Supply Chain Management and Regional Strategic Transportation Planning Integration

A case for sustainability

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Agenda

- Supply Chains Overview
- RSTP Overview
- SCM / RSTP Interfaces
- Use of CLIOS as framework to study SCM/RSTP
- Further Research
Supply Chain Management
What are supply chains?

A Supply Chain View

Source: Sgouridis (2004)
Generic Supply Chains Characteristics

- Geographically dispersed
- Multi-tiered.
- Knowledge may or may not reside within the integrator.

Suppliers of Infrastructure

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How are Supply Chains Managed?
A Snapshot of Current Trends

Outside factors
- Specialized Consumer Demand
- Increased Firm Competition
- ICT Advances
- Transportation Technology Advances
- Globalization

Firm
- Reverse Logistics
- Increased customer satisfaction
- Inventory Reduction
- Total Cost Reduction
- Total Quality Management
- e-Commerce
- Outsourcing
- EDI
- Vendor Managed Inventory

SCM Internal Responses
- Manufacturing to Demand
- Postponed manufacturing
- Mass Customization
- Risk-pooling
- In-transit Inventory
- JIT Delivery
- Cross-docking
- Vertical SCM Integration
- 3PL

Increased Firm Competition
- Increased customer satisfaction
- Total Cost Reduction
- Increased customer satisfaction
- Total Quality Management
- e-Commerce
- Outsourcing
- EDI
- Vendor Managed Inventory
- Vertical SCM Integration
- 3PL

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# How are Supply Chains Managed? II
## A Snapshot of Current Trends

<table>
<thead>
<tr>
<th>SCM Layer</th>
<th>Influenced Factors</th>
<th>Planning horizon</th>
<th>Return on Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC-informed Product Design</td>
<td>Regional differences, supplier input, compartmentalization, design for assembly, product demand data</td>
<td>Several years (Based on product life-cycle)</td>
<td>High.</td>
</tr>
<tr>
<td>Strategic Network Design and Optimization</td>
<td>Number, capacity and location of production plans, suppliers, warehouses, retailers. Decision on transport resources.</td>
<td>Few months to few years.</td>
<td>High.</td>
</tr>
<tr>
<td>Supply Chain Master Planning</td>
<td>Production, distribution, and transportation strategies</td>
<td>Weekly to monthly</td>
<td>Medium</td>
</tr>
<tr>
<td>Operational Planning</td>
<td>Inventory levels, transport, production</td>
<td>Hourly to daily</td>
<td>Low.</td>
</tr>
</tbody>
</table>
So why should we care about Supply Chains?

• Importance:
  – **Economic Impact** – capital mobility.
  – **Sustainability Impact** – Efficiencies gained and resource conservation.
  – **Global nature**.
  – **Competitive Advantage** for firms and regions.

• Engineering Systems:
  – **Complexity**, process optimization.
  – **Organizational Restructuring / Learning**.
  – **Critical** decisions for enterprise **viability**.
Regional Strategic Transportation Planning
What is RSTP?

• Traditional Perspective of RSTP
  – The creation of a framework based on existing legislation to support and promote mobility of passenger and freight in a region.
Shortcomings of Traditional RSTP

[From Conclin and Sussman (2000)]

- **Intermodalism.**
- **Economic integration.**
- **Freight.**
- **Private sector involvement.**
- **Operations.**
- **Technology scanning.**
- **Transport and telecommunications.**
- **Human resources.**

[Added by Sussman, Sgouridis and Ward (2004)]

- **Sustainability.**
- **Institutional change.**
- **Uncertainty management.**
Freight Specific Expanded RSTP Goals

From:
“[The goal of freight transportation policy planning is] the discovery and effective implementation of measures which will reduce the total social cost of goods movement to the lowest possible level commensurate with the freight requirements and objectives of society.”
[Ogden (1994)]

To:
“The freight aspect of a regional strategic transportation plan should ensure (i) an adequate, efficiently operated, robust, and secure transportation network based on (ii) a commensurate regulatory framework that in coordination aim to maximize total societal benefits within a sustainable framework.”
[Sgouridis (2004) based on Hall and Sussman (2004)]
Freight Specific Expanded RSTP Goals II

- Freight mobility based on
- Sustainability
  - Economic growth (possible decoupling)
  - Economic development / regional competitive advantage
  - Environmental stewardship
  - Social impact awareness
- Safety
- Security / Robustness
A Framework for RSTP


6. Identify Performance Measures and Refine System Goals
7. Identify & Design Strategic Options for System Performance
8. Flag Important Areas of Uncertainty
9. Evaluate Strategic Options and Select Robust Ones that Perform "Best" Across Uncertainties

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Implementing the Framework (A View)

Partial CLIOS Diagram for the Transportation Layer

CLIOS Sub-systems (Layering)

- Economic Activity
- Land Use
- Environment

Transportation

Institutional Sphere Map

- State DOT
- Federal DOT
- EPA

Resident and Workplace location

Vehicle Emissions

Highway Infrastructure

VMT

Congestion Charging

Emission Regulations

Intermodal Connections

Highway Network

Highway Operations

Funding Allocation

SCM / RSTP Interfaces
SCM / RSTP How is it viewed?

