Towards Hyperconnected Distribution: the Retail Supply Chain Reengineering

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Presentation plan

- Motivations and Business case challenges
- The current distribution system of the retailer company
- Exploring several reengineering scenarios
- Optimization-based Results
- Conclusion & Future work
Motivations: Omnichannel Business & City Logistics

The Omnichannel Business seeks to provide the customers with a seamless shopping experience, allowing them to order anytime from anywhere, in person or through digital devices and be delivered at their preferred time and location.

City logistics aims to minimize the negative impact of freight-vehicle movements on city-living conditions and to reduce the number of empty vehicles getting in, through and out of the city. It also seeks to improve last-mile delivery management and pre-position deployment of goods in cities.
A Generic Vision of OmniChannel Distribution in the City

Adapted from Montreuil (2016)
The need of a Hyperconnected Distribution Strategy

- Distribution Network Design drives Revenues

\[ EVA = (1 - \text{Tax rate}) \times (\text{Revenues} - \text{Expenses}) - \left( \text{Cost of capital} \times \text{Capital employed} \right) \]
The need of a Hyperconnected Distribution Strategy

Exploiting Physical Internet and interconnection in B2C goods deployment, pickup and delivery is expected to create potential for drastic fulfillment online orders process, profitability and ecological performance improvements.

- **Distribution Web Strategy drives Revenues**
  - Mid-term Planning Horizon (1 to 2 years)
  - Design a flexible distribution schema (configuration & contracts).
  - Own/rent/share/exploit a distribution web
  - Offers are modulated by product-market (Prime response time)
  - Plan to deploy flows dynamically (a variable mission for each DC)
Overview on the current Distribution system

Service Level: Baseline responsiveness to monthly orders demand

<table>
<thead>
<tr>
<th>Duration</th>
<th>Baseline responsiveness</th>
<th>Online orders demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>In 2 hours</td>
<td>20%</td>
<td>40%</td>
</tr>
<tr>
<td>In 1 day</td>
<td>16%</td>
<td>30%</td>
</tr>
<tr>
<td>1 to 2 days</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>2 to 4 days</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Unfulfilled orders</td>
<td>44%</td>
<td></td>
</tr>
</tbody>
</table>

- 921 online orders / month
- 653 clients
- 9 stores

Flow mapping of fulfilled online orders shipped from the central warehouse

04/07/2017
Methodology

0. Baseline option facility

1. Ship from store using existing inventory
   - {Unfulfilled orders}\(^{(0)}\)
   - {Fulfilled orders}\(^{(0)}\)

2. Ship from store using existing and advanced inventory
   - {Unfulfilled orders}\(^{(1)}\)
   - {Fulfilled orders}\(^{(1)}\)

3. Hyperconnected distribution network using existing and advanced inventory
   - {Unfulfilled orders}\(^{(2)}\)
   - {Fulfilled orders}\(^{(2)}\)

<table>
<thead>
<tr>
<th>Percentage of fulfilled orders</th>
<th>Baseline</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>{Fulfilled orders}(^{(0)})</td>
<td>{Fulfilled orders}(^{(0)})</td>
<td>{Fulfilled orders}(^{(0)}) U {Fulfilled orders}(^{(1)})</td>
<td>{Fulfilled orders}(^{(0)}) U {Fulfilled orders}(^{(1)}) U {Fulfilled orders}(^{(2)})</td>
<td>{Fulfilled orders}(^{(0)}) U {Fulfilled orders}(^{(1)}) U {Fulfilled orders}(^{(2)}) U {Fulfilled orders}(^{(3)})</td>
</tr>
</tbody>
</table>
Distribution design models

Scenario 1: Ship from store using existing inventory

If the online order **could be met** from multiple stores, then it is shipped from the most convenient one.

- $o_{d,t}^{DT}$: Online order placed from point of demand $d$, at time $t$ with a required delivery time $DT$.
- $DT$: Delivery time required for the online order $o_{d,t}^{DT}$.
- $DT_{w}^{t}$: Delivery time provided by the warehouse $w$ for servicing point of demand $d$ at time $t$.
- $DT_{s}^{t}$: Delivery time provided by the store $s$ for servicing point of demand $d$ at time $t$ (Exceptions such as working time schedule (normal days of working/weekends) were considered.)
Scenario 1: Ship from Store

Flow of orders shipped directly from the warehouse

Flow of orders shipped from the store using existing inventory
Scenario 2: Ship from store using existing and advanced inventory

In addition to the first scenario option, if the online order belongs to the fast moving high-quantity and doesn’t exist in any store, then we anticipate/forecast its optimal location in stores.

