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MGMT714

Advanced Supply Chain Management

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MGMT714

Advanced Supply Chain Management

Lecture-Wise Study Handout
Virtual University of Pakistan

14 lectures • prepared for exam study 

Table of Contents

1. Supply Chain Management: Concept and Strategic Fit
2. The Six Drivers of Supply Chain Performance
3. Supply Chain Network Design
4. Demand Forecasting
5. Aggregate Planning and S&OP;
6. Inventory Management: EOQ and Safety Stock
7. Transportation and Distribution
8. Sourcing and Supplier Relationships
9. Coordination and the Bullwhip Effect
10. Information Technology in the Supply Chain
11. Pricing, Revenue Management and the Newsvendor
12. Sustainable and Green Supply Chains
13. Supply Chain Risk and Resilience
14. Global Supply Chains and Future Trends

About This Course

Supply chain management coordinates the flow of products, information and funds from raw-material suppliers to end customers. Advanced SCM goes beyond the basics into network design, planning under uncertainty, coordination, and the strategic use of supply chains for competitive advantage.

This handout covers SCM strategy and drivers, network design, forecasting, aggregate planning, inventory, transportation, sourcing, coordination and the bullwhip effect, information technology, sustainability, risk and performance measurement — with definitions, examples and exam pointers  throughout.

Lecture 1: Supply Chain Management: Concept and Strategic Fit

Learning Objectives

- Define SCM
- Apply strategic fit

A supply chain encompasses all parties involved in fulfilling a customer request: suppliers, manufacturers, distributors, retailers and the customers themselves. Supply chain management is the coordination of product, information and fund flows across these parties to maximize total supply chain surplus — the value created minus the cost of fulfilling it.

SCM decisions fall into three phases. Strategic (design): facility locations, capacities, products, transport modes — years-long commitments. Planning: demand forecasts, inventory policies, promotions — quarterly to yearly. Operational: daily order fulfillment, scheduling, last-mile delivery. Higher phases constrain lower ones — a badly located warehouse cannot be fixed by clever daily scheduling.

The strategic fit principle is very important: the supply chain's capabilities (responsiveness vs efficiency) must match the product's demand uncertainty. Functional products (stable demand: groceries) need efficient chains; innovative products (uncertain demand: fashion tech) need responsive chains. Mismatch — an efficient chain for an innovative product — causes stockouts and markdowns simultaneously.

Key Definitions

Supply chain surplus is defined as the total value created by the supply chain minus the cost of fulfilling customer requests

Key Points — very important for exams

SCM coordinates product, information and fund flows to maximize total surplus.

Decisions: strategic design (years) → planning (quarters) → operations (daily); upper constrains lower.

Strategic fit: efficient chains for functional products; responsive chains for innovative products.

Review Questions

- ? What is supply chain surplus?
- ? Give a strategic-fit mismatch example and its consequences.

Section Summary

SCM maximizes chain-wide surplus through fitted, phased decisions from network design to daily delivery.

Exam Pointers

- Define SCM and its decision phases; explain strategic fit with examples.

Lecture 2: The Six Drivers of Supply Chain Performance

Learning Objectives

- Identify SCM drivers
- Trade efficiency against responsiveness

Supply chain performance rests on drivers. Facilities (location, capacity) decide proximity and scale; inventory (cycle, safety, seasonal) buffers uncertainty; transportation (mode, routing) trades speed against cost; information (forecasts, visibility) enables coordination; sourcing (supplier choice) sets cost and resilience; pricing (revenue management) shapes demand to match supply.

Each driver faces an efficiency–responsiveness trade-off: more facilities, inventory and fast transport raise responsiveness but also cost. The art is positioning each driver on the efficient frontier consistent with strategic fit — Zara's fast fashion accepts higher transport cost for speed; Walmart's everyday-low-price accepts slower replenishment for cost.

Cross-functional drivers (information, sourcing, pricing) are the advanced levers: information sharing tames the bullwhip effect, strategic sourcing builds resilient supply bases, and pricing/revenue management aligns demand with capacity — topics developed in later lectures.

Key Definitions

Supply chain drivers is defined as the six levers — facilities, inventory, transportation, information, sourcing, pricing — determining SCM performance

Key Points — very important for exams

Drivers: facilities, inventory, transportation, information, sourcing, pricing.

