



# **Certified in Logistics, Transportation and Distribution**

**Storage Systems**



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# **Storage Systems**

## **1. Principles of Storage System Design**

Effective storage systems rely on space utilization, accessibility, product protection, throughput requirements, and safety. Understanding how these principles interact helps determine the best storage method for different product profiles. Key considerations include SKU velocity, load characteristics, replenishment frequency, and storage density. Mastery of these principles establishes a foundation for designing efficient, scalable, and cost-effective storage operations aligned with organizational goals.

## **2. Inventory Classification and Slotting**

Slotting places products in optimal storage locations based on velocity, demand patterns, size, weight, and handling requirements. ABC analysis and cube-per-order index (COI) help determine optimal placement. High-velocity items receive prime locations near pick paths, while slower-moving SKUs are placed in higher or more distant locations. Proper slotting reduces travel, improves picking rates, and enhances overall storage efficiency.

## **3. Static Shelving Systems**

Static shelving is suited for small, lightweight items with low turnover. It offers simplicity, low cost, and easy reconfiguration. Shelving may be open, closed, bin-based, or modular. Understanding its limitations—poor space utilization, limited height, and labor-intensive access—is essential. Static shelving plays a critical role in maintenance parts storage, office supplies, and slow-moving items.

#### **4. Pallet Racking Basics**

Pallet racking stores palletized goods and supports high-density storage. Components include uprights, beams, bracing, and decking. Understanding rack configuration, seismic requirements, load rating, and rack safety ensures proper selection and operation. Pallet racking is foundational in most warehouses, making its principles essential for CLTD mastery.

#### **5. Selective Pallet Racking**

Selective racking offers 100% accessibility to all pallets, making it ideal for high SKU counts and moderate inventory levels. While not the highest-density option, its flexibility and ease of reconfiguration make it widely used. Understanding aisle widths, forklift types, load handling, and rack height optimization is critical for designing selective pallet storage systems.

#### **6. Drive-In and Drive-Through Racking**

Drive-in and drive-through racking are high-density systems for large quantities of the same SKU. Forklifts enter the rack structure, storing pallets in deep lanes. Drive-in supports LIFO, while drive-through supports FIFO. These systems maximize cube utilization but require careful consideration of load stability, upright protection, and operational safety due to higher forklift interaction.

#### **7. Push-Back Racking**

Push-back racking uses carts or gravity rollers mounted on inclined rails to store multiple pallets deep. When one pallet is removed, the next rolls forward. It supports LIFO and provides higher density than selective racking while

maintaining good accessibility. Key considerations include load compatibility, depth limitations, and maintenance of cart mechanisms.

## **8. Pallet Flow (Gravity Flow) Racking**

Pallet flow systems use inclined roller lanes that allow pallets to flow from the loading side to the picking side, supporting true FIFO. They maximize space utilization and throughput but require uniform pallet quality and reliable braking systems. These systems are ideal for fast-moving, perishable, or date-sensitive goods. Understanding flow dynamics and lane maintenance is critical.

## **9. Cantilever Racking**

Cantilever racking is used for long, bulky items such as lumber, pipes, and furniture. It provides open access with arms extending from upright columns. Key considerations include arm length, load balance, anchoring, and forklift clearance. Cantilever racks improve accessibility for non-palletized, irregular-shaped goods that cannot be stored in standard racking.

## **10. Mezzanines and Multi-Level Storage**

Mezzanines create additional storage or work areas by utilizing vertical space without expanding facility footprint. They support shelving, picking, or office spaces. Key concepts include load-bearing capacity, fire protection, egress requirements, and lighting. Multi-level storage structures improve cube utilization and support scalable growth.

## **11. Bin and Drawer Storage Systems**

Bin shelving, modular drawers, and small-parts cabinets support high-density storage of small items. These systems maximize cube usage, improve SKU organization, and reduce search time. Understanding labeling systems, bin sizing, ergonomics, and replenishment methods is essential for environments such as spare parts distribution and assembly support.

## **12. Vertical Lift Modules (VLMs)**

VLMs are automated storage systems that bring trays to the operator. They improve space utilization, increase picking accuracy, and enhance security. Key concepts include tray height optimization, throughput capacity, inventory control software, and preventive maintenance. VLMs are best for small, high-value, or slow-moving items requiring secure, compact storage.

