

Group A

**Answer TWO questions.
(2×12 = 24)**

Q1. Explain the concept and importance of supply chain. Discuss SMART goals of supply chain analytics with examples.

◊ **Concept of Supply Chain:**

A **supply chain** is a complex network of individuals, organizations, resources, activities, and technologies involved in the creation and sale of a product. It starts from sourcing raw materials and ends with the delivery of the final product to the customer. This network includes suppliers, manufacturers, logistics providers, warehouses, distributors, and retailers. The primary goal of a supply chain is to produce and distribute the right product, in the right quantities, to the right location, and at the right time—while minimizing cost and maximizing customer satisfaction.

A typical supply chain includes:

1. **Suppliers** – provide raw materials or components.
2. **Manufacturers** – transform raw materials into finished goods.
3. **Warehouses and Distribution Centers** – store and distribute goods.
4. **Retailers** – sell products to end customers.
5. **Consumers** – the final users of the product or service.

◊ **Importance of Supply Chain:**

Supply chains are essential to the success of a business. Proper supply chain management ensures:

- **Improved efficiency** in production and distribution
- **Lower operational costs** due to better resource utilization
- **Timely product delivery**, increasing customer satisfaction
- **Competitive advantage** in the market
- **Reduced risks and disruptions** due to better forecasting and planning
- **Support for globalization** through streamlined international logistics

For example, in an e-commerce business like Amazon, an efficient supply chain enables same-day or next-day delivery to millions of customers across different regions.

◊ **SMART Goals in Supply Chain Analytics:**

Supply Chain Analytics is the application of data analysis tools and techniques to improve supply chain operations. Setting **SMART goals** in this context allows organizations to monitor, control, and improve performance.

SMART stands for:

- S Specific** – Clearly defined goal
- M Measurable** – Quantifiable target
- A Achievable** – Realistic to attain
- R Relevant** – Aligned with business strategy
- T Time-bound** – Deadline for achievement

◊ **Example of SMART Goals in Supply Chain:**

- **Specific:** Reduce inventory holding costs in regional warehouses.
- **Measurable:** By 10% over the next quarter.
- **Achievable:** Through use of real-time inventory tracking and demand forecasting.
- **Relevant:** Helps improve working capital and reduce overhead.
- **Time-bound:** Within 3 months.

□ **Goal Statement:** “*Reduce inventory carrying costs by 10% in three months using predictive demand analysis and automated replenishment systems.*”

◊ **Importance of SMART Goals:**

- Helps in **tracking KPIs** like lead time, stockouts, and transportation cost.
- Improves **strategic planning** and accountability.
- Ensures **better alignment** between operational and business goals.
- Drives **continuous improvement** in supply chain performance.

Q2. What do you understand by data manipulation? Briefly explain different aspects of data processing.

◊ **Definition of Data Manipulation:**

Data manipulation refers to the process of adjusting, organizing, transforming, and structuring data to make it useful for analysis and decision-making. It allows raw data to be cleaned and prepared so it can be used for reporting, visualization, or predictive modeling.

Data manipulation can be done using programming tools like **Python**, **SQL**, or **Excel**, and plays a crucial role in **data preprocessing**, a vital step in data analytics, business intelligence, and machine learning.

❖ **Importance of Data Manipulation in Supply Chain:**

- Helps identify patterns in demand, inventory, and sales.
 - Enables better forecasting and planning.
 - Supports automated decision-making and optimization.
-

❖ **Aspects of Data Processing:**

1. Data Collection:

- The first step in data processing, involving the gathering of raw data from sources like sensors, ERP systems, spreadsheets, or APIs.
- Example: Collecting delivery time data from GPS-enabled trucks.

2. Data Cleaning:

- Involves removing duplicates, handling missing values, correcting data types, and resolving inconsistencies.
- Example: Fixing incorrect location names or filling missing product prices.

3. Data Integration:

- Combining data from various sources to create a unified dataset.
- Example: Merging order data from CRM with delivery logs from logistics platforms.

4. Data Transformation:

- Converting data into suitable formats for analysis, like normalizing, aggregating, encoding categorical variables, etc.
- Example: Converting currencies into a standard unit for financial analysis.

