

Vehicle Selection in Domestic Logistics

17 Vehicle Selection: Types of vehicles

Selecting the appropriate transportation asset is a primary determinant of a supply chain's efficiency, cost baseline, and physical capability. Fleet deployment is categorized by capacity, weight classes, and mechanical configurations.

Classification by Gross Vehicle Weight (GVW)

Vehicles are strictly tiered into standard capacity segments to match commercial density profiles:

- **Light Commercial Vehicles (LCVs):** Typically rated under 3.5 metric tons. These compact units (vans, mini-trucks) offer exceptional maneuverability in urban cores and are primarily deployed for high-frequency last-mile parcel distribution, retail replenishment, and direct-to-consumer e-commerce fulfillment.
- **Medium Commercial Vehicles (MCVs):** Ranging from 3.5 to 7.5 metric tons. These flatbed or box trucks handle regional transport routes, moving goods from regional distribution hubs to secondary market stores.
- **Heavy Commercial Vehicles (HCVs):** Operating above 7.5 metric tons (extending to 40+ tons multi-axle freightliners). These assets are built for long-distance, large-volume line-haul corridors, interconnecting major ports, industrial complexes, and primary warehouses.

Structural & Mechanical Configurations

The engineering frame of the vehicle dictates its turning capability, route access, and structural safety limits:

Rigid Trucks: The driver's cabin, engine chassis, and structural cargo-carrying body form a single, unbroken structural unit. Rigid designs are structurally robust and commonly utilized for localized delivery networks due to their predictable handling characteristics.

Articulated Vehicles: Consist of an independent tractor unit containing a high-power engine coupled to a detachable semi-trailer via a pivoting fifth-wheel connection. This articulation mechanism grants the vehicle a significantly sharper turning radius relative to its total payload length, making it the global standard for high-volume, cross-country freight routing.

Operational Selection Criteria

Logistics managers evaluate fleet composition using several key operational factors:

- **Infrastructure Constraints:** Bridge weight limitations, overhead clearance restrictions, narrow inner-city alleys, and legal emissions zones (LEZs).
- **Economic Efficiency:** Balancing initial capital expenditure (CapEx) against operational running parameters, such as fuel burn metrics, tire wear cycles, and preventive maintenance intervals.
- **Cargo Volume & Nature:** Aligning vehicle payload capacities with customer order sizes to minimize under-utilized transit runs.

18 Load types and characteristics

A vehicle cannot be chosen effectively without a detailed analysis of the cargo load. Cargo parameters govern space management inside the vehicle body and dictate safety compliance metrics.

Physical States & Handling Modalities

- **Dry Bulk Cargo:** Homogeneous commodities shipped loose and unpackaged (e.g., grains, minerals, coal, cement). These require specialized self-discharging hoppers, tipper bodies, or pneumatic suction setups.
- **Liquid & Gaseous Bulk:** High-fluidity chemical compounds, petroleum products, liquid food components, or compressed natural gases. These demand pressurized, insulated tank systems with surge-damping internal architectures.
- **Unitized & Palletized Cargo:** Standard commercial freight secured on uniform wood or plastic pallets (e.g., ISO standard pallets). This configuration enables rapid mechanical cross-docking using standard forklifts, optimizing loading cycles.

Operational Risk Classes

Specialized handling protocols must be applied based on the cargo's risk profile:

- **Perishables:** Temperature-sensitive agricultural produce, dairy items, frozen proteins, and biopharmaceuticals. These require an unbroken cold chain with continuous multi-zone temperature tracking.
- **Hazardous Materials (HAZMAT):** Explosive, flammable, toxic, or corrosive chemicals. Transport requires legally certified drivers, placard signaling systems, secure segregation matrices, and emergency response kits.
- **Fragile & High-Value:** Consumer electronics, designer goods, or precision industrial instrumentation. These require high-security locking mechanisms, unmarked trailers, and air-ride suspension setups to mitigate road vibration damage.

The Volumetric Trade-Off: Weighing Out vs. Cubing Out

Every transport asset features two strict engineering limits: a maximum weight capacity (payload tonnage) and a maximum spatial capacity (cubic volume). This creates two distinct operational challenges:

1. Weighing Out (High-Density Cargo): Occurs when heavy materials (e.g., steel coils, concrete structures, marble blocks) hit the legal or structural gross vehicle weight capacity while leaving a significant portion of the trailer's physical space empty. Optimization relies on maximizing axle weight distribution.

2. Cubing Out (Low-Density Cargo): Occurs when lightweight, high-volume products (e.g., retail pet clothing, apparel, plastic packaging, insulation sheets) completely fill the physical space of the trailer before reaching the vehicle's legal weight capacity. Optimization focuses on maximizing the trailer's cubic capacity or using double-deck trailer systems.

