



MOLDOVA STATE UNIVERSITY



Exploring transport optimization models in supply chains

an International Comparative Analysis
and Development Directions for the Republic of Moldova

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"SUSTAINABLE TRANSPORT AND TRADE"
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Integration of Transport-Related topics within the study programmes and curricula of Moldova State University



Bachelor Programmes

Marketing and Logistics
World Economy & International Economic Relations



Master Programmes

Marketing Studies
Logistics and Marketing in Commercial Distribution



Relevant courses

Logistics & Supply Chain Management
International Transport
Transport Operations Management



Key competencies

Transport mode selection and planning
Cost and route optimization
Understanding transport infrastructure
Sustainable mobility solutions.

AGENDA

- 1. Transport modes and selection strategies**
- 2. Road transport**
- 3. Planning road transport activities**
- 4. Integration of technology in transport optimization strategies**



1. Transport modes and selection strategies



TRANSPORT AND DISTRIBUTION: COST STRUCTURE AND IMPACT



Exploring advanced methodologies in transport

Advanced methodologies in transport optimization are critical for enhancing efficiency and responsiveness within supply chains.



General principles of transport optimization

Understanding the general principles of transport optimization helps in creating effective strategies for resource allocation and route planning.



Key innovations in logistics transport

Key innovations in logistics transport optimization can greatly reduce costs and improve delivery times, benefiting overall supply chain management.



Transport modeling applications in supply chains

Transport modeling applications in supply chains include analyzing logistics networks and developing strategies to streamline operations.

OPERATIONAL CRITICAL POINTS: TRANSPORT MANAGEMENT



Route inefficiency

Suboptimal routing increases fuel consumption by 12–18% and extends delivery time windows. Poor consolidation leads to empty mileage rates exceeding 25%.



Cost volatility

Fuel surcharges, spot rates, and lack of capacity generate budget variations of 15–30%. Forecast accuracy drops below 70% during peak periods.



Compliance risk

Documentation errors, violations of driving and rest time regulations, as well as licensing deficiencies expose the company to fines of €500–€5,000 per incident. Repeated violations may lead to license suspension.



Lack of visibility

The absence of real-time tracking delays exception management by 2–4 hours. Customers receive delivery updates 30–60 minutes after the actual arrival, affecting trust and service levels..

ROAD TRANSPORT: OPERATIONAL PROFILE AND COST STRUCTURE

Characteristics:

- Distance: optimal range 50–1,500 km
- Flexibility: door-to-door service, route adaptability
- Lead time: 4–48 hours, depending on distance
- Capacity: 24–26 tons payload (standard EU truck)
- Cost: €0.80–€1.50 per km (full truckload – FTL), €1.20–€2.20 per km (less-than-truckload – LTL)

Cost components:

- Fixed costs: vehicle depreciation, insurance, licensing (€15,000–€25,000/year)
- Variable costs: fuel (€0.35–€0.50/km), driver salaries (€0.30–€0.45/km), road tolls (€0.05–€0.15/km), maintenance (€0.08–€0.12/km).



RAIL TRANSPORT: OPERATIONAL PROFILE AND COST STRUCTURE

Characteristics:

- Distance: optimal range 300–3,000 km
- Volume: minimum 500–1,000 tons for economic viability
- Lead time: 24–96 hours, depending on route and terminals
- Infrastructure: requires rail connection or access to an intermodal terminal
- Cost: €0.02–€0.05 per ton-km (bulk), €0.05–€0.08 per ton-km (containers)

Constraints:

- Scheduled services limit flexibility. Loading and unloading require specialized equipment. Road transport on the first and last segment adds costs and complexity. Border crossings may involve gauge changes and locomotive replacement.



MARITIME TRANSPORT: OPERATIONAL PROFILE AND COST STRUCTURE



Characteristics:

- Distance: intercontinental (5,000–20,000 km, typical routes)
- Volume: 20- and 40-foot containers (TEU/FEU), bulk transport
- Lead time: 15–45 days, depending on the route and port congestion
- Capacity: vessels carry 5,000–24,000+ TEU
- Cost: €0.005–€0.015 per ton-km (6–10 times cheaper than air transport)

Operational profile:

- Port dwell time adds 2–5 days.
- Demurrage charges for containers apply after the free period expires (usually 5–7 days).
- The booking deadline is 3–5 days before the vessel's departure.
- Shipment consolidation (LCL) increases the cost to €0.02–€0.04 per ton-km but allows smaller volumes.
- Documentation includes the bill of lading, commercial invoice, packing list, and customs declarations.