Each trades efficiency against responsiveness; position per strategic fit.

Cross-functional drivers (information, sourcing, pricing) are the advanced coordination levers.

Review Questions

- ? How does Zara's driver positioning differ from Walmart's?
- ? Why is information a driver, not just a support?

Section Summary

Six drivers, one trade-off: tune each for the responsiveness your strategy demands.

Exam Pointers

- List the six drivers and explain the efficiency–responsiveness trade-off.

Lecture 3: Supply Chain Network Design

Learning Objectives

- Design distribution networks
- Apply inventory centralization logic

Network design decides the number, location and capacity of facilities — the chain's physical skeleton. The classic trade-off: more facilities cut transport cost and response time but raise facility and inventory costs (safety stock multiplies across locations — the square-root law of inventory). E-commerce (few large fulfilment centres) and retail (many stores) sit at opposite ends.

Quantitative models guide design: the gravity model locates a single facility at the demand-weighted centre; network optimization (mixed-integer programming) chooses among candidate sites considering fixed costs, transport rates and capacities. Qualitative factors — labour, taxes, infrastructure, political stability — then filter the mathematics.

Design must handle uncertainty: flexible capacity (overtime, outsourcing options), postponed differentiation, and scenario planning for demand shifts. A network designed only for the forecast fails at the first surprise — robustness is designed in, not added later.

Key Definitions

Square-root law of inventory is defined as the principle that total safety stock grows with the square root of the number of stocking locations

Key Points — very important for exams

Trade-off: more facilities → lower transport/faster response but higher facility + inventory costs.

Models: gravity location, network optimization; qualitative filters (labour, tax, stability).

Design for uncertainty: flexible capacity, postponement, scenarios — robustness by design.

Review Questions

- ? Why does e-commerce centralize while retail disperses?
- ? What is the square-root law's implication for consolidation?

Section Summary

Network design skeletons the chain: locate for cost and speed, but engineer for uncertainty.

Exam Pointers

→ Explain network design trade-offs and the square-root law with the e-commerce vs retail contrast.

Lecture 4: Demand Forecasting

Learning Objectives

- Choose forecasting methods
- Measure and manage forecast error

Demand forecasting drives all planning. Qualitative methods (market research, expert panels, Delphi) suit new products; time-series methods (moving averages, exponential smoothing, trend-and-seasonality decomposition) extrapolate history; causal methods (regression on price, promotions, economic indicators) model drivers. Advanced practice blends methods and judgment.

Forecast error is inevitable — plan for it, don't pretend it away. Measures (MAD, MSE, MAPE, bias) track accuracy; the forecast is always wrong, so safety stock, flexible capacity and responsive transport must cover the error. Aggregate forecasts (product families) are more accurate than SKU-level ones — forecast at the level you plan.

Collaborative planning, forecasting and replenishment (CPFR) shares forecasts between retailers and suppliers, cutting the information distortion behind the bullwhip effect. Point-of-sale data shared upstream is the single most powerful forecast input — a very important practical point. 

Key Definitions

CPFR is defined as sharing forecasts and plans between supply chain partners to reduce distortion

Key Points — very important for exams

Methods: qualitative (new products), time-series (history), causal (drivers); blend them.

Forecasts are always wrong — measure error (MAPE, bias) and buffer with stock/capacity.

Aggregate forecasts beat SKU forecasts; share POS data upstream (CPFR).

Review Questions

- ? Which method for a brand-new product? Why?
- ? How does CPFR reduce the bullwhip effect?

Section Summary

Forecast honestly, measure error, share data — and plan buffers for the inevitable miss.

Exam Pointers

→ Compare forecasting methods; explain error measurement and CPFR.

Lecture 5: Aggregate Planning and S&OP;

Learning Objectives

- Build aggregate plans
- Run S&OP; logic

Aggregate planning balances supply and demand over 3–18 months at the product-family level. Strategies: chase (vary workforce/production with demand — low inventory, hiring/firing costs), level (constant production, inventory absorbs swings — stable workforce, holding costs), and mixed strategies blending both, plus subcontracting, overtime and backlogging as adjustment levers.

