**Case Study: Supply Chain and Inventory Management**

**Background:**

ABC Supermarket is a retail chain with multiple stores across different cities. The company has been struggling with stock imbalances—some products run out too quickly (stockouts), while others remain unsold for months (overstocking). These inefficiencies are increasing costs and reducing profits.

The management has decided to use data-driven insights to optimize their inventory and supply chain operations.

**Problem Statement:**

ABC Supermarket wants to improve its inventory management by:

1. **Balancing stock levels –** Ensure products are neither understocked nor overstocked.
2. **Improving demand forecasting –** Use historical sales data to predict future demand.
3. **Optimizing reorder strategies –** Automate when and how much to reorder.
4. **Reducing waste and carrying costs –** Minimize holding costs while maintaining availability.

**Dataset Description:**

The company has a following tables:

1. **Sales Data (sales)**

| Sale\_ID | Product\_ID | Store\_ID | Sale\_Date | Quantity\_Sold | Revenue |
| --- | --- | --- | --- | --- | --- |
| 1001 | P001 | S101 | 2024-02-15 | 30 | 4500 |
| 1002 | P002 | S102 | 2024-02-25 | 3000 |  |

**2. Inventory Data (inventory)**

| Product\_ID | Store\_ID | Warehouse\_ID | Stock\_Level | Reorder\_Level | Last\_Updated |
| --- | --- | --- | --- | --- | --- |
| P001 | S101 | W001 | 50 | 100 | 2024-02-15 |
| P002 | S102 | W002 | 200 | 150 | 2024-02-15 |

**3. Supplier Data (suppliers)**

| Supplier\_ID | Supplier\_Name | Product\_ID | Lead\_Time (days) | Order\_Frequency |
| --- | --- | --- | --- | --- |
| SUP001 | ABC Ltd | P001 | 5 | Weekly |
| SUP002 | XYZ Co | P002 | 7 | Biweekly |

**4. Purchase Orders (purchase\_orders)**

| Order\_ID | Product\_ID | Supplier\_ID | Order\_Date | Quantity | Arrival\_Date |
| --- | --- | --- | --- | --- | --- |
| PO1001 | P001 | SUP001 | 2024-02-01 | 100 | 2024-02-06 |
| PO1002 | P002 | SUP002 | 2024-02-05 | 200 | 2024-02-12 |

**Tasks for Students:**

**1. SQL Tasks (Inventory Analytics & Reporting)**

* Identify slow-moving and fast-moving products – Query products with the highest and lowest sales in the past 3 months.
* Find products below reorder level – Generate a report listing products that need restocking.
* Supplier lead time analysis – Find suppliers with high lead times and suggest alternatives.

**2. Python Tasks (Forecasting & Optimization)**

* **Demand Forecasting:**
  + Use Python (Pandas, NumPy, Matplotlib, Scikit-L) to perform time-series analysis and to predict demand for the next month.
* **Reorder Point Calculation:**
  + Implement a formula to calculate the optimal reorder point for each product.
* **Supplier Performance Analysis:**
  + Use clustering (K-Means or Hierarchical) to classify suppliers based on lead time and order frequency.

**3.** **Data Warehousing Concepts**

* **Star Schema Design –** Build a warehouse schema to optimize queries for inventory and supply chain management.
* **ETL Pipeline –** Design an ETL process to extract sales and inventory data, transform it, and load it into a data warehouse.
* **Aggregation Strategy –** Implement aggregated tables for fast reporting.

**Expected Outcome:**

**By completing this case study, students will:**

* Learn to track and optimize inventory using SQL queries.
* Use Python for demand forecasting and supplier evaluation.
* Apply data warehousing techniques for better decision-making.
* Improve supply chain efficiency using data-driven insights.