Inventory Optimization and Demand Forecasting

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**1. Introduction**  
This project explores the optimization of inventory and demand forecasting for Urban Retail Co. The objective is to analyze historical retail sales data using SQL-based queries and Power BI dashboards to identify inefficiencies and propose data-driven improvements.

**2. Methodology**  
A dimensional **star schema** was implemented in MySQL, encompassing dimension tables for Product, Store, Calendar, Inventory, Pricing, and Season. SQL views were created to aggregate and compute key inventory metrics which were then visualized in Power BI.

The analysis included:  
- Inventory turnover ratio calculations  
- ABC classification of products by revenue  
- Stockout rates and forecasting accuracy (MAPE)  
- Seasonal sales and external influence assessments (e.g., Weather and Competition)

**3. Key Findings**

**3.1 Fast-Moving vs. Slow-Moving Products**  
Inventory turnover ratios across product IDs revealed significant variation:  
- Fast-Moving: Clothing products such as P0046, P0057, and P0133 had turnover ratios exceeding 5,000.  
- Slow-Moving: Electronics like P0068 and P0085 had lower ratios, categorizing them as slow movers.  
- Turnover by Category:  
 - Clothing: Fast & Medium movers (~55,000 combined)  
 - Electronics: Predominantly Slow movers (~37,712)  
 - Furniture and Groceries: Mostly Medium/Slow movers

**3.2 Stock Adjustment Recommendations**  
- Clothing (A-Class): Maintain or slightly increase stock.  
- Electronics & Furniture (C-Class): Gradually reduce stock levels to minimize holding costs.  
- Strategy: Prioritize A-Class items (63% of revenue), optimize B-Class, and discount or rotate C-Class.

**3.3 Forecasting Accuracy and Demand Trends**- Average Forecast MAPE: 15.73% across all categories  
 - Good Forecast (15.0–15.5%): Clothing, Electronics  
 - Fair to Poor Forecast (>15.5%): Furniture, Groceries  
- Seasonal Demand Patterns:  
 - Clothing & Toys peak in Winter and Autumn  
 - Electronics show consistent Winter demand  
 - Groceries have modest peaks in Summer and Winter

**3.4 Revenue Distribution & ABC Analysis**  
- Category Revenue Contribution:  
 - Clothing: ₹117.86M (40.07%)  
 - Electronics: ₹71.47M (24.3%)  
- ABC Segmentation:  
 - A-Class: 63.07% of revenue  
 - B-Class: 21.87%  
 - C-Class: 15.07%

**4. External Influences**

**4.1 Weather Impact**  
- Average weather impact: -0.01%, with snow and rain slightly reducing sales  
- Best sales observed during sunny and cloudy conditions

**4.2 Price Sensitivity**  
- Price premium percent fluctuated slightly between -2% and +4%  
- Categories like Groceries are more price-sensitive compared to Clothing and Electronics

**5. Recommendations**

- Inventory Planning: Implement dynamic inventory thresholds based on seasonal peaks.   
- Demand Forecasting: Improve forecasts using ML models and external factor integration.  
- Stock Management:  
 - Increase safety stock for fast-moving A-Class SKUs  
 - Implement clearance strategies for slow-moving C-Class items

**6. Conclusion**  
This project successfully demonstrates the application of SQL and Power BI in optimizing inventory for retail operations. Key takeaways include actionable insights into product movement, forecast precision, and stock strategy improvements. These data-driven strategies are crucial for enhancing operational efficiency and ensuring product availability while minimizing excess inventory and cost.