Costs drive the choice: hiring/firing, overtime premium, inventory holding, stockout/backlog penalties. Linear programming can optimize the mix, but the strategic insight matters more: chase suits flexible labour markets; level suits skilled, hard-to-replace workforces.

Sales and operations planning (S&OP;) is aggregate planning's organizational form: a monthly cross-functional process reconciling demand plans with supply capabilities into one agreed plan. S&OP; maturity — from spreadsheet arguments to integrated scenario planning — predicts planning performance.

Key Definitions

S&OP; (Sales and Operations Planning) is defined as the monthly cross-functional process reconciling demand and supply into one operating plan

Key Points — very important for exams

Chase: vary production (hiring/firing costs); level: steady output, inventory buffers; mixed blends.

Choose by cost structure and labour flexibility; LP can optimize.

S&OP;; monthly demand–supply reconciliation into one plan — process maturity matters.

Review Questions

? When is chase strategy preferable to level?

? What goes wrong without S&OP;?

Section Summary

Balance supply and demand over months with chase/level mixes — reconciled monthly through S&OP.;

Exam Pointers

→ Compare chase, level and mixed aggregate strategies; describe S&OP.;

Lecture 6: Inventory Management: EOQ and Safety Stock

Learning Objectives

- Compute EOQ
- Set safety stocks

Inventory exists because supply and demand are mismatched in time, quantity and uncertainty. Types: cycle stock (from batch ordering), safety stock (against variability), seasonal stock (anticipatory), pipeline stock (in transit). Holding inventory costs capital, space, risk and obsolescence; not holding it costs stockouts and expediting.

The EOQ model balances ordering and holding costs: $Q^* = \sqrt{(2DS/H)}$ — order this quantity to minimize total cost. Its assumptions (constant demand, fixed costs) rarely hold exactly, but its insights — larger

orders when ordering is costly, sensitivity analysis — are robust. Reorder-point systems trigger orders at demand-during-lead-time plus safety stock.

Safety stock quantifies uncertainty: $z \times \sigma \times \sqrt{L}$ — service level (z), demand variability (σ), lead time (L). Reduce it by cutting variability (better forecasts), shortening lead times, or pooling (centralization). The very important managerial message: safety stock is the price of uncertainty — attack the uncertainty, not just the stock.

Key Definitions

EOQ (Economic Order Quantity) is defined as the order quantity minimizing total ordering plus holding cost: $\sqrt{(2DS/H)}$

Key Points — very important for exams

Inventory types: cycle, safety, seasonal, pipeline — each mismatches supply and demand.

EOQ balances ordering vs holding: $Q^* = \sqrt{(2DS/H)}$; insights beat exact assumptions.

Safety stock = $z \cdot \sigma \cdot \sqrt{L}$: cut it via better forecasts, shorter lead times, pooling.

Review Questions

- ? What happens to EOQ if ordering cost doubles?
- ? Name three ways to reduce safety stock without hurting service.

Section Summary

Order economically, stock scientifically — and shrink uncertainty to shrink stock.

Exam Pointers

- Derive EOQ intuition and explain safety stock's three levers.

Lecture 7: Transportation and Distribution

Learning Objectives

- Choose transport modes
- Design distribution flows

Transportation moves product; its choice trades cost against speed and flexibility. Modes: air (fastest, costliest — high-value, urgent), truck (flexible, door-to-door — the backbone), rail (cheap for heavy bulk over land), water (cheapest per ton — containers, commodities), pipeline (specialized), intermodal (combining modes). Total landed cost — not freight rate alone — decides.

Network design shapes transport: direct shipping (full truckloads, cross-docking) versus milk runs and hub-and-spoke consolidation. Cross-docking — inbound trucks unload directly to outbound trucks with near-zero storage — made Walmart's distribution legendary. Last-mile delivery dominates e-commerce cost and customer experience.

Incoterms allocate international transport responsibility between buyer and seller; 3PLs (third-party logistics) outsource execution while the firm keeps control. The exam lens: total cost + service — mode, routing and outsourcing chosen together. 

Key Definitions

Cross-docking is defined as distribution with goods transferred directly from inbound to outbound trucks, minimal storage

Key Points — very important for exams

Modes trade speed vs cost: air > truck > rail > water; decide on total landed cost.

Cross-docking and consolidation cut handling; last mile dominates e-commerce cost.

