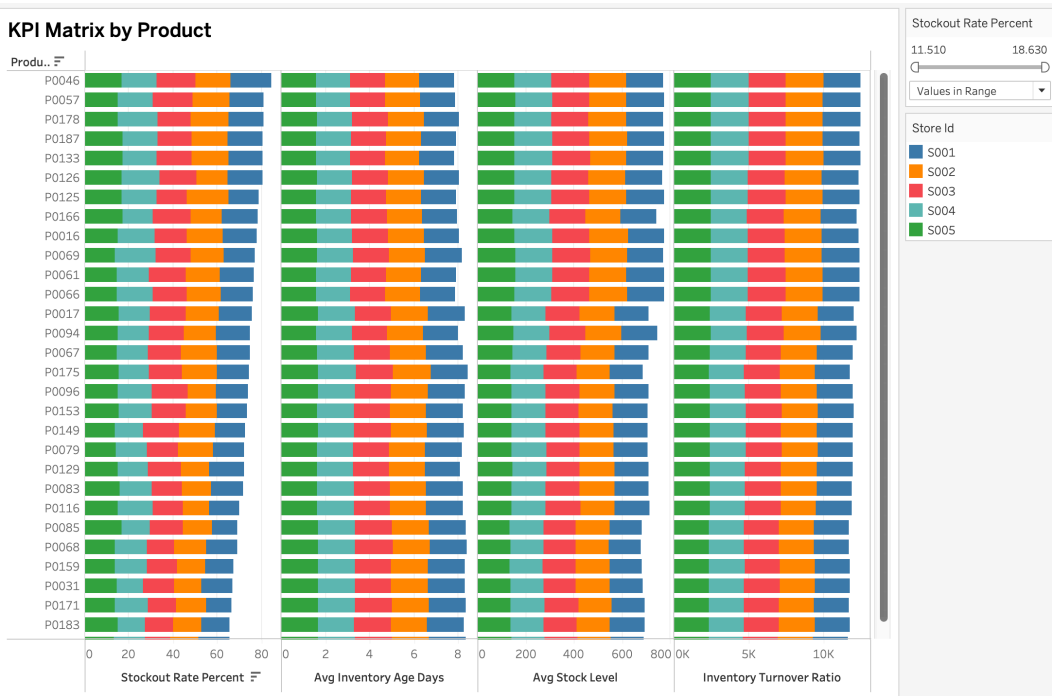
3. Average Inventory Age:

- Highlights buildup of unsold inventory



4. Reorder Point Estimation:

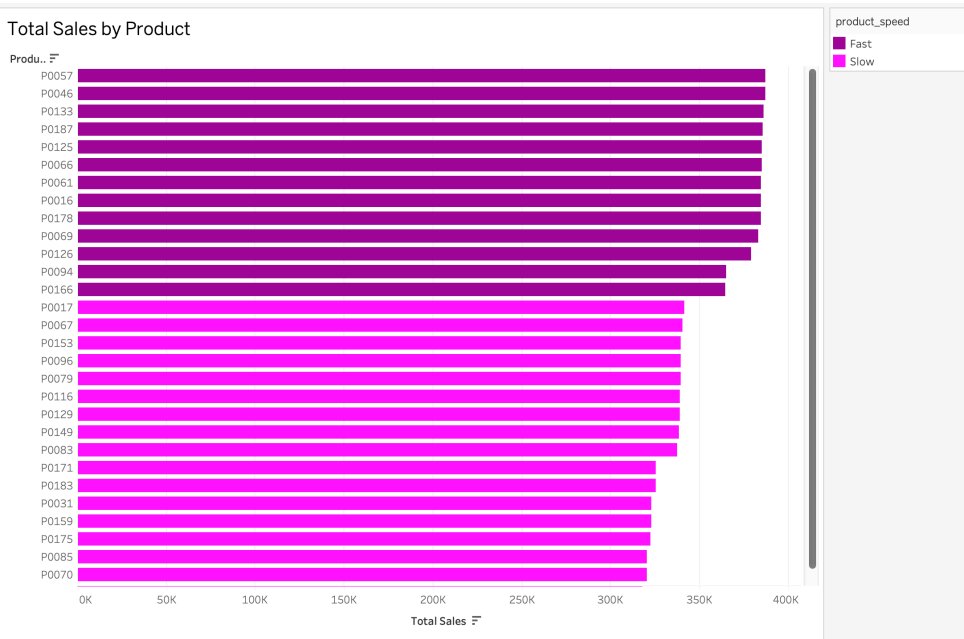
- Used a 2-day lead time assumption
- it comes out to be null so i hide it



