Economically Viable Intermodal Integration of Surface and Waterway Freight Transport for Sustainable Supply Chain

2015 UTC Conference For The Southeastern Region, Birmingham, AL, March 25-27, 2015
NCITEC – Intermodal Integration
UM-DU-MSU : Freight Transport Projects

2012-2014: Supply Chain

2014-2015: Highway-Waterway Freight Integration
Intermodal Optimization for Economically Viable Integration of Surface and Waterborne Freight Transport

Study Objectives

(1) Identify major freight transportation corridors involving shipping ports (marine and inland waterways), highway and rail infrastructure; global and cross border commerce data

(2) Analyze alternative corridors for intermodal integration to increase the share of rail, waterway, and short-haul trucks

(3) Estimate model transport demand, visualize routing scenarios, and optimize locations of intermodal terminals,

(4) Evaluate the economic competitiveness considering travel time efficiency, safety, emissions, and economic development opportunities over 10-20 years
Freight traffic and supply chain inventory
(NCFRP Report 14)

- Trillion dollars on freight logistics (10% of U.S. GDP)
- 65% of goods originate or terminate in cities
- Road and rail surface modes of freight transport provided economic competitiveness

- Traffic congestion and delays
- Safety risks due to commercial trucks
- Vehicle emissions harmful to health
- CO₂ & GHG emissions
- Long Haul truck—Wastage of Fuel & travel time
Inbound Freight (ton-miles) from All Foreign Origins to U.S. by Each Mode, 2011

- Waterway: 58%
- Rail, 80,855 (13%)
- Truck, 79,982 (13%)
- Pipeline, 85,560 (14%)
- Other and Unknown, 274 (<1%)
- Air (include truck-air), 6,215 (1%)
- Multiple modes & mail, 2,428 (<1%)

Total Inbound Freight from All Foreign Origins to U.S. 604,459 ton-miles
Value of U.S International Merchandise Trade by Mode of Transportation: 2011 (millions of current U.S. dollars)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Merchandise Trade</td>
<td>3,687,622 million Dollars</td>
</tr>
<tr>
<td>Waterborne</td>
<td>47%</td>
</tr>
<tr>
<td>Trucks</td>
<td>17%</td>
</tr>
<tr>
<td>Rail</td>
<td>4%</td>
</tr>
</tbody>
</table>

-source: RITA, Pocket Guide to Transportation, 2013 (Table 4-6, pg. 34) Accessed Date: 06/13/2013

Freight Shipments within the U.S by Mode: 2007

<table>
<thead>
<tr>
<th>Mode</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air (Include truck-air)</td>
<td>0.03%</td>
</tr>
<tr>
<td>Water</td>
<td>3%</td>
</tr>
<tr>
<td>Rail</td>
<td>11%</td>
</tr>
<tr>
<td>Multiple modes &amp; mail</td>
<td>3%</td>
</tr>
<tr>
<td>Pipeline</td>
<td>9%</td>
</tr>
<tr>
<td>Other and unknown</td>
<td>2%</td>
</tr>
</tbody>
</table>

Trucks: 72%

Total Freight Shipments of Tons = 18,579 Millions
Freight Shipments within the U.S by Mode: 2007

**Truck shipments:**

- **48%** Louisiana
- **66%** Texas
- **85%** Mississippi

Note: Trucks carry 15 times more freight by dollar values compared to rail and waterborne transport combined and almost same truck ton-mile. (This implies that a greater freight share of rail and waterway will reduce congestion on highways, operating long-haul costs, and emissions.)
Environmental Degradation and Public Health Impacts of Transportation Modes

Modal comparison of freight transport emissions

Modal Comparison of Nitrogen Emissions

Building more roads for relieving congestion due to vehicular traffic is not a sustainable solution.

TTI’s Modal comparison of net freight ton-mile per gallon (NTMG) of diesel: 155 for truck, 413 for rail, and 576 for barge
Environmental Degradation and Public Health
Impacts of Emissions and Pollution

- Headache and anxiety ($SO_2$)
- Impacts on the central nervous system (PM)
- Irritation of eyes, nose and throat
- Breathing problems ($O_3$, PM, NO$2$, SO$2$, BaP)
- Cardiovascular diseases (PM, O$3$, SO$2$)
- Impacts on the respiratory system:
  - Irritation, inflammation and infections
  - Asthma and reduced lung function
  - Chronic obstructive pulmonary disease (PM)
  - Lung cancer (PM, BaP)
- Impacts on liver, spleen and blood (NO$2$)
- Impacts on the reproductive system (PM)


Source: European Environment Agency
Need for Freight Intermodal Integration

2008 NAFTA study (CEC 2011):

• Trucks transported a larger percentage of the tonnage of the U.S. land imports from Mexico compared to Canada from Mexico (74%) and from Canada (25%)
• Rail transported 24% of the tonnage of land imports from Mexico and 33% from Canada.

