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4.https://www.transportation.gov/research-and-technology/how-connected-vehicles-work

METHODS AND MODELS FOR CARRIER SELECTION

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In the current era of globalization and intensified market competition, supply chain management has become a decisive determinant of organizational performance. Within this system, carrier selection occupies a particularly high-impact position: it directly shapes total logistics costs, delivery velocity, cargo safety and integrity, as well as the level of satisfaction experienced by the end customer. The core difficulty of this task stems from the need to harmonize cost minimization with service quality maximization under conditions of market uncertainty [1].

Carrier Selection Criteria To ensure a well-founded decision, it is essential to establish a clear, measurable set of evaluation criteria. In earlier logistics practices, the central emphasis was often placed on tariffs and transportation lead times. However, contemporary SCM logic requires a broader, more analytical approach. Empirical studies indicate that—particularly for high-value-added products—operational reliability and service quality frequently outweigh purely price-based considerations [2].

The modern criterion framework may be organized into several key dimensions:

1. Operational Indicators and Service Quality

This group forms the practical basis for a carrier's capability to move cargo effectively and safely.

- On-Time Performance: the share of shipments delivered within the agreed schedule; one of the most important KPIs.

- Transit Time: the average duration of delivery from origin point A to destination point B.

- Freight Integrity (Damage-Free Delivery): the percentage of shipments arriving without damage or shortages.

- Frequency and Flexibility: the carrier's capacity to respond to variations in order volumes, routing needs, and urgent shipments.

2. Economic Indicators

- Transportation Tariff: the baseline cost of transport services.

- Surcharges: fuel surcharges, detention charges, and fees associated with special delivery conditions.

- Financial Stability: the risk that a carrier may face insolvency, potentially triggering supply chain disruption.

3. Information and Technological Capabilities

- Track & Trace Systems: real-time monitoring of cargo location and shipment status.

- Data Integration (EDI/API): the ability to exchange information automatically with the customer's ERP systems.

- Electronic Document Interchange: accuracy and speed in the processing of transport documentation.

4. Reputational and Strategic Factors

- Market Experience and Customer Reviews.

- Sustainability: compliance with CO_2 emission requirements and adoption of "green" technologies, which is especially important for international companies.

- Geographic Coverage: availability of proprietary infrastructure such as warehouses and terminals [2, 3].

Classification and Detailed Analysis of Selection Methods The carrier selection process has progressively evolved from largely subjective judgments into the use of structured mathematical and decision-support tools. In general, the available methods can be grouped into qualitative approaches, quantitative (mathematical) approaches, and hybrid models.

1. Qualitative and Expert Methods

These methods draw heavily on professional experience, practical judgment, and subjective assessment.

- Direct Negotiation: carrier selection based on personal contacts, reputation, or previous cooperation; commonly applied for small shipment volumes or emergency needs.

- Weighting and Scoring: specialists establish a list of criteria, assign weight coefficients (often summing to 1 or 100%), and score alternatives on a predefined scale (e.g., 1–5). The final result is typically calculated as a weighted sum. While methodologically straightforward, the approach remains strongly dependent on expert subjectivity [3].

2. Multi-Criteria Decision Making (MCDM)

This category represents one of the most widely used groups of approaches in modern logistics. MCDM techniques enable the simultaneous evaluation of heterogeneous criteria—for instance, costs measured in USD, delivery time measured in hours, and service performance measured in points.

2.1. Analytic Hierarchy Process (AHP)

Proposed by Thomas Saaty, the AHP method is widely regarded as a standard tool for complex management decisions.

- Hierarchy Construction: the goal at the top level, criteria in the middle, and alternatives at the bottom.

- Pairwise Comparison: experts compare criteria through a 1–9 scale (e.g., “How much more important is reliability than price?”).

- Alternative Comparison: each carrier is compared relative to each criterion.

- Priority Synthesis: the final ranking is computed mathematically. A key advantage of AHP is the Consistency Ratio, which supports logical coherence in expert judgments [4].