## **13. Vertical and Horizontal Carousels**

Carousels rotate inventory to the operator, supporting goods-to-person operations. Vertical carousels save floor space, while horizontal carousels are suitable for high throughput. Key principles include safe loading, balanced weights, control systems, and integration with WMS. Carousels significantly reduce picker travel and increase accuracy.

## **14. Automated Storage and Retrieval Systems (AS/RS)**

AS/RS systems use cranes, shuttles, or robots to automate pallet or case storage. They offer exceptional accuracy, high density, and reduced labor. Concepts include throughput modeling, deep-lane vs. aisle-based design, buffer

positioning, load interface restrictions, and integration with warehouse software. AS/RS is ideal for large distribution centers and manufacturing support.

## **15. Bulk Storage Systems**

Bulk storage handles non-unitized items such as grains, powders, liquids, and aggregates. Methods include silos, tanks, bins, and bulk floor storage. Key considerations include flow characteristics, compaction, containment, safety, and environmental controls. Understanding bulk behavior ensures safe handling and prevents degradation or contamination.

## **16. Cold Storage Systems**

Cold storage includes chill, frozen, and controlled-atmosphere environments. Key concepts include insulation, racking type selection (frozen-rated equipment), condensation control, load stability, and energy efficiency. Cold storage facilities prioritize space density and fast handling to maintain temperature integrity. Understanding temperature zoning and defrost cycles is essential.

## **17. Hazardous and Special Materials Storage**

Hazardous materials require specialized compliance with regulations such as OSHA, NFPA, and EPA. Concepts include segregation, ventilation, spill containment, fire suppression, chemical compatibility, and labeling. Storage of flammables, corrosives, or explosives must follow strict guidelines. Understanding these regulations ensures safety and legal compliance.

## **18. Cross-Docking vs. Storage Decisions**

Cross-docking minimizes storage by synchronizing inbound and outbound flows. Understanding when to store vs. when to cross-dock is crucial for handling lead times, inventory turnover, and service requirements. Concepts include pre-distribution vs. post-distribution models, sortation needs, dock configuration, and flow-through layout.

## **19. Safety, Compliance, and Rack Protection**

Storage systems must meet regulatory standards and incorporate safety features such as rack guards, aisle markings, load plaques, seismic bracing, and fall protection. Regular inspections prevent structural failures. Understanding the interaction of equipment, human behavior, and layout helps create a safe storage environment.

## **20. Cost Analysis and Capacity Planning**

Storage decisions require evaluating capital cost, operating cost, space utilization, labor requirements, and lifecycle value. Capacity planning considers SKU growth, peak demand, vertical space, replenishment frequency, and handling equipment constraints. Understanding cost-benefit trade-offs and ROI ensures that storage solutions support both current and future business needs.

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8. Supply Chain Performance Metrics (KPIs)
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13. Supply Chain Digital Transformation
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15. Supply Chain Sustainability and Green Logistics
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17. Supply Chain Collaboration and Integration
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19. Global Supply Chain Strategy
20. Transportation Management Systems (TMS)
21. Inventory Optimization Models
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24. Supply Chain Cost Reduction Techniques
25. SCOR Model and Process Improvement

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49. Supply Chain in Crisis Management and Recovery
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12. Total Cost of Ownership (TCO) Analysis
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14. Procurement Policies and Governance
15. Procurement in Public vs. Private Sectors
16. Procurement Audit and Compliance
17. Procurement Data Analytics and Reporting
18. Procurement Scorecards and KPIs
19. Strategic Supplier Partnerships
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22. Negotiation Simulation Workshop
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# Micro-Learning Programs in Procurement ...



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29. Procurement Ethics and Transparency
30. Procurement in the Digital Supply Chain
31. Vendor Consolidation Strategies
32. Spend Analysis and Optimization
33. Demand Forecasting for Procurement
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35. Inventory and Procurement Alignment
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37. Supplier Onboarding and Development
38. Procurement Market Intelligence
39. Measuring Supplier Innovation
40. Procurement in Times of Supply Disruption
41. Cross-Functional Collaboration in Procurement
42. Writing Effective RFPs, RFQs, and RFIs
43. Contract Negotiation Best Practices
44. Green Procurement and Circular Economy
45. Legal Aspects of Procurement Contracts
46. Performance-Based Contracting
47. Procurement Leadership and Strategic Influence
48. Cost Avoidance and Value Creation in Procurement
49. Managing Procurement with Power BI Dashboards
50. Future Skills and Trends in Procurement



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