Advanced Analytics Outputs

1. Fast-Selling vs Slow-Moving Products

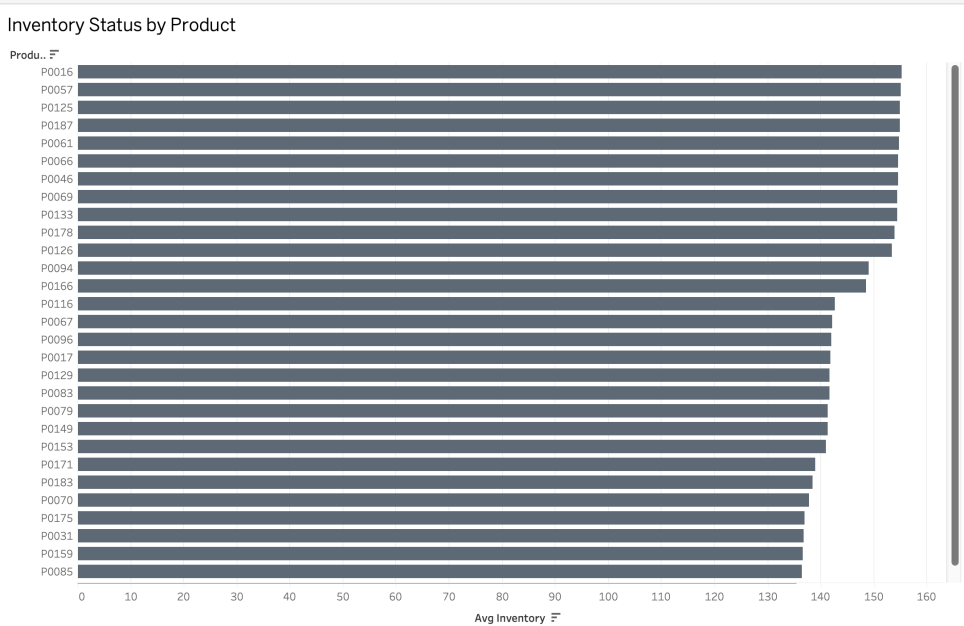
- Products were ranked by total units sold
- `product_speed` category created in Tableau to distinguish Fast/Slow based on sales thresholds



2. Inventory Status by Product

This bar chart illustrates the **average inventory levels** across different products over the analysis period. Products are sorted in descending order based on their average inventory, helping identify items that may be consistently overstocked or understocked.

- **Top Inventory Holders:** Products such as **P0016**, **P0057**, and **P0125** have the highest average inventory levels, which could



indicate potential overstocking and increased holding costs.

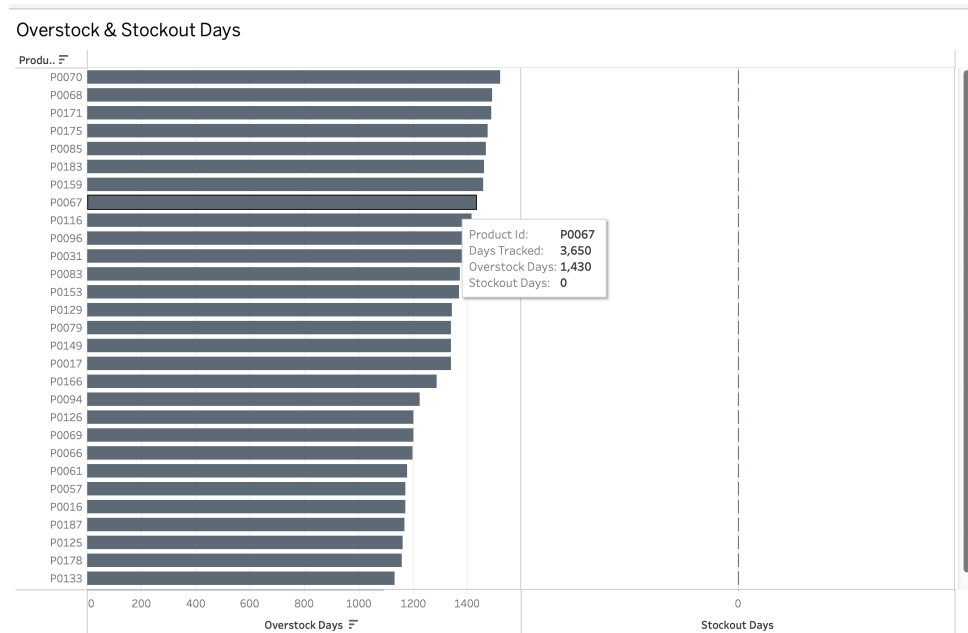
- **Low Inventory Items:** Products like **P0159**, **P0031**, and **P0085** appear at the lower end, suggesting they may require closer monitoring to avoid stockouts.