• Porter: management of supply chains can provide regional competitive advantage
• Transition to the new economics of regional competition:
  1. macroeconomic to microeconomic,
  2. productivity growth to capacity to innovate,
  3. from economy-wide policies to clusters,
  4. from internal to external company success,
  5. from separation of economic and social policy to integration, and
  6. from national to cross-national, regional and local.
SCM / RSTP How is it viewed? II

• Building the facilities may not be enough: industry coordination needed.
  – [Examples Alameda Corridor (USA), Zaragoza Logistics Center (Spain), Port of Tanjung Pelepas (Malaysia)]

• Other relevant work (US DOT Freight Planning, Mobility Report 2001, EU White Paper on Transportation, Moving the Economy (Canada).
SCM / Economic Growth: Ambivalence

• SCM allows for flexibility in the supply chains (outsourcing).
• Globalization implies that the region could accept both gains and losses.
• Not all regions can become logistics hubs.
How Supply Chains are affected?
A Policy Inventory

- **Transportation Infrastructure Building**:
  - Conventional infrastructure
    - Tolls
  - Transportation Operations
  - Information Systems and geo-coding

- **Regulation**:
  - Product and Process Regulations (Regulation of Items transported)
    - Local Content Requirements (important in terms of transport but free trade agreements are reducing their extent)
    - Performance-based standards (safety, emissions, composition – can dictate the import of one product over another)
    - Basic Standards and Design specification (ISO, TUV, CE)
    - Labor and Manufacturing Process regulations, including manufacturing emissions (potential for relocation of facilities)
  - Transport Regulation
    - Safety regulations (for trucks: weight, driver rest etc and similar for other modes)
    - Emissions requirements (air pollutants and noise)
    - Rate and market regulations (most modes tend to be deregulated but there are still cabotage laws for shipping)
  - International regulations in terms of Free Trade Agreements influence the existing policy options.

- **Taxation**
  - Taxes on industry profits (potential for relocation of facilities)
  - Import duties (usually tied to Local Content requirements)
  - Taxes on the use of the transportation network (fuel, emission, or ton-mile taxes)

- **Subsidization**
  - Direct subsidies
  - Indirect modal subsidies (e.g. preferential taxation)
  - Research and Development grants

- **Development Strategies**
  - Industrial clusters and zoning
  - Supply chain centers (e.g. freight villages and the Zaragoza project)
  - Free Trade Zones
  - Identification of “national champion” industries
Current Research
Objective

Create a framework of sustainable freight transportation planning based on the generic RSTP framework.

Start by architecting a simple regional model for freight transport.
Introducing the Model A Region

Initially:

one product,

one self-sufficient region

(no imports / exports)
Representation Phase. Step 1: Goal Identification.

<table>
<thead>
<tr>
<th>General</th>
<th>Primary System objectives for Model A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Satisfy the demand for product A</td>
</tr>
<tr>
<td></td>
<td>Provide sufficient capacity for freight and passenger transportation</td>
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<td></td>
<td>Keep externalities within tolerable levels</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Private Sector</th>
<th>Secondary Objectives for Model A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Profit maximization</td>
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<tr>
<td></td>
<td>Efficient operations</td>
</tr>
<tr>
<td></td>
<td>Low production cost</td>
</tr>
<tr>
<td>Tertiary Objectives for Model A’s Supply Chain</td>
<td>Low inventory</td>
</tr>
<tr>
<td></td>
<td>Fast Delivery</td>
</tr>
<tr>
<td></td>
<td>Reliability</td>
</tr>
<tr>
<td></td>
<td>Flexibility</td>
</tr>
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<td></td>
<td>Transparency/real-time information</td>
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</tbody>
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<thead>
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<th>Public Sector</th>
<th>Secondary Objectives for Model A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive Economic Impact on Growth</td>
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<tr>
<td></td>
<td>Acceptable environmental external costs</td>
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<tr>
<td></td>
<td>Safety</td>
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<tr>
<td></td>
<td>Low operating costs</td>
</tr>
<tr>
<td></td>
<td>Low capital costs</td>
</tr>
<tr>
<td></td>
<td>Efficient operations</td>
</tr>
<tr>
<td></td>
<td>Passenger transport retains enough capacity</td>
</tr>
</tbody>
</table>
Representation Phase. Step 2:

Major Sub-system Identification.

- Transportation
- Environment
- Economy
- Land Use
- Manufacturing & SCM
Representation Phase. Step 3: (I)

Transportation Sub-system.

- Externalities Magnitude
  - Externalities Regulation
  - Transport Regulation and Pricing
  - Infrastructure Financing
- Fleet
  - Infrastructure Network
  - Transport Flows
- Transport Area
  - Product Demand
  - Production Output
  - Economy Area
- Residency Location
  - Factory Location
  - Retail / Warehouse Location
- Land Use Area
- Regional Strategy
- Private Strategy
Representation Phase. Step 3: (II)

Economy Sub-system.