- $o_{d}^{t,DT}$: Online order placed from point of demand $d$, at time $t$ with a required delivery time $DT$.
- $DT$: Delivery time required for the online order $o_{d}^{t,DT}$.
- $DT_{w}^{t}$: Delivery time provided by the warehouse $w$ for servicing point of demand $d$ at time $t$.
- $DT_{s}^{t}$: Delivery time provided by the store $s$ for servicing point of demand $d$ at time $t$ (Exceptions such as working time schedule (normal days of working/weekends) were considered.)
Scenario 2: Advanced inventory & Ship from stores

Flow of orders shipped directly from the warehouse

Flow of orders shipped from the store using existing inventory

Flow of orders shipped from the store using advanced inventory

Point of demand
3PL final hub
Store
Distribution design models

Scenario 3: Hyperconnected distribution network using existing and advanced inventory

The business imparts a part of its operations to a **fulfillment service provider (FSP)**. The FSP allows to cross-dock the business products in **open Hubs**, spread over the region and fed from the business central warehouse. The **advanced** inventory is based on **forecasted deployment** of products in all sites.

- \( o_{dt}^{t} \): Online order placed from point of demand \( d \), at time \( t \) with a required delivery time \( DT \).
- \( DT \): Delivery time required for the online order \( o_{dt}^{t} \).
- \( DT_{w}^{t} \): Delivery time provided by the warehouse \( w \) for servicing point of demand \( d \) at time \( t \).
- \( DT_{f}^{t} \): Delivery time provided when selecting the facility \( f \) for servicing point of demand \( d \) at time \( t \)

(Exceptions such as working time schedule (normal days of working/weekends) were considered.)
Scenario 3: Fulfillment centers-based distribution

Final sites for orders delivery

- $f_1$: Central warehouse (Fulfillment center) → Point of demand
- $f_2$: Central warehouse (Fulfillment center) → Open Fulfillers → Point of demand
- $f_3$: Central warehouse (Fulfillment center) → Store → Point of demand
- $f_4$: Central warehouse (Fulfillment center) → Open Fulfillers → Point of demand
- $f_5$: Central warehouse (Fulfillment center) → Store → Point of demand
Scenario 3: Fulfillment centers-based distribution

- Flow of orders shipped directly from the warehouse
- Flow of orders shipped from the store using existing inventory
- Flow of orders shipped from the fulfillment center
- Flow of orders shipped from the openly FC/fulfillers using advanced inventory
Results

Percentage of fulfilled online orders

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>56%</td>
<td>62.50%</td>
<td>78.28%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Percentage of profitability growth rate

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth Rate</td>
<td>6%</td>
<td>26%</td>
<td>54%</td>
<td></td>
</tr>
</tbody>
</table>

Percentage of CO2 emission

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission Rate</td>
<td>100.00%</td>
<td>100.00%</td>
<td>96.20%</td>
<td>95.51%</td>
</tr>
</tbody>
</table>
Results: Impact of Hyperconnected distribution on service level

Service Level: Scenario 1 responsiveness to monthly orders demand

- In 2 hours: 20% (Scenario 1), 5% (Online orders demand)
- In 1 day: 40% (Scenario 1), 18% (Online orders demand)
- 1 to 2 days: 30% (Scenario 1), 30% (Online orders demand)
- 2 to 4 days: 10% (Scenario 1), 10% (Online orders demand)
- Unfulfilled orders: 38% (Online orders demand)

Service Level: Scenario 2 responsiveness to monthly orders demand

- In 2 hours: 20% (Scenario 2), 11% (Online orders demand)
- In 1 day: 40% (Scenario 2), 28% (Online orders demand)
- 1 to 2 days: 30% (Scenario 2), 30% (Online orders demand)
- 2 to 4 days: 10% (Scenario 2), 10% (Online orders demand)
- Unfulfilled orders: 22% (Online orders demand)

Service Level: Scenario 3 responsiveness to monthly orders demand

- In 2 hours: 20% (Scenario 3), 20% (Online orders demand)
- In 1 day: 40% (Scenario 3), 40% (Online orders demand)
- 1 to 2 days: 30% (Scenario 3), 30% (Online orders demand)
- 2 to 4 days: 10% (Scenario 3), 10% (Online orders demand)
- Unfulfilled orders: 10% (Online orders demand)
The percentage of fulfilled online orders increased by 22.2% when the retailer stores were exploited; and by 44% in a hyperconnected distribution network.

