Application of a Cost Model to Evaluate the Impacts from B2C E-commerce Parcel Deliveries on Urban Logistics

I-NUF 2015, urban logistics session

Ivan Cardenas, Thierry Vanelislander, Wouter Dewulf,
University of Antwerp. Department of Transport and Regional Economics.
I. Introduction

II. B2C e-commerce parcel deliveries demand

III. B2C e-commerce parcel deliveries supply

IV. Cost Estimation

V. Failed deliveries

VI. Conclusions
I. Introduction

London congestion could rise due to e-commerce deliveries

10 September 2015 - 09:45

By Simon Crisp

The number of commercial vehicles prowling the streets of the capital is set to increase, with the rise in online being blamed by London Mayor, Boris Johnson, according to the Evening Standard.

Johnson said that the rise of e-commerce deliveries will lead to a 20 per cent increase in the number of vehicles across London by the year 2031. And with traffic already proving problematic in this historic city, the mayoral team is highlighting the impact of rising online sales.

Uber gets more serious about delivering shoes, flowers to your doorstep
I. Introduction

- Fragmentation
- Failed Deliveries
- Return flows

Measure the impacts of e-commerce on urban logistics
- Account internal and external costs of B2C e-commerce last mile deliveries
- Model urban distribution of B2C e-commerce
  - Demand
  - Supply
  - Routes
- Analyze different distribution schemes trough simulation
II. Where B2C e-commerce parcels are delivered? (1)

Source: Own composition based on own data
II. Where B2C e-commerce are delivered? (2)

- Urbanization in Belgium 97.8% *World Urbanization Prospects, 2014*
- Deliveries concentrated in urban areas, is e-commerce more important in urban areas?
- Correlation
  - Density and Deliveries **71.13%**

Source: Own composition based on own data
II. Where B2C e-commerce are delivered? (3)
II. Where B2C e-commerce are delivered? (4)

- Companies and highways highlighted
- Correlation between Population Density and Deliveries per Capita -0.07%
- Define a typology of demand areas
III. How B2C e-commerce parcels are delivered?

Three different streams to deliver the goods.
- Home Delivery
- Pick-up
- Drop-off

(The green mile?, EY, 2015)
III. Who is delivering B2C e-commerce parcels?

<table>
<thead>
<tr>
<th>NPO</th>
<th>Integrators</th>
<th>Parcel Carriers</th>
<th>Last Mile Specialists</th>
</tr>
</thead>
<tbody>
<tr>
<td>PostNL</td>
<td>DHL</td>
<td>Hermes</td>
<td>Doddle</td>
</tr>
<tr>
<td>Deutsche Post</td>
<td>TNT</td>
<td>DPD</td>
<td>Bring</td>
</tr>
<tr>
<td>Royal Mail</td>
<td>FedEx</td>
<td>GLS</td>
<td>Kiala</td>
</tr>
<tr>
<td>Bpost</td>
<td>UPS</td>
<td>DHL Parcel</td>
<td>BubblePost</td>
</tr>
<tr>
<td>USPS</td>
<td></td>
<td></td>
<td>PackStation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Parcel Home</td>
</tr>
</tbody>
</table>
IV. Internal costs of the last mile in B2C e-commerce deliveries

\[
\text{Last Mile Internal Costs per Stop} = \frac{\text{Transport Costs + Delivery Costs + Fixed Costs}}{\text{Number of successful stops}}
\]

\[
\text{Number of successful stops} \approx \text{Number of parcels delivered}
\]

\[
\frac{\text{B2C Last Mile internal costs per stop}}{\text{Stop}} = \frac{2D_{lh}(d+\frac{t}{s\bar{p}_{lh}})+D_{d}d+T_{d}t+f_{cv}}{S(1-f)}
\]

Where:
- \(S\) is the number of daily stops
- \(d\) is the vehicle costs distance coefficient in monetary units per kilometre.
- \(t\) is the labour costs time coefficient in monetary units per hour
- \(D_{lh}\) is the one way distance between arrival terminal and the starting point of the route in kilometres
- \(s\bar{p}_{lh}\) is the average speed of the line-haul leg in kilometres per hour
- \(T_{d}\) is the average time spent delivering the goods from the first to the last stop in hours
- \(D_{d}\) is the delivery tour total distance from the first to the last stop in kilometres
- \(f_{cv}\) is the vehicle usage fixed costs per day in monetary units
- \(f\) is the failed delivery rate
IV. Numerical example, city of Mechelen

