INVENTORY SIMULATION AND FORECASTING MODEL FOR SEASONAL RETAIL BUSINESS

1. Background and Problem Statement:

A retail chain specializing in seasonal merchandise, particularly clothing, decor, and accessories struggled with forecasting demand during peak periods like Diwali, Christmas, and summer sales. The lack of accurate predictions led to frequent stockouts of trending items and excessive unsold inventory of low-demand products. The company required a **simulation-based inventory forecasting model** that could account for seasonal fluctuations, promotional impacts, and demand variability to guide more effective stock planning.

2. Objectives:

- To develop a demand forecasting model tailored to seasonal retail trends

- To simulate different inventory scenarios using historical data and promotional calendars

- To identify optimal reorder strategies that balance stock availability with carrying costs

- To improve service levels during high-demand periods while minimizing overstock risk

3. Methodology:

Data Used:

- 3 years of weekly sales data across product categories (SKUs, quantities, prices)

- Seasonal campaign calendar (e.g., festival periods, clearance sales)

- Promotion data including start/end dates and discount depth

- Lead time and reorder lag information

Model Design:

1. **Forecasting Component:**

    o Time series forecasting using seasonal decomposition and moving averages

    o Regression models with external variables (promotion dummy, holiday flag)

    o Forecast horizon set to 12 weeks per cycle

2. **Inventory Simulation Component:**

- o Simulated inventory flow using forecasted demand, lead time, and safety stock

- o Modeled three stock strategies: Conservative, Balanced, and Aggressive

- o Evaluated metrics: Service Level, Inventory Turnover, Overstock %, Stockout Days

3. **Tools Used:**

- o Python (pandas, NumPy, statsmodels, matplotlib)

- o Jupyter Notebook for scenario testing

- o Excel summary sheets for stakeholder interpretation

4. Results:

- Forecast accuracy improved from 68% to **87%** using promotion-adjusted models

- Balanced strategy simulation yielded the best result:

  - o **95% service level**

  - o **17% reduction** in overstock value

  - o Inventory turnover increased from 4.1 to 6.2

- Category-specific simulations enabled differentiated stocking policies for apparel, decor, and accessories

- Scenario modeling helped plan pre-purchase quantities for Diwali based on 3 forecast tiers

5. Interpretation and Insights:

- Aggressive inventory plans resulted in higher service levels but increased unsold inventory post-season

- Simulation models helped quantify trade-offs between service level and holding cost before execution

- Stockouts were most frequent during the first 3 days of campaigns due to under-forecasting of new arrivals

- Model recommendations led to early restocking for high-margin categories, reducing lost sales

6. Recommendations:

- Use the balanced strategy simulation as the default inventory plan for future campaigns

- Update forecasts bi-weekly to account for new trends and live sales patterns

- Expand the model to include supplier constraints and delivery window uncertainties

- Train planners to interpret simulation outputs and build order plans accordingly

7. Future Work:

- Integrate weather and footfall data for demand sensitivity modeling

- Build a web-based inventory planning interface connected to the simulation model

- Incorporate markdown optimization to handle end-of-season inventory

8. Stakeholder Relevance:

Academic:

- Demonstrates how simulation enhances demand forecasting and inventory strategy

- Applicable in retail analytics, supply chain simulation, and inventory theory courses

Corporate:

- Provides retail businesses with a practical approach to seasonal inventory planning

- Helps align buying, merchandising, and logistics teams using predictive insights