METHODOLOGICAL FRAMEWORK DEVELOPMENT FOR EVALUATING HIGHWAY TRUCK PARKING LOCATION AND CAPACITY EXPANSION

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Rutgers, the State University of New Jersey
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**BACKGROUND**

- Shortage of truck parking

In 2006, NJTPA found that parking lots are...  
In 2011, DVRPC found that parking lots are...

- 80% Overcapacity
- 1,300 Additional spaces needed
- 1,400 Existing spaces
- 100% Over Utilization 7%
- 466 Spaces Dearth by 2035
BACKGROUND

- Shortage of truck parking: unbalanced demand
  - Growing demand, larger vessels
  - New federal legislation on HOS on July 1st, 2013
  - Narrow pick-up and delivery windows
  - “Truck parking dilemma”
MOTIVATION & OBJECTIVE

- Jason’s Law in 2012

- Strategic expansion at optimal locations
  - Fulfill maximal demand and facilitate freight operations
  - Improve compliance of HOS restriction and highway safety
  - Minimize negative environmental and social impacts and community resistance
  - Boost local economy with employment and revenue opportunities
Little research has focused on expanding parking capacity.

<table>
<thead>
<tr>
<th>Problem addressed</th>
<th>Year</th>
<th>Agency/Publisher</th>
<th>Location/Scope</th>
<th>Analysis/Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Truck parking issue:</strong> estimate gap between demand and supply; identify demand bottleneck location</td>
<td>2008, 2009</td>
<td>NJTPA</td>
<td>Northern New Jersey</td>
<td>Identify potential sites</td>
</tr>
<tr>
<td></td>
<td>2011</td>
<td>DVRPC</td>
<td>Metropolitan Philadelphia</td>
<td>Identify potential sites</td>
</tr>
<tr>
<td></td>
<td>2001</td>
<td>Connecticut DOT</td>
<td>Connecticut</td>
<td>Discuss improving site condition and ITS technology</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>Minnesota DOT</td>
<td>Minneapolis Metropolitan Area</td>
<td>Review previous attempts to reduce parking deficit</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>Baltimore MC</td>
<td>Maryland</td>
<td>Advocating for ITS implementation</td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>NYMTC</td>
<td>Greater NYC Metropolitan Area</td>
<td>A origin-destination survey of truck drivers</td>
</tr>
<tr>
<td></td>
<td>2003</td>
<td>TRB</td>
<td>Countrywide</td>
<td>A national focus on the truck parking issue</td>
</tr>
<tr>
<td></td>
<td>2012</td>
<td>US DOT</td>
<td>Countrywide</td>
<td>Spatial analysis overlaying freight generators</td>
</tr>
<tr>
<td></td>
<td>2014</td>
<td>ATRI</td>
<td>Countrywide</td>
<td>Explains legislation drafted in SAFETEA-LU; identifies funding challenges</td>
</tr>
<tr>
<td></td>
<td>2014</td>
<td>ATRI</td>
<td>Countrywide</td>
<td>4000-participant survey of trucking industry stakeholders</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Identifying congestion levels, calculating time delay and cost</td>
</tr>
<tr>
<td><strong>Parking Feasibility and Location</strong></td>
<td>2008</td>
<td>Caltrans</td>
<td>Oakland &amp; Greater Alameda County, California</td>
<td>Ranked potential truck parking sites based on a wide range of criteria with assigned weights</td>
</tr>
<tr>
<td><strong>ITS</strong></td>
<td>2009</td>
<td>I-95 Corridor Coalition</td>
<td>Interstate 95 Northeast Corridor</td>
<td>Plan for truck stop ITS development</td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td></td>
<td></td>
<td>System architecture of ITS at truck stops</td>
</tr>
</tbody>
</table>
Little research has focused on expanding parking capacity.

