MEASI
Institute of Management

SUPPLY CHAIN ANALYTICS QUESTION BANK

UNIT 1: INTRODUCTION TO ANALYTICS & DATA-DRIVEN SUPPLY CHAINS

PART-A (Bloom's Taxonomy K1/K2 - Remember/Understand)

1. Define the three types of analytics: descriptive, predictive, and prescriptive. Provide one example of each in supply chain context.
2. What is a Data-Driven Supply Chain? List four key characteristics that distinguish it from traditional supply chains.
3. Identify the major barriers to implementing analytics in supply chain management.
4. Explain the concept of supply chain transformation through data analytics. What are the primary drivers?
5. Describe the basic components of a roadmap for implementing analytics in supply chain operations.

PART-B (Bloom's Taxonomy K3/K4 - Apply/Analyze)

1. Compare and contrast descriptive, predictive, and prescriptive analytics with specific supply chain examples. Analyze how each type builds upon the previous to create business value.
2. Apply the analytics roadmap framework to a retail company planning to implement demand forecasting. Outline the phases, required resources, and expected challenges at each stage.
3. Analyze the barriers to analytics implementation in a traditional manufacturing supply chain. Categorize these barriers into technological, organizational, and cultural factors, and propose mitigation strategies for each.
4. Examine a case where prescriptive analytics is used for inventory optimization. Demonstrate how historical data (descriptive) and forecasting (predictive) feed into the optimization model (prescriptive).

5. Develop a business case for transforming a conventional supply chain into a data-driven supply chain. Include cost-benefit analysis, key performance indicators, and implementation timeline.

PART-C (Bloom's Taxonomy K5/K6 - Evaluate/Create)

1. Evaluate the readiness of an organization to adopt data-driven supply chain practices. Design a comprehensive maturity assessment model with dimensions including data infrastructure, analytical capabilities, organizational culture, and leadership commitment.
2. Create an end-to-end analytics framework for a global supply chain network that integrates descriptive, predictive, and prescriptive analytics. Justify your architecture choices and demonstrate how different analytics types interact to support decision-making.
3. Critically assess the role of emerging technologies (IoT, AI, Blockchain) in enabling data-driven supply chains. Synthesize these technologies into an integrated roadmap for digital supply chain transformation.
4. Design a change management strategy to overcome organizational resistance to analytics adoption in supply chain operations. Include stakeholder analysis, communication plans, training programs, and success metrics.
5. Synthesize the concepts of supply chain visibility, real-time analytics, and decision automation to propose an innovative control tower framework for managing global supply chain disruptions.

UNIT 2: WAREHOUSING DECISIONS

PART-A (Bloom's Taxonomy K1/K2 - Remember/Understand)

1. Define the P-Median problem in facility location. What is the primary objective of this model?
2. Explain the basic concept of the Balmer-Wolfe method for warehouse location decisions.
3. What are Greedy Drop Heuristics? Describe their application in warehouse location problems.

4. List the key factors that influence warehouse space determination and layout design.
5. Describe the difference between static and dynamic location models in warehousing decisions.

PART-B (Bloom's Taxonomy K3/K4 - Apply/Analyze)

1. Formulate a P-Median problem for locating 3 distribution centers among 8 potential locations to serve 15 customer zones. Define the mathematical model with decision variables, objective function, and constraints.
2. Apply the Guided LP approach to solve a warehouse location problem with the following data: 4 potential warehouse sites, 6 customer locations, fixed costs, variable transportation costs, and capacity constraints.
3. Analyze the trade-offs between centralized and decentralized warehouse networks using mathematical programming models. Compare total costs, service levels, and responsiveness.
4. Use a greedy drop heuristic to reduce the number of warehouses from an initial solution of 10 facilities. Demonstrate the iterative process and calculate cost savings at each step.
5. Develop a dynamic location model that accounts for changing demand patterns over a 5-year planning horizon. Include relocation costs and demonstrate how the optimal network evolves.

PART-C (Bloom's Taxonomy K5/K6 - Evaluate/Create)

1. Evaluate different warehouse location methodologies (P-Median, Set Covering, Center of Gravity) for a retail company expanding into new markets. Design a hybrid approach that combines the strengths of multiple methods.
2. Create a comprehensive warehouse network optimization model that integrates location decisions, capacity planning, and inventory policies. Formulate the mixed-integer programming model and propose a solution methodology.

