Efficiency and Sustainability in Multi-Modal Supply Chains

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Efficiency and Sustainability in Multi-Modal Supply Chains

- Global Supply Chains and Multi-Modal Transportation
- The Greening of Supply Chains: An Elusive Goal
- Integrating Multi Modal Supply Chains
- Conclusion: Efficiency or Sustainability?
Global Supply Chains and Multi-Modal Transportation
Intermodalism, Multimodalism and Transmodalism

**Intermodalism**
- Origin
- Road
- Terminal
- Rail
- Carrier
- Maritime
- Destination
- Ticket / Contract

**Multimodalism**
- Origin
- Road
- Terminal
- Rail
- Carrier
- Maritime
- Ticket / Contract

**Transmodalism**
- Rail
- Rail
Intermodalism: North-American Gateway Regions and Corridors

Multi-Port Gateway Regions
1. San Pedro Bay
2. Northeastern Seaboard
3. Southwestern Seaboard
4. Puget Sound
5. Southern Florida
6. Gulf Coast
7. Pacific Mexican Coast
Transmodalism: Transshipment Hubs
Transmodalism: North American Landbridge
Transmodalism: The Eurasian Landbridge
Major Steps in Intermodal Integration

- **1930s**: Pallets, Fork lifts
- **1940s**: TOFC (1952)
- **1950s**: Container (1956), Container gantry crane and straddle carrier (1959), Dedicated container terminal (1962), Container standardization (1965), Transatlantic container services (1966), COFC (1967), Cellular containership (1968)
- **1960s**: Rail deregulation, Satellite terminals, Inland container depots
- **1980s**: Container standardization (1965), Transatlantic container services (1966), COFC (1967), Cellular containership (1968)
- **1990s**: Dedicated container terminal (1962), Container standardization (1965), Transatlantic container services (1966), COFC (1967), Cellular containership (1968)
- **2000s**: Blockchain (2015), Electronic bill of lading, Advanced container
- **2010s**: Container standardization (1965), Transatlantic container services (1966), COFC (1967), Cellular containership (1968)
Value Chain Drivers of the Fourth Industrial Revolution

**Value Chain**
- R&D
- Procurement
- Fabrication
- Distribution
- Marketing
- Services

**Added Value**
- Open innovation, Collaborative design
- Flexibility and compliance, New materials
- 3D Printing and robotics, Distributed manufacturing
- Automation (warehouses, terminals and vehicles)
- Ecommerce, Omni facilities
- ‘Internet of Things’, Shared services

**Infrastructure**

**Labor**
Automation changes processes but also locations

High automation potential (>50%)
- Manufacturing
- Food service
- Retail and distribution

Low automation potential (<30%)
- Education
- Healthcare
- Management

Outputs
- (Markets, Customers)

Non-material inputs
- (Labor, Capital, Technology, Policies, Regulations)

Material Inputs
- (Resources, Parts, Energy, Land)
The Greening of Supply Chains: An Elusive Goal
Logistic Activities and their Green Dimensions

Materials Management
- Product design
- Near sourcing
- Sustainable sourcing
- Packaging and packing
- Circular material use

Physical Distribution
- Demand responsive systems
- Load consolidation
- Alternative modes and fuels
- Certification of carriers and distribution facilities
- Shipping scheduling and routing

Forward and Reverse Supply Chains
- Suppliers
- Manufacturers
- Distributors
- Collectors
- Recyclers
- Disposal
- Consumers
The Circular Economy and Supply Chains

- **Suppliers**
  - Materials
  - Technical Goods
  - Recycling
  - Remanufacture
  - Reuse
  - Maintenance
  - Collection

- **Manufacturers**
  - Suppliers

- **Distributors**
  - Manufacturers

- **Users**
  - Distributors
  - Collection

- **Consumers**
  - Users
  - Collection
  - Leakage

- **Biosphere**
  - Harvesting
  - Fertilizers
  - Biogas
  - Biochemical processing

- **Biological Goods**
  - Biosphere

- **Technical Goods**
  - Technical Goods

- **Burning / Disposal**
  - Leakage
  - Maintenance
  - Collection
The Balance between Regulation, Innovation and Certification

Top-Down

Governments: Policies and regulations

Certification: Accreditation and standards

Bottom-Up

Industry: Innovation and best practices
Effective Environmental Practices

- **Match activities with environmental components**
  What are the environmental components the logistics activities of the firm?

- **Link environmental components with regulations**
  What is the regulatory standing of each environmental component?

- **Assess risks, impacts and responsibilities**
  What are the risks of doing nothing? What are the rewards of improvements?

- **Identify environmental issues to be addressed**
  What are the most important issues to be addressed and their priority?

- **Develop commercial strategies**
  Which improvements can be implemented in management and operations?

- **Introduce best practices**
  How improvements can be implemented?

