Increasing the sustainability of urban freight systems

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City Logistics concepts
Vehicle Routing & Scheduling
Logistics Network Design
Collaborative Freight Systems
Urban Consolidation Centres
Centre for Sustainable Urban Freight Systems
References
City Logistics is an integrated approach for urban goods distribution based on the systems approach. It promotes innovative schemes that reduce the total cost (including economic, social & environmental) of goods movement within cities.

Structure of visions for city logistics
Key Stakeholders in City Logistics

Administrators

Shippers

Carriers

Residents

Receivers
<table>
<thead>
<tr>
<th><strong>Stakeholder Group</strong></th>
<th><strong>Common Goals &amp; Objectives</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipper</td>
<td>Maximise levels of service, including cost, time for picking up or delivering &amp; reliability of transport (delivery without any delay with respect to designated time at customers).</td>
</tr>
<tr>
<td>Carriers</td>
<td>Minimise costs associated with collecting &amp; delivering goods to customers to maximise their profits.</td>
</tr>
<tr>
<td>Residents</td>
<td>Minimise traffic congestion, noise, air pollution &amp; traffic accidents near their residential &amp; retail areas.</td>
</tr>
<tr>
<td>Receivers</td>
<td>Minimise storage, disruption to business, impacts on local environment. Maximise reliability, punctuality &amp; flexibility of deliveries.</td>
</tr>
<tr>
<td>Administrators</td>
<td>Enhance economic development of city &amp; increase employment opportunities. Alleviate traffic congestion. Improve environment &amp; increase road safety</td>
</tr>
</tbody>
</table>
Urban Consolidation Centres
Joint Delivery Systems
Off Hour Deliveries
Access Control (eg. LEZ)
Intelligent Transport Systems (ITS)
Alternative Fuel Vehicles
Recommendations

Active measures needed to increase awareness of importance of urban goods transport & to diffuse knowledge

_Evaluation methods & data_ are prerequisites for effective policy measures

*Consolidation* key to achieving sustainable urban goods transport

Regulations to be harmonised, standardised, stable, easy to enforce & cost-effective

Infrastructure capacity be used more imaginatively on a _24-hour basis_
Cleaner, low noise & more energy-efficient vehicles to be promoted
Adequate logistic facilities to be provided
Efforts to be made to reduce safety risks
Reverse logistics to be developed
Technological & conceptual innovation can support sustainable urban goods transport
Next steps – further study & international co-operation
Benefits of considering travel time *variability* in vehicle routing with time windows

Risk of delays modelled using stochastic programming & robust optimisation

Formed the basis for City Logistics modelling and intelligent transport systems research programs…

2 International Patients registered.

Thompson et al (2011)
• Vehicle operating cost savings
• Safety
• Environmental Benefits
• Costs
  – Compliance
  – Administrative
  – Infrastructure
• Flow on Benefits
• Vehicle usage depends on commodity carried & type of freight network
• 16 case studies simulations to estimate distance & vehicle reductions
• Growth rates by vehicle class for ancillary and hire and reward sector produced
Super B Double 30m

2 x 40' or 4 x 20' containers

Hassall and Thompson, 2011
Urban Port Scenario Simulation
Single Articulated Vehicles
Urban Port Scenario Simulation
Super B-Double Vehicles
Simulation Results

To Port Super B-double vs Single Articulated Truck

<table>
<thead>
<tr>
<th></th>
<th>Single</th>
<th>Super B-double</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directional Trips</td>
<td>24</td>
<td>12</td>
<td>-50.0%</td>
</tr>
<tr>
<td>Kilometers</td>
<td>708</td>
<td>530.4</td>
<td>-25.1%</td>
</tr>
<tr>
<td>Vehicles</td>
<td>4</td>
<td>3</td>
<td>-25.0%</td>
</tr>
<tr>
<td>On duty hours</td>
<td>26.5</td>
<td>22</td>
<td>-17.0%</td>
</tr>
<tr>
<td>Ave kms per trip duty</td>
<td>29.5</td>
<td>44.2</td>
<td>49.8%</td>
</tr>
</tbody>
</table>

Other Data

- Container Mix: 60% TEU, 40% FEU
- Customers: 17
- Time window: 8 hour total shift operation
• Vehicle usage depends on commodity carried & type of freight network
• 16 case studies simulations to estimate distance & vehicle reductions
• Growth rates by vehicle class for ancillary and hire & reward sector produced
<table>
<thead>
<tr>
<th></th>
<th>Reduction in Kilometres</th>
<th>Reduction in Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linehaul/Regional</td>
<td>25.2</td>
<td>28.3</td>
</tr>
<tr>
<td>Urban</td>
<td>19.1</td>
<td>21.0</td>
</tr>
</tbody>
</table>