AIR TRANSPORT: OPERATIONAL PROFILE AND COST STRUCTURE

Characteristics:

- Distance: optimal for 1,000–10,000 km
- Lead time: 1–3 days, door-to-door, including ground handling
- Capacity: maximum 100–150 tons per aircraft (cargo)
- Cost: €1.50–€5.00 per kg (10–50 times more expensive than maritime transport)
- Use cases: time-critical goods, high-value goods, perishables, small volumes

Regulatory and security requirements:

- IATA Dangerous Goods Regulations apply to hazardous materials.
- The Air Waybill serves as the contract of carriage.
- The Montreal Convention limits the carrier's liability to 19 SDR per kg, unless a higher value is declared.
- X-ray screening and inspection are mandatory for all shipments.



MULTIMODAL AND INTERMODAL TRANSPORT: DEFINITIONS AND CONTRACTS

Multimodal transport

The movement of goods using two or more modes of transport, based on separate contracts. Each segment has its own carrier, its own liability regime, and specific documentation. The shipper coordinates transfers between modes and manages each carrier independently. It is used when no single carrier provides end-to-end services.

Intermodal transport

The movement of goods in the same loading unit (container, swap body) using multiple modes of transport. A single contract covers the entire route. A single carrier or a transport operator / freight forwarder assumes responsibility for all segments. It reduces handling and the risk of damage. It is commonly used for containerized maritime-rail and maritime-road transport.

Combined transport

A form of intermodal transport in which the main segment is carried out by rail or inland waterways. EU regulations provide incentives for shifting freight volumes from road to more environmentally friendly transport modes. Road toll reductions, tax benefits, and priority at border crossings may apply.

COMPARISON OF TRANSPORT MODES: COST PER TON-KILOMETER

Total Landed Cost formula (TLC)

TLC = Transport cost + Storage cost + Risk cost + Administrative cost

Transport cost = Distance × Weight × Rate per ton-km

Storage cost = (Lead time + Variability buffer) × Daily demand × Unit cost × Holding rate

Risk cost = Damage rate × Value of the shipment

Administrative cost includes documentation, customs formalities, and coordination

Air transport may have a lower TLC than maritime transport for high-value and fast-rotation goods, despite a transport cost that can be up to 250 times higher.

DECISION MATRIX FOR MODE SELECTION: QUANTITATIVE CRITERIA

Delivery time requirement (Lead Time)

The delivery window to the customer (hours or days). Customs clearance time, handling, and buffer time are deducted. The remaining time determines the feasible transport modes.

Transport characteristics

Weight (kg), volume (m³), value (€), fragility, temperature sensitivity. A high value-to-weight ratio favors air transport. Large volumes and lower value favor maritime or rail transport.

Cost constraint

The maximum acceptable transport cost as a percentage of the product's value. Calculating the break-even point between transport modes using the TLC (Total Landed Cost) formula.

Compliance and risk

Regulatory requirements (for example, dangerous goods, cold chain).
Probability of damage and loss. Insurance cost depending on the mode of transport.

TRANSPORT CONSTRAINTS SPECIFIC TO THE FMCG INDUSTRY

Operational characteristics:

- **High delivery frequency:** daily or several times per week
- **Low product margins:** 5–15%, depending on the category
- **Strict delivery windows:** 2–4 hour intervals at retail locations
- **High inventory turnover:** 10–30 days of stock
- **Seasonal demand peaks:** volume increases of 30–100% during peak periods

Transport requirements:

- Road transport is predominant
- Routes serve 10–30 delivery points per day
- **Target load factor:** 85–92%
- **On-time delivery requirement:** 95–98%
- **Penalty for missing delivery windows:** €50–€200 per deviation
- Temperature control is required for refrigerated products (2–8°C)

Multi-temperature zones increase costs by 15–25%.

Case study: TRANSPORT CONSTRAINTS SPECIFIC TO THE PHARMACEUTICAL INDUSTRY

Cold chain requirements

- Temperature-sensitive products require maintaining ranges of **2–8°C** or **15–25°C** throughout the entire transport process.
- Continuous temperature monitoring using a **data logger** is mandatory.
- Any deviation from the permitted limits makes the product **unsellable**.
- Cold chain transport involves **40–80% higher costs** compared to ambient temperature transport.
- **Qualification of carriers and vehicles** is required before use, as well as **requalification every 1–2 years**.