2.2. Analytic Network Process (ANP)

ANP represents an enhanced variant of AHP that captures interdependencies among criteria. For example, a carrier’s technological maturity (IT capability) may correlate with delivery reliability. ANP uses supermatrices to represent such complex relationships [3, 4].

2.3. TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution)

TOPSIS is grounded in the concept of the “distance to ideal solutions.” The preferred alternative is the one that is closest to the Positive-Ideal Solution and simultaneously furthest from the Negative-Ideal Solution [5].

3. Efficiency Evaluation Methods

3.1. Data Envelopment Analysis (DEA)

DEA is a robust non-parametric method based on linear programming, designed to estimate the relative efficiency of Decision Making Units—in this context, carriers.

- Inputs: resources consumed, such as transportation tariffs, documentation efforts, and claim-processing expenditures.

- Outputs: performance outcomes, including on-time delivery rates, shipment volumes, and customer satisfaction levels.

DEA constructs an efficiency frontier. Carriers located on the frontier obtain an efficiency score of 1.0, indicating relative efficiency; those positioned below the frontier are considered inefficient and require corrective measures or replacement [6].

4. Artificial Intelligence and Predictive Analytics

With Big Data and the Internet of Things (IoT), logistics models increasingly shift from descriptive to predictive capabilities.

- Machine Learning (ML): algorithms process historical GPS trajectories, border-crossing delays, weather conditions, and fuel market fluctuations to forecast route-specific carrier reliability with high precision—often even before contract finalization [7].

5. Strategic Partnership Models

Beyond isolated selection decisions, carriers may be engaged through varying relationship models:

- Transactional Model (Arm’s-Length): carrier choice based mainly on the lowest price for one-off shipments.

- Contractual Model: medium-term agreements with defined volumes and performance KPIs.

- Strategic Alliance: deep integration of business processes, shared IT infrastructure, and collaborative logistics planning [1, 2].

Carrier Selection Process Model

1. Needs and Criteria Definition: specify what must be transported, where deliveries occur, and the required delivery speed.

2. Sourcing (Prequalification): conduct market monitoring and issue RFI requests.

3. Request for Quotation (RFQ): gather detailed tariff structures and service terms.

4. Analysis and Evaluation: apply models such as AHP or DEA to compare alternatives.

5. Negotiation and Contracting: finalize SLAs and operational obligations.

6. Performance Monitoring: continuously track KPIs and conduct post-selection evaluation [1].

Conclusion Carrier selection has developed from a purely procurement-oriented procedure into a strategic instrument within supply chain management. Overreliance on price alone is inefficient and inherently risky.

A more robust approach consists of adopting MCDM models—such as AHP and DEA—to balance cost objectives with reliability requirements and technology-related performance. In the near future, the integration of these methods with AI will enable a transition from reactive supplier selection to proactive, data-driven decision-making [4, 7].

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SUPPLY CHAIN IN LOGISTICS: THE FLOW OF GOODS FROM SUPPLIERS TO CUSTOMERS

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In today's global economy, moving goods efficiently is crucial for businesses to succeed and for customers to be satisfied. A core concept supporting this is the supply chain, which represents a complex system. This system connects suppliers, manufacturers, distributors, and retailers into a unified network, ensuring products move smoothly from raw materials to final consumers. The importance of managing these supply chains has grown significantly, driven by globalization, digital transformation, and increasing customer expectations for speed and reliability in deliveries [1][4].

Companies these days are expected not only to deliver products quickly but also to optimize costs and maintain high service quality. As a result, supply chain management has become a strategic function, directly influencing a company's competitiveness and its long-term viability. It integrates various business processes, allowing companies to respond effectively to market changes and unexpected disruptions [2].

A supply chain can be defined as a network of organizations, people, activities, information, and resources involved in producing and delivering a product. Its primary goal is to ensure the delivery of the right product at the right time, in the right place, and at the lowest possible cost. This concept goes beyond simple transportation and includes planning, coordination, and control of all processes within the network [1].

Logistics is an integral part of the supply chain, focusing mainly on transportation, storage, and handling of goods. However, supply chain management has a broader scope, as it integrates procurement, production, and distribution processes.