This visualization supports inventory optimization by highlighting which products maintain excessive or minimal stock levels, enabling data-driven stock adjustment decisions.

3. Overstock & Stockout Days

This visualization displays the number of days each product experienced overstocking or stockouts over the tracked period. Each bar represents a product, plotted against the number of **overstocked days**, while stockout days are separately visualized.

- Products like **P0070**, **P0068**, and **P0171** show the **highest number of overstocked days**, exceeding 1,400 days in some cases.
- Notably, **many products show zero stockout days**, which could imply excessive safety stock levels or inefficiencies in forecast-based replenishment.
- Example: **Product P0067** was overstocked for **1,430 days out of 3,650 tracked days**, with no stockout incidents — a potential signal for inventory cost optimization.



This chart helps identify inventory imbalances and highlights where stock holding strategies may need to be revised to reduce excess inventory while maintaining service levels.

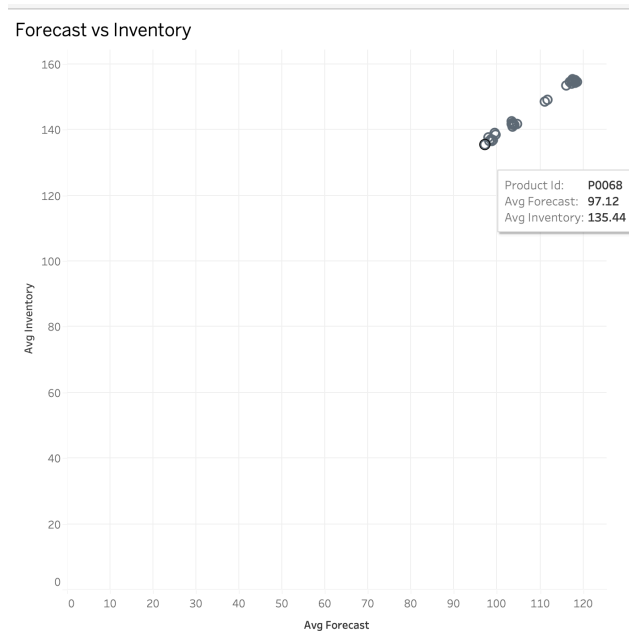
4. Forecast vs Inventory

This scatter plot compares the **average forecasted demand** against the **average inventory held** for each product. Each point represents a product, helping visualize the gap between anticipated demand and actual stock levels.

- Products appearing **above the diagonal trend line** (e.g., **P0068**) have inventory levels significantly higher than their forecast — potentially indicating **overstocking** or conservative stocking strategies.
- In the case of **Product P0068**, the average forecast is **97.12 units**, while average inventory stands at **135.44 units**, highlighting a possible mismatch.

- The concentration of most points in the **upper-right zone** reflects a tendency toward **over-preparedness**, possibly to avoid stockouts, but this can increase holding costs.

This visualization enables quick identification of products where **inventory strategies may need adjustment**, either due to poor forecast alignment or unnecessary safety stock buffers.