3PLs outsource execution; Incoterms split international responsibility.

Review Questions

? When is air freight justified?

? How does cross-docking reduce cost?

Section Summary

Move it at the right speed and cost — mode, consolidation and outsourcing as one decision.

Exam Pointers

→ Compare transport modes and explain cross-docking and last-mile economics.

Lecture 8: Sourcing and Supplier Relationships

Learning Objectives

- Classify purchases
- Design sourcing strategies

Sourcing decides who supplies what: supplier selection (cost, quality, reliability, capacity, sustainability), single versus multiple sourcing (leverage and partnership vs resilience and competition), and contract design. The Kraljic matrix classifies purchases: leverage items (bid competitively), strategic items (partner deeply), bottleneck items (secure supply), routine items (automate) — different items, different strategies.

Strategic supplier relationships go beyond price: early supplier involvement in design, shared improvement programs, and long-term commitments that justify supplier investment. But partnership concentrates risk — the advanced answer is segmented relationships: partner where it matters, transact where it doesn't.

Procurement economics: total cost of ownership (price + quality failure + disruption risk) beats purchase price; auctions suit commodities, negotiations suit complex strategic buys. E-procurement

and catalogues tame routine spending so professionals can focus on the strategic.

Key Definitions

Kraljic matrix is defined as the purchasing portfolio matrix sorting items into leverage, strategic, bottleneck and routine quadrants

Key Points — very important for exams

Kraljic: leverage (compete), strategic (partner), bottleneck (secure), routine (automate).

Partner where it matters, transact where it doesn't — segmentation manages risk.

Decide on total cost of ownership, not purchase price; auctions for commodities, negotiation for strategy.

Review Questions

? Where would semiconductors for a phone maker sit in Kraljic? Why?

? Why is purchase price a misleading metric?

Section Summary

Source strategically: classify, segment relationships, and buy on total cost.

Exam Pointers

→ Explain the Kraljic matrix and single vs multiple sourcing with contract implications.

Lecture 9: Coordination and the Bullwhip Effect

Learning Objectives

- Diagnose the bullwhip effect
- Design coordination mechanisms

The bullwhip effect — order variability amplifying upstream — is SCM's classic pathology. A small retail demand swing becomes a factory production earthquake. Causes: demand forecasting (each stage forecasts from orders, not demand), order batching, price fluctuations (forward buying on promotions), rationing gaming (inflating orders when supply is short), and lead-time delays.

Consequences: excess safety stock, poor service, expediting costs, and strained relationships — everyone pays for distortion. Remedies attack causes: share POS data, reduce batch sizes (EDLP pricing, smaller lots), stabilize prices, allocate fairly without gaming incentives, shorten lead times.

Coordination mechanisms align incentives: contracts (buyback, revenue-sharing, quantity flexibility) share risk; CPFR shares information; vendor-managed inventory (VMI) gives the supplier the demand signal directly. The exam theme: bullwhip is an information and incentive problem — fix information flow and incentives.

Key Definitions

Bullwhip effect is defined as the amplification of order variability moving upstream in a supply chain

Key Points — very important for exams

Bullwhip: small retail swings → upstream earthquakes; causes: forecasting, batching, price games, rationing, lead times.

Costs: excess stock, poor service, expediting — everyone pays.

Fixes: share POS data, EDLP, VMI, risk-sharing contracts — information + incentives.

Review Questions

- ? How do promotions cause the bullwhip effect?
- ? How does VMI attack the root cause?

Section Summary

Distorted information whips the chain — share real demand and align incentives to calm it.

Exam Pointers

→ Explain bullwhip causes, consequences and remedies with coordination mechanisms.

Lecture 10: Information Technology in the Supply Chain

Learning Objectives

- Map IT to SCM needs
- Evaluate emerging technologies

Information technology makes modern SCM possible. ERP systems integrate transactions across the firm; advanced planning systems (APS) optimize networks, plans and schedules; WMS/TMS execute warehouse and transport; visibility platforms track shipments in real time. The progression — transact, plan, execute, see — structures IT choices.

E-business transformed chains: e-procurement, online marketplaces, and platform models (Amazon, Alibaba) that orchestrate ecosystems rather than owning inventory. Blockchain pilots promise tamper-evident traceability (food safety, conflict minerals); IoT sensors stream condition data (cold-chain temperature); AI forecasts demand and optimizes routes.

