HUMANITARIAN SUPPLY CHAIN CHALLENGES: FROM EFFECTIVE TO SUSTAINABLE OPERATIONS

Bogotà, 3rd of August 2018
Prof. Matthieu Lauras
matthieu.lauras@mines-albi.fr
AGENDA

1. HUMANITARIAN SUPPLY CHAIN RESEARCH FEATURES

2. IMPROVING HSC EFFECTIVENESS

3. ENHANCING HSC EFFICIENCY

4. MOVING TO HSC SUSTAINABILITY

5. CONCLUDING REMARKS
HUMANITARIAN SUPPLY CHAIN RESEARCH FEATURES
Humanitarian Supply Chains is still a recent research area

Humanitarians could benefit a lot from the use of decision-support systems to design and control a highly capable Supply Chain

But a gap exists between the research work proposals and their applications on the field.
RESEARCH CONTEXT EVOLUTION

The HSC objectives are changing

The HSC has an intangible objective…

“Alleviating human suffering”

[Beamon and Balcik, 2008]

Near future

Sustainable

[Haavisto and Kóvacs, 2014]
[Haavisto and Kóvacs, 2014]

Since 2000’

Effective + Efficient

[Charles et al., 2010]

End of XXth cent.

Effectiveness as main driver

[Wassenhove, 2006]

Requirements, funding and unmet requirements

[Global Humanitarian Assistance report, 2016]
RESEARCH APPROACH: CROSS-LEARNING AND INDUCTIVE METHODOLOGY

Commercial SC

Humanitarian SC

Practitioner expectations

Identify & implement existing solutions

Identify Research problem

Suggest solution

Data gathering

Test/discussion

Artifact development

Conclusions

Adapted from
[Järvinen, 2007]
[Peffers et al., 2008]
EFFECTIVENESS CHALLENGES
Doing the right things… … quickly!

But in a disrupted world!
RESILIENT = Robustness + Recovery capabilities
Robustness: Able to avoid strong impacts on the system in case of disruption
Recovery: Able to allow getting back to an acceptable situation after a disruption

AGILE = Detection + Adaptation capabilities
Detection: Able to notice something wrong in the system comparing to expected situation
Adaptation: Able to modify the ongoing processes to solve the unexpected situation

FLEXIBILITY as pre-requisite!
AGILITY AND FLEXIBILITY ASSESSMENT MODELS

[Charles et al., 2010]

[Baharmand et al., 2017]
Optimize location on a local level

Choice of the weights of each environmental parameter

Location of warehouses (local level)

Environmental parameters:
- Security
- Accessibility
- Telecommunication
- Corruption

Environment uncertainty

TOWARD EFFECTIVE NETWORKS
HSC design is done by studying:

The potential disasters,
Their consequences,
The existing infrastructures and available resources.

But when the disaster occurs, some hazards can impact strongly the network by destroying some resources or collapsing infrastructures.

The performance of the relief network could be strongly decreased.

[Vargas et al., 2015]
APPLICATION TO PERUVIAN RECURENT DISASTERS

[Vargas et al., 2015]
PERUVIAN CASE: NUMBER OF UNMET DEMAND VS NUMBER OF WAREHOUSES / INVENTORIES
EFFICIENCY… WHAT DOES IT MEAN FOR HSC?

Doing the things right… … cost-effectively!

But again in a disrupted world!
Minimize costs on a regional level

Choice of the « cost » of stockout

Choice of the size of the warehouse and its contingency stock

Supply uncertainty

Actual and potential location of suppliers (per product and region)

Scenarios of demand

Minimize costs on a regional level

- Costs
  - Purchase costs, fixed and variable costs (warehouse)
  - Delivery costs upstream/downstream by plane and boat

- Delays
  - Delivery time upstream/downstream by plane and boat

Location, number and size of warehouses (regional level)