Regulatory compliance

- **Good Distribution Practice (GDP)** requires written procedures, staff training, and **full traceability (audit trail)**.
- Protection against counterfeiting requires the use of **tamper-evident seals** and **serialization systems**.
- **High-value products** (oncology, biologics) require **security escort** and **TAPA-certified carriers**.
- **Insurance coverage** ranges between **€1M–€10M per shipment**, depending on the product value.

The **claims process** requires complete documentation and **root cause analysis**.

HIGH-VALUE GOODS: SECURITY AND INSURANCE REQUIREMENTS

Theft risk by product category:

- **Electronics:** theft rate 0.5–1.5% of shipments
- **Pharmaceutical products:** theft rate 0.3–0.8% of shipments
- **Luxury goods:** theft rate 0.2–0.6% of shipments
- **Average loss per incident:** €50,000–€500,000

Security measures:

- **TAPA FSR certification (levels 1–3)** for carriers
- **GPS monitoring** with **geo-fencing** and movement alerts
- **Two-driver crews** for high-value shipments
- **Secure parking** only in certified facilities
- **Route planning** to avoid areas with high crime rates
- **Insurance premium:** 0.5–2.0% of the shipment value, depending on the risk profile.



2 Road transport



CMR CONVENTION: TRANSPORT CONTRACT AND LIABILITY RULES

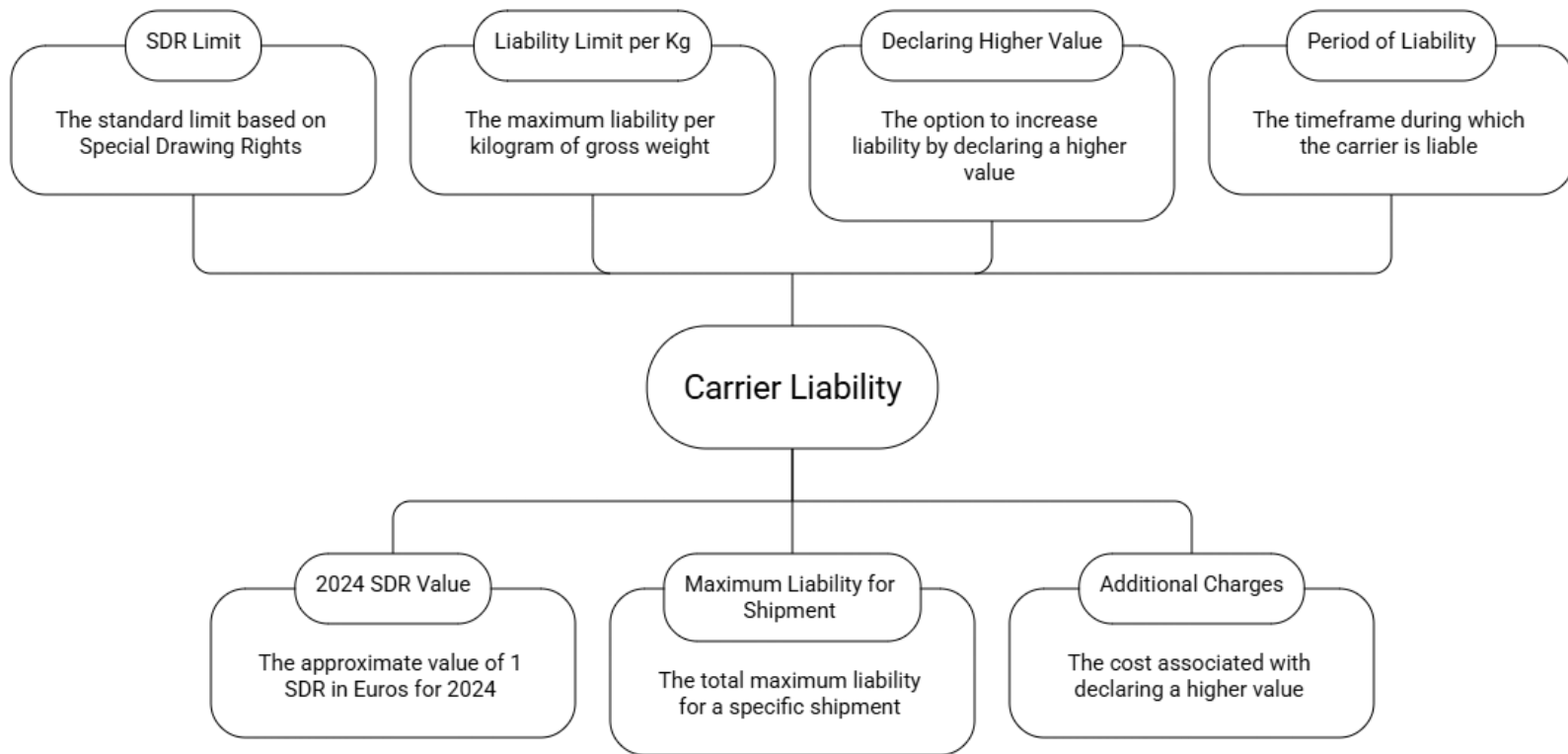
▲ Legal framework

The CMR Convention (Convention on the Contract for the International Carriage of Goods by Road) establishes the carrier's liability from the moment the goods are accepted until delivery.

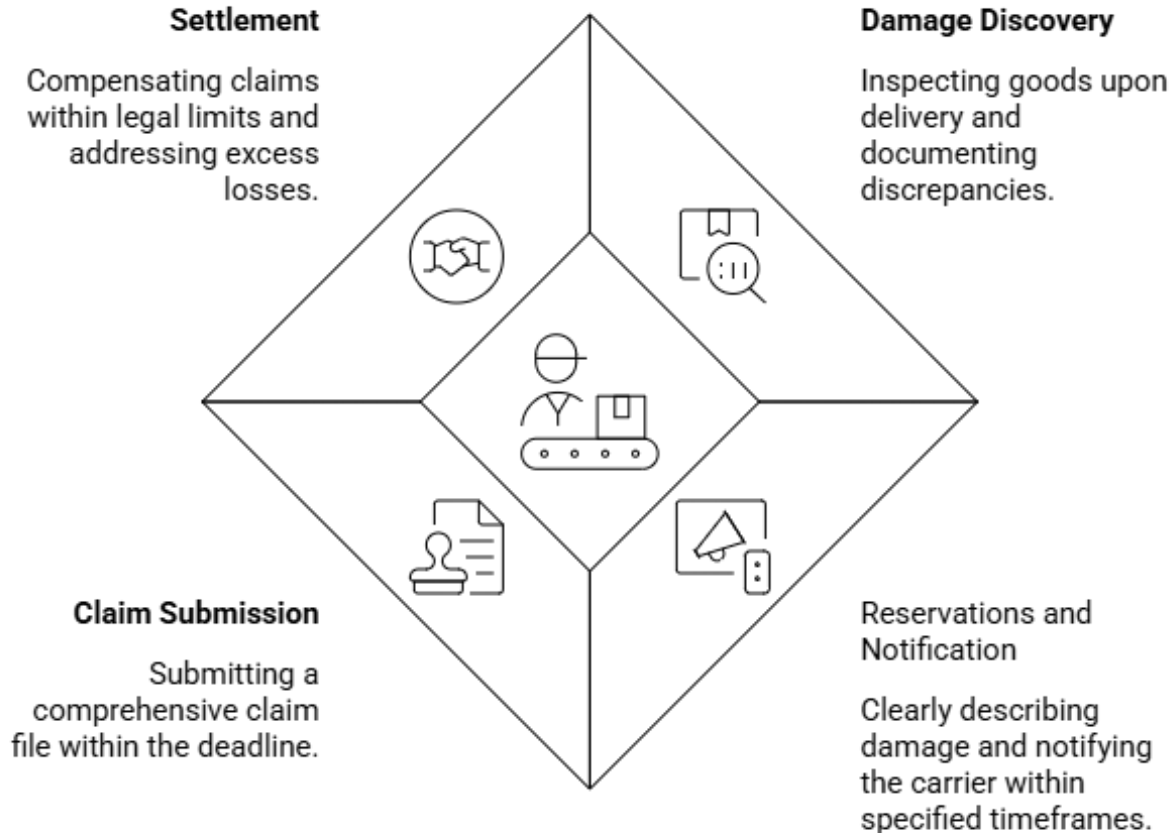
The carrier is liable for the total or partial loss, damage, or delay of the goods. Liability is strict, except in cases where the carrier can prove the existence of a cause for exemption.

The CMR Convention automatically applies to all international road transport involving countries that are signatories to the Convention (over 50 countries, including all European Union member states).

