Ho.Re.Ca. logistics and European Medieval Structured Cities: A search for cost generators

Thomas Verlinden, Eddy Van de Voorde & Wouter Dewulf
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1. Introduction
2. Research aim, structure and methodology
3. The developed cost function
4. Specific delivery characteristics
5. Results
6. Conclusions and further research opportunities
1. Introduction - Sector

**Ho.Re.Ca. = Hotel-Restaurant-Café/Catering**

<table>
<thead>
<tr>
<th></th>
<th>Ho.Re.Ca. owners</th>
<th>Delivering companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market structure</td>
<td>Monopolistic competition</td>
<td>Monopolistic competition and oligopoly</td>
</tr>
<tr>
<td>Demand</td>
<td>Elastic</td>
<td>Elastic</td>
</tr>
<tr>
<td>Labour characteristics</td>
<td>Intensive</td>
<td>Intensive</td>
</tr>
<tr>
<td>Operational hours</td>
<td>11 am – 2 pm and 5 pm – 2 am</td>
<td>7 am – 5 pm (Daytime)</td>
</tr>
<tr>
<td>Storage/ inventories</td>
<td>Limited</td>
<td>Relatively large</td>
</tr>
<tr>
<td>Quality regulations</td>
<td>High</td>
<td>(Very) High</td>
</tr>
</tbody>
</table>
1. Introduction – Market typology

1. Franchise

2. Local specialist

3. Supermarket with deliveries/
Goods specialist

4. Cash-and-carry

Linked types of goods:

| All product categories (e.g., cheese, fish, meat, eggs, cream) | Drinks, dry foods, accessories, additional services, laundry services, cleaning services (e.g., beer, coffee, blankets) | All product categories Except high volume drinks | All franchise specific goods |
“30-50% of deliveries towards city centres are foods”
(B@sConsultants, 2014)

“One restaurant asks on average for 25 different products”
(Verlinden, Van de Voorde & Dewulf, 2015)
1. Introduction - Medieval structured city

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4. Specific delivery characteristics

5. Results

6. Conclusions and further research opportunities
2. Research aim, structure and methodology

Aim of this presentation = Present a Ho.Re.Ca. specific cost function

- Highlight specific delivery characteristics of Ho.Re.Ca.
- Determine cost generators in the delivery process of Ho.Re.Ca.

Methodology = Literature, O-D matrices, databases of locations, interviews and questionnaires

More technical details: kindly invite you to read the paper
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3. The developed cost function

**Socioeconomic costs per route**

\[
\text{Socioeconomic costs per route} = 2 \times [d_s \cdot D_s + [n \times (u \cdot U_s)]] + [d_u \cdot D_u + [n \times (u \cdot U_u)]] + Z + 2 \times [l_{dc} \cdot L_{dc}] + r \cdot P_g \\
+ \left[ D_s \times \left( \frac{\%Mr_s}{100} \right) \times Mr_s \times MrC_s + \left( 1 - \frac{\%Mr_s}{100} \right) \times Or_s \times OrC_s \right] + [D_s \times Ap_{sd}] + [D_s \times Np_{sd}] \\
+ \left[ D_u \times \left( \frac{\%Mr_u}{100} \right) \times Mr_u \times MrC_u + \left( 1 - \frac{\%Mr_u}{100} \right) \times Or_u \times OrC_u \right] + [D_u \times Ap_{ud}] + [D_u \times Np_{ud}] \\
+ [Cq \times \#Spots]
\]
3. The developed cost function