The CO2 gas emission of total hyperconnected network flows decreased by 220 Kg in one month due to improvement of trucks fill rate.

- **Scenario 1**: we are exploring the idea to add pick-up and delivery lockers at stores
- **Scenario 2**: we are working on Machine Learning algorithms to improve the forecasts
- **Scenario 3**: we need to estimate the opening/warehousing cost of the fulfillment center
- A Simulation model is under development to strength the proof-of-concept
Thank you for your attention
APPENDIX
Upstream Transportation Cost Estimation

The trinomial formulation of the cost price makes it possible to calculate simply the cost of a Transport using three terms:

- **Kilometer cost term**: encompasses fuel, tires, maintenance-repairs and tolls costs
- **Hourly cost term**: includes the driver’s salary and remuneration
- **Daily cost term**: covers the total indirect structural costs, Insurance and axle tax

\[
\text{Transport operation cost} = \text{Kilometric cost} \times \text{total number of kilometers traveled for the transport operation} + \text{Hourly cost} \times \text{number of hours of service required by the operation} + \text{Daily cost} \times \text{number of days of use of the vehicle for the transport operation}
\]

\[
\text{Transport operation cost} (A \rightarrow B) = \text{Kilometric cost} \times \frac{\text{distance}(A \rightarrow B)}{\text{distance}(A \rightarrow B)} + \text{Hourly cost} \times \frac{\text{speed}}{\text{distance}(A \rightarrow B)} + \text{Daily cost} \times \frac{\text{speed} \times \text{number of working hours}}{\text{distance}(A \rightarrow B)}
\]

\[
\text{Online order transport cost} (A \rightarrow B) = \frac{\text{Transport operation cost} (A \rightarrow B)}{\text{Total freight}(A \rightarrow B)} \times \text{Online order weight}
\]
Upstream Transportation Cost Estimation

Advanced store

\[ \text{Online order transport cost } (A \rightarrow B) = \frac{\text{Transport operation cost } (A \rightarrow B)}{\text{Total freight}(A \rightarrow B) + \text{Additional weight}(A \rightarrow B)} * \text{Online order weight} \]
Upstream CO2 Emission Estimation

CO2 emission for a 3.5 tons PTAC truck

\[ y = 0.2861x^{-1} \]

Payload (%)

CO2 factor emission (kg per ton-km)

Initial filling rate

Advanced store

+ Additional weight per delivery

Online order CO2 emission = CO2 factor emission \times \text{distance} \times \text{Order weight}
Potential of a cross-company reusable modular secondary packaging system in E2E FMCG chains

Yanyan YANG, Eric BALLOT
4th IPIC 2017, Graz
1. Context

**Packaging:** technology of enclosing and protecting products for distribution, storage, sale and use.

**Logistics units (Units load):** combines primary products into single shipping “units” to facilitate transport, handling and storage that represent 12-15% of retail sales price.

- **Primary packaging (sales unit):** package to final consumers, e.g., bottles, bags etc.

**Scope of study**

- **Secondary unit load:** basic handling unit consisting a group of sales units, e.g., trays, crates, boxes etc.

- **Tertiary unit load:** combines secondary unit loads or sales units, e.g., pallets, dollies, roll cages etc.

**Fig 1. Three level of packaging**
1. Context

**Challenge ahead:** Different solutions by different actors across the chain.

**Global inefficiencies:**

1) Poor fill level of packaging units and transportation means, e.g., averagely 42.6% average utilisation of trucks and containers at departure.

2) Poor storage space utilisation.

3) Negative impacts on environmental footprint, e.g., increased waste, CO2 emission.

4) Inefficiencies in handling, e.g., re-package of products to feed into new systems.
2. Objective and methodology

**Objective**: to provide a generic modular solution across categories and supply chain levels globally.

**Method**: global assessment of implementing a small set of standardized modular boxes throughout a reduced set of typical FMCG supply chains.
3. Other projects related

Project RTI (Reusable Transport Items): to define a practice approach to establish a cross-company returnable packaging system in the retail supply.