Mississippi moves 84% freight by trucks
Intermodal integration needed to enhance efficiency
Freight traffic impacts on congestion and safety

➢ The competitive edge linked to efficient transportation is fading out because of capacity limits of surface transportation and waterway/port systems.

Solution: Intermodal integration

Intermodal integration increases rail and barge shares and Reduces:

• Congestion related wastage of fuel
• Crashes and Stress on commuters
• Harmful air pollutants (PM, NOx and Ozone)
• CO₂ and GHG emissions
Port of Baton Rouge to:
- Port of Memphis = 516.3 km
- Port of Minneapolis = 2,436 km

Average Speed of Vessels:
- Downbound 8 knots
- Upbound 4 knots

(1 knot = 1.15078 mph)

Travel Time from Memphis:
- 285 miles on MS River
  - Downbound 34.4 h
  - Upbound 52.1 h
Integrated Freight Corridor: I-55 & Miss. River
Diverting 30% freight trucks from port of Gulfport to the integrated Mississippi river corridor, the cost is reduced. It is 2.6 times more costly for the base highway truck freight case. Travel time is reduced by 1/3rd and CO$_2$ emission is also reduced...
Freight Rail Line Network

AAR Freight Rail Network for the United States by Company
Integrated Freight Truck – Intermodal Rail
Integrated Freight Truck – Intermodal Rail

Extensive Commodity Flow Study

Proposed freight rail line and two alternative highway corridors for commodity flow from Colorado to California

Benefits of using rail for 30% freight per year (183,600 tons).

- Total travel time using the freight rail corridor is only 1.1% vs all highway trucks.
- Total cost by the freight rail corridor is reduced by 18.7%, compared to long-haul trucks.
- Total CO₂ emission is reduced by 58.2% using rail.
NAFTA Integrated Freight Corridor: Highway-Rail

Port of Entry between Laredo, TX & Nuevo Laredo, Mexico
NAFTA Integrated Freight Corridor: Highway-Rail

Legend
- Canada Border Post (5)
- Mexico Border Post (3)
- Interstate
- States

Route A (I-5)
Route B (I-15)
Route C (I-35, I-29)
Route D (I-35)
Route E (I-35, I-40, I-55)
Route F (I-35, I-40, I-65, I-75)

NOTE: There are no U.S./Canada Border Posts in Chicago, IL or Duluth, MN, but because these locations are major freight hubs, they were selected for analysis.
NAFTA Integrated Freight Corridor: Highway-Rail

By diverting 40% truck freight to rail, the annual benefits of the integration of highway and rail corridors include the following considering:

- Saving in **travel time** = 917,610 days = 98.8%
- Saving in **ton-mile cost** = $3,000 million = 87.2%
- Savings in **CO₂** produced = 416,769 tons = 58.2%
- About **60%** part of truck freight will still be transported by **long-haul trucks**

NAFTA Corridor: Laredo, TX to Detroit
Supply Chain Infrastructure and Intermodal Freight Survey Questionnaire

Purpose of Survey: The survey of supply chain stakeholders is being conducted to learn their dependence on multimodal transportation needs and assess their willingness to consider the intermodal integration and innovative funding strategies to improve the intermodal infrastructure and economic competitiveness. The intermodal freight corridor case studies and supply chain survey results will be used to develop a “best practice guide” and intermodal infrastructure bank proposal for consideration by government transportation agencies, private transport operators, and other stakeholders.
Conclusions and Future Work

**Freight Intermodal Integration**

1. Contributes to sustainable freight transportation and disaster resiliency in domestic supply chain.
2. Eases congestion on highways.
3. Reduces travel time and freight costs compared to trucks.
4. Reduces greenhouse gas emissions, and overall air pollution.
5. Results of partial I-55 freight trucks diverted to Mississippi River barges support these conclusions.
6. Results of NAFTA Corridor and West Coast truck-rail integration support these conclusions.

**Future work:** AIS data for Level-of Service modeling.
CAIT Transportation Modeling & Visualization Lab

Geospatial Analysis by M.S. Student: Seth Cobb

NCITEC / USDOT Supported UG & Grad Students