Logistics Innovations and Freight Modeling: A Future-Oriented Research Agenda

FMRI Webinar
ITE FAU Student Chapter Lecture Series
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Delft University of Technology
Ambition

- Envision logistics system in 2040
- Understand key changes in mechanisms
- Which aspects of freight modeling are essential?
Innovation in F&L topics

Many many changes...

Overarching vision?

a. Cyber-physical systems
b. Industry 4.0
c. Physical Internet
d. all of the above
Each product its own supply chain

- **BTS**: built to stock
- **BTO**: built to order
- **FOP**: flexible order production
- **RFD**: rapid fulfillment depot
- **EDC**: European distribution center

**Long lead time** (days-weeks)
- **BTO**, **EDC**

**Short lead time (<1 day)**
- **BTS**, **FOP**, **RFD**

*After Vermunt, 2000*
Each customer their own delivery option

Q: how long can retailers afford this luxurious service?
Societal megatrends:
• Servitization of economy
• Individualized society

Customized product and service offerings

Increase of costs for production and delivery

Co-procurement
Cross-chain coordination

Receiver-led consolidation
Crowdshipping
 Freight markets
LSP Mergers & acquisitions
Rail transport
Carrier collaboration

now
upcoming

Co-procurement
Cross-chain coordination

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Search for scale externally: compete in front office, cooperate in back-office

Cannot balance internally. Pressure to reduce costs remains

Balance within company via revenue management, cost cutting and/or cross-subsidization

“Physical Internet” vision

"island of loss in a sea of profit"

Ton van der Veen, Jumbo CFO on e-delivery
The “Physical internet” (PI)
PI: Continuous **system-level** optimization

Improved coordination creates new business value*:

- Visibility: dynamic planning and decision postponement
- Next wave standardization: modular units, digitalization
- Asset sharing through collaboration

* WEF projection 2016-2025: + 3.5 trillion USD

Graphics from Prof. Benoit Montreuil, Georgia Tech
Activate and exploit an Open Global Distribution Web

Most companies design, run and optimize independently their private distribution networks, investing in DCs or engaging in long-term leases or contracts.

There are 535,000 distribution centers in the U.S.A. only.

Most of them are used by a single company. Most companies use only a single DC and generally less than 20 DCs.

Imagine the potential if each company could deploy its products through an open web including 535,000 open DCs in the USA.

Monteuri and Sohrabi, From Private Supply Networks to Open Supply Webs, IERC 2010

Physical Internet Manifesto, Version 1.11.1
Professor Benoit Monteuri, CIRRELT, Universite Laval
Quebec, 2012-11-28, 55/76
Open Supply Web

Supply network 1 + Supply network 2 = Open supply web exploited by 1 and 2

First signs: platform economy
Logistics Service Providers (LSP) roadmap: from intranets to internet

LSP #1 (example DHL)
- air
- road

LSP #2 (example: DBSchenker)
- road
- rail

shippers

receivers

2

3

12
Capacity of maritime alliances (mTEU)
China’s State Planner Imposed Regulatory Rules On Online Food Ordering Platform

February 18, 2022, China’s National Development and Reform Commission (NDRC), issued a set of rules to help struggling restaurants to recover from the pandemic. The online food delivery platforms have been hammered and over-reacted in response to lower service fees of restaurants.
Questions

• Is the PI feasible?

• Will the PI solve our sustainability challenge?

• Who has to do what, when – how to coordinate?

• Isn’t this just all too megalomaniac??
A contrasting view – the artist’s

“If at first the idea is not absurd, then there is no hope for it.”
Albert Einstein

Inari, artist

http://irational.org/inari/
Installation 1: Moving a potato mountain (350kg) by Deliveroo
Installation 2: the contingent cycle courier (grid-based P2P delivery relay network)
Installation 3: the single container ship (ridiculing scale in container liner shipping)
Installation 4: the human dimension of a container (ridiculing scale pt 2)
Innovation- how to

(from big bangs to living labs)
Easy context
Naïve

“Man on the moon”
Big bucks & full control

Agile & Scrum / Minimum Viable Product
Incremental, consensus based

Fig source: A. Wetters (Kimitisik)
Roadmap for PI (ALICE/ EU SENSE project)
Challenges for modelling towards 2040

1. The model user?

2. The system to model?

3. System’s relevant behaviour?
1. The model user of tomorrow

Predict-and-provide --
Experimentation in living labs ++
Decision cycle times --
Trust in data ++
Trust in theory --
2. What system to model?

Responsibilities outside transportation (e.g. sustainability)

Lasting dependence on major transitions (e.g. energy, ICT)

Disruptions
- Natural disasters
- Pandemics
- War
3. System’s relevant behaviour

• Capturing more, relevant decisions
  ➔ Collaboration, carrier choices, inventory trade-offs

• Decision making under complexity and uncertainty
  ➔ Gaming and game theory

• Dynamics
  ➔ Supply chain dynamics AD2022, long term decision making (decarbonization pathways)
Which logistics decisions are relevant for transportation?