Project Orange Box: to identify quick wins and profit return of investment of standard containers across the chain with distributors.

Project NMLU: to develop and prototype New Modular Load Units (NMLUs), especially for the use of multimodal logistic clusters.

Our initiative: To quantitatively study the major differences of using modular boxes compared to actual solutions in end-to-end FMCG chains, eventually the global benefits and frontiers of modularization in secondary packaging.
4. Example of possible scenarios - typical FMCG chains

1. Fast moving
   High volume
   - Manufacturer's warehouse (WH)
   - Pick by store
   - Direct

2. Fast moving
   High volume
   - Cross-docking
   - Pick by store

3. Fast moving
   Small volume
   - Break Bulk at DC
   - Pick by line

4. Slow moving
   Small volume
   - Stock keeping
   - Pick by line

Retailer's Distribution centre (RDC)

Hipermarket
Supermarket
Hipermarket
Supermarket
Supermarket
Corner Shop
Corner Shop
5. Assumptions and model

Assumptions

1. A set of four modular boxes by (Meller, Lin, and Ellis 2012): Sizes = 
   \{600x400x240\}, \{400x300x240\}, \{600x400x120\}, \{400x300x120\} in mm
2. Recycling or disposal of packaging material: close loop (shipment back to
   origin) and open loop (shipment to nearest consolidation centre).
3. A product could be packed in boxes of different sizes according to the
demand.
4. A modular box can contain a single type of product or different products
5. Average shipping unit height and weight will be used instead of actual loads.

....
5. Assumptions and model

Objective of calculation model: analysis of following key differences

1. Asset utilization (saturation of means)
   a) Boxes level
   b) Handling unit level
   c) Transportation means level

2. Handling productivity
   a) Loading and unloading at handling unit level
   b) Breakdown, when boxes are manipulated from one pallet to another
   c) Picking when a product is manipulated from one box to another

3. Circulation/Recycling of RICs or the support
   a) Re-utilization: close loop and open loop (wit)
   b) Disposal & supply of actual cardboard boxes

Objective for the pilots:

1. Quality: Does the switch from a dedicated cardboard to a plastic box change quality issues (contamination, break ratio, damage ratio, etc)?
2. Sustainability: product waste, means fill rate, raw material consumption, water
5. Assumptions and model – calculation model

Inputs:
- Distribution flows
- Information of products delivered (size, price, characteristics such as slow-mover or fast mover).
- Information of supports, packaging, and transportation (size, price etc).
- All cost settings: transportation cost, recycling cost, handling cost, etc.

Expected results:
1. Key differences such as asset utilization across the chain.
2. Average costs: transportation costs per item delivered, handling costs per item delivered, recycling or disposal costs, stocking cost per item delivered.
6. Conclusions and next steps – main levers

Via:
- Significantly reduced transportation costs through standardisation of boxes, e.g., open loop for recycling modular boxes vs. close loop for disposing current packaging units.
- Open loop: shipment to consolidation centre via standardisation.

Key Drivers

- High handling productivity
- High space utilisation
- High fill rates of transportation
- High Box fill rates
- High storage space utilisation

Via:
- Less non-value adding handling operations, e.g., pallets breakdowns, repackaging.
- Automation handling system through standardisation.
- Adapted quantity directly to shelves.
- Avoid extra manipulation

Via:
- Reduced lead times, especially for slow moving products and small quantities.
- Improved shelf availability

Via:
- Significantly reduced transportation costs through standardisation of boxes, e.g., open loop for recycling modular boxes vs. close loop for disposing current packaging units.
- Open loop: shipment to consolidation centre via standardisation.

Via:
- Reduced damage through automatic handling.

Via:
- Less void of space utilisation through modularity
- Stackability of modular boxes
- Capability of containing different products in the same box.
6. Conclusions and next steps

Qualitative analysis of potential benefits:

- **Volume of flows**
  - **Small quantity**
  - **Big quantity**

- **Benefits increase**
  - **Fast-mover**
  - **Slow-mover**

Product characteristic in sales (frequency of flows)
6. Conclusions and next steps

What is done:
✓ A calculation model developed in the Excel and need to be further applied in France or European horizon.
✓ Qualitative analysis is taken out to study the potential drivers of modular boxes.

Next steps:
✓ Encourage more partners to join to have a vision of the whole chain.
✓ Case studies of different categories of product from different industrial partners as to demonstrate the qualitative results.