5. Data Reduction:

- Summarizing and filtering data to reduce complexity.
- Example: Selecting only key columns like product ID, demand, and price for a forecast model.

6. Data Storage:

- Processed data is stored in databases or warehouses for further analysis or retrieval.
- Example: Storing cleaned sales data in SQL for weekly performance dashboards.

7. Data Visualization:

- Using charts, graphs, and dashboards to represent data insights.
- Tools: Matplotlib, Power BI, Tableau.

8. Data Validation:

- Ensures that the data is accurate, complete, and reliable.
 - Example: Cross-validating total sales against the company ledger.
-

Q3. Define the concept of logistics management. Explain different modes of transport in logistics with examples.

◊ **Concept of Logistics Management:**

Logistics management refers to the **planning, implementation, and control** of the movement and storage of goods, services, and information within the supply chain—from the point of origin to the point of consumption.

It ensures that the right products are delivered in the right quantity, at the right time, to the right place, and at the right cost.

◊ **Core Functions of Logistics Management:**

1. **Transportation**
2. **Warehousing**
3. **Inventory Management**
4. **Order Fulfillment**
5. **Packaging and Handling**
6. **Information Management**

Effective logistics management ensures minimal delays, cost-effectiveness, and maximum customer satisfaction.

◊ **Modes of Transportation in Logistics:**

1. **Road Transport (Truck/Van):**
 - Most commonly used for short to medium distances.
 - Example: FMCG companies delivering groceries to retail shops.
 - **Advantages:** Door-to-door service, flexible routes.
 - **Disadvantages:** Prone to traffic, weather, and fuel price fluctuations.
2. **Rail Transport:**
 - Suitable for bulk transportation over long distances.
 - Example: Coal, cement, and agricultural goods.
 - **Advantages:** Cost-effective, safe for heavy goods.
 - **Disadvantages:** Limited flexibility, fixed routes and schedules.
3. **Air Transport:**
 - Used for high-value, perishable, or time-sensitive goods.
 - Example: Pharmaceuticals, electronics, and luxury goods.
 - **Advantages:** Fastest mode, global coverage.
 - **Disadvantages:** Very expensive, weight/volume limitations.
4. **Water Transport (Ship/Barge):**
 - Ideal for international trade and bulk cargo.
 - Example: Oil, automobiles, machinery parts.
 - **Advantages:** Low cost for large volumes, good for heavy cargo.

- **Disadvantages:** Very slow, affected by weather and port availability.
 - 5. **Pipeline Transport:**
 - Used for the transport of liquids and gases.
 - Example: Crude oil, natural gas, water supply.
 - **Advantages:** Continuous flow, safe and efficient.
 - **Disadvantages:** High initial cost, limited to specific materials.
-

◊ **Importance of Choosing the Right Mode:**

- Affects the overall **cost, speed, and reliability** of supply chain operations.
- Impacts **inventory levels, delivery performance, and customer satisfaction**.
- Companies often use a **multi-modal approach** (combination of air, road, and rail) to balance cost and speed.

◊ **Example:**

An electronics company may:

- Import microchips via **air** for speed.
 - Use **rail** to send bulk components from port to central warehouse.
 - Deliver finished goods to retailers via **road** for final distribution.
-

Group B

**Answer SIX questions.
($6 \times 6 = 36$)**

Q4. What do you mean by data-driven supply chain? Explain the importance of data and its value in supply chain management.

◊ **Definition of Data-Driven Supply Chain:**

A **data-driven supply chain** refers to a supply chain system where decisions and operations are heavily influenced by accurate, real-time, and actionable data. Instead of relying on intuition or static models, data is continuously collected, processed, and analyzed to drive efficiency, agility, and responsiveness across the supply chain.

This approach uses various technologies such as **IoT sensors, RFID, AI, machine learning, big data analytics, and cloud computing** to gather and utilize data from multiple sources.

◊ **Key Features:**

- **Real-time data capture** from logistics, sales, production, and customers
 - **Data integration** across platforms like ERP, CRM, and WMS
 - **Predictive analytics** for demand forecasting and inventory planning
 - **Optimization** of routes, labor, and warehouse space using AI
-

◊ **Importance of Data in Supply Chain:**

1. **Improved Demand Forecasting:**

- Data allows companies to predict future demand based on historical sales, seasonal trends, promotions, and market behavior.
- Example: A retailer can stock up before a festival season using past sales data.