Hassall and Thompson, 2011
B2C Food Items

Household Characteristics → Density → Population

Density → Trip Frequency

Load → Customers

Customers → Market Share

Home Deliveries → Delivery Fleet Characteristics

Delivery Fleet Characteristics → VRS Deliveries

Time Windows

Distance Travelled

Shop Sales

Distribution Fleet Characteristics → VRS Distribution

Thompson et al, 2001
Single Urban DC

- Stores
- Medium density
- Low density

DC

- Low density
- Medium density

Stores
## VKT with 1 DC

<table>
<thead>
<tr>
<th></th>
<th>Internet</th>
<th>Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>Suppliers to distribution centre</td>
<td>481.1</td>
<td>481.1</td>
</tr>
<tr>
<td>Distribution to stores</td>
<td>458.5</td>
<td>458.5</td>
</tr>
<tr>
<td>Stores and homes (customers)</td>
<td>24037</td>
<td>22835.3</td>
</tr>
<tr>
<td>Deliveries to homes</td>
<td>0</td>
<td>2805.9</td>
</tr>
<tr>
<td>Total</td>
<td>24977</td>
<td>26580.9</td>
</tr>
<tr>
<td>Increase (%)</td>
<td></td>
<td>6.4</td>
</tr>
</tbody>
</table>
## VKT with regional DCs

<table>
<thead>
<tr>
<th></th>
<th>Internet Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0%</td>
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<tr>
<td>Suppliers to distribution centre</td>
<td>481.1</td>
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<tr>
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<td>458.5</td>
</tr>
<tr>
<td>Stores and homes (customers)</td>
<td>24037</td>
</tr>
<tr>
<td>Deliveries to homes from RDC’s</td>
<td>0</td>
</tr>
<tr>
<td>Distribution to RDC’s from MDC</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>24977</td>
</tr>
<tr>
<td>Change (%)</td>
<td>0.4</td>
</tr>
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</table>
Collaborative Distribution

- Shared storage location(s)
- Networks restructured using advanced vehicle routing & scheduling systems
- Distribution to outlets by areas & priority
- Substantial savings in transport costs (20-30%)
- Significant reduction in environmental & social costs
Independent Networks from suppliers
Around 20% saving in distance travelled
Collaborative Distribution in Melbourne
Motomachi Joint Delivery Centre in Yokohama, Japan

PIARC, 2012
Binnenstadservice (inner city service)

www.binnenstadservice.nl

Quak and Hendriks, 2012
Objective function
Optimal location pattern

\( f_1: \text{Transportation cost} \quad (2, 5, 7, 10) \)

\( f_2: \text{Costs of travel time} \quad (1, 2, 5, 15) \)

\( f_3: \text{CO}_2 \text{ emissions} \quad (1, 5, 7, 10, 15) \)
Volvo Centre of Excellence in Sustainable Urban Freight Systems

Aims to increase the quality of life, economic efficiency and ecological sustainability of urban freight systems

Research Themes

City Logistics (Collaborative & Intelligent Freight Systems)

Innovative Freight Vehicles (Alternative Fuels & High Productivity)

Freight Planning Methods (Surveys & Modelling)

Intermodal Freight Systems (Road & Rail)

Currently working with industry partners (Vicroads, CoM, DoTPLI) to define their research & training needs…
Core Research Partners: Group Leaders

ASIA

KYOTO UNIVERSITY
Taniguchi

The University of Melbourne
Thompson

UNIVERSITY OF WESTMINSTER
Browne

CAB, IAG

Rensselaer
Holguin-Veras

THE AMERICAS

PENNSTATE
Friesz

EUROPE, AFRICA AND MIDDLE EAST

TU Delft
Tavaszy

Associate Research Centers (ARCs)
CoE SUFS Goal

To jumpstart an integrative and participatory process—involving cities, private sector, and researchers—that will lead to the implementation of new UFS paradigms that:

– Are sustainable
– Increase quality of life
– Foster economic competitiveness and efficiency
– Enhance environmental justice
Featuring

Dynamic Vehicle Routing & Scheduling
Pick-up & Deliveries with Transfers
HPFVs: Network Design & Safety Benefits
VRS: phone traffic data (HERE)
Off Hours deliveries (NYC)
Urban consolidation centres with cargobikes
Parcel Lockers (AP & InPost)
References