\[ d_s \quad \text{Kilometer coefficient for suburban route} \]
\[ D_s \quad \text{Distance on suburban route in kilometer} \]
\[ n \quad \text{Number of workers} \]
\[ u \quad \text{Hour coefficient} \]
\[ U_s \quad \text{Time on suburban route in hours} \]
\[ d_u \quad \text{Kilometer coefficient for urban route} \]
\[ D_u \quad \text{Distance on urban route in kilometer} \]
\[ U_u \quad \text{Time on urban route in hours} \]
\[ Z \quad \text{Other fixed costs e.g. tolls} \]
\[ l_{dc} \quad \text{(Un)loading coefficient in distribution center} \]
\[ L_{dc} \quad \text{Hours of (Un)loading in the distribution center} \]
\[ r \quad \text{Risk coefficient} \]
\[ P_g \quad \text{Total wholesale price of the goods} \]
\[ D_u \quad \text{Distance on suburban route in kilometer} \]
\[ d_u \quad \text{Kilometer coefficient for urban route} \]
\[ \%M_{rs} \quad \text{Percentage of kilometers on suburban main roads} \]
\[ M_{rs} \quad \text{Coefficient for congestion on suburban main roads} \]
\[ M_{rsC_s} \quad \text{Capacity of the suburban main road category} \]
\[ O_{rs} \quad \text{Coefficient for congestion on suburban other roads} \]
\[ O_{rsC_s} \quad \text{Capacity of suburban other road category} \]
\[ A_{psd} \quad \text{Air pollution coefficient suburban during daytime} \]
\[ N_{psd} \quad \text{Noise pollution coefficient suburban during daytime} \]
\[ M_{ru} \quad \text{Coefficient for congestion on urban main roads} \]
\[ M_{ruC_u} \quad \text{Capacity of the urban main road category} \]
\[ O_{ru} \quad \text{Coefficient for congestion on urban other roads} \]
\[ O_{ruC_u} \quad \text{Capacity of urban other road category} \]
\[ A_{pud} \quad \text{Air pollution coefficient urban during daytime} \]
\[ N_{pud} \quad \text{Noise pollution coefficient urban during daytime} \]
\[ C_{q} \quad \text{City quality coefficient} \]
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Location

Location of demand and supply
4.1 Location - Medieval structured city

Pattern of demand for e-commerce
4.1 Location - Medieval structured city

Clustered pattern of demand for Ho.Re.Ca. products
4.1 Location - Medieval structured city

Clustered pattern of demand for Ho.Re.Ca. products
4.1 Location - Medieval structured city

Clustered pattern of demand for Ho.Re.Ca. products
4.1 Location - Medieval structured city

Marginal cost of an extra delivery is close to 0
Comparable with pickup points for e-commerce
BUT no behaviour change needed

Delivery rate per stop = \( \frac{\text{# deliveries}}{\text{# stops}} \)
Location in cost function

\[
\text{Economic costs per stop} = \frac{2 \times [d_s \cdot D_s + n \times (u \cdot U_s)] + [d_u \cdot D_u + n \times (u \cdot U_u)] + Z + 2 \times [l_{dc} \cdot L_{dc}] + r \cdot P_g}{\text{Stop}}
\]

Costs per stop give a good indication of the efficiency of the equipment or for pricing

\[
\text{Economic costs per delivery} = \frac{2 \times [d_s \cdot D_s + n \times (u \cdot U_s)] + [d_u \cdot D_u + n \times (u \cdot U_u)] + Z + 2 \times [l_{dc} \cdot L_{dc}] + r \cdot P_g}{\text{delivery}}
\]

Costs per delivery give a good indication for vehicle choice decisions or unloading equipment investments
4.1 Location - Medieval structured city

Location of suppliers of Ho.Re.Ca. products

Fresh food suppliers

Drinks
4.1 Location - Medieval structured city

Location of suppliers of Ho.Re.Ca. products

<table>
<thead>
<tr>
<th></th>
<th>Average distance</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh foods</td>
<td>6,5 km</td>
<td>2,1</td>
</tr>
<tr>
<td>Drinks</td>
<td>24,2 km</td>
<td>12,6</td>
</tr>
<tr>
<td>Dry foods</td>
<td>9,3 km</td>
<td>4,8</td>
</tr>
<tr>
<td>Special goods</td>
<td>22,5 km</td>
<td>15,2</td>
</tr>
</tbody>
</table>

Shorter lead time and B2C opportunities bring suppliers to the city.

