Logistics for Public Freight Planners: Theory and Practice

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Outline

- Background
- Introduction to Supply Chain and Logistics
- Topic Areas
  - Supply Chain Strategies
  - Network Design and Facility Location
  - Procurement and Outsourcing
  - IT and Logistics
- Summary
- Online GIS Tool for Truck Parking Study
Background

- Continued growth in freight traffic
- Logistics and freight planning
- Freight planners lack of logistics background
- Mississippi Valley Freight Coalition Project
  - Online course
  - Team: Teresa Adams, Bruce Wang and Ernie Wittwer
Course Outline

- Part One
  - Introduction and total cost competition
  - Managing inventories
  - Managing transportation
  - The European experience and conclusions

- Part Two
  - Logistics strategies
  - Network design
  - Outsourcing and third party logistics
  - Information technology

- Summary
Growth in Ton-Miles

<table>
<thead>
<tr>
<th>Year</th>
<th>Ton-miles (billions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>4,000</td>
</tr>
<tr>
<td>1997</td>
<td>4,100</td>
</tr>
<tr>
<td>1998</td>
<td>4,200</td>
</tr>
<tr>
<td>1999</td>
<td>4,300</td>
</tr>
<tr>
<td>2000</td>
<td>4,400</td>
</tr>
<tr>
<td>2001</td>
<td>4,500</td>
</tr>
<tr>
<td>2002</td>
<td>4,600</td>
</tr>
<tr>
<td>2003</td>
<td>4,700</td>
</tr>
<tr>
<td>2004</td>
<td>4,800</td>
</tr>
<tr>
<td>2005</td>
<td>4,900</td>
</tr>
</tbody>
</table>
2020 Congestion: A Challenge to Public Freight Planners
Modal Share Trends

![Graph showing modal share trends from 1996 to 2005 with Index on the y-axis and years on the x-axis. The modal types include Truck, Air, Railroad, Total, Pipeline, and Water. Each modal type is represented by a different line color or pattern. The graph indicates trends and changes over time.]
## Obstacles to Modal Diversion

<table>
<thead>
<tr>
<th>Market Viability</th>
<th>Institutional Readiness</th>
<th>Public Barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Equivalent Services</td>
<td>1. Capacity</td>
<td>1. Public acceptance</td>
</tr>
<tr>
<td>3. Interoperability</td>
<td>3. Institutional Commitment</td>
<td></td>
</tr>
<tr>
<td>4. Density</td>
<td>4. Institutional structure</td>
<td></td>
</tr>
</tbody>
</table>
Truck Rail Intermodal

Highway

Terminal

Rail

Terminal

Highway
Trucking Strategy

Origin or Destination

Transfer Point

Driver A

Driver B

Origin or Destination
Supply Chain Management

- Encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities.
- It also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers.
Logistics Management

- The part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements.

- Logistics is part of the supply chain management concerning materials movement and storage.
Factors in Logistics

- Cost reduction
- Inventory and service
  - Commodity characteristics, markets and service needs
- Service and mode choice
- Corridor density and transportation availability
  - Truck-rail intermodal constraints
• Capital
• Shrinkage
• Uncertainty
• Obsolescence
The T-Shirt

Shanghais, China
Cotton is spun, knitted and T-shirts

Long Beach, California
Cotton shipped

Lubbock, Texas
Cotton grown

Miami, Florida
T-shirts printed, warehoused and shipped to US and Europe
Cyclical Inventory

![Graph showing inventory over time with cyclical peaks and valleys](image-url)
Trade-off Considerations

- Unit purchase price
- Fixed ordering costs
- Holding costs
  - Capital
  - Storage
  - Shrinkage, loss, damage, obsolescence
Safety Stock

Inventory

Time

Re-order Point

Safety Stock
Issues in Safety Stock

- Uncertainty in demand
- Uncertainty in delivery
- Cost of holding
- Cost of administration
Implications for Freight

- Reliability
- Timed arrivals
- More frequent delivery
- More truck-reliant
- More complex congestion solutions
Several Topic Areas

Supply Chain Strategies
Objectives of Supply Chain Strategies

To reduce total cost through

- Reducing the time from manufacturing to consumption, reduce redundant inventory in the supply chain;
- Facilitating smooth flow of products, raw materials, finance, information, technology between parties through partnership and cooperation;
- Improving system integration and system resiliency.
## Logistics Cost as a Percentage of GDP

<table>
<thead>
<tr>
<th>Country</th>
<th>GDP %</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>10.5</td>
</tr>
<tr>
<td>Canada</td>
<td>12</td>
</tr>
<tr>
<td>UK</td>
<td>10.63</td>
</tr>
<tr>
<td>Denmark</td>
<td>12.88</td>
</tr>
<tr>
<td>Ireland</td>
<td>14.26</td>
</tr>
<tr>
<td>Spain</td>
<td>11.52</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>13.71</td>
</tr>
<tr>
<td>Japan</td>
<td>11.37</td>
</tr>
</tbody>
</table>