2. **Inventory Optimization:**

- Real-time inventory data prevents overstocking or understocking.
- Example: Automatic reordering when inventory falls below threshold.

3. **Enhanced Visibility:**

- GPS and IoT provide real-time location of shipments.
- Managers can track product flow from warehouse to customer.

4. **Faster Decision Making:**

- Data dashboards and KPIs help managers make quick and informed decisions.
- Example: Identifying delays in transit and rerouting deliveries.

5. **Cost Reduction:**

- Analytics identify waste, bottlenecks, and inefficiencies.
- Optimizing transport routes and warehouse layout reduces operational costs.

6. **Customer Satisfaction:**

- Data-driven personalization, faster delivery, and fewer stockouts lead to happier customers.

7. **Risk Management:**

- Data helps predict and mitigate risks such as supplier failure, demand spikes, or transportation delays.
-

◊ **Real-life Example:**

Amazon uses a data-driven supply chain to manage inventory, predict customer behavior, plan delivery routes, and manage suppliers. This allows them to offer same-day or next-day deliveries globally.

Q5. Explain the process of creating and formatting a figure in Python for data visualization.

◊ **Introduction:**

In Python, data visualization is commonly done using libraries like **Matplotlib**, **Seaborn**, and **Plotly**. These tools help to convert raw data into understandable visual forms such as bar charts, line graphs, pie charts, and heatmaps.

◊ **Steps to Create and Format a Figure:**

1. Import Required Libraries

```
import matplotlib.pyplot as plt
import seaborn as sns
import pandas as pd
```

2. Prepare the Data

```
data = {
    'Product': ['A', 'B', 'C', 'D'],
    'Sales': [100, 250, 175, 300]
}
df = pd.DataFrame(data)
```

3. Create a Basic Plot

```
plt.figure(figsize=(8,5))
plt.bar(df['Product'], df['Sales'])
```

4. Format the Chart

```
plt.title('Product-wise Sales Performance')
plt.xlabel('Product')
plt.ylabel('Sales Units')
plt.grid(True)
plt.tight_layout()
plt.show()
```

◊ Advanced Formatting Options:

Feature	Description	Example
Color & Style	Custom colors and line styles	color='skyblue', linestyle='--'
Legends	Add labels	plt.legend(['Sales'])
Annotations	Add values on bars	plt.text(x, y, label)
Themes	Using Seaborn for better aesthetics	sns.set_style("whitegrid")

Seaborn Example:

```
sns.barplot(x='Product', y='Sales', data=df, palette='Blues')
plt.title('Sales by Product')
plt.show()
```

◊ Importance in Supply Chain:

- Visualizing trends like demand, stock levels, delivery times
 - Monitoring supplier performance over time
 - Comparing costs, revenues, and margins
 - Sharing insights in management reports and dashboards
-

Q6. Explain different benefits of customer-centered supply chain.

◊ Definition:

A **customer-centered supply chain** is a supply chain strategy that puts the needs, preferences, and expectations of the end customer at the core of its operations. Unlike traditional supply chains that focus on internal efficiency, this model prioritizes **customer satisfaction, responsiveness, and personalization**.

◊ Key Benefits:

1. Enhanced Customer Satisfaction:

- Products and services are tailored to customer expectations, resulting in happier and loyal customers.
- Example: Personalized delivery options or product customization.

2. Faster Delivery Times:

- Processes are optimized to reduce lead times and ensure quick order fulfillment.
- Example: Use of regional distribution centers to enable same-day shipping.