- **Undertake monitoring and auditing**
  What is the effectiveness of the best practices and which adjustments are required?
The Implementation of an Environmental Management System (EMAS)

**Direct Environmental Aspects**
- Air emissions
- Water emissions
- Waste
- Material use (resources and raw materials)
- Local emissions (noise, odors, vibrations)
- Land use
- Risks of environmental accidents

**Indirect Environmental Aspects**
- Product life cycle
- Capital investments
- Insurance
- Management and planning process
- Environmental management of suppliers

**Environmental Management System**

**Process**
- General requirements
- Environmental policy
- Planning
- Implementation and operation

**Internal Audit and Review**

**Environmental Statement**

**Verification and Validation**

**Registration**
EMAS and ISO 14001

- Identify environmental factors and their impacts.
- Evaluate the potential damage to the environment and their legal obligations.
- Adopt an environmental policy.
- Implement an EMS.

1996 - 2015

EMAS

1993 - 2010

Eco-Management and Audit System

- Internationally: All the firm’s activities
- Requires environmental review
- Publicly available environmental policy
- Infrequent audits

- European Union: Site specific
- Does not require environmental review
- Requires environmental review
- Publicly available environmental statement, policy and EMS
- More frequent and rigorous audits
Benefits and Challenges for Supply Chains

**Benefits**

- Improved environmental performance
- Improved company image
- Competitive advantage in regulated markets
- Mitigation of non-tariff trade barriers
- Reduction of capital and insurance costs

**Challenges**

- Can be biased to protect specific interests
- Barriers to entry due to costly time and resources commitment
- Long term commitment and recurring auditing

The benefits have been difficult to demonstrate
Integrating Multi Modal Supply Chains
Main Elements in Supply Chain Integration and Connectivity

**Transport Connectivity**
Improving connectivity and interoperability of modes and terminals (intermodalism). Infrastructure and superstructure improvements (capacity and throughput). Synchronizing terminals and hinterland flows to increase throughput and reliability.

**Commercial Integration**
Trade and commercial agreements. Mergers and acquisitions along the supply chain. Cost, time and reliability of transport and distribution services. Vertical and horizontal integration of actors and processes (e.g. bill of lading).

**Customs and Security Integration**
Moving cargo more efficiently across borders through prescreening and inspections. Harmonization of customs and security procedures. Assessments of cargo contents, cargo integrity, route integrity and information integrity.

**Regulatory Integration**
Promote modal choice and avoid subsidized modal preference. Harmonization of regulations across jurisdictions such as for vehicles, goods handling and transport, land use, labor and finance. Promotion of standards and certification.
Main Elements in Supply Chain Integration and Connectivity

Planning and Funding Integration
Planning and funding of infrastructure provision from an integrated multi-modal and logistics chain perspective. Respective roles and competencies of the public and private actors.

Work Practices Integration
Organizational (managing labor as a group) and skills (managing individual workers) competencies to move cargo efficiently. Operational window (working hours), minimal service levels and essential services.

Information Systems Integration
Interconnectivity of information systems with blockchains. Asset tracking, status monitoring, customs facilitation, freight status information and transport network status information.
Supply Chains and Blockchains

Physical Flows:
- Supplier
- Carrier
- Manufacturer
- Carrier
- Distributor
- Customer

Information Flows:
- Certificate of origin
- Batch numbers
- Assembly data
- Order number
- Shipment number
- Equipment number
- Shipment date
- Order number
- GTIN/SKU
- Certificate of origin
- Batch numbers
- Assembly data
- Order number
- GTIN/SKU
- Shipment date
- Order number
- GTIN/SKU
- Receive date
- Storage location
- Packaging
- Order number
- Shipment number
- Equipment number
- Receive date
- Order number
- Invoice number
- Customer ID

Blockchain:

Smart Contracts:
- Match order, invoice, shipment
- Quality check
- Pay supplier
- Match order, invoice, shipment
- Quality check
- Update inventory
- Pay manufacturer
- Match order, invoice, shipment
- Update inventory
- Pay distributor
Expected Benefits of Blockchains on Supply Chains

**Velocity of Supply Chains**

Faster transactions.
Less latency, improving cash flow and inventory carrying costs.

**Supply Chain Visibility (Tracking)**

Track shipments along an intermodal transport chain and identify issues causing delays.
Create a market where service providers bid to handle “blocs”.

**Supply Chain Security (Tracing)**

See where, when and how a specific event took place (e.g. cold chain logistics).
Counterfeiting and the use of sub-par materials easier to detect.

**Standards and Certification Compliance**

Proof that cargo was handled by specific modes, carriers and distribution centers.
Calculate accurately energy use and environmental impacts (e.g. CO2 footprint).
Conclusion: Efficiency or Sustainability?
Efficiency or Sustainability?

• Sustainability remains contingent on efficiency improvements
  • Improvements are ad hoc because of the diversity of actors, their goals and strategies.
  • Environmental benefits are usually derived from other goals.
  • Complex propagation of benefits within supply chains.

• The appeal of certification
  • Natural outcome of standard setting behavior.
  • A self examination process under the EMS framework.
Efficiency or Sustainability?

- Circular economy
  - An emerging paradigm combining forward and reverse supply chains principles.
  - Requires significant changes in producer, distributor and consumer behavior.

- Multi-modal supply chain integration
  - Functional integration led to physical connectivity improvements.
  - Blockchains of supply chains (digital multimodalism).
  - Enables efficient EMS.