The need for surface for daily operations pushes suppliers further away from the city.
Location in cost function

Socioeconomic costs per route

\[
= 2 \times [d_s \cdot D_s + [n \times (u \cdot U_s)]] + [d_u \cdot D_u + [n \times (u \cdot U_u)]] + Z + 2 \times [l_{dc} \cdot L_{dc}] + r \cdot Pg \\
+ \\
\left[ D_s \cdot \left( \frac{\%Mr_s}{100} \right) \cdot Mr_s \cdot MrC_s + \left( 1 - \frac{\%Mr_s}{100} \right) \cdot Or_s \cdot OrC_s \right] + [D_s \cdot Ap_{sd}] + [D_s \cdot Np_{sd}] \\
+ \left[ D_u \cdot \left( \frac{\%Mr_u}{100} \right) \cdot Mr_u \cdot MrC_u + \left( 1 - \frac{\%Mr_u}{100} \right) \cdot Or_u \cdot OrC_u \right] + [D_u \cdot Ap_{ud}] + [D_u \cdot Np_{ud}] \\
+ [Cq \times \#Spots]
\]

→ Suburban route towards the city counts double
→ Fuel consumption and the effect on congestion is lower towards the city
Products

Heterogeneous product groups and risk
4.II Ho.Re.Ca. products
4.II Ho.Re.Ca. products
4.11 Ho.Re.Ca. products
Product characteristics in the cost function

Socioeconomic costs per route

\[
= 2 \times [d_s \cdot D_s + [n \times (u \cdot U_s)]] + [d_u \cdot D_u + [n \times (u \cdot U_u)]] + Z + 2 \times [l_{dc} \cdot L_{dc}] + r \cdot P_g
\]

\[
+ \left[ D_s \cdot \left( \frac{\%M_r_s}{100} \cdot M_r_s \cdot M_r C_s + \left( 1 - \frac{\%M_r_s}{100} \right) \cdot Or_s \cdot Or C_s \right) \right] + [D_s \cdot Ap_{sd}] + [D_s \cdot Np_{sd}]
\]

\[
+ \left[ D_u \cdot \left( \frac{\%M_r_u}{100} \cdot M_r_u \cdot M_r C_u + \left( 1 - \frac{\%M_r_u}{100} \right) \cdot Or_u \cdot Or C_u \right) \right] + [D_u \cdot Ap_{ud}] + [D_u \cdot Np_{ud}]
\]

\[
+ [Cq \times \#Spots]
\]

- Depending on the type of product → risk of perishability and quality loss

  = potential cost for supplier/delivery company
4.II Ho.Re.Ca. products – Reverse flow
Product characteristics in the cost function

**Socioeconomic costs per route**
\[= 2 \times [d_s \cdot D_s + [n \times (u \cdot U_s)]] + [d_u \cdot D_u + [n \times (u \cdot U_u)]] + Z + 2 \times [l_{dc} \cdot L_{dc}] + r \cdot P_g +
\]
\[+ 
\left[ D_s \times \left( \frac{\% Mr_s}{100} \right) \times Mr_s \times MrC_s + \left( 1 - \frac{\% Mr_s}{100} \right) \times Or_s \times OrC_s \right] + [D_s \times Ap_{sd}] + [D_s \times Np_{sd}]
\]
\[+ 
\left[ D_u \times \left( \frac{\% Mr_u}{100} \right) \times Mr_u \times MrC_u + \left( 1 - \frac{\% Mr_u}{100} \right) \times Or_u \times OrC_u \right] + [D_u \times Ap_{ud}] + [D_u \times Np_{ud}]
+ [Cq \times \#Spots]
\]

- Loading and unloading process has to be done twice
  BUT positive effect on load rate
- ‘Noisy’ goods
Handling operation

Time, equipment and reverse flow
4. III Handling operation

Handling operation of e-commerce:

13m³ - 60 ft²

5'

15% not at home
=> 12'

4'
4.11 Handling operation - time

On average 8’