Step further: methodological framework for evaluation of potential truck parking locations
- Comprehensive aspects and factors
- Utilize and integrate existing models
METHODOLOGY FRAMEWORK

- BCA based approach
- Quantification of losses and gains
- NJ Data → general areas

**ECONOMY**

(+) Employment size
(+) Payroll Volume, Sales Volume
(+) Economy multiplier effect
(+) Freight system improvement, travel cost and reliability improvement

**ENVIRONMENTAL**

(+) Reduction of GHG emission, tons of GHGs
(-) Increased noise pollution to the community
(-) Increased emission concentrations in and around truck stops

**FISCAL**

(+) Sales Tax
(+ Payroll Tax
(+ Property Tax
(- Land cost, investment, opportunity cost

**SAFETY**

(+ Better roadway safety resulting from reduced shoulder parking on high way or local road
(+ Better roadway safety resulting from reduced fatigued driving
(- Increased safety concern for the surrounding area

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METHODOLOGY FRAMEWORK

Parking Demand Estimation: FHWA (2002)

- Estimate of peak-hour parking spaces demanded for a highway segment

Peak-hour SH parking demand:

\[ PPD_{SH} = THT_{SH} \times \frac{D_{ST}}{D_{ST/stop}} \times PPF_{SH} \]

Peak-hour LH parking demand:

\[ PPD_{LH} = THT_{LH} \times \frac{D_{LT}}{D_{LT/stop}} \times PPF_{LH} + THT_{LH} \times \frac{D_{ST}}{D_{ST/stop}} \times PPF_{SH} \]
## METHODOLOGY FRAMEWORK

### Economic & Fiscal Analysis: Reference USA & New Jersey Transparency Center Data

<table>
<thead>
<tr>
<th>Types of facilities</th>
<th>Total Parking Spaces</th>
<th>Total Acreage</th>
<th>Spaces per Acre</th>
<th>Aggregate Number of Employees Needed</th>
<th>Jobs per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Service</td>
<td>89</td>
<td>19.48</td>
<td><strong>4.57</strong></td>
<td>37-85</td>
<td><strong>1.90-4.36</strong></td>
</tr>
<tr>
<td>All Full-Service Truck Stops</td>
<td>2208</td>
<td>364.75</td>
<td><strong>6.05</strong></td>
<td>564-1298</td>
<td><strong>1.55-3.56</strong></td>
</tr>
<tr>
<td>Large Full-Service Truck Stops (15 + Acres)</td>
<td>1682</td>
<td>280.95</td>
<td><strong>5.99</strong></td>
<td>315-740</td>
<td><strong>1.12-2.63</strong></td>
</tr>
</tbody>
</table>
METHODOLOGY FRAMEWORK

Economic & Fiscal Analysis

<table>
<thead>
<tr>
<th></th>
<th>Single-Service</th>
<th>All Full-Service Truck Stops</th>
<th>Large Full-Service Truck Stops (15+ Acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Payroll Volume &amp; Tax (1%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Payroll</td>
<td>$3,300,000 -  $11,600,000</td>
<td>$23,250,000 - $61,250,010</td>
<td>$10,750,000 - $37,500,000</td>
</tr>
<tr>
<td>Total Payroll Tax</td>
<td>$33,000 - $116,000</td>
<td>$232,500 - $612,500</td>
<td>$107,500 - $375,000</td>
</tr>
<tr>
<td>Payroll per Acre</td>
<td>$169,405 - $595,483</td>
<td>$63,742 - $167,923</td>
<td>$38,263 - $133,475</td>
</tr>
<tr>
<td>Payroll Tax per Acre</td>
<td>$1,694 - $5,954</td>
<td>$363 - $1,679</td>
<td>$382 - $1,335</td>
</tr>
<tr>
<td><strong>Sales Volume &amp; Tax (7%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Sales</td>
<td>$30,000,000 - $70,000,000</td>
<td>$502,000,000 - $1,695,000,000</td>
<td>$213,000,000 - $745,000,000</td>
</tr>
<tr>
<td>Total Sales Tax</td>
<td>$2,070,000 - $4,900,000</td>
<td>$35,140,000 - $118,650,000</td>
<td>$14,880,000 - $521,500,000</td>
</tr>
<tr>
<td>Sales Volume per Acre</td>
<td>$1,510,000 - $3,590,000</td>
<td>$1,380,000 - $4,650,000</td>
<td>$760,000 - $2,650,000</td>
</tr>
<tr>
<td>Sales Tax per Acre</td>
<td>$110,000 - $250,000</td>
<td>$100,000 - $330,000</td>
<td>$50,000 - $190,000</td>
</tr>
<tr>
<td><strong>Property Tax (Varies)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Net Property Value</td>
<td>$4,496,100</td>
<td>$91,494,700</td>
<td>$57,110,500</td>
</tr>
<tr>
<td>Total Prior Year Tax Amount (2014)</td>
<td>$111,104</td>
<td>$1,651,245</td>
<td>$836,793</td>
</tr>
<tr>
<td>Net Property Value per Acre</td>
<td>$230,806</td>
<td>$250,843</td>
<td>$203,276</td>
</tr>
<tr>
<td>Prior Year Net Tax Amount per Acre</td>
<td>$5,704</td>
<td>$4,428</td>
<td>$2,978</td>
</tr>
</tbody>
</table>