3. **Greater Flexibility:**
 - Customer-centered supply chains can quickly adapt to changes in demand, preferences, or market conditions.
 - Example: Responding to a viral trend by adjusting production priorities.
 4. **Improved Demand Forecasting:**
 - Better understanding of customer behavior leads to more accurate forecasts.
 - Example: Using purchase history and search trends for forecasting.
 5. **Better Customer Engagement and Retention:**
 - Personalized communications and services encourage repeat purchases.
 - Example: Sending tailored offers or restock reminders.
 6. **Reduction in Returns and Complaints:**
 - By delivering exactly what the customer wants, the rate of product returns decreases.
 - Example: Size guides and reviews help customers make informed decisions.
 7. **Higher Revenue and Market Share:**
 - Satisfied customers are more likely to recommend the brand, increasing customer base.
 - Example: Positive reviews and social media recommendations.
 8. **Use of Data-Driven Insights:**
 - Customer feedback and analytics drive continuous improvements.
 - Example: Analyzing post-purchase feedback to improve packaging or delivery methods.
-

◊ **Example:**

Nike allows customers to design their own shoes online. The supply chain is aligned to manufacture and deliver personalized products efficiently, making it highly customer-centric.

Q7. Explain the concept of supplier relationship management with examples.

◊ **Definition:**

Supplier Relationship Management (SRM) is a strategic approach to managing an organization's interactions with the suppliers of goods and services. It involves evaluating suppliers, managing contracts, and developing long-term partnerships to maximize the value and performance of supplier interactions.

The goal of SRM is to **build strong, mutually beneficial relationships** that improve the supply chain's efficiency, reduce costs, foster innovation, and ensure a stable supply of quality goods.

◊ Objectives of SRM:

1. Improve collaboration and communication with key suppliers.
 2. Ensure timely delivery and high quality of goods and services.
 3. Reduce supply chain risks and disruptions.
 4. Promote innovation and joint development initiatives.
 5. Achieve cost savings through long-term partnerships.
-

◊ Key Components of SRM:

1. **Supplier Segmentation:**
 - Classifying suppliers based on criticality, spend, and risk.
 - Example: A pharmaceutical company treats raw material providers as strategic suppliers and stationery providers as transactional.
 2. **Performance Monitoring:**
 - Using KPIs such as on-time delivery, defect rates, and cost efficiency.
 - Tools like scorecards, dashboards, and supplier audits are used.
 3. **Collaboration and Communication:**
 - Regular meetings, joint planning sessions, and information sharing.
 - Encourages trust and transparency.
 4. **Contract Management:**
 - Clearly defining terms, expectations, penalties, and renewal conditions.
 - Helps in managing disputes and compliance.
 5. **Risk Management:**
 - Identifying and mitigating supplier risks (e.g., financial, geopolitical, operational).
-

◊ Types of Supplier Relationships:

Type	Description	Example
Transactional	Based on price and quantity, no long-term commitment	Office supplies vendor
Collaborative	Shared information, mutual benefit	Raw material supplier for auto manufacturing
Strategic Alliance	Deep integration and joint innovation	Apple & Foxconn (iPhone assembly)

◊ Example:

Toyota practices SRM through its *Keiretsu* system, where it builds long-term relationships with suppliers, supports their operations, shares data, and jointly develops new parts and technologies. This approach helped Toyota ensure high quality and resilience during global disruptions.

Q8. What is warehouse management? Explain different principles of warehouse management.

◊ **Definition:**

Warehouse Management refers to the processes involved in operating a warehouse efficiently, including receiving, storing, managing inventory, picking, packing, and shipping goods. It ensures that goods move through the warehouse efficiently and accurately while maintaining optimal inventory levels and minimizing costs.

Warehouse management is often supported by a **Warehouse Management System (WMS)**, a software solution that tracks stock levels, orders, shipments, and workforce.

◊ **Objectives of Warehouse Management:**

- Maximize space utilization
 - Ensure accurate inventory tracking
 - Speed up order fulfillment
 - Reduce labor and operational costs
 - Maintain product safety and quality
-

◊ **Key Principles of Warehouse Management:**

1. **Inventory Accuracy:**
 - Keeping real-time, accurate records of inventory.
 - Techniques: Barcode scanning, RFID, cycle counting.
2. **Efficient Layout Design:**
 - Arranging products in a way that minimizes travel time and speeds up picking.
 - Zones can be organized by product type, frequency, size, or temperature.
3. **First-In, First-Out (FIFO):**
 - Ensuring older stock is shipped before newer stock, especially for perishable goods.
4. **Space Optimization:**
 - Using vertical storage, racking systems, and slotting strategies to utilize every cubic meter.