<table>
<thead>
<tr>
<th>Goods stream</th>
<th>Volume per delivery</th>
<th>Delivery time</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Variation</td>
<td>Average</td>
</tr>
<tr>
<td>Drinks</td>
<td>2 pallets</td>
<td>0,1</td>
<td>15’</td>
</tr>
<tr>
<td>Dry foods</td>
<td>1 pallet</td>
<td>0,5</td>
<td>5’</td>
</tr>
<tr>
<td>Fresh foods</td>
<td>0,25 pallet*</td>
<td>0</td>
<td>5’</td>
</tr>
<tr>
<td>Special goods</td>
<td>0,25 pallet*</td>
<td>0</td>
<td>5’</td>
</tr>
<tr>
<td>Accessories</td>
<td>0,25 pallet*</td>
<td>0</td>
<td>7’</td>
</tr>
<tr>
<td>Additional services</td>
<td>/</td>
<td>/</td>
<td>5’ – 45’</td>
</tr>
<tr>
<td>Hotel specific deliveries (Laundry,</td>
<td>/</td>
<td>/</td>
<td>5’ – 45’</td>
</tr>
<tr>
<td>cleaning and others)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*0,25 pallet = small package which can be carried by one person

1 Observation based on small sample of deliveries towards 7 Ho.Re.Ca. places situated in the targeted zone of figure 3.

1 During observation spoken with 22 suppliers and 7 Ho.Re.Ca. owners.
4. III Handling operation - Equipment
Handling operation in the cost function

Socioeconomic costs per route

\[
\begin{align*}
&= 2 \cdot [c_s \cdot D_s + n \cdot (u \cdot U_s)] + [c_u \cdot D_u + n \cdot (u \cdot U_u)] + Z + 2 \cdot [l_{dc} \cdot L_{dc}] + r \cdot P_g \\
&\quad + \left[ D_s \cdot \left( \frac{\%Mr_s}{100} \cdot Mr_s \cdot MrC_s + \left( 1 - \frac{\%Mr_s}{100} \right) \cdot Or_s \cdot OrC_s \right) \right] + \left[ D_u \cdot \left( \frac{\%Mr_u}{100} \cdot Mr_u \cdot MrC_u + \left( 1 - \frac{\%Mr_u}{100} \right) \cdot Or_u \cdot OrC_u \right) \right] + [Cq \cdot \#Spots]
\end{align*}
\]

- Depending on the product characteristics: driver + extra worker
- Vehicle choice: more and older trucks
Handling operation in the cost function

- ‘Noisy’ goods, equipment and vehicles
- City quality: truck before tourist attraction but also Ho.Re.Ca. as generator of congestion
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5. Results

Route for drinks with typical parameters:

<table>
<thead>
<tr>
<th>Man Truck EURO 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total distance</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Total time</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Total stops</strong></td>
</tr>
<tr>
<td><strong>Total deliveries</strong></td>
</tr>
</tbody>
</table>
## 5. Results

**Costs:**

<table>
<thead>
<tr>
<th></th>
<th>€</th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal costs</td>
<td>259,26</td>
<td>345,85</td>
</tr>
<tr>
<td>External costs</td>
<td>54,83</td>
<td>73,14</td>
</tr>
<tr>
<td>Total costs</td>
<td>314,09</td>
<td>419,00</td>
</tr>
<tr>
<td>Per stop:</td>
<td>52,33</td>
<td>69,81</td>
</tr>
<tr>
<td>Per delivery:</td>
<td>17,44</td>
<td>23,26</td>
</tr>
</tbody>
</table>
5. Results

Total costs

Internal costs

External costs

Internal costs

Labor

Vehicle choice

DC

Risk analysis

External costs

Congestion

Air Pollution

Noise Pollution

City Quality
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6. Conclusions & further research

Ho.Re.Ca. deliveries are very specific

- Location
- Product characteristics
- Handling

**Decisive cost generators:**

1. Labor
2. Specific product characteristics
3. Network configuration
4. Congestion
5. Vehicle choices
Thank you for your attention!

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