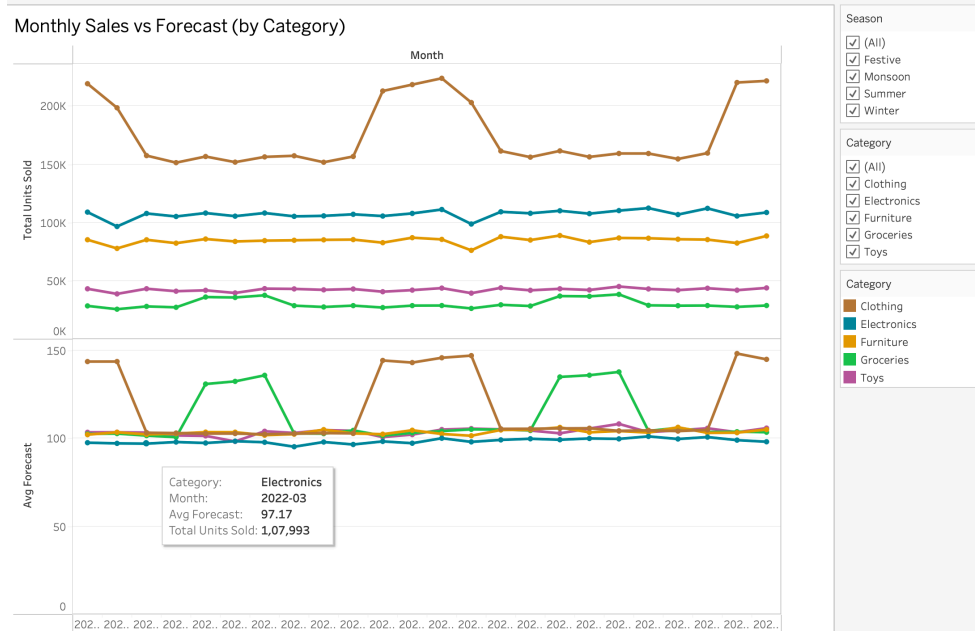


5. Monthly Sales vs Forecast (by Category)

This visualization compares the **actual monthly sales (Total Units Sold)** with the **average forecasted demand** across five product categories: Clothing, Electronics, Furniture, Groceries, and Toys. It is split into two synchronized line charts for better clarity — the top showing sales trends, and the bottom showing forecast values.

Observations:

- Clothing** consistently records the **highest sales**, with clear seasonal spikes — especially around festive and year-end months. However, its forecasts remain relatively flat, indicating **underestimation during peak demand periods**.
- Electronics** show **stable and predictable performance**, with monthly sales closely aligned with forecast values. This reflects a **well-calibrated demand model**.
- Groceries** display high **forecast variability**, despite fairly stable sales trends. This suggests a need to refine forecasting methods for perishable or fast-moving goods.



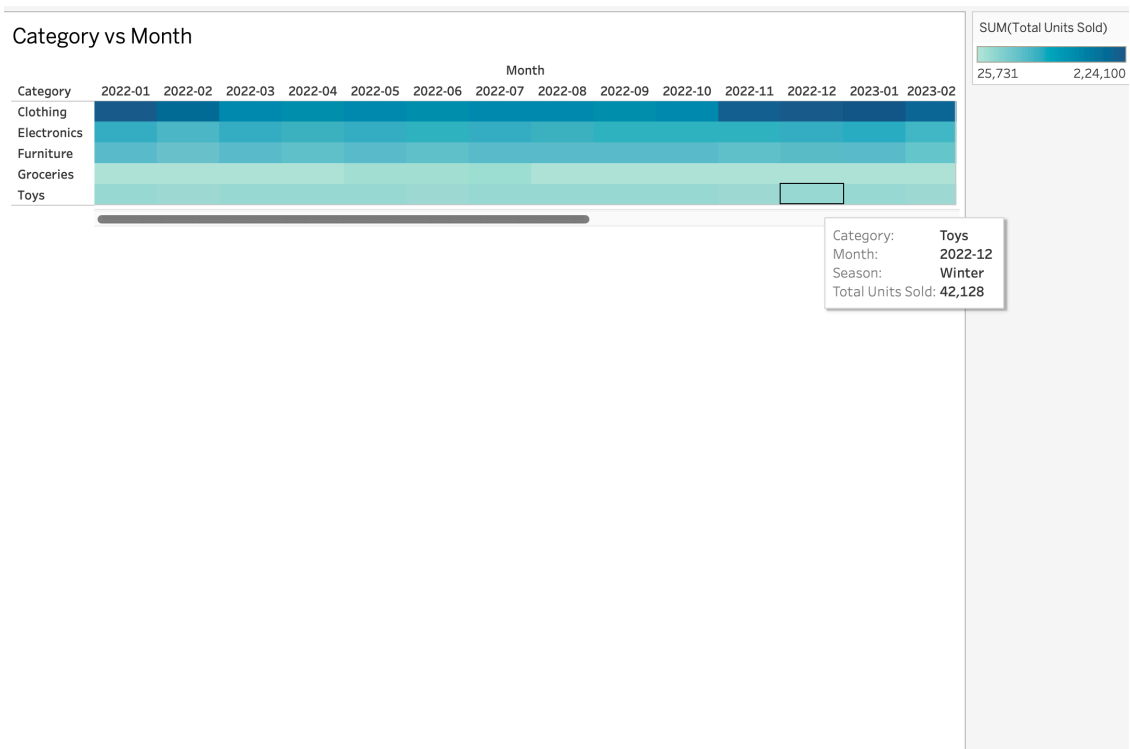
- **Furniture** and **Toys** maintain moderate but consistent sales and forecast levels, with minimal deviation — indicating relatively accurate forecasting or low seasonality influence.