<table>
<thead>
<tr>
<th>Logistics Decision</th>
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<tbody>
<tr>
<td>Transportation</td>
</tr>
<tr>
<td>23. Transportation modes</td>
</tr>
<tr>
<td>24. Types of carriers</td>
</tr>
<tr>
<td>25. Carriers</td>
</tr>
<tr>
<td>26. Degree of consolidation</td>
</tr>
<tr>
<td>27. Transportation fleet mix</td>
</tr>
<tr>
<td>28. Assignment of customers to vehicles</td>
</tr>
<tr>
<td>29. Vehicle routing and scheduling</td>
</tr>
<tr>
<td>30. Vehicle load plans</td>
</tr>
</tbody>
</table>

**Strategic Planning Level**
- 1. Definition of customer service
- 2. Customer service objectives
- 3. Degree of vertical integration and outsourcing

**Physical Facility (PF) Network**
- 4. PF network strategy
- 5. PF network design

**Communication and Information (C&I) Network**
- 6. C&I network strategy
- 7. C&I network design

**Demand Forecasting**
- 8. Forecasts of demand magnitude, timing, and locations
- 9. Inventory management strategy
- 10. Relative importance of inventory
- 11. Control methods
- 12. Desired inventory level
- 13. Safety stock

**Production**
- 14. Product routing
- 15. Facilities layout
- 16. Master production schedule
- 17. Production scheduling

**Procurement and Supply Management**
- 18. Procurement type
- 19. Specifications of goods procured
- 20. Suppliers
- 21. Order intervals and quantities
- 22. Quality control

**Material Handling**
- 36. Unit loads
- 37. Types of material handling equipment
- 38. Material handling fleet mix
- 39. Material handling fleet control

**Warehousing**
- 40. Warehousing mission and functions
- 41. Warehouse layout
- 42. Stock location
- 43. Receiving/shipping dock design
- 44. Safety systems

**Order Processing**
- 45. Order entry procedures
- 46. Order transmission means
- 47. Order picking procedures
- 48. Order follow-up procedures

Riopel & Langevin 2005
Recent examples of PI-inspired modelling work

• Dynamic synchronomodal freight networks
• Demand side and supply side of hyperconnected networks
• Preference-driven optimization
• Economic of collaborative networks
Synchronized intermodality (Synchromodality)

Intermodaal
Van A naar B met de binnenvaart of trein en van B naar C - "the last mile" - per truck.

Co-modaal
De verlader kan in A kiezen uit binnenvaart, spoor, feeder en weg.

Synchromodaal
Maximaal flexibel en duurzaam systeem: in A een keuzeoptie uit verschillende modaliteiten, maar ook in B en in C bij retourvracht.

“You’ve got freight!” shipment synchronization game

Recent PhD research on synchromodality
What shippers want

- **36%** high service-level seekers
- **32%** cost-sensitive risk-taking shippers
- **18%** transportation technology hunters
- **14%** cost-sensitive risk-averse shippers

2/3 prone to a-modal booking, with right incentives!

Share of cost and service focused shippers about 50/50!

What carriers want

EXPLORING THE MARKET POTENTIAL OF BICYCLE CROWDSHIPPING: A BI-LEVEL ACCEPTANCE PERSPECTIVE

Satrio Wicaksono
MSc Transport, Infrastructure and Logistics

Demand side (shippers)

Supply side (“bringers”)

Table 11: Willingness to pay (WTP) for each service attributes.

<table>
<thead>
<tr>
<th>Willingness to pay for:</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased Delivery Speed (Crowdshipping)</td>
<td>0.25</td>
<td>Euro/hr</td>
</tr>
<tr>
<td>Adjustable Delivery Time Window</td>
<td>6.00</td>
<td>Euro/day</td>
</tr>
<tr>
<td>CO2 emission reduction</td>
<td>2.29</td>
<td>Euro/kg</td>
</tr>
<tr>
<td>Performance rating improvement</td>
<td>1.00</td>
<td>Euro/kg</td>
</tr>
<tr>
<td>Increased Delivery Speed (Traditional Shipping)</td>
<td>0.07</td>
<td>Euro/hr</td>
</tr>
<tr>
<td>Unitary pay</td>
<td>1.68</td>
<td>Euro/day</td>
</tr>
</tbody>
</table>

Table 14: Willingness to work (WTPW) for each service attributes.

<table>
<thead>
<tr>
<th>Willingness to work for:</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional travel time</td>
<td>0.39</td>
<td>Euro/min</td>
</tr>
<tr>
<td>Package weight</td>
<td>23.76</td>
<td>Euro/kg</td>
</tr>
</tbody>
</table>

Preference-based network optimization
Collaborative approach to supply chain optimization

A dynamic hypernetwork model of combined supply chain choices: Supplier selection, Pricing, Shipment size, Inventory location, Transport mode, Transport route, Collaboration, Dynamics......
In short,

• R&D in freight modelling needs anticipation to tackle societal challenges

• How:
  • Shared vision on future logistics
  • Aligns R&D
  • shapes needs for freight modelling

• Big issues:
  • Model user of tomorrow
  • We have to model different systems
  • The system’s relevant behavior is different