5. **Process Automation:**
 - Use of conveyor belts, robotics, and WMS to automate repetitive tasks.
 6. **Safety and Compliance:**
 - Ensuring workplace safety regulations, fire prevention, and hazardous material handling.
 7. **Real-time Tracking:**
 - Monitoring inbound and outbound logistics, stock movement, and workforce productivity in real-time.
 8. **Labor Management:**
 - Assigning the right tasks to the right employees and minimizing idle time.
 9. **Order Accuracy:**
 - Reducing picking errors through verification systems and proper labeling.
-

◊ **Example:**

Amazon uses advanced warehouse management principles such as:

- Robot-assisted picking (Kiva robots)
 - Real-time inventory tracking
 - Cross-docking to avoid storing fast-moving items
 - Data-driven layout design to increase fulfillment speed
-

Q9. Explain the procedures of demand forecasting.

◊ **Definition:**

Demand Forecasting is the process of estimating future customer demand for a product or service based on historical data, market trends, and analytical techniques. It is a critical part of supply chain planning and helps businesses maintain the right inventory, optimize production, and meet customer expectations.

◊ **Objectives of Demand Forecasting:**

- Minimize inventory holding and stockout costs
- Plan production and procurement efficiently
- Improve customer satisfaction
- Reduce wastage and obsolescence
- Align workforce and resource planning with expected demand

◊ Steps in the Demand Forecasting Process:

1. Define Objectives:

- Clarify the goal: Is it short-term sales, seasonal demand, or long-term planning?

2. Data Collection:

- Collect relevant data such as:
 - Historical sales
 - Market trends
 - Customer feedback
 - Promotions and pricing
 - Economic indicators

3. Data Preparation:

- Clean and organize the data by removing inconsistencies, duplicates, and outliers.

4. Select Forecasting Method:

Type	Methods	Use Cases
Qualitative	Expert opinion, Delphi method	New product or market
Quantitative	Time series, regression, moving average	Stable, historical demand patterns
Causal	Based on external factors like marketing, economy	Complex forecasting involving variables

5. Apply the Model:

- Use tools like Excel, Python, R, or forecasting software to apply the selected model.

6. Validate and Compare:

- Check accuracy using metrics like **Mean Absolute Error (MAE)** or **Root Mean Square Error (RMSE)**.
- Compare different models and choose the most accurate one.

7. Monitor and Adjust:

- Regularly review forecasts and update based on real-time data and changing conditions.
-

◊ Tools Used in Demand Forecasting:

- **Software:** SAP IBP, Oracle Demantra, Forecast Pro
 - **Languages:** Python (e.g., ARIMA, Prophet, sklearn), R
 - **Techniques:** Moving average, exponential smoothing, neural networks
-

◊ Example:

A fashion retailer uses historical sales data and weather forecasts to predict the demand for winter jackets. This helps them stock enough units before the cold season and avoid overstocking after it ends.

Q10. Explain the process of geographic mapping with Basemap in Python.

◊ Introduction to Geographic Mapping:

Geographic mapping is the process of visualizing data on maps to understand **spatial relationships, distribution patterns, and geographical trends**. In supply chain analysis, this helps with **route optimization, location analysis, tracking deliveries, and logistics planning**.

Python supports geographic visualization through various libraries, and one of the commonly used tools (though now deprecated) is **Basemap**, which was a part of the Matplotlib toolkit. Modern alternatives include **Cartopy**, **Folium**, and **GeoPandas**, but understanding Basemap remains useful for legacy systems.

◊ Key Uses of Geographic Mapping in Supply Chain:

- Track the movement of goods between warehouses and distribution centers.
 - Visualize delivery coverage zones.
 - Monitor supply chain disruptions due to weather or geopolitical issues.
 - Plot customer locations for demand hotspot identification.
-

◊ Steps for Geographic Mapping using Basemap:

Note: You may need to install Basemap using:

```
pip install basemap
```

1. Import Required Libraries

```
from mpl_toolkits.basemap import Basemap  
import matplotlib.pyplot as plt
```

2. Create a Basemap Object

Specify map projection and boundary coordinates.

```
m = Basemap(projection='merc', llcrnrlat=10, urcrnrlat=50,  
            llcrnrlon=60, urcrnrlon=100, resolution='i')
```

- `projection`: Map projection type (e.g., 'merc' for Mercator).
- `llcrnrlat` and `urcrnrlat`: Lower and upper latitude corners.
- `llcrnrlon` and `urcrnrlon`: Lower and upper longitude corners.

