Planning and Modelling Urban Consolidation Centres

Assoc. Prof. Russell G. Thompson
Department of Infrastructure Engineering
rgthom@unimelb.edu.au

IIT Bombay 10th April 2014
Outline

Definition
Key Concepts
Advantages & Disadvantages
Common Structures
Case Studies
  Binnenstadservice
  Motomachi Shopping Street
Modelling Approaches
Ongoing Research
References
A logistics facility that is situated in relatively close proximity to the urban area that serves a city centre, an entire town or a specific site such as a shopping centre, airport, hospital or major construction site. Goods destined for these locations are dropped off at the UCC.
A logistics facility that is situated in relatively close proximity to the urban area that serves a city centre, an entire town or a specific site such as a shopping centre, airport, hospital or major construction site. Goods destined for these locations are dropped off at the UCC. The UCC operator sorts and consolidates these loads dropped off by logistics companies and makes deliveries to the final destinations, often using environmentally friendly vehicles, for example electric and gas-powered goods vehicles, and electrically-assisted tricycles.

Browne at al. (2005)
Key Concepts

- **Consolidation** identified as key to achieving sustainable urban goods transport (OECD, 2003)

- Increasing consolidation for last kilometre reduces unnecessary vehicle movements, and thus congestion & pollution

- To increase efficiency of city distribution systems, different deliveries have to be *bundled*
Kolher & Groke, 2004

Diagram:
- Producers of cosmetics, pharmaceutics, electronics, and pet food.
- Production points:
  - Delivery to forwarding agents in Freiburg.
  - Delivery to City-Terminal by the forwarding agents.
- City-Terminal.
- Supply to recipient by neutral carrier.
- Recipients 1, 2, and 3.
Kolher & Groke, 2004
producer of cosmetics
producer of pharmaceutics
producer of electronics
producer of pet food
delivery to forwarding agents in Kassel
forwarding agents
City-Terminal
collection by neutral carrier
supply to recipients by neutral carrier
recipient 1
recipient 2
recipient 3

Kolher & Groke, 2004
Multiple UCC

Kolher & Groke, 2004
Advantages of UCCs

• Environmental & social benefits
• Better planning & implementation of logistics operations
• Better inventory control, product availability & customer service
• Compatibility with wider policy and regulatory initiatives
• Public relations benefits for participants
• Better use of resources at delivery locations
• Opportunity for carrying out value-added activities
Disadvantages of UCCs

- Potentially high set up & operating costs
- Large transport companies & retailers already efficient
- Difficulty handling a wide range of goods
- Increased direct delivery costs
- Lack of enforcement of regulations for vehicles not included in consolidation scheme
- Organisational & contractual problems often limit effectiveness
- Potential to create monopolies (legal)
- Loss direct interface between suppliers & customers
Poorly Loaded Vehicles on Direct Deliveries Replaced by Better Loaded Vehicles from UCC

Browne et al, 2005
Large Goods Vehicles on Direct Deliveries Replaced by Smaller Vehicles from UCC

Browne et al, 2005
• Commenced in Yokohama, Japan in 2004

• Developed to address concerns: roadside environment (air quality & noise) & traffic safety

• Aim: reduce number of trucks going through & parking on shopping street (300 shops)

See PIARC, (2012)
Motomachi Joint Delivery Centre in Yokohama, Japan

PIARC, 2012
<table>
<thead>
<tr>
<th>Type</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of carriers</td>
<td>17 (participating carriers)</td>
<td>1 (jointly-owned carrier)</td>
</tr>
<tr>
<td>Total number of vehicle-days</td>
<td>40 vehicles 30 days</td>
<td>20 vehicles 30 days</td>
</tr>
<tr>
<td>Type of vehicle</td>
<td>Diesel truck</td>
<td>CNG truck</td>
</tr>
<tr>
<td>Number of participating stores</td>
<td>-</td>
<td>Almost all stores</td>
</tr>
<tr>
<td>Goods of exclusion</td>
<td>-</td>
<td>Directly delivered goods from manufactures, High-value items</td>
</tr>
</tbody>
</table>
• Joint Delivery Centre (1km from shopping street, managed by independent business)
• 3 Eco-Cargo-Areas (parking stations to load/unload goods)
• Low emission vehicles (3 CNG vehicles)
• Delivery from Eco-Cargo-Area to each shop performed by cart
• Distribution companies pay 150 Yen per parcel to operator
• Trucks reduced from 100 to 29

PIARC, (2012)
• Commenced in Nijmegen, the Netherlands in 2008
• Focuses on *receivers* & shippers rather than on carriers
• Subsidy only provided in 1st year (>9 cities now operating)
• After 1st year: ↓5% truck kilometres & ↓7% of truck stops
• Consolidation centre located 1.5 km outside city centre, open 18 hours a day
• When small retails join, suppliers then sent UCC address for carriers to deliver goods to www.binnenstadbservice.nl
Optimal location for each objective function

<table>
<thead>
<tr>
<th>Objective function</th>
<th>Optimal location pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f_1$: Transportation cost</td>
<td>(2, 5, 7, 10)</td>
</tr>
<tr>
<td>$f_2$: Costs of travel time</td>
<td>(1, 2, 5, 15)</td>
</tr>
<tr>
<td>$f_3$: CO2 emissions</td>
<td>(1, 5, 7, 10, 15)</td>
</tr>
</tbody>
</table>

Quak and Hendriks, 2012
• Deliberately focuses on small & independent retailers
• Goods delivered when retailer wishes
• Additional services: Storage, Home deliveries & reverse logistics (waste)
• Uses clean vehicles: electronic bicycles & natural gas trucks, electric vehicles

Quak & Hendriks (2012)
Public Logistics Terminals

- Planning Decisions (Number, Size & Location) have significant impact on inventory-related costs & customer service levels

- Queuing Theory & Non-linear programming, accounting for traffic conditions on road network

- Multi-objective optimisation model considering transport & facility costs, travel time & CO$_2$ emissions

Taniguchi et al, (2001)
For determining *viability* for co-operative freight organization

- Size & Location of UCCs
- Demand
- Transhipment costs
- Rates for use
- Routes of JDS
- Costs for UCCs & JDS
- Benefits (noise, fuel consumption & emissions)
Structure of logistics systems

Taniguchi et al, (2001)
Study area
(Kyoto-Osaka area in Japan)

Taniguchi et al, (2001)
Multiple UCCs

Upper level problem: Behaviour of planner

- Optimal locations of terminals
- Optimal size of terminals

Location pattern of terminals

Number of trucks that use each terminal

Traffic condition at each link

Lower level problem: Behaviour of each company and each truck

- Terminal choice
- Route choice

Optimal location model with co-operative freight transport systems (Taniguchi et al., 2001)
Ongoing Research

• Planning
  – Integration with other policy measures (eg. Road Pricing & AFVs)
  – Incentives for participating carriers & receivers

• Modelling
  – Estimating supply chain impacts
  – Interactions between stakeholders (Agent Based Modelling, see Duin et al, 2012)