Limits of liability



Limits of liability





3 Planning road transport activities



DOCUMENTATION REQUIREMENTS FOR CROSS- BORDER TRANSPORT

Commercial Invoice

Details: seller, buyer, description of goods, quantity, unit price, total value, currency, payment terms. Used for customs valuation and calculation of duties and taxes. It must correspond exactly with the other transport documents. Errors may delay customs clearance by 1–3 days.

Packing List

Details: number and type of packages, gross/net weight, dimensions, marks and numbers. It allows customs authorities and the carrier to verify the cargo. Required for container loading inspection and security checks.

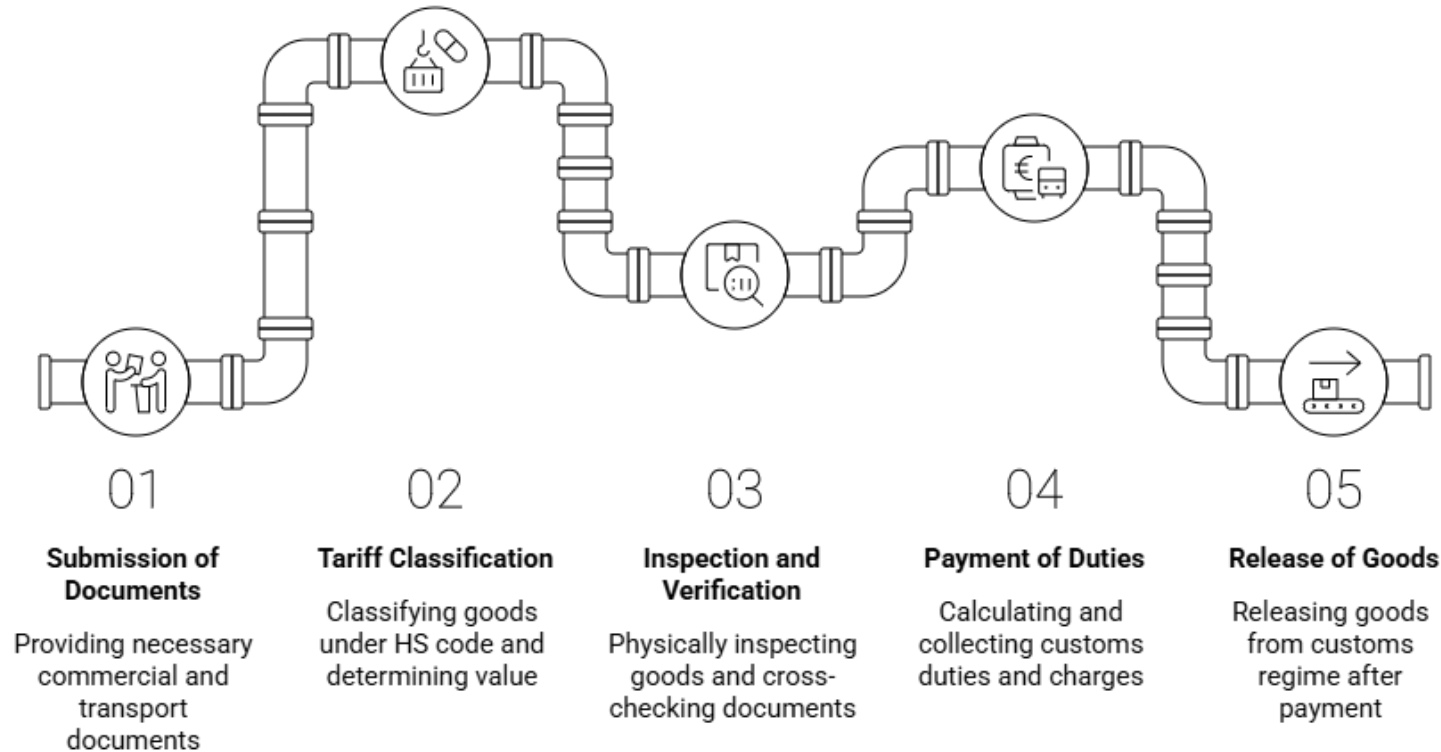
Certificate of Origin

Indicates the country where the goods were manufactured or produced. It is required for applying preferential tariff treatment under trade agreements (e.g., EU-UK TCA, USMCA). It is issued by the chamber of commerce or an authorized authority/body. Non-preferential origin is determined according to the applicable customs rules.