EFFECTIVE AND EFFICIENT NETWORK DESIGN: THE UPSTREAM PART

[Charles et al., 2016]
EXPLANATION OF THE OBJECTIVE FUNCTION

Objective Function

\[
\begin{align*}
\text{Min} & \quad \left( \sum_{p} \sum_{s} \sum_{w} (DCPU_{psw} \times \sum_{t} QPU_{pswt}) \right) + \left( \sum_{p} \sum_{w} \sum_{c} (DCPD_{pwct} \times \sum_{t} QPD_{pwct}) \right) \\
& + \left( \sum_{p} \sum_{s} \sum_{w} (DCBU_{psw} \times \sum_{t} QBU_{pswt}) \right) + \left( \sum_{p} \sum_{w} \sum_{c} (DCBD_{pwct} \times \sum_{t} QBD_{pwct}) \right) \\
& + \sum_{w} (CostF_{w} \times WCh_{w}) \\
& + \sum_{t} \sum_{w} CostV_{w} \times \left( \sum_{p} \sum_{s} (QPU_{pswt} + QBU_{pswt}) + \sum_{p} \sum_{c} (QPD_{pwct} + QBD_{pwct}) \right) \\
& + \sum_{p} \sum_{w} \sum_{c} \sum_{t} (Stockout_{pct} \times dim_{p} \times S)
\end{align*}
\] (1)

1. Transportation costs by air
2. Transportation costs by boat
3. Fixed costs of maintaining a functioning warehouse
4. Variable costs incurred in running the warehouse
5. Penalty cost incurred if products are not delivered on time

[Charles et al., 2016]
ICRC
International committee of the Red Cross
IFRC
International Federation of the Red Cross and Red Crescent Societies
NS
Red Cross and Red Crescent National Societies (186 countries)

[Charles et al., 2016]
# OPTIMIZING IFRC HSC NETWORK

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<thead>
<tr>
<th></th>
<th>IFRC network</th>
<th>Modification of IFRC network</th>
<th>New network</th>
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<tr>
<td></td>
<td>No change</td>
<td>Bigger stocks</td>
<td>Local supply</td>
</tr>
<tr>
<td>Western Asia</td>
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<td>X</td>
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</tr>
<tr>
<td>Central America</td>
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</tr>
<tr>
<td>South-Eastern Asia</td>
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<tr>
<td>South Central Asia</td>
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<tr>
<td>Eastern Africa</td>
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**Carribean**

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<th></th>
<th>No change</th>
<th>Bigger stocks</th>
<th>Local supply</th>
<th>Plus 1W</th>
<th>Minus 1W</th>
<th>Plus 2Ws</th>
<th>Plus 3Ws</th>
<th>Relocate Ws</th>
<th>Relocate + loc S</th>
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<tbody>
<tr>
<td>Number of warehouses</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Possible savings (real costs)</td>
<td>0%</td>
<td>0.9%</td>
<td>9.7%</td>
<td>5.3%</td>
<td>3.5%</td>
<td>6.2%</td>
<td>6.2%</td>
<td>8.7%</td>
<td>10.6%</td>
</tr>
<tr>
<td>Percentage of scenarios with stock-outs</td>
<td>3%</td>
<td>0.5%</td>
<td>0%</td>
<td>3%</td>
<td>9%</td>
<td>2%</td>
<td>1%</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>Total stock-out (nb products late x nb days waiting)</td>
<td>878,605</td>
<td>56,808</td>
<td>0</td>
<td>168,916</td>
<td>2,319,460</td>
<td>88,926</td>
<td>56,808</td>
<td>358,620</td>
<td>98,421</td>
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<tr>
<td>Possible savings (incl. Stockout costs)</td>
<td>0%</td>
<td>7.6%</td>
<td>16.25%</td>
<td>10.75%</td>
<td>-8.55%</td>
<td>12.2%</td>
<td>12.5%</td>
<td>12.3%</td>
<td>16.3%</td>
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</tbody>
</table>

[Charles et al., 2016]
SUMMARY OF RESULTS FOR IFRC NETWORK

- **Warehouses used the most often**
- **Additional warehouses in case of possibility to have local agreements or supply**
EFFECTIVE NETWORK DESIGN: LOCATING TEMPORARY STAGING AREAS (SAS) 

To design an HSC

Phase 0 Preparedness

Phase 1 Immediate response

Phase 2 Relief

Phase 3 Early recovery

Sudden onset natural disaster

Locate SAs

Revise locations

Several months 72h to 6 weeks 3 months to 1 year Several weeks

Time

Criteria

Response time

Logistics costs

Demand coverage

Response time

Logistics costs

[Baharmand et al., 2017]
SUSTAINABILITY CHALLENGES
Meeting current needs… … without compromising future!