Source: Financial Times, December 1998
### Logistics Cost Breakdown in USA

<table>
<thead>
<tr>
<th>Cost</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>46</td>
</tr>
<tr>
<td>Storage/Warehousing</td>
<td>22</td>
</tr>
<tr>
<td>Inventory Carrying</td>
<td>22</td>
</tr>
<tr>
<td>administration</td>
<td>10</td>
</tr>
</tbody>
</table>

Cited in the Handbook of Logistics and Distribution Management.  
### Cost Itemization as a Percentage of Final Sales Turnover

<table>
<thead>
<tr>
<th>Main Business</th>
<th>Transport Cost</th>
<th>Warehousing/Depot</th>
<th>Inventory Holding</th>
<th>Administration</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office Equipment</td>
<td>3.2</td>
<td>10.7</td>
<td>0.87</td>
<td></td>
<td>14.77</td>
</tr>
<tr>
<td>Health Supply</td>
<td>1.36</td>
<td>9.77</td>
<td>0.66</td>
<td>0.19</td>
<td>11.98</td>
</tr>
<tr>
<td>Beer</td>
<td>8.16</td>
<td>2.82</td>
<td>0.56</td>
<td>2.19</td>
<td>13.74</td>
</tr>
<tr>
<td>fashion</td>
<td>0.38</td>
<td>1.31</td>
<td>0.33</td>
<td></td>
<td>2.02</td>
</tr>
<tr>
<td>Cement</td>
<td>25.2</td>
<td>9.1</td>
<td>7.1</td>
<td>4.6</td>
<td>46</td>
</tr>
<tr>
<td>Auto Parts</td>
<td>2.07</td>
<td>6.35</td>
<td>1.53</td>
<td></td>
<td>9.96</td>
</tr>
<tr>
<td>Computer Supply</td>
<td>0.65</td>
<td>0.78</td>
<td>0.09</td>
<td></td>
<td>1.52</td>
</tr>
</tbody>
</table>

Inventory Policies

- Continuous Review
- Periodic Review
- \((s, S)\) Ordering Policy
- Economic Order Quantity (EOQ) Model – Most Basic Model

\[
Q^* = \sqrt{\frac{2KD}{h}}
\]

D = Demand; K = fixed ordering cost; h = inventory carrying cost
Time Reliability (Lead Time Variance) to Optimal Inventory Cost (B)

<table>
<thead>
<tr>
<th>Standard Deviation (in days)</th>
<th>Re-order Point (units)</th>
<th>Inventory increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>179</td>
<td>0.78%</td>
</tr>
<tr>
<td>3</td>
<td>183</td>
<td>1.72%</td>
</tr>
<tr>
<td>4</td>
<td>188</td>
<td>2.97%</td>
</tr>
<tr>
<td>5</td>
<td>194</td>
<td>4.49%</td>
</tr>
<tr>
<td>6</td>
<td>202</td>
<td>6.23%</td>
</tr>
<tr>
<td>7</td>
<td>210</td>
<td>8.14%</td>
</tr>
<tr>
<td>8</td>
<td>219</td>
<td>10.20%</td>
</tr>
<tr>
<td>9</td>
<td>228</td>
<td>12.38%</td>
</tr>
</tbody>
</table>

Note: order quantity remains the same. Assume a lead time of 2 weeks.

Source: Formula from Designing and Managing the Supply Chain by Simchi-Levi, etc.
### Lead Time Duration to Inventory Cost

<table>
<thead>
<tr>
<th>New Lead Time (day)</th>
<th>Demand During Lead Time</th>
<th>Safety Stock</th>
<th>Re-order Point</th>
<th>Average Inventory Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>153</td>
<td>113</td>
<td>266</td>
<td>6.26%</td>
</tr>
<tr>
<td>23</td>
<td>146</td>
<td>110</td>
<td>257</td>
<td>5.70%</td>
</tr>
<tr>
<td>22</td>
<td>140</td>
<td>108</td>
<td>248</td>
<td>5.13%</td>
</tr>
<tr>
<td>21</td>
<td>134</td>
<td>106</td>
<td>239</td>
<td>4.55%</td>
</tr>
<tr>
<td>20</td>
<td>127</td>
<td>103</td>
<td>230</td>
<td>3.95%</td>
</tr>
<tr>
<td>19</td>
<td>121</td>
<td>100</td>
<td>221</td>
<td>3.34%</td>
</tr>
<tr>
<td>18</td>
<td>115</td>
<td>98</td>
<td>212</td>
<td>2.71%</td>
</tr>
<tr>
<td>17</td>
<td>108</td>
<td>95</td>
<td>203</td>
<td>2.06%</td>
</tr>
<tr>
<td>16</td>
<td>102</td>
<td>92</td>
<td>194</td>
<td>1.40%</td>
</tr>
<tr>
<td>15</td>
<td>96</td>
<td>89</td>
<td>185</td>
<td>0.71%</td>
</tr>
<tr>
<td>14</td>
<td>89</td>
<td>86</td>
<td>175</td>
<td>0.00%</td>
</tr>
<tr>
<td>13</td>
<td>83</td>
<td>83</td>
<td>166</td>
<td>-0.74%</td>
</tr>
<tr>
<td>12</td>
<td>76</td>
<td>80</td>
<td>156</td>
<td>-1.50%</td>
</tr>
<tr>
<td>11</td>
<td>70</td>
<td>76</td>
<td>146</td>
<td>-2.30%</td>
</tr>
<tr>
<td>10</td>
<td>64</td>
<td>73</td>
<td>137</td>
<td>-3.14%</td>
</tr>
</tbody>
</table>
Pull vs Push Systems

Push vs. Pull

Make all we can just in case.