3. Synthesize space determination models with layout optimization techniques to design an efficient warehouse facility. Include material handling considerations, storage systems selection, and labor productivity factors.
4. Critically assess the limitations of static location models in today's dynamic business environment. Design an adaptive warehouse network strategy that incorporates flexibility and can respond to market uncertainties.
5. Develop an integrated decision support system for warehouse location and sizing decisions that combines mathematical optimization with simulation modeling. Justify the model architecture and demonstrate how it addresses real-world complexities.

UNIT 3: INVENTORY MANAGEMENT

PART-A (Bloom's Taxonomy K1/K2 - Remember/Understand)

1. Define inventory aggregation and explain how it reduces overall inventory costs in a supply chain.
2. What is the Wagner-Whitin algorithm? Describe its application in dynamic lot sizing problems.
3. Explain the concept of multi-echelon inventory systems. What are the key challenges in managing them?
4. List and describe the three types of supply chain risks: transit risks, supply risks, and delivery risks.
5. What is risk pooling? Explain how it works as a strategy to reduce inventory variability.

PART-B (Bloom's Taxonomy K3/K4 - Apply/Analyze)

1. Apply inventory aggregation principles to a company with 5 regional warehouses. Calculate the safety stock requirements before and after consolidation, given demand standard deviations and service level targets.

2. Use the Silver-Meal heuristic to solve a dynamic lot sizing problem with the following demand pattern over 6 periods: D = [50, 60, 40, 70, 55, 65]. Include setup cost = $200 and holding cost = $2/unit/period.

3. Analyze a two-echelon inventory system with one central warehouse and three retailers. Develop the base-stock policy and calculate optimal inventory levels at each location using given demand and cost parameters.

4. Examine the LIMIT (Lot-size Inventory Management Interpolation Technique) approach for aggregate inventory systems. Apply it to determine optimal order quantities for a product family with 8 SKUs.

5. Assess transit risk for a global supply chain using variance reduction through risk pooling. Calculate the coefficient of variation before and after implementing a postponement strategy.

PART-C (Bloom's Taxonomy K5/K6 - Evaluate/Create)

1. Evaluate the effectiveness of different dynamic lot sizing methods (Wagner-Whitin, Silver-Meal, Least Unit Cost, Part-Period Balancing) for a product with highly variable demand. Design a decision framework for selecting the most appropriate method based on demand characteristics.

2. Create a comprehensive multi-echelon inventory optimization model for a three-tier supply chain (suppliers-manufacturers-retailers). Incorporate stochastic demand, lead times, and service level constraints. Formulate the optimization problem.

3. Synthesize inventory aggregation strategies with risk pooling concepts to design an innovative distribution network for an e-commerce company. Justify your design choices considering trade-offs between cost, service, and flexibility.

4. Critically assess various risk measurement methodologies in supply chains. Develop an integrated risk management framework that combines qualitative and quantitative approaches to measure and mitigate transit, supply, and delivery risks.

5. Design a dynamic inventory management system that adapts to supply chain disruptions in real-time. Integrate multi-echelon optimization with

risk analysis to create contingency policies tailored to different risk scenarios.

UNIT 4: TRANSPORTATION NETWORK MODELS

PART-A (Bloom's Taxonomy K1/K2 - Remember/Understand)

1. Define the basic terminology of graph theory as applied to transportation networks: nodes, arcs, paths, and cycles.
2. Explain the concept of Minimal Spanning Tree. What is its significance in network design?
3. Describe Dijkstra's shortest path algorithm. Under what conditions is it most effectively used?
4. What is the Traveling Salesman Problem (TSP)? State why it is classified as an NP-hard problem.
5. Define the maximal flow problem. Explain the concept of flow capacity and bottleneck arcs.

PART-B (Bloom's Taxonomy K3/K4 - Apply/Analyze)

1. Apply Kruskal's or Prim's algorithm to find the Minimal Spanning Tree for a network with 8 nodes and 15 edges. Show the step-by-step selection process and calculate the total minimum cost.
2. Use Dijkstra's algorithm to find the shortest path from source node A to all other nodes in a network with 6 nodes. Provide the distance labels at each iteration and construct the shortest path tree.
3. Solve a maximal flow problem using the Ford-Fulkerson algorithm for a network with given arc capacities. Identify the maximum flow value and the minimum cut that limits the flow.
4. Formulate and solve a multistage transshipment problem with 3 supply nodes, 2 transshipment nodes, and 4 demand nodes. Use the transportation simplex method or network optimization approach.

