Urban Logistics Innovation Opportunities

Dr. Yari Borbon-Galvez
Dr. Wouter Dewulf
Prof. Thierry Vanelslander
CONTENT

• Background
  • Urban Logistics and Mobility Project
  • Urban Logistics

• Methods

• Results

• Conclusions

• Further research
BACKGROUND

Urban Logistics and Mobility Project
An ever increasing retail world
  • Online, offline, and omni-channel
A more complex urban area
  • Road congestion costs 1% of the EU GDP
  • 21% of CO₂ emissions come from freight
  • Access Restriction Schemes spread over the EU
EU Non-Binding Guidelines for Urban Logistics

People
Planet

Authorities’ solutions
Urban Logistics
Access Restriction Schemes
+ Internalising Externalities

Impacts
People
Planet
Profit?

TPR Solution
Ex-ante
Cost
Simulation
Tool
METHODS

• Literature review of retail trends, urban logistics, and urban access restriction
• Development of a cost function for urban logistics
• Case study of a retailer and its distribution within the Antwerp city ring

Generalised Urban Retail Logistics Cost Function

\[ TC = Lc + Rc + Ec \]

| Factors to take into account | \(- Congestion costs\) | \(- Accidents costs\) | \(- Air pollution costs\) | \(- Noise costs\) | \(- Climate change costs\) | \(- Energy production and transfer costs\) | \(- Urban logistics operations (e.g. loading/unloading bays) costs\) |
|-----------------------------|------------------------|------------------------|---------------------------|-------------------|---------------------------|---------------------------------------------------|
| Vehicle type               | Distance               |                        |                           |                   |                           |                                                   |
| Zone                       | Road type              |                        |                           |                   |                           |                                                   |
| Congestion level           | Euro emission          |                        |                           |                   |                           |                                                   |
| Traffic density            | Time of day            |                        |                           |                   |                           |                                                   |
| Load factors               | ....                   |                        |                           |                   |                           |                                                   |

Based on DG Move (2014) Update of the Handbook on External Costs of Transport
# METHODS

- Literature review of retail trends, urban logistics, and urban access restriction
- Development of a cost function for urban logistics
- Case study of a retailer and its distribution within the Antwerp city ring

<table>
<thead>
<tr>
<th>2013 Sales rank</th>
<th>Company</th>
<th>Country of origin</th>
<th>2013 retail revenue (Million USD)</th>
<th>2011 Sales rank</th>
<th>Company</th>
<th>Country of Origin</th>
<th>2011 retail revenue (Million USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Costco Wholesale Corporation</td>
<td>U.S.</td>
<td>$105,156</td>
<td>2</td>
<td>Carrefour S.A.</td>
<td>France</td>
<td>113,190</td>
</tr>
<tr>
<td>3</td>
<td>Carrefour S.A.</td>
<td>France</td>
<td>$98,688</td>
<td>3</td>
<td>Tesco PLC</td>
<td>U.K.</td>
<td>101,574</td>
</tr>
<tr>
<td>4</td>
<td>Unternehmens Treuhand KG</td>
<td>Germany</td>
<td>$98,662</td>
<td>4</td>
<td>Metro AG</td>
<td>Germany</td>
<td>92,902</td>
</tr>
<tr>
<td>5</td>
<td>Tesco PLC</td>
<td>U.K.</td>
<td>$98,631</td>
<td>5</td>
<td>The Kroger Co.</td>
<td>U.S.</td>
<td>90,327</td>
</tr>
<tr>
<td>7</td>
<td>Metro AG³</td>
<td>Germany</td>
<td>$86,393</td>
<td>7</td>
<td>Lidl</td>
<td>Germany</td>
<td>87,841</td>
</tr>
<tr>
<td>8</td>
<td>Aldi Einkauf GmbH &amp; Co. oHG</td>
<td>Germany</td>
<td>$81,090</td>
<td>8</td>
<td>Aldi</td>
<td>Germany</td>
<td>73,375</td>
</tr>
<tr>
<td>9</td>
<td>The Home Depot Inc.</td>
<td>U.S.</td>
<td>$78,812</td>
<td>9</td>
<td>Walgreen Co.</td>
<td>U.S.</td>
<td>72,184</td>
</tr>
<tr>
<td>10</td>
<td>Target Corporation</td>
<td>U.S.</td>
<td>$72,596</td>
<td>10</td>
<td>The Home Depot, Inc.</td>
<td>U.S.</td>
<td>70,395</td>
</tr>
</tbody>
</table>
### RESULTS