Avg. speed line haul = 36.54 km/h
Labor cost = 18.12 EUR/h
Fuel costs per kilometer = 0.14 EUR/km
Transport cost per kilometer = 0.64 EUR/km
Line haul distance = 84.14 km

Transport Costs = 53.25 EUR/tour

Tour total time = 7.95 hours
Labor cost = 18.12 EUR/h
Fuel costs per kilometer = 0.14 EUR/km
Tour total distance = 63.85 km

Labor route cost = 144.05 EUR
Fuel route cost = 8.7 EUR

Delivery Costs = 152.75 EUR/tour

Monthly lease & maintenance = 608 EUR
Yearly expenses (e.g. taxes, insurances) = 861 EUR
Monthly working days = 20.92 days

Vehicle Costs = 32.5 EUR/tour

Tour Costs = 238.5 EUR/tour
Number of stops per tour = 100 stops
Failed deliveries rate = 16.8%

Cost per stop = 2.87 EUR/stop
IV. External costs of the last mile in B2C e-commerce deliveries

<table>
<thead>
<tr>
<th>Pollution</th>
<th>Congestion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pollution</strong></td>
<td><strong>Congestion</strong></td>
</tr>
<tr>
<td>Data from Handbook of External Costs of Transport (RICARDO-AEA, 2014) in urban areas. Corresponding to EURO 5 Diesel Vans.</td>
<td>Data from Handbook of External Costs of Transport (RICARDO-AEA, 2014) in urban areas.</td>
</tr>
<tr>
<td>1.4 €ct / kilometer</td>
<td>Near capacity main roads</td>
</tr>
<tr>
<td>2.07 EUR / tour</td>
<td>48.7 €ct / kilometer</td>
</tr>
<tr>
<td><strong>2.5 €ct / stop</strong></td>
<td>Over capacity main roads</td>
</tr>
<tr>
<td>3.8 €ct / parcel in The Netherlands (<em>The green mile?</em>, EY, 2015)</td>
<td>75.8 €ct / kilometer</td>
</tr>
<tr>
<td>78.91 EUR/tour</td>
<td>Near capacity other roads</td>
</tr>
<tr>
<td>0.95 EUR/stop</td>
<td>139.4 €ct / kilometer</td>
</tr>
<tr>
<td></td>
<td>Over capacity other roads</td>
</tr>
<tr>
<td></td>
<td>230.5 €ct / kilometer</td>
</tr>
</tbody>
</table>
IV. Cost composition

**Internal Costs**
- Time Related Costs
- Distance Related Costs
- Fixed Costs

**Internal + External Costs**
- Time Related Costs
- Distance Related Costs
- Fixed Costs
V. Failed Deliveries (1)

About 15% of the e-commerce deliveries are unsuccessful, mainly because the absence of the recipient the moment of the delivery.

According to recent data, in the UK failed deliveries costed more than one billions of dollars in 2014, (Deloitte, 2015).

ParcelHome last mile specialist based in the city of Mechelen, Belgium.

- Parcel box at recipients’ individual homes
- Large enough to fit around 95-98% of the products bought online and works for both delivery and collection.
- Opening mechanism uses an authentication smartphone app providing security to the owner and access history to consumers.
- Built to be weather-resistant and strong enough to deal with vandalism attacks
V. Failed Deliveries (2)

Current Demand

Failed Deliveries
V. Failed Deliveries (3)

• The impact of variations in the failed delivery rate?
  • Given a new failed deliveries rate $f'$ the new number of stops will be

\[ S' = S \frac{(1+f')}{(1+f)} \]

• Does the distance reduce? Less stops? Impacts on the density of the delivery network?
• Does the time reduce? Some observations indicate successful delivery time < failed delivery time, this is because the driver has to wait more time to confirm the “no show” of the receiver.
IV. Conclusions

• Share of cities in e-commerce? Need of a typology of “demand e-commerce areas”
• New players in the parcel delivery market specializing in urban distribution
• Last mile distribution is 64% of the internal cost.
• Externals costs from congestion can be more representative in urban distribution.
• 73% of internal costs related to time. Importance of time in external costs?
• Need of model the current traffic network to have more accurate estimations.
• Gather data with higher level of detail. Kilometers and minutes per stop
• Investigate in the distance per stop. Urban vs Rural
Thank you for your attention!

Ivan Cardenas
Ivandario.cardenasbarbosa@uantwerpen.be
+32 3 265 51 46

Dr. Wouter Dewulf
Wouter.Dewulf@uantwerpen.be
+32 3 265 49 36