3. Draw Map Features

```
m.drawcoastlines()  
m.drawcountries()  
m.drawstates()  
m.drawmapboundary(fill_color='lightblue')  
m.fillcontinents(color='lightgray', lake_color='lightblue')
```

4. Add Points (e.g., Warehouse or Customer Locations)

```
# Example: Plot Kathmandu (Lat: 27.7, Lon: 85.3)  
x, y = m(85.3, 27.7)  
m.plot(x, y, marker='o', color='red', markersize=8)  
plt.text(x + 50000, y + 50000, 'Kathmandu')
```

5. Display the Map

```
plt.title("Warehouse Location - Kathmandu")  
plt.show()
```

◊ Limitations of Basemap:

- Deprecated in favor of **Cartopy**.
 - Less support for interactive mapping compared to tools like **Folium** or **Plotly**.
-

◊ Modern Alternatives:

- **Cartopy**: Better projection handling.
- **Folium**: Interactive web maps with Leaflet.js.

- **GeoPandas:** Spatial data analysis with pandas-style syntax.
-

◊ **Example in Supply Chain:**

A logistics company can plot multiple warehouses and delivery routes to identify bottlenecks and optimize delivery paths.

Q11. What is cohort analysis? How does it help to analyze the customer? Explain.

◊ **Definition:**

Cohort Analysis is a behavioral analytics method that groups customers into **cohorts** (segments) based on shared characteristics or experiences over a specific time frame, such as the month they made their first purchase. It helps businesses understand **customer retention**, **purchase behavior**, and **lifetime value** over time.

◊ **Purpose of Cohort Analysis:**

- Track how different groups of customers behave over time.
 - Measure customer retention rates and repeat purchase trends.
 - Optimize marketing strategies based on segment behavior.
 - Identify product engagement levels and satisfaction rates.
-

◊ **Types of Cohorts:**

1. **Acquisition Cohort:**

- Based on when users made their first purchase or signed up.
- Example: Customers who joined in January 2025.

2. **Behavioral Cohort:**

- Based on user actions or behaviors.
- Example: Customers who bought shoes in the first purchase.

3. **Demographic Cohort:**

- Based on location, age, or other static attributes.
 - Example: Customers from Province 1 or urban areas.
-

◊ Steps in Performing Cohort Analysis:

1. Data Collection:

Gather data on customer ID, order date, purchase amount, and other relevant info.

2. Define Cohorts:

Group customers by acquisition month or first purchase behavior.

```
df['cohort_month'] =  
df.groupby('customer_id')['purchase_date'].transform('min').dt.to_period('M')
```

3. Analyze Customer Activity Over Time:

Create metrics like retention, average spend, or repeat purchase rate across time intervals.

4. Visualize Using Cohort Charts:

- Use a **retention matrix** or **heatmap** to show how many users from each cohort are active in subsequent months.
- Example:
 - | Month 0 | Month 1 | Month 2 |
 - Jan | 100% | 70% | 40% |
 - Feb | 100% | 65% | 35% |

5. Interpret Results:

Identify which cohorts are more loyal or high-value and focus marketing efforts accordingly.

◊ Tools Used:

- **Excel/Pivot Tables**
 - **Python:** pandas, seaborn, matplotlib
 - **SQL:** for cohort-based queries
 - **BI Tools:** Power BI, Tableau
-

◊ Example in E-commerce:

An online shoe store notices that customers who buy during holiday sales (November cohort) return more often and spend more over 6 months than customers from other months. Based on this insight, the company increases promotional efforts in November.

❖ Benefits of Cohort Analysis:

1. **Improved Retention Strategies:** Focus on high-churn cohorts to reduce loss.
 2. **Better Customer Segmentation:** Tailor services or offers for different segments.
 3. **Optimized Marketing Spend:** Invest more in cohorts with higher lifetime value.
 4. **Data-Driven Decision Making:** Clear insights into user behavior over time.
-