#### Retail Logistics

<table>
<thead>
<tr>
<th>Logistics Operations</th>
<th>Distribution Centre (d)</th>
<th>Line-haul transportation (l)</th>
<th>Urban DC/Cross-docking (u)</th>
<th>Urban Logistics Last-Mile Delivery (m)</th>
<th>Retail outlet (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation distance (K)</td>
<td>K_t</td>
<td>K_u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation time (T)</td>
<td>T_l</td>
<td>T_m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handling time (H)</td>
<td>H_d</td>
<td>H_u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage time (S)</td>
<td>S_t</td>
<td>S_u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idle time (I)</td>
<td>I_t</td>
<td>I_u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of vehicles (V)</td>
<td>V_t</td>
<td>V_m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Human resources (R)</td>
<td>R_d</td>
<td>R_u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment units (P)</td>
<td>P_d</td>
<td>P_u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Units of energy/fuel (F)</td>
<td>F_d</td>
<td>F_u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share of charged transport network (N)</td>
<td>N_t</td>
<td>N_m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage quantity (Ss)</td>
<td>S_d_t</td>
<td>S_u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utilisation costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle Leasing (L)</td>
<td>L_t</td>
<td>L_m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human resources wage (W)</td>
<td>W_d</td>
<td>W_m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equipment Leasing (Pl)</td>
<td>Pl_d</td>
<td>Pl_u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy/Fuel cost (Fc)</td>
<td>Fc_d</td>
<td>Fc_u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport network charge (Nch)</td>
<td>Nch_t</td>
<td>Nch_m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage charge (Sc)</td>
<td>Sc_d</td>
<td>Sc_u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access Restriction Scheme</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost (A)</td>
<td>A_t</td>
<td>A_u</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External costs (E)</td>
<td>E_t</td>
<td>E_m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh product decay value.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value of time (VT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban retail logistics costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Distribution Centre Costs

\[
D = H_d(P_d * Pl_d + R_d * W_d) + (S_d * S_d + Sc_d) + (I_d * V_l + L_l) + (I_d * R_l * W_l) + VT(H_d + S_d + I_d)
\]

#### Line-Haul Costs

\[
L = (K_l * V_l)(F_l + Fc_l + N_l * Nch_l + A_l + E_l) + (T_l + V_l + W_l) + (I_l * V_l)(L_l + F_l + Fc_l) + (I_l * R_l * W_l) + VT(T_l + I_l)
\]

#### Urban DC/Cross-Docking Costs

\[
U = H_u(P_u * Pl_u + R_u * W_u) + (S_u * S_u + Sc_u) + (I_u * V_m + L_m + A_m) + (I_u * R_m * W_m) + VT(H_u + S_u + I_u)
\]

#### Last-Mile Delivery Costs

\[
M = (K_m * V_m)(F_m + Fc_m + N_m + Nch_m + A_m + E_m) + (T_m + V_m + W_m) + (I_m * V_m)(L_m + F_m + Fc_m) + (I_m + R_l * W_l) + VT(T_m + I_m)
\]

#### Retail Outlet Costs

\[
R = H_r(P_r * Pl_r + R_r * W_r) + (S_r * S_r + Sc_r) + (I_r * V_m + L_m + A_r) + (I_r * R_m * W_m) + VT(H_m + S_m + I_m)
\]

#### Total Costs

\[
C_T = D + L + U + M + R
\]
RESULTS

Unloading time per delivery

Weekly deliveries

- Quantity per CDC delivery
- Quantity per wholesaler delivery
- Quantity per DSD delivery

Quantities per delivery type vary with weekly deliveries.
RESULTS

Optimisation opportunities

• *Low emission zones/roads scenario*

\[
(K \times V_{LE5} \times 0,124\,€) < \begin{pmatrix} K \times V_{LE4} \times 0,145\,€ \\ K \times 0,5V_{LE4} \times 0,145\,€ + K \times 0,5V_{LE3} \times 0,176\,€ \\ K \times V_{LE0} \times 0,196\,€ \end{pmatrix}
\]

• *Micro-urban distribution centres and cross-docking scenario*

\[
C_T(v_l,u,v_m,t_m) < C_T(a,v_l,t_m)
\]

• *Tethering scenario*

\[
C_T(a,su) = D + L + SU + M + R < C_T(a) = D + L + R
\]

• *Public transport systems for freight delivery*

\[
C_T(a,rail,u,v_m) = D + Rail + U + M + R < C_T(a) = D + L + R
\]
\[
C_T(u,pv_m,r_m) = D + L + U + M + R < C_T = D + L +
\]
CONCLUSIONS

• Growing importance of transport externalities
• Growing number of factors to internalize from transport externalities
• Early adoption of logistics innovations requires ex-ante impact assessments
• Access restriction schemes play a major role in driving sustainable logistics not by forcing industry but by setting a level playing field for competition and innovation.
FURTHER RESEARCH

• Execute simulations and cost function calibrations
• Estimate external transport costs of urban retail logistics
• Application to different areas (i.e. Cross-Border B2C Parcel Deliveries)
Thank you for your attention and comments!