Key Insight:

For categories with significant seasonality (like **Clothing**), forecasting models should be adjusted to capture demand surges. Meanwhile, categories like **Electronics** demonstrate that stable demand with well-tuned forecasts can lead to more efficient inventory planning.

6.Category vs Month Heatmap Dashboard

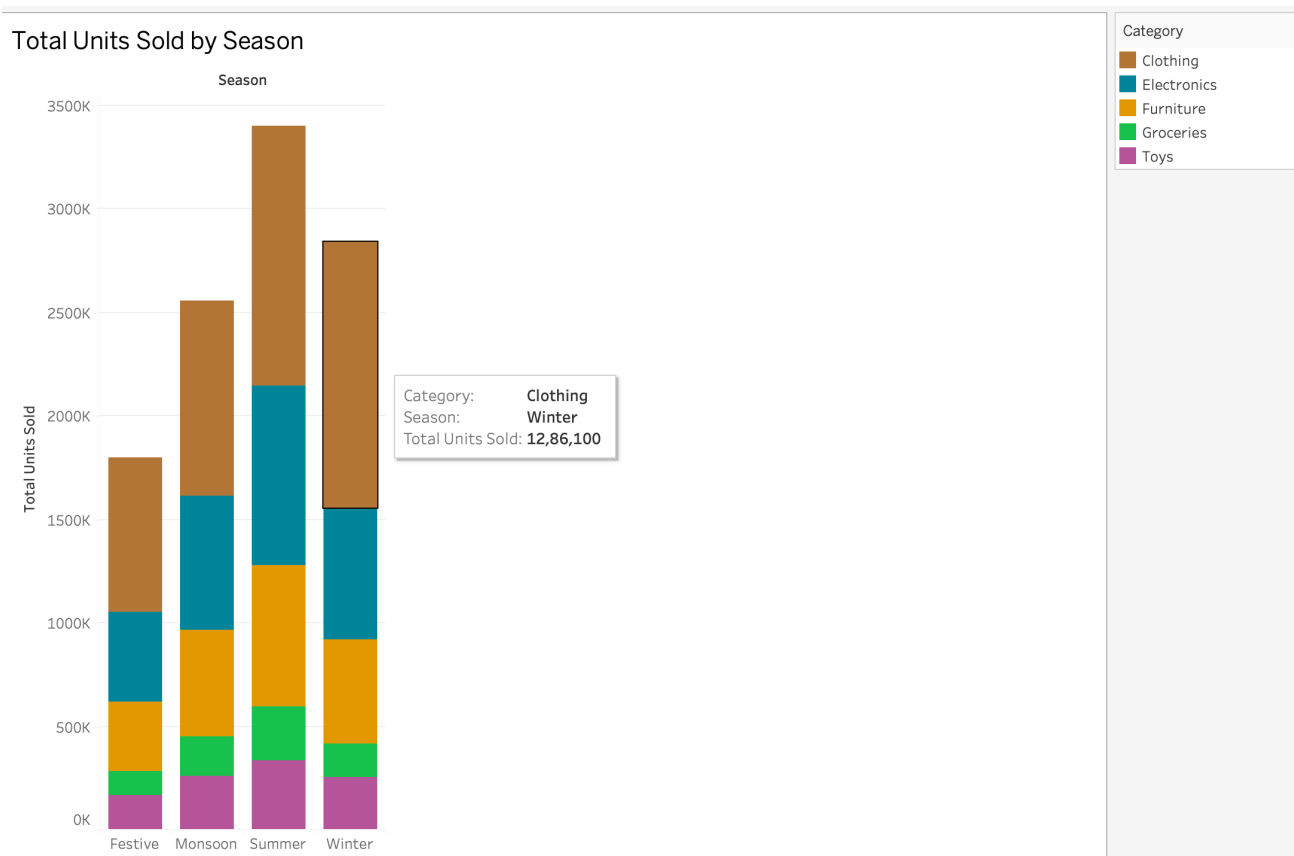
This heatmap visualizes the monthly sales performance across five product categories — **Clothing, Electronics, Furniture, Groceries, and Toys** — from **January 2022 to February 2023**, using the total units sold as the metric.