- Production Approximation
- Anticipated Usage
- Large Lots
- High Inventories
- Waste
- Management by Firefighting
- Poor Communication

Make what’s needed when we need it

- Production Precision
- Actual Consumption
- Small Lots
- Low Inventories
- Waste Reduction
- Management by Sight
- Better Communication

Push vs. Pull systems

Source: Designing and Managing the Supply Chain by Simchi Levi et al. 2000
Vendor Managed Inventory (VMI) System

- Under VMI, instead of the customer monitoring its sales and inventory for the purpose of triggering replenishment orders, the vendor assumes responsibility for these activities.
Assemble-to-order system

- Components ordered
- Product not assembled until order arrives
- Application condition
  - Plethora of products sharing the same set of components with different configurations.
  - Demand for each product is uncertain
- Examples
  - PC Industry
  - Stain mixture
Just-In-Time System

- JIT demands timely, but not too early, supply of needed materials for production in just the right quantity.
- It views inventory as a cost and redundant
- Inventory needed is reduced to the minimum
- It imposes high standard onto products quality (no backup in the inventory!)
Logistics Network Design and Facility Location
Multi-echelon System

An assemble system
Multi-echelon System: An Example of Distribution

Key link in transportation
Illustrative Distribution Network

Suppliers

Distribution Centers

Vendors
Example Logistics Network
Factors Affecting Logistics Network Design

- Strategic factors
- Technological factors
- Macroeconomic factors
- Exchange rate and demand risk
- Political factors
- Infrastructure factors
- Competitive factors
- Customer response time and local presence
- Logistics and facility cost
Example: Demographic Shift

![Graph showing a demographic shift with points plotted on an x-y axis.]

- The x-axis is labeled as 'x' and ranges from 5 to 10.
- The y-axis is labeled as 'y' and ranges from 5 to 10.
- Several data points are plotted on the graph, illustrating the demographic shift.
Example: Demographic Shift
Procurement and Outsourcing
Dreamliner Assembly
Results of Sourcing/Outsourcing

- More business exchanges
- Closer relationship between businesses
- Expedited globalization

Question: Does this mean more reliance on transportation?
Information Technology and Logistics
Information Technology

Information must be accurate, accessible in a timely manner and of the right kind in order to be useful.
Information Flow on a Supply Chain

Product flow

suppliers

Information flow

Intrafirm

interfirm

interfirm

retailers
Major Applications of IT

- **Strategic network design**
  This layer decides the optimal number of facilities (manufacturing plants, warehouses, distribution centers), their locations, outsourcing strategies and best distribution channel, etc. These decisions lay the ground for the general cost picture of operations.

- **Supply chain master planning**
  This layer of decision is made on a weekly to monthly schedule in order to coordinate production, distribution strategies, and storage requirements by efficiently allocating supply chain resources to maximize profit or minimize system wide cost.

- **Operational planning**
  These systems enable efficiencies in production, distribution, inventory and transportation for short term planning. The planning horizon is typically from daily to weekly. This layer includes typically four factors: demand planning, production scheduling, inventory management, and transportation planning.

- **Operational execution**
  This system generally provides the data, transaction processing, user access, and infrastructure for running a company. It includes five factors: enterprise resource planning, customer relationship management, supplier relationship management, supply chain management and transportation management.
IT Examples: RFID

- Batch
- Wireless
- Fixed Station
GPS

Source: www.howstuffworks.com

Photo courtesy U.S. Department of Defense
Routing/Scheduling Software: an Example

- Automated Decision Support System

- Input
  - Available resources (vehicles, drivers, connectivity between locations, etc.)
  - Demand
  - Constraints: drivers working hours, weight limit, road restrictions, etc.

- Output
  - Work schedules (where to go, at what time and on which route)
Concluding Remarks

Public vs Private Sectors Planning and Implementation
Public and Private Sector Planning

Shippers

Responding to changing markets, demographic shifts—Focus is short to medium term

Transportation Providers

Respond to changing service requirements

Infrastructure Providers

Responding to changing markets, demographic shifts—Focus is medium-long term

Source: http://www.fhwa.dot.gov/freightplanning/caldwell.htm
Differences in Planning Perspectives

Source: http://www.fhwa.dot.gov/freightplanning/caldwell.htm
Truck Parking Study In the Upper Midwest Region

- **Survey for Truck Parking Problems**
  - Truckers and other stakeholders can mark locations and answer location specific questions

- **Result Display**