Technology's limits are organizational: systems fail when processes are broken, data is dirty, or partners won't share. The very important lesson: digitize good processes and trusted relationships — software amplifies both discipline and dysfunction.

Key Definitions

ERP is defined as software integrating a firm's transactions and master data across functions

Key Points — very important for exams

ERP (transact) → APS (plan) → WMS/TMS (execute) → visibility (see).

E-business: platforms orchestrate ecosystems; blockchain/IoT/AI add traceability and intelligence.

Limits: broken processes, dirty data, unwilling partners — digitize discipline, not dysfunction.

Review Questions

- ? What does each system layer (ERP/APS/WMS) do?
- ? Why do SCM IT projects fail organizationally?

Section Summary

IT enables the chain — but only trusted processes and clean data let it deliver.

Exam Pointers

- Describe SCM information systems and evaluate e-business, IoT and blockchain applications.

Lecture 11: Pricing, Revenue Management and the Newsvendor

Learning Objectives

- Apply newsvendor logic
- Design revenue management

Revenue management adjusts pricing and availability to match demand with capacity: airlines, hotels and fashion retailers are the masters — segmenting customers by willingness to pay and protecting capacity for high-value demand. The newsvendor model is the foundational math: order quantity balancing overstock against understock costs for single-period perishable products.

Markdown optimization, promotions planning and assortment decisions extend the logic to retail. Dynamic pricing (ride-hailing surge, e-commerce repricing) automates it — with the caveat that customer fairness perceptions constrain algorithms; surge pricing during emergencies backfires reputationally.

The SCM link is profound: pricing shapes demand to fit supply, reducing the mismatch inventory and capacity must absorb. Coordinated pricing and operations — not operations alone — maximize surplus. Exam favourite: solve a newsvendor intuition (order more when understock cost dominates).

Key Definitions

Newsvendor model is defined as the single-period inventory model balancing overstock and understock costs for perishables

Key Points — very important for exams

Revenue management: segment, price and protect capacity to match demand with supply.

Newsvendor: balance overstock vs understock costs for perishables — order up when stockout hurts more.

Dynamic pricing automates it; fairness constrains it; pricing + operations maximize surplus.

Review Questions

- ? When should a newsvendor order aggressively?
- ? Why did surge pricing during crises backfire?

Section Summary

Price to shape demand — the cheapest capacity is demand that fits supply.

Exam Pointers

→ Explain revenue management and the newsvendor logic with applications.

Lecture 12: Sustainable and Green Supply Chains

Learning Objectives

- Design green supply chains
- Build the sustainability business case

Green SCM reduces environmental harm: carbon footprinting, green procurement, eco-design, reverse logistics (returns, recycling, remanufacturing) and closed-loop supply chains where products return for reuse. Regulation (emissions standards, extended producer responsibility) and customers increasingly demand it; cost often favours it — waste is inefficiency.

Circular economy thinking redesigns the chain: products designed for disassembly, packaging minimized, waste streams becoming inputs. Patagonia's repairs, Dell's recycled plastics, and industrial symbiosis (one factory's waste = another's input) show the models. Measurement — lifecycle assessment, Scope 1/2/3 emissions — makes it manageable.

The business case: risk reduction (regulation, reputation), cost reduction (energy, materials), and revenue (green premium segments). Very important: sustainability is now a supply chain design criterion alongside cost and service — the triple bottom line in operations.

Key Definitions

Reverse logistics is defined as managing product returns, recycling and remanufacturing to recapture value and reduce waste

Key Points — very important for exams

Green SCM: carbon, eco-procurement, reverse logistics, closed loops.

Circular economy: design for disassembly; waste = input; measure via lifecycle assessment.

Business case: risk, cost, revenue — sustainability as a design criterion.

Review Questions

- ? What is a closed-loop supply chain? Give an example.
- ? How is waste reduction also cost reduction?

Section Summary

Green chains cut harm and often cost — design for the triple bottom line.

Exam Pointers

- Explain green SCM practices and the circular economy business case.

