Conceptualising Inventory Pre-positioning in the Humanitarian Sector:
Improving the effectiveness and efficiency in the relief network

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Joint work: Sander de Leeuw & Iris F. A. Vis
Aim

Present:

* definition & description of Inventory pre-positioning (IPP)

* the factors affecting IPP decision making
Outline

• Introduction

• What is in the Literature

• Part 1
  – Describe and Define IPP
  – Decisions relevant to IPP
  – Factors affecting these decisions

• Part 2:
  – The Impact of Collaboration on IPP
  – Demand Analysis

• Conclusion & Further Research
Context of Disasters

Earthquake

Floods

Tropical storms & Hurricanes
## 2010, hit hard by natural disasters

<table>
<thead>
<tr>
<th></th>
<th>Haiti Earthquake</th>
<th>Pakistan Floods</th>
<th>China Floods, drought, dust storm, ice storms, landslides, earthquake</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of people killed</strong></td>
<td>200,000+</td>
<td>2,000+</td>
<td>3514</td>
</tr>
<tr>
<td><strong>No. of people affected</strong></td>
<td>3,000,000</td>
<td>21,000,000</td>
<td>45,000 (evacuated) 486 (unaccounted)</td>
</tr>
<tr>
<td><strong>Estimated damage</strong></td>
<td>US$8–14 billion</td>
<td>20% land under water</td>
<td>US$31.19 billion (economic loss)</td>
</tr>
</tbody>
</table>
The Challenge!

How to effectively supply those affected by natural disasters?

How to increase the efficiency of the relief chain?

One way: Through the design of the relief supply chain and the pre-positioning of inventory!
## The Impact of IPP: The IFRC

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to activate the supply chain</td>
<td>18</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Partial relief packages to families by 2 months</td>
<td>28,021</td>
<td>29,229</td>
<td>53,112</td>
</tr>
<tr>
<td>Av. no. families served per day</td>
<td>445</td>
<td>555</td>
<td>613</td>
</tr>
<tr>
<td>% goods delivered from region</td>
<td>13</td>
<td>68</td>
<td>100</td>
</tr>
<tr>
<td>Costs to deliver relief packages per family at 2 months (US)</td>
<td>Not available</td>
<td>860</td>
<td>148</td>
</tr>
</tbody>
</table>

(Gatignon et al 2010, IFRC 2010,)
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The Literature shows....

• IPP not clearly defined
  – Storage at/ near disaster for seamless delivery of critical goods (Ukkisuri & Yushimito 2008)
  – Facility location and inventory policy decisions (Balcik & Beamon 2008)
  – Facility location, inventory management, network flows (Duran et al 2007)

• Emphasis on quantitative factors
  – Budgetary constraints (Balcik & Beamon 2008)
  – Response time (Duran et al 2007)

• Minimal inclusion of qualitative factors
  – Customs clearance, level of unrest, infrastructural damage, socio-political factors (Chopra & Meindl 2007, Duran et al 2007)
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Step 1: IPP Described and Defined

The strategic positioning of inventory integration of facility location, inventory management & transportation decisions, key factors affecting it
Step 2: IPP Decisions

**Facility Location Decisions**
- Number of facilities
- Facility points
- Capacity of facility
- Allocation

**Inventory Management Decisions**
- Inventory Types
- Inventory Policy
- Target inventory levels, order quantities, replenishment policy

**Transportation Decisions**
- The number of vehicles
- Vehicle routing and scheduling
- Transportation mode
- Resource positioning
## Step 3: Crucial Decisions

<table>
<thead>
<tr>
<th>Factors</th>
<th>Where?</th>
<th>Whom?</th>
<th>What?</th>
<th>How much?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Demand forecasting</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Political enviro (safety)</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logistics &amp; facility costs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Financial resources</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macro–ec factors</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product characteristics</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
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Collaboration and IPP

- Reduced facility & location costs
- Personnel resource capability
- Reduced need for financial resources
## Benefits to Collaboration

<table>
<thead>
<tr>
<th>Opportunities to collaboration</th>
<th>Facility &amp; Logistics costs</th>
<th>Need for financial resources</th>
<th>Infrastructure (obtain skilled personnel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility location</td>
<td>Shared facilities improves inventory turnover</td>
<td></td>
<td>Provide storage, handling and other functions</td>
</tr>
<tr>
<td>Inventory Management</td>
<td>Improves inventory turnover</td>
<td>Less resources needed</td>
<td>Inventory management decisions and inventory</td>
</tr>
<tr>
<td>Transport'ion</td>
<td>Reduced cost: Close to disaster area coordinated shipments (air crafts, trucks)</td>
<td>Less need due to reduced freight costs</td>
<td>–Management of transportation systems –Time savings in handling customs clearance</td>
</tr>
<tr>
<td>Procurement</td>
<td>Reduced costs: –Joint procurement procedures –Procure jointly, increase bargaining power &amp; purchase larger quantities at lower prices</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Compiled from Duran et al 2007, Balcik and Beamon 2008, Balcik et al 2010)
Understanding demand, Asia hit hardest of all regions (2005-2009)

The percentage (%) shows the number of people affected 87% of people affected by natural disasters in the world are in Asia

Source: Richardson et al (2010), Facility location project
Floods have biggest impact of all disasters (2005 – 2009), mil. people

<table>
<thead>
<tr>
<th>Disaster Type</th>
<th>Cumulative no. of people affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floods</td>
<td>386</td>
</tr>
<tr>
<td>Storm</td>
<td>206</td>
</tr>
<tr>
<td>Drought</td>
<td>91</td>
</tr>
<tr>
<td>Extreme temperature</td>
<td>80</td>
</tr>
<tr>
<td>Earthquake</td>
<td>60</td>
</tr>
<tr>
<td>Epidemic</td>
<td>2</td>
</tr>
<tr>
<td>Wildfire</td>
<td>1.2</td>
</tr>
<tr>
<td>Volcano</td>
<td>0.95</td>
</tr>
<tr>
<td>Insect infestation</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*Source: Richardson et al (2010), Facility location project*
June & July are the critical months

- Large number of people affected between May and November, but the peaks are in June and July.
- The large figure in January due to extreme temperature in China in 2008 where 77 million people were recorded as being affected.


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• Conclusion
  1. Described & defined IPP
  2. Factors affecting IPP & Conceptual framework of IPP

• What next.....
  1. Empirical validation of IPP & important decisions for IPP
  2. Investigation of relationships amongst decisions, factors & decisions
  3. Development of the framework to assist with IPP decision making
  4. Development of solution approaches for IPP that consider factors
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