SINGLE-SERVICE
$169,405-$595,483 payroll/acre
$1.51 M-$3.59 M sales/acre
$5,704 property tax/acre

ALL
$63,742-$167,923 payroll/acre
$1.38 M-$4.65 M sales/acre
$4,428 property tax/acre

FULL-SERVICE
$38,263-$133,475 payroll/acre
$0.76 M-$2.65 M sales/acre
$2,978 property tax/acre
METHODOLOGY FRAMEWORK

Rest Stop Design and Construction Cost
(VTPI, 2013)

- Cost of parking area: $118,200 per acre
- Cost of building: $72.61 per square foot (small strip-mall style shopping center, including site work, hard construction and building design)

*All of numbers have been adjusted for inflation to 2015 dollars.
METHODOLOGY FRAMEWORK

Environmental Analysis

Air Pollution: (+) reduced emission from reduced VMT searching for parking
(-) increased emission concentrations in and around truck stops

Equation 2: Modeling of Truck Plume Emissions by Distance

\[ C(X, Y, 0) = \frac{Q}{(\Pi u \sigma_y \sigma_z)} \exp \left[ \left( -\frac{H^2}{2 \sigma_z^2} \right) \right] \exp \left[ \left( -\frac{Y^2}{2 \sigma_y^2} \right) \right] \]

Where:
- \( C \) = Concentration at some specific point or receptor in g/m^3 (grams/meters cubed)
- \( Q \) = Source pollutant emission rate in g/s (grams/second)
- \( \Pi \) = Pi
- \( u \) = Horizontal wind velocity along plume centerline (meters/second)
- \( \sigma_y \) & \( \sigma_z \) = Horizontal & Vertical Dispersion Coefficients* (meters)
- \( H \) = Effective plume stack height* (meters)
- \( Y \) = Downwind perpendicular distance (meters)
- \( X \) = Downwind distance at which \( C \) is calculated (meters)
METHODOLOGY FRAMEWORK

Environmental Analysis

Sound Pollution: (-) negative effect on property values in proximity

A maximum cost of $55,000 per severely affected household or noise-sensitive land where dBA levels exceed 76 dBA or increase by 20 dBA over original totals

- Net Sound Pollution = Increase in Noise Level at Truck Stop – Noise Abatement Implementation
- Noise estimation models and impact on property values (Palmquist, 1980)

\[ \Delta L = 10 \times \log_{10} n \]

Where: \( \Delta L \) = the decibel level increase
\( n \) = the number of equal sound sources

\[ 2 \times d = L - 6 \text{ dBA} \]

Where: \( d \) is the distance from the sound source
\( L \) is the decibel level in dBA
METHODOLOGY FRAMEWORK

**Safety Analysis:** New Jersey crash data 2003-2014 (NJDOT)

(+) Safety enhancement from reduced accidents (fatigue driving and illegal parking)
LOCATION ANALYSIS & CURRENT FREIGHT TRENDS