Lecture 13: Supply Chain Risk and Resilience

Learning Objectives

- Manage supply chain risk
- Trade efficiency against resilience

Supply chain risk has moved from footnote to boardroom: natural disasters, pandemics, geopolitical shocks, supplier bankruptcies and cyberattacks. Risk management follows: identify (map the chain to tier-2/3 suppliers), assess (probability × impact), mitigate and monitor. Most firms discover they cannot see past tier 1 — the first gap to close.

Mitigation strategies: diversification (multi-sourcing, multi-region), redundancy (safety stock, backup capacity), flexibility (postponement, flexible contracts), and visibility (control towers, stress testing). Resilience — recovery speed — increasingly matters more than robustness — withstanding shock — because shocks are now certain, only their form uncertain.

The efficiency–resilience trade-off is the advanced theme: lean eliminated buffers that shocks require. The answer is segmented resilience — lean where stable, buffered where critical — plus the realization, priced in after recent crises, that resilience has quantifiable value.

Key Definitions

Resilience is defined as a supply chain's ability to recover quickly from disruptions

Key Points — very important for exams

Process: map (to tier 2/3) → assess (probability × impact) → mitigate → monitor.

Mitigations: diversify, redundancy, flexibility, visibility/control towers.

Segmented resilience: lean where stable, buffered where critical — resilience has value.

Review Questions

- ? Why is tier-1 visibility insufficient?

? Contrast robustness and resilience.

Section Summary

Shocks are certain; map deeply, buffer smartly, and recover fast.

Exam Pointers

→ Describe the risk management process and the efficiency–resilience trade-off.

Lecture 14: Global Supply Chains and Future Trends

Learning Objectives

- Manage global supply chains
- Anticipate SCM trends

Global supply chains chase comparative advantage — cost, skills, markets — but add complexity: longer lead times, currency and political risk, cultural and language barriers, and coordination across time zones. Offshoring, nearshoring and reshoring decisions weigh landed cost against risk and responsiveness; recent shocks have shifted the calculus toward regionalization.

Managing globally requires: Incoterms and trade compliance, currency hedging, quality systems that work across cultures, and ethical sourcing — labour standards, conflict minerals, anti-corruption — now demanded by regulators and consumers. Audits plus capability-building beat audits alone.

The future: diversified regional networks, digital twins for design and disruption simulation, AI-driven planning, autonomous logistics, and sustainability as a qualifier. The course's closing message: the supply chain is a strategic weapon — designed deliberately, it wins markets; neglected, it loses them.

Key Definitions

Digital twin is defined as a virtual replica of the supply chain used to simulate designs and disruptions

Key Points — very important for exams

Global = comparative advantage + complexity: lead times, currency, politics, culture.

Manage via Incoterms, hedging, cross-cultural quality, ethical sourcing.

Future: regionalization, digital twins, AI planning, autonomy, sustainability as qualifier.

Review Questions

- ? What shifted firms from offshoring toward regionalization?
- ? How would you use a digital twin?

Section Summary

Think global, design regional, digitize everything — the supply chain as strategic weapon.

Exam Pointers

→ Discuss global SCM complexities and future trends.

Glossary of Key Terms

Supply chain surplus — the total value created by the supply chain minus the cost of fulfilling customer requests

Supply chain drivers — the six levers — facilities, inventory, transportation, information, sourcing, pricing — determining SCM performance

Square-root law of inventory — the principle that total safety stock grows with the square root of the number of stocking locations

CPFR — sharing forecasts and plans between supply chain partners to reduce distortion

S&OP; (Sales and Operations Planning) — the monthly cross-functional process reconciling demand and supply into one operating plan

EOQ (Economic Order Quantity) — the order quantity minimizing total ordering plus holding cost:
 $\sqrt{(2DS/H)}$

Cross-docking — distribution with goods transferred directly from inbound to outbound trucks, minimal storage

Kraljic matrix — the purchasing portfolio matrix sorting items into leverage, strategic, bottleneck and routine quadrants

Bullwhip effect — the amplification of order variability moving upstream in a supply chain

ERP — software integrating a firm's transactions and master data across functions

Newsvendor model — the single-period inventory model balancing overstock and understock costs for perishables

Reverse logistics — managing product returns, recycling and remanufacturing to recapture value and reduce waste

Resilience — a supply chain's ability to recover quickly from disruptions

Digital twin — a virtual replica of the supply chain used to simulate designs and disruptions