5. Apply the nearest neighbor heuristic and 2-opt improvement procedure to solve a 10-city Traveling Salesman Problem. Compare the solution quality and computational effort.

PART-C (Bloom's Taxonomy K5/K6 - Evaluate/Create)

1. *Evaluate different shortest path algorithms (Dijkstra, Bellman-Ford, Floyd-Warshall, A) for various transportation network scenarios. Design a decision tree that guides the selection of the most appropriate algorithm based on network characteristics.**
2. Create an advanced Vehicle Routing Problem (VRP) solution that incorporates time windows, heterogeneous fleet, and multiple depots. Formulate the mathematical model and propose a hybrid metaheuristic approach combining genetic algorithms with local search.
3. Synthesize set covering and set partitioning formulations to design an optimal delivery route network for last-mile logistics. Develop a column generation approach to solve large-scale instances efficiently.
4. Critically assess the deficit function approach and linking algorithms for scheduling problems in transportation. Design an integrated scheduling system for a logistics company managing both vehicle routing and driver scheduling simultaneously.
5. Develop a comprehensive decision support framework for real-time transportation network optimization that combines shortest path algorithms, maximal flow models, and dynamic vehicle routing. Include adaptive capabilities for handling traffic disruptions and demand fluctuations.

UNIT 5: MULTI-CRITERIA DECISION MAKING (MCDM) MODELS

PART-A (Bloom's Taxonomy K1/K2 - Remember/Understand)

1. Define the Analytic Hierarchy Process (AHP). Explain the concept of pairwise comparison and consistency ratio.

2. What is Data Envelopment Analysis (DEA)? Describe its basic principle for measuring efficiency.
3. Explain the fundamental concepts of fuzzy logic. How does it differ from classical binary logic?
4. Describe the Analytic Network Process (ANP). How does it extend the capabilities of AHP?
5. What is TOPSIS (Technique for Order Preference by Similarity to Ideal Solution)? Outline its basic steps.

PART-B (Bloom's Taxonomy K3/K4 - Apply/Analyze)

1. Apply AHP to select the best supplier among four alternatives based on criteria: cost (40%), quality (30%), delivery (20%), and flexibility (10%). Construct the pairwise comparison matrices and calculate priority weights. Verify consistency.
2. Use DEA to evaluate the relative efficiency of 6 distribution centers with inputs (labor hours, warehouse space) and outputs (orders processed, customer satisfaction). Identify efficient and inefficient units using the CCR model.
3. Analyze a supplier selection problem using fuzzy logic. Convert linguistic variables (e.g., "good quality," "high cost") into triangular fuzzy numbers and perform fuzzy arithmetic operations to rank alternatives.
4. Apply the TOPSIS method to evaluate 5 transportation modes based on 6 criteria (cost, speed, reliability, capacity, flexibility,

environmental impact). Calculate separation measures and relative closeness to determine the ranking.

5. Develop an ANP model for a strategic supply chain network design problem considering interdependencies between location selection, supplier choice, and distribution strategy. Construct the supermatrix and calculate limiting priorities.

PART-C (Bloom's Taxonomy K5/K6 - Evaluate/Create)

1. Evaluate the strengths and limitations of AHP and ANP for complex supply chain decisions. Design a hybrid MCDM framework that

combines AHP/ANP with other techniques (fuzzy logic, TOPSIS) to address uncertainty and interdependencies simultaneously.

2. Create a comprehensive supplier performance evaluation system using integrated DEA and AHP. Use AHP to determine criteria weights and DEA to measure technical and scale efficiency. Demonstrate how this combination provides superior insights.

3. Synthesize fuzzy logic techniques with TOPSIS to develop a Fuzzy-TOPSIS model for green supplier selection. Incorporate environmental criteria with linguistic assessments and demonstrate the complete methodology with a case study.

4. Critically assess different MCDM methods (AHP, ANP, TOPSIS, ELECTRE, PROMETHEE) for their suitability in various supply chain decision contexts. Design a decision support system that automatically recommends the most appropriate method based on problem characteristics.

5. Develop an integrated MCDM framework for sustainable supply chain management that combines multiple techniques: ANP for capturing interdependencies, fuzzy logic for handling uncertainty, DEA for efficiency analysis, and TOPSIS for final ranking. Apply this framework to a real-world case of selecting sustainable logistics partners.