- **Color Gradient:** The intensity of color (from light blue to dark blue) represents the volume of units sold, with darker shades indicating higher sales.
- **Peak Performance:** The highest units sold are seen in **Clothing**, particularly in **November and December 2022**, suggesting strong seasonal demand.
- **Seasonal Insight:** Notably, **Toys** experienced a spike in **December 2022 (Winter)**, with **42,128 units sold**, likely due to holiday shopping.
- **Overall Trend:** Clothing maintained consistently high sales across months, while Groceries and Toys showed lower baseline performance except for isolated spikes.

This visualization helps identify **seasonal patterns, category-specific demand surges, and sales optimization opportunities** across product lines.

7. Total Units Sold by Season – Stacked Bar Chart



This stacked bar chart illustrates the total units sold across different **product categories**—**Clothing, Electronics, Furniture, Groceries, and Toys**—segmented by season (Festive, Monsoon, Summer, and Winter).

- **Dominant Category:** Clothing consistently leads in all seasons, especially in **Winter**, with a peak of **12,86,100 units sold**, indicating strong seasonal demand and possible promotional influence.
- **Seasonal Trends:**
 - **Summer** marks the highest total sales across all categories, driven by increased purchases in **Electronics and Furniture**.
 - **Festive season** shows moderate yet diversified sales, likely due to multi-category demand spikes.
- **Product Behavior:**
 - **Electronics** performs strongly in Monsoon and Summer.
 - **Groceries** and **Toys** have relatively steady sales throughout but with no seasonal dominance.

This visualization is key for identifying **seasonal buying behavior, optimizing inventory planning, and category-specific marketing strategies** for each season.

Key Recommendations

1. **Replenish High-Demand Products**

Ensure fast-selling SKUs are restocked proactively to prevent lost sales due to frequent stockouts.

2. **Optimize Forecasting Models**

Identify and adjust models where large discrepancies exist between forecasted and actual demand — especially in seasonal categories.

3. **Manage Slow-Moving Inventory**

Flag products with low turnover and high inventory age for liquidation or promotional clearance to reduce carrying costs.

4. **Implement Seasonal Stocking Strategies**

Align inventory levels with expected demand peaks during **festive** and **summer** periods to maximize availability and revenue.

5. **Enable Real-Time Inventory Alerts**

Set up automated alerts based on thresholds for overstock, stockout, and turnover to support timely decision-making and avoid manual monitoring.

Conclusion

This project delivers a comprehensive, data-driven inventory management solution by integrating robust **SQL-based analysis** with **Tableau visual analytics**. The system not only reveals deep insights into stock performance but also supports smarter decision-making through actionable KPIs, trend analysis, and category-level diagnostics.

The solution is **scalable and extendable** — capable of being integrated with live data sources, automated refresh pipelines, and broader supply chain dashboards for continuous performance monitoring and optimization.

...Thank You!...