Retail Trade
- Supermarkets appear to be a strong indicator of freight flow

Manufacturing
- Manufacturing uses can be located in a wide range of areas

Warehousing & Distribution
- Important driver of truck traffic in New Jersey
LOCATION ANALYSIS & CURRENT FREIGHT TRENDS

2040 Largest Expected Truck Flow for Each NJTPA County

2040 Parking Deficit for each NJTPA County

Warehousing and Distribution Facilities by County

- Middlesex: 19%
- Bergen: 19%
- Hudson: 11%
- Essex: 13%
**LOCATION ANALYSIS & CURRENT FREIGHT TRENDS**

**County level Analysis: NAICS Association Data**

- Southern NJ: the most feasible opportunities for parking
- Northern NJ: mostly built up
- Northwestern NJ: some spaces are less populated areas, but such locations are far from ideal for truckers
CASE STUDY- NEWARK

- Identified by NJTPA as a site of interest.
- 44.9-acre parcel, a 30,000 square foot facility.
- Situated between Interstate 95 and US 1-9, which separate it from any residential or noise-sensitive sites, which is especially useful in noise pollution evaluations.
**CASE STUDY**

**Economic and Fiscal Analysis**

- **Annual Sales Volume Comparison**
  - Newark Site: 80 M
  - Annual Sales Volume: 479 M
  - Proposed Site: 16.7%

- **Annual Payroll Comparison**
  - Newark Site: 4 M
  - Annual Payroll: 17.87 M
  - Proposed Site: 22.3%

**Rest Stop Design and Construction Cost**

- **Building Construction Cost**
  - 2 million

- **Parking Lot Construction Cost**
  - 5.5 million

**Annual Sales Tax**
- Newark Site: 5.6 M
- Annual Payroll: 33.51 M
- Proposed Site: 16.7%

**Annual Payroll Tax**
- Newark Site: 0.04 M
- Annual Sales Volume: 0.17 M
- Proposed Site: 22.3%

**Annual Property Tax**
- Newark Site: 0.139 M
- Annual Payroll: 0.836 M
- Proposed Site: 16.6%

**Total Jobs Created**
- Newark Site: 88
- Total Jobs Created: 453
- Proposed Site: 19.4%

- Newark Site: 280
- Total Jobs Created: 1,682
- Proposed Site: 16.6%

*Comparison is based on proposed site in Newark and nine selected Large Full-size Truck stops in New Jersey.*

**Apparently, proposed site will increase around 16% to 22% in each item.**
CASE STUDY - NEWARK

Environmental Analysis

- 722.5 gram reduction in NOx per night of parking ~ 263.71 kg per Year
- 3% to over 4% reduction in nearby residential property values. (Combined with reduction from NOx emission and Noise Pollution)
- The median home value in Newark is $200,600 with 1.4% yearly growth. However, if we build up a truck stop in Newark, it may drop the home value by 3%~4% based on our research.

Safety Impact

- Reduce accidents and improving trucker safety.
FINDINGS & INSIGHTS

- Certain factors of a truck stop development or expansion are more impactful to society than others
  - Significant economic and safety benefits
  - Noise pollution to communities
- Truckers’ perspective: along major truck routes or near destination
- Challenges: community resistance, and long process of land development permits
- Possible solutions
  - Existing brownfields, especially those near the ports or industrial areas
  - Partnership with existing motels and hotels and large retail stores (such as Wal-Mart)
  - Dedicated freight land use, such as freight village
WEB-BASED ANALYSIS TOOL

- Truck stops visualization and interactive map
- More functions/info to incorporate
CONCLUSIONS

- **Methodology framework**
  - Could be perfected and applied to other regions
  - Estimate the gap in financial incentives for both public agencies, private investors, and community
  - Identify, recommend and prioritize best locations of parking facilities in a freight network perspective

- **Future research**
  - Data collection and fine-tune parameters
  - In-depth quantitative BCA
  - Location optimization
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