CMR or Bill of Lading

Represents the transport contract and proof of receipt of the goods. CMR is used for road transport, while the Bill of Lading (B/L) is used for maritime transport. It may be negotiable (transferable) or non-negotiable (non-transferable). The original document is usually required for the release of the goods. Electronic versions (eCMR, eBL) are increasingly accepted, but they are not universally recognized.

CUSTOMS PROCEDURES: CUSTOMS CLEARANCE FOR IMPORT AND EXPORT



INTRA-EU ROAD TRANSPORT: CABOTAGE RULES AND THEIR APPLICATION

Definition of cabotage:

- Cabotage refers to the transport of goods carried out by a foreign carrier within the territory of another European Union member state.
- A carrier licensed in state A may perform a maximum of three cabotage operations in state B within 7 days after completing an incoming international transport.
- The seven-day period begins from the moment of unloading the international shipment.
- After completing the third cabotage operation or after the seven days expire, the carrier must:
 - o either leave the territory of that state;
 - o or perform a new international transport.

Control and sanctions:

Road inspections verify tachograph data, CMR documents, and the history of previous deliveries to confirm compliance with cabotage rules.

Fines usually range between €1,000 and €5,000 for each unauthorized operation.

Repeated violations may lead to temporary bans from operating in that country.

Carriers are required to keep supporting documents for all transports (CMR, invoices, delivery confirmations – POD) for a period of 12 months.

KEY IDEAS: DOCUMENTATION AND COMPLIANCE

Documentation provides legal protection

- Proper documentation (CMR, POD – proof of delivery, commercial documents) enables the submission of claims, demonstrates compliance, and protects against legal liability.
- Shortcuts in documentation create risk exposure that may significantly exceed the time or cost savings.

Incoterms prevent costly disputes

- Clear and correctly applied Incoterms eliminate ambiguity regarding cost allocation and risk transfer.
- The use of incorrect terms or incomplete specifications generates disputes and confusion regarding liability.

KEY IDEAS: DOCUMENTATION AND COMPLIANCE

Understanding liability limits and risk exposure

- The CMR Convention limits the carrier's liability to approximately €10/kg, unless a higher value of the goods is declared.
- Understanding these limits is essential for informed decisions regarding insurance and value declaration.

Controlling subcontracting through contracts

- Subcontracting reduces control and increases operational risk.
- It is recommended to implement contractual mechanisms that require approval of subcontracting, maintain the liability of the main carrier, and ensure appropriate monitoring mechanisms.

Proactive planning for seasonal volatility

- Capacity and rates during peak season are predictable.
- Advance planning, long-term contracts, and diversified capacity sources reduce operational and financial risks.



4. Integration of technology in transport optimization strategies



Leveraging technology for advanced transport optimization solutions



Innovations in transport optimization models

The integration of innovative technologies has revolutionized transport optimization models, enhancing efficiency and reducing costs in supply chain management.



General insights on supply chain dynamics

Understanding the dynamics of supply chains is crucial for effective transport optimization, as it influences decision-making and operational strategies.



Strategies for efficient transport logistics

Implementing effective transport strategies can significantly improve logistics performance, leading to enhanced customer satisfaction and competitive advantage.



Technological trends in transportation

Recent technological trends, such as AI and IoT, are reshaping transportation, providing new opportunities for optimization within supply chains.

The future of transport optimization through technology integration



Predictions for transport logistics advancements

As technology continues to evolve, future predictions indicate substantial advancements in transport logistics that will streamline operations and reduce environmental impact.



General overview of transport optimization

A comprehensive overview of transport optimization highlights its importance in supply chain efficiency and the role of technology in driving improvements.



Integrating AI in transport models

The incorporation of artificial intelligence in transport models can enhance decision-making processes, leading to smarter logistics solutions and improved efficiency.

Emerging technologies in supply chain management

Emerging technologies are playing a pivotal role in transforming supply chain management practices, particularly in optimizing transport and logistics operations.

Exploring technological advancements in supply chain transport optimization

Recent developments in transport technologies

Recent developments in transport technologies have opened new avenues for optimizing supply chain processes, enabling better resource management and cost reduction.

General trends in supply chain optimization

Identifying general trends in supply chain optimization is essential for businesses aiming to enhance their transport strategies and overall performance.

Impact of data analytics on logistics

The impact of data analytics on logistics is profound, providing insights that drive transport optimization and support effective decision-making.

Future-proofing transport strategies

Future-proofing transport strategies through technological advancements ensures sustainability and resilience in the face of evolving market demands.

THANK YOU



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