19 Main types of vehicle body

The vehicle's body configuration represents the specialized enclosure engineered to protect, contain, and ease the loading/unloading of specific cargo types.

| Body Type | Structural Engineering Profile | Primary Industrial Applications |
|------------------------------|---|--|
| Flatbed / Platform | An open chassis flat platform lacking fixed side walls or an overhead roof structure. Facilitates unrestricted, rapid multi-angle loading using heavy cranes or forklifts. Cargo must be manually secured using tension straps or chains. | Construction steel, structural lumber, oversized industrial machinery, concrete pipes, and project cargo. |
| Box Trailer / Dry Van | A completely enclosed, rigid rectangular structure manufactured from aluminum or fiberglass panels. Offers absolute environmental protection from rain, wind, and sun, alongside high anti-theft security via sealable rear locking rods. | Palletized consumer goods, fast-moving consumer goods (FMCG), electronics, apparel, and dry foodstuffs. |
| Reefer (Refrigerated) | An advanced insulated box body coupled to a diesel-powered, automated climate control unit. Features internal thermal air-circulation tracking channels to maintain strict multi-zone temperatures ranging from -30°C to +20°C. | Chilled and frozen foods, seafood, dairy products, biological vaccines, and temperature-sensitive chemicals. |
| Curtainsider | Combines a rigid roof frame and solid rear doors with structural, high-tension PVC side curtains that slide on overhead roller tracks. Blends the full structural weather protection of a dry van with the side-loading speed of a flatbed. | Palletized industrial freight, automotive components, multi-drop drink distribution, and building materials. |
| Tanker | A cylindrical, aerodynamic storage vessel manufactured from stainless steel or reinforced alloys. Contains internal transverse baffles (bulkheads) designed to slow the momentum of liquid sloshing, ensuring vehicle stability during cornering. | Petroleum products, aviation fuels, liquid chemicals, liquid milk, edible oils, and liquefied gases. |

| Body Type | Structural Engineering Profile | Primary Industrial Applications |
|---------------------------|--|---|
| Tipper / Dump Body | An open-top, high-strength steel box body equipped with heavy-duty front-mount or under-body hydraulic pistons. Lifts the front of the bed to dump loose bulk cargo via gravity through a hinged tailgate. | Sand, gravel, mining ore, demolition debris, agricultural waste, and bulk raw aggregates. |

20 Transport resource requirements, Vehicle routing and scheduling issues

Once vehicles and loads are defined, logistics execution shifts to mathematical optimization—matching fleet capacity, operational times, and driver availability against real-world delivery constraints.

Transport Resource Requirements

To establish a cost-efficient fleet operation, managers must balance three key resources:

- **Fleet Capacity Sizing:** Determining the optimal mix of owned assets (Core Fleet) vs. spot-market sub-contracted carriers to handle seasonal demand peaks without carrying expensive excess capacity during low cycles.
- **Driver Allocation & Compliance:** Balancing driver schedules against strict statutory mandates, such as Hours of Service (HOS) laws and mandatory rest periods to prevent operator fatigue.
- **Fuel and Maintenance Asset Kits:** Structuring preventive maintenance schedules based on telemetry mileage data to prevent roadside breakdowns during customer delivery runs.

The Vehicle Routing Problem (VRP)

The **Vehicle Routing Problem** is a central mathematical challenge in logistics. The goal is to determine the most cost-effective set of routes for a fleet of vehicles to service a dispersed group of customers, starting and ending at a central depot.

Capacitated VRP (CVRP): Routes must be mathematically optimized to ensure the total cargo demand assigned to a single pickup run never exceeds the vehicle's legal weight or cubic capacity limits.

VRP with Time Windows (VRPTW): Adds the real-world constraint that deliveries must occur within specific time frames designated by the customer (e.g., a retail mall receiving dock open only from 06:00 AM to 09:00 AM). Missing these windows results in rejected shipments and financial penalties.

Key Routing & Scheduling Operational Bottlenecks

Real-world logistics networks must continuously mitigate several operational challenges:

Urban Congestion & Delays

Unpredictable traffic jams increase fuel burn and disrupt tight delivery schedules. Mitigation requires real-time dynamic rerouting via GPS telematics.

The Backhaul Dilemma

Running a delivery truck empty on its return trip to the warehouse is known as "**Deadheading**". This represents a significant waste of resource capacity. Managers must actively procure reverse logistics loads or return assets to maintain profitability.

Dynamic Exceptions

Sudden vehicle break-downs, abrupt weather storms, or customer order cancellations require agile automated scheduling systems to re-allocate cargo instantly.

End of Module 4