- Trade Regulations
- Regional Strategy
- Private Strategy
- Transport Pricing
- Factory Output
- Factory Location
- Infrastructure Financing
- Economic Output
- Product Pricing
- Product Demand
Representation Phase. Step 3: (III)

Land-use Sub-system.

- Infrastructure Network
- Residency Location
- Factory Location
- Retail / Warehouse Location
- Damp / Recycle Location
- Land Use Regulations
Representation Phase. Step 3: (IV)

Environmental Sub-system.

- Regional Strategy
- Externalities Regulation

- Infrastructure
- Industrial and Residential Location
- Ecosystem and Habitat Loss

- Production Process
- Production Output
- Manufacturing Emissions & Waste

- Fleet
- Vehicle Emissions

- Externalities Magnitude
Representation Phase. Step 3: (V)

Manufacturing Sub-system.

- Product Demand
- Private Strategy
- Competition
- Product Pricing
- Product Design
- Profitability
- Production Output
- Raw Materials
- Production Process
- Supply Chain Methods
- Transport Costs
- Transport Regulations
- Trade Regulations
- Outsourcing Decisions
- Warehousing
- Retailers
- Transportation Flow
- Fleet
- Suppliers
Institutional Sphere.

- Transport Pricing
  - Infrastructure Financing
  - Transport Regulations
  - Externalities Regulation
  - Land Use Regulations
  - Trade Regulations
- Private Carriers
  - Infrastructure Operators
- Suppliers
  - Outsourcing
  - Product Design
- Manufacturer
  - Profitability
- Enterprise
  - Product Pricing
- Consumer Groups
- Private Strategy
- Regional Strategy
  - Department of Transportation
  - Department of Environment
  - Department of Planning
  - Department of Commerce

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Representation Phase. Step 3: (VII)

Overview
Representation Phase. Step 4:

Describe Components and Links:

Link Matrix Analysis
Seek Insight About System Behavior (System Dynamics Support)
### Design and Evaluation Phase. Step 6: Need – Metrics Matrix

#### Private Sector

| Needs                  | Metrics | Profits/Share Value | Percent of Market Share | Survey Answers | Return Ratio | Service and Maintenance Frequency | Percent of on-time delivery | $/Item | $/Item/Day | T/Item | Load Time | Emissions of Effluent/Heating Fuel | Emissions of Waste | Emissions of Noise | Emissions of Radiological | Emissions of Chemical | Emissions of Ozone Depletion | $/Item | % of Scrap | % of Growth in GNP | % of Unemployment | % of Processed & Over Billed | % of Processed & Over Billed | Officer Turnover | % of Processed & Over Billed | % of Processed & Over Billed |
|------------------------|---------|---------------------|-------------------------|-------------------|-------------|-----------------------------------|-----------------------------|--------|------------|--------|-----------|--------------------------------|-------------------|-------------------------|--------------------------|-----------------|--------------------------|-----------------|--------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 1 Shareholder Value    |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.1 Competitive Position |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.1.1 Customer satisfaction |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.1.1.1 Product Quality |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.1.2 Flight Price     |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.1.3 On-time Delivery |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.2 Profit Maximization |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.2.1 Cost Constrained |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.2.1.1 Transport Costs |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.2.1.2 Inventory Holding Costs |   |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.2.1.3 Labor Costs   |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.3 Efficiency        |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.3.1 Productivity    |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.3.1.1 Inventory levels |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.3.2 Patentability   |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.3.2.1 Regulatory compliance |   |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.4 Environmental     |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.4.1 Production Emissions |     |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.4.1.1 Production Emissions |   |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.4.1.2 Fleet Emissions |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.4.1.3 Waste         |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.4.1.4 Recyclablility |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.4.2 Labor           |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.4.3 Trade           |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| Public Sector         |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1 Maximizing External Benefits |     |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1. Economic Growth |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.2 Employment        |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 1.2.1 Regional Development |     |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 2 Minimizing External Costs |     |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 2.1 Congestion |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 2.2 Environmental      |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 2.3 Social             |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 2.4 Safety             |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 3 Financing |         |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 3.1 Infrastructure Utilization |   |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |
| 3.2 Infrastructure Pricing |       |                     |                         |                   |             |                                   |                             |        |            |        |           |                                |                   |                         |                           |                 |                         |                 |              |                |                  |                |                  |                |                |                |                |

*Note on market share: The market share classification is important. Ford and Ferrari, for example, do not share the same market share although they both sell cars. The same is true for individual products.

*(for example if part of the competitive strategy)*
Further Research
Steps forward

- Iterate insights from the modeling process by identifying critical areas of intervention.
- Complete the design and evaluation phase of CLIOS for model region.
- Expand model to include imports and exports (Malaysia as target region is major exporter) and more products (competition).
- Refine SD model.
- Expand SD model into simulation for quantification of policy effects.
- Transfer insights to existing regions (Malaysia).
Your Feedback
(Some) References