But again and again, in a disrupted world!
High level concepts vs. Plenty of indicators

Triple Bottom Line (TBL) dimensions consideration

[Ahi and Searcy, 2015]

[Bauman, 2014]
THE HOUSE OF SUSTAINABLE HSC OPERATIONS

[LAGUNA SALVADO ET AL., 2017]
THE HOUSE OF SUSTAINABLE HSC OPERATIONS

Sustainable HSC Operations

HSC business processes

HSC business processes

HSC business processes

HSC business processes

Sustainable HSC Operations

THE HOUSE OF SUSTAINABLE HSC OPERATIONS

03/08/2018

CIIO CONFERENCE - MATTHIEU LAURAS
THE SUSTAINABLE HSC MATURITY MODEL

L4 – Expert
L3 – Good
L2 – Medium
L1 – Beginner
L0 – Unaware

[Laguna Salvadó et al., 2018]
Effectiveness

SOCIAL

ECONOMICAL

ENVIRONMENTAL

Labor conditions

Local community development

Resource conservation

HSC processes
How to support decision-makers consciously and systematically making sustainability trade-offs and exploring consequences?
TOWARD A SUSTAINABLE HSC MASTER PLANNING

MULTI CRITERIA DECISION-MAKING

∀ Flow & Week

Effectiveness objective

\[ \max \sum \left( \text{Demand Value} - \text{Delay penalties Value} \right) \]

Economic objective

\[ \min \sum \left( \text{Acquisition + Transportation costs} \right) \]

Social objective

\[ \max \sum \text{Local procurement Value} \]

Environmental objective

\[ \min \sum \text{Carbon Emissions} \]
Lexicographic Ordering (LO)

The Decision-Maker provides the sustainable performance criteria priority

→ Effectiveness has the absolute priority

Sequential Optimization + Constraint

→ The Decision-Maker can introduce a tolerance within each couple of criteria

Criteria
Lexicographic Order
i.e.
LO1: Economic
LO2: Social
LO3: Environmental
Criteria order:
(1) Economy
(2) Social
(3) Environment

Effectiveness Optimal = 27.5 CHF Millions

+ EFF Constraint: Effectiveness optimal + 2%

DECISION MAKER

MAKE A PLAN

Order of criteria

Effectiveness Optimal

Tolerance impact analysis

Value of the tolerance

DECISION SUPPORT SYSTEM

(1) Economy optimal vs.
(0) Effectiveness tolerance
Criteria order:
(1) Economy
(2) Social
(3) Environment

+ EFF Constraint: Effectiveness optimal + 2%
+ ECO Constraint: Economy optimal + 1%
Criteria order:
(1) Economy
(2) Social
(3) Environment

+ **EFF Constraint**: Effectiveness optimal + 2%
+ **ECO Constraint**: Economy optimal + 1%
+ **SOC Constraint**: Social optimal + 1%
<table>
<thead>
<tr>
<th>Indicator</th>
<th>Effectiveness</th>
<th>Economic</th>
<th>Social</th>
<th>Environmental</th>
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<tr>
<td>Value 0% Tolerance</td>
<td>27.9 CHF Millions</td>
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<td>1%</td>
<td>1%</td>
<td>/</td>
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<td>Value</td>
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<td>9.9 CHF Millions</td>
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### WEEKLY PLAN

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<th>Mode</th>
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<th>3</th>
<th>4</th>
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</table>
CONCLUDING REMARKS
Up to 2004, HSC were centralized

**Objectives:** effectiveness and easy coordination

Since 2004, HSC are regionalized

**Objectives:** faster, better, cheaper (effective and efficient)

Today is the beginning of sub-regionalization era

**Objectives:** sustainability
THE FUTURE: GOING DIRECTLY TO HYPERCONNECTED HSC MATURITY LEVEL

**Atomistic:** fragmented network and managed through solo operations.

- Long leadtime, big lots, large inventory...

**Integrated:** network as an end-to-end channel, in which production and distribution plants are centralized and dedicated.

- High level of assets, short leadtimes, Lean Management...

**Collaborative:** network as a whole in which partners are able to share data and activities in peer-to-peer relationships.

- Long to deal, tough to adapt and hard to scale...

**Hyperconnected:** network is based on open-hubs and cooperative platforms for both data and material flows.

- Flexible, real time oriented, sustainable...
THANK YOU… QUESTIONS…